COMPUTERIZED PREVENTIVE-MAINTENANCE PROGRAM FOR EBR-II
REACTOR-ASSOCIATED MECHANICAL AND POWER-ELECTRICAL COMPONENTS

by

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ABSTRACT

This report describes the computer program that has been set up to assist in meeting the preventive-maintenance requirements of the EBR-II reactor-associated mechanical and power-electrical components. The program can provide several types of listings, including all equipment covered by the program, all equipment due for maintenance, and all equipment due for maintenance under specified plant conditions. This report also describes some other areas of the preventive-maintenance program that are not computerized. Possibilities for expansion of the computer program are briefly indicated.

I. INTRODUCTION

There are approximately 2500 items of mechanical and power-electrical equipment (located in the reactor building, the power plant building, the sodium boiler building, and the cooling-tower area) that require periodic preventive maintenance to satisfy the established requirements for the EBR-II facility. Each piece of equipment must be regularly scheduled for maintenance and a history of its maintenance maintained; also, a periodic listing must be prepared that shows the maintenance status of each piece of equipment. Reactor operating conditions complicate the scheduling of preventive maintenance from the standpoint that much of the equipment can only be worked on when the reactor is shut down. Some items can be worked on only when the reactor is running; others can be worked on only when fuel handling is in progress; and some can be worked on at almost any time as long as backup equipment is available to perform the function. Because of the number of variables and the limited number of personnel for document handling, manual control of the preventive-maintenance program is very difficult.

Because of the above-mentioned information, it was recognized that a computerized program was needed. An IBM/360 computer was available, and a program was written to make use of it. The program follows the format of the EBR-II Instrument and Control Section program as nearly as possible, so that all reactor-associated components will come under the same type of system. The next section describes the basic elements of the computerized program as presently set up.

II. COMPUTER PROGRAM

The primary functions of the computer program are as follows:

- (1) To provide a permanent record to properly identify each item of equipment in the program.
- (2) To provide for scheduling of preventive maintenance and/or the replacement of each item of equipment.
- (3) To provide for updating the maintenance data, for expanding the program for additional items of equipment, and for deleting equipment items no longer required.
- (4) To provide information for evaluating equipment performance.
- (5) To provide various types of computer-printout information sheets for installed in-plant equipment.

The elements of the computer program required to provide the listed functions are as follows:

A. The Master Card

A master card is required for each piece of equipment or maintenance unit* in the program. Each card has an individual number and carries the following information on each piece of equipment:

- (1) The number of the maintenance requirement card (see Section VI.A).
- (2) The equipment numbering system originally set up by the architect-engineer and updated by the EBR-II Operating Instructions, Revision Bulletin No. 155, dated Feb. 5, 1972 (where available).
- (3) An abbreviated description or function of the piece of equipment or maintenance unit.

*A maintenance unit is any unit that is grouped together for the purpose of performing maintenance: e.g., a motor-generator set, a pump and motor, or the piping and valves of a system.

- (4) Manufacturer's name.
- (5) The equipment model number (where one exists).
- (6) The equipment serial number (where one exists).
- (7) The condition the plant must be in prior to performance of preventive maintenance on the equipment.
- (8) Preventive-maintenance priority.
- (9) The desired period(s) between scheduled preventive maintenance.
- (10) Any specified date for maintenance (if applicable).
- (11) Estimated time required to perform the maintenance, in hours and tenths of hours.
- (12) The month and year of last maintenance.
- (13) The number of times the item of equipment or maintenance unit has had unscheduled nonroutine maintenance since replacement or overhaul.
- (14) The date the equipment item had to be replaced (if ever).
- (15) Date by month and year of last complete overhaul (if ever).

B. The Maintenance-data Update Card

The maintenance-date update card (see Fig. 1) is used to update the master-card file. After information is received on the services performed, a maintenance data update card is punched to reflect the following information:

- (1) The master-card number, which is required for the computer to identify the item of equipment.
- (2) The date the maintenance was performed.
- (3) The number of times nonroutine maintenance was performed since replacement (if ever); this number must be "00" if no nonroutine maintenance was performed.
- (4) The date the item of equipment was replaced (if ever) by month and year; this number must be "0000" if the equipment has never been replaced.
- (5) The date, by month and year, of last overhaul (if ever); this number must be "0000" if never overhauled.
- (6) The approximate number of hours required for maintenance.

C. Function Card

The function card (see Fig. 2) is used to provide instructions to the computer as to the desired output. The card contains:

Function. Code		Plant Condition		Priority	Current Date (Month and Year)				
1	2	3	4	5	6	7	8	9	

Fig. 2. Function Card

- (1) A number that determines the computer output (see Section E below).
- (2) A number for certain plant conditions (if applicable); this number must be "00" if not used.
- (3) A number for future use to specify system priority.
- (4) The current date, by month and year.

D. Computer Input

The input data can consist of master cards or master-card information as stored on discs, the maintenance information as stored on punched cards, or additions or deletions to the master-card file as stored on punched cards. The master-card information will always be part of the computer input, and depending on the desired output, the maintenance, additions, or deletions information may also be used.

E. Computer Output

The output of the computer program is controlled by the code numbers shown in the first two columns of the function card. Any one or all of the function-card codes can be used for the computer output required. The following are the outputs according to the function codes:

(1) Function Code 01

The computer will update the master-card disc file and will list, on the printer, all equipment due for maintenance. All overdue and special-maintenance items will be identified on the listing. The required input is the master-card disc file and the maintenance-data update cards.

(2) Function Code 02

The computer will list, on the printer, all items with the plant-condition code specified in columns 3 and 4 of the function card. The required input is the master-card disc file.

(3) Function Code 03

The computer will list, on the printer, all equipment due for maintenance with the plant-condition code specified in columns 3 and 4 of the function card. The required input is the master-card disc file.

(4) Function Code 04

The computer will list, on the printer, all the items contained in the master-card disc file. The required input is the master-card disc file.

(5) Function Code 05

The computer will revise the master-card disc file according to the changes and additions or deletions as indicated on the revision cards. The required input is the revision cards and the master-card disc file. The output is the revised master-card file.

(6) Function Code 06

The computer will punch a new deck of master cards from the master-card disc file. The only input required is the master-card disc file.

(7) Function Code 00

This function indicates to the computer that no more output is required and terminates the program.

III. EQUIPMENT HISTORY FILE

A complete and accurate written record of all equipment maintained is kept as the equipment history file. This history file is directly correlated with the computer program. The major components of the history file are as follows:

A. History Card

The history card (see Fig. 3) contains the following information:

(1) Type No.

The type number serves to identify the type of equipment: e.g., motor, pump, or valve.

(2) Manufacturer

Name of company that manufactured the equipment.

(3) Model No.

The manufacturer's model number.

(4) Serial No.

Serial number assigned by the manufacturer. Note that many equipment items do not have a manufacturer's assigned serial number. If this is the case, no number is required in the program.

(5) System

Identification of plant system of which the equipment is a part, describing the function of the equipment as installed.

(6) Equipment No.

The identification number assigned to this particular item of equipment.

VISIBLE CROSS-VIDING #66P05

EQUIPMENT				RECORD			
MFG. NAME		TYPE OR MODEL		MFG. ORDER NO.		SERIAL NO.	
EQUIP. NO.				DRAWING NO.		OUR P.O. NO.	
VENDOR		APPROP. NO.		SHOP ORDER NO.			
EQUIPMENT COST		INSTALLATION COST		DATE INSTALLED		LOCATION	
EQUIPMENT DESCRIPTION							
MAINTENANCE REQUIREMENTS				ELECTRICAL EQUIPMENT			
INSPECTION REQUIREMENTS				EQUIP.			
				MAKE			
				SERIAL NO.			
				TYPE FRAME			
				VOLTAGE			
				PHASE			
				H. P.			
				R.P.M.			
				DRIVE			
				CIRCUIT			
LUBRICATION				DATE INSTALLED			
				COST			
MANUAL PAGE		LUBE PERIOD					

SPARE PARTS ON OTHER SIDE

Fig. 3. History Card

(7) Date Installed

This date applies to a replacement or to a new system requiring this equipment.

(8) Maintenance Interval

The time interval at which this equipment is scheduled for preventive maintenance.

(9) Maintenance-requirement-card No.

The identification number of the maintenance requirement card (see Section VI.A) written for this item of equipment.

B. Maintenance Data Card

The maintenance-data-card portion of the history file (see Fig. 4) provides space for writing up the significant items of maintenance performed. This includes unscheduled as well as scheduled maintenance. If the item of equipment or any of its parts are replaced this is also recorded.

If a special report or other information relative to the repair or replacement of the item of equipment is prepared, it is filed in the equipment history file and referenced on the maintenance data card.

All entries on the maintenance data card are dated, and the work-request number is recorded in the "W.O. No." column of the card.

C. Maintenance-requirement Analysis Sheet

For each piece of equipment or maintenance unit that is in the computerized maintenance program, a maintenance-requirement analysis sheet (see Fig. 5) is prepared. This analysis sheet is the work sheet for establishing the preventive-maintenance requirements for a piece of equipment. All normal requirements and frequencies for performing the maintenance are entered on this sheet. If changes to these basic requirements are made in the future for any reason, this sheet will document why the changes were made. This sheet becomes an historical record of the maintenance requirements. Current information from the analysis sheet is then transferred to the maintenance requirement card and appropriately referenced.

The maintenance-requirement analysis sheet contains the following information:

- (1) The sheet number.
- (2) The computer master-card number.
- (3) The system the equipment is installed in.
- (4) The ANL-assigned equipment number.

WISCONSIN CROSS: V-20-4-2 #60P01

[illegible]

RE-ORDER FORM NO. 60P01

ALME VISIBLE RECORDS, INC.
CROZET, VIRGINIA

PRINTED IN U.S.A.

Fig. 4. Maintenance Data Card

MRA NO. _____ MAINTENANCE REQUIREMENT ANALYSIS SHEET (MRA) PAGE _____ OF _____

SYSTEM _____ EQUIPMENT _____ REF. DRWS. AND MANUALS _____
 DESCRIPTION _____ NUMBER _____

MASTER CARD NO. _____ MFG. _____ MODEL NO. _____

N U M B E R	MAINTENANCE REQUIREMENT IDENTIFY ANY NORMAL RE- QUIREMENTS INCLUDING LUBRICATION, FUNCTIONAL TESTS, PAINTING, ETC.	FREQ. W; M; Q; SA; A; BA	WHAT DOES THIS REQ. DO TO PREVENT BREAK- DOWN? DETERIORATION, MAINTAIN ACCURACY, ETC.	EQUIP. STATUS TO PERFORM REQ. SHUTDOWN; RUN- NING. ANY.	PLANT COND. TO PERFORM.	EST. TIME & NO. MEN	CONSIDERING MANPOWER DOWNTIME, ACCESSIBILITY. IS THIS REQUIREMENT NECESSARY?			ACTION TRANSFER TO MR CARD NO. _____. I&C OR P.S. TO PERFORM.
							YES	NO	IF NO, JUSTIFY	

COMMENTS: (AMPLIFY ANY ITEM AS NECESSARY IN THIS SPACE.)

Fig. 5. Maintenance-requirement Analysis Sheet

- (5) The manufacturer's name.
- (6) The manufacturer's model number.
- (7) The reference drawings and manual numbers.
- (8) A description of the equipment.

Also included on the sheet are the maintenance-requirements data in the following form:

- (1) A written description of normal requirements, including lubrication, functional tests, parts replacement, painting, etc.
- (2) Preventive-maintenance frequency, using the following time units: weekly, monthly, quarterly, semiannually, annually, biennially, etc.
- (3) What the preventive maintenance is supposed to do: e.g., reduce or prevent breakdown and deterioration, or maintain functional accuracy.
- (4) Equipment operational status required to perform the required maintenance: i.e., shut down, running, or any time.
- (5) The condition the plant must be in for performance of the required maintenance: i.e., running, shut down, fuel handling, or any time.
- (6) The estimated number of men and hours required to perform the preventive maintenance.
- (7) A justification for delaying or not performing the maintenance in those cases where it cannot or should not be performed on schedule (i.e., where the equipment is inaccessible, excessive downtime is involved, the maintenance is not plant controlling, or it is not worth the manpower effort. This may mean in some cases that maintenance will be performed on the equipment after malfunction rather than at the scheduled intervals.
- (8) In all cases where the maintenance requirement should be carried out on schedule, the action to be taken to implement the requirement will be noted: i.e., the maintenance-requirement card number will be referenced; or a group other than Crew E* will be referenced if the services of another group are required to perform the maintenance.

*Crew E is the local designation for the EBR-II Mechanical and Power-electrical Maintenance Section.

IV. OPERATION OF PROGRAM

The computer program, as noted in Section II.E, is presently set up to provide several types of equipment listings. In addition to the complete list of equipment covered, the program can supply lists of equipment due for maintenance, equipment requiring a specified plant condition for maintenance, and equipment requiring a specified plant condition and due for maintenance.

The following narrative gives an idea of how the program typically operates: Figure 6 is a flow diagram that shows the interconnection of the computer program with the equipment history file. Let us assume the starting point of the diagram to be the DISC OR MAG. TAPE box. (The disc or tape has been previously recorded to contain all the information on the status of each item of equipment, duplicating the information in the master-card file.) Let us also assume that a period of reactor shutdown has just been completed and that during this period both maintenance and modifications were performed. Because both were performed, there will be "maintenance-data update cards" and also "additions or deletions cards" for updating the master-card file. We know from the reactor operating schedule that there will be a refueling in the next month, and we wish to have a printout of the maintenance that will be due during the refueling shutdown and during the month following.

A function card is punched with the information necessary to provide for a computer printout of the equipment due for maintenance during the refueling shutdown and the month following. Because we have made additions and/or deletions during the last shutdown we also desire a complete printout of all the equipment for record purposes and for use as a directory for manufacturer's numbers, file numbers, etc. The function card, plus maintenance-data update cards and addition and/or deletion cards, are processed through the computer, and the disc or tape is corrected and updated. The updated disc or tape is then processed back through the computer. The output from the computer will be two listings: (a) a complete inventory of the equipment, and (b) a maintenance-due listing, naming all the equipment requiring service for the period desired. The printer listings go on four-copy dry-carbon paper. The four copies are then delivered to the Maintenance Supervisor for distribution to the personnel requiring copies for scheduling, auditing, performance evaluation, etc.

Fig. 6 Flow Diagram Showing Interconnection of Computer Program with Maintenance History File

From the maintenance-due listing, a work schedule is prepared for the next reactor shutdown. Work requests are prepared, special approvals obtained, and prerequisite work completed; and the requests filed until the work can be completed. After the work has been completed, the processed work requests and the maintenance data cards are given to the Job Control Foreman. The Job Control Foreman enters the updating information on the maintenance data cards, files the cards, and has updated computer cards punched for the next computer run.

V. WORK REQUEST

The EBR-II work request (see Fig. 7) provides for EBR-II Operations supervisory approval and work clearance of any maintenance or modification work performed in the power plant, reactor building, sodium boiler building, and cooling-tower areas. The work request ensures a record of maintenance activities so that the necessary notations can be made on the equipment history cards.

The work-request form has three main uses: routine preventive maintenance can be requested; equipment malfunctions can be reported and maintenance requested; and system abnormalities can be submitted as problems that may require not only maintenance but possible further action such as replacement or redesign of equipment.

The work request is normally initiated by Operations technicians, Maintenance personnel, or Operations Engineers, but may also be initiated by other EBR-II Project personnel desiring work to be performed.

The normal routing of a work request from initiation to completion is as follows:

- (1) Operations technicians make out a work request and the Shift Supervisor initials it. It is then placed on the job-status board under the applicable area: electrical, coolant, reactor, etc. The white copy is removed and placed in a basket for information to the Operations Engineers.
- (2) The work request is picked up by a Crew E* representative and passed on to the Maintenance Supervisor.

*See note on p. 16.

EBR-II WORK REQUEST

9441

Date_____	WORK CLEARANCE BY SHIFT SUPERVISOR	
Requestor_____	Approved_____	Date_____
Supervisor_____	Red Tag No._____	
Plant Condition Required_____	Safe Work Permit Required:	Yes_____ No_____
_____	Welding Permit Required:	Yes_____ No_____
Equipment Name & No._____	H. P. Coverage Required:	Yes_____ No_____

Job Description of Work to be Performed_____		

Job Supervisors Instructions_____		

Job Supervisors Approval_____	Date_____	
Engineer to Contact_____		
Job Order No._____	Plant Modification No._____	
Date Job to Start_____	Date Required_____	
Work Performed_____		

Material Used and Spare Part No._____		

Work Completed by_____	Date_____	Total Job Hrs._____
Operational Checkout of Equipment by:_____		
Job Cleared By:_____	(Shift Supervisor)	Date_____
Machinery History Posted:	Yes_____ No_____	Date_____

Fig. 7. EBR-II Work Request

- (3) The Maintenance Supervisor removes the blue copy, notes any special actions required on this copy, and transmits the blue copy and the original to the Job Control Foreman.
 - (4) The Job Control Foreman will schedule the work if the Maintenance Supervisor has so noted on the blue copy. The work request is then passed on to the appropriate Systems Foreman.
 - (5) The Crew E technician receives the work request from the Systems Foreman and then takes it to the Shift Supervisor, who enters the work-request number in a log and hangs the request on the status board on a "work in progress" clip.
 - (6) The Crew E technician completes the work and signs the work request off.
 - (7) The Shift Supervisor clears the work request and clears the entry in his log. The work request is placed back on the status board on a "work completed" clip.
 - (8) The completed work request is picked up by a Crew E representative and returned to the Job Control Foreman, who ascertains that appropriate equipment-history entries are made. The blue copy is marked complete and returned to the Maintenance Supervisor. It is then transmitted to the Crew E secretary who files it in the work-request log.
 - (9) The complete work request is filed for future reference.
- A flow diagram for a work request is shown in Fig. 8.

VI. SUPPORTING PROCEDURES

The computer program is limited to providing general information, information for scheduling, special information regarding plant conditions, etc. To actually accomplish maintenance tasks, the "how" as well as "when" information must be provided to the personnel performing the tasks. The following are typical of the procedures used to provide the "how" in support of the computer.

A. Maintenance Requirement Card

The maintenance requirement card (MRC) is written as step-by-step instructions to the technician (see Fig. 9). The intent of the MRC is to serve as a guide and check of the work performance and a record of work performed. Should additional details be required, the manufacturers' manuals, the System Design Descriptions, and supervisory help are available.

Fig. 8. Flow Diagram for Work Request

COMPLETED BY	TECHNICIAN	DATE
REVIEWED BY	FOREMAN	DATE
COMMENTS:		
APPROVED	MAINTENANCE SUPERVISOR	
	2/31/73 DATE	
REVIEWED ON ENG. EVAL. OS-260 ON 10/3/72		

SYSTEM	COMPONENT	MRC NO. P-87
CONDENSATE	#1 HEATER LEVEL CONTROL VALVE	EQUIP. NO. P5-VC-607
SPARES LOCATION REA-131	MANUALS & DRAWINGS MOTOR OPERATED VALVE LIST FISHER GOVERNOR	
WORK ORDER NO.	MAINT. PRIORITY 11	DUE DATE
CHECK (✓) IF OK MARK 'X' IF FURTHER REPAIRS ARE NEEDED. THE MAINT. FOREMAN SHALL TRANSFER INSTRUCTIONS FOR CORRECTING DEFICIENCIES TO A WORK ORDER AND RECORD THE WORK ORDER NO. ON THE REQUIREMENT CARD AND RECORD THE REQUIREMENT CARD NO. ON THE WORK ORDER.		
6 MONTHS .3 OPERATING (C-248A) SCHEDULE EST. HRS. PLANT COND.		
CLEARANCE REQUIRED NONE		
1. INSPECT FOR LEAKS ON PACKING, GASKETS, ETC. INSPECT CONDITION OF INSULATION, EQUIPMENT NO. AND GENERAL MECHANICAL CONDITION.		
12 MONTHS 4 SHUTDOWN (C-248B) SCHEDULE EST. HRS. PLANT COND.		
CLEARANCE REQUIRED WORK ORDER		
1. CYCLE THROUGH FULL TRAVEL CHECKING CLOSURE, BINDING, STICKING, OR OTHER MALOPERATION. REPACK IF NECESSARY.		
60 MONTHS 6 SHUTDOWN (C-248C) SCHEDULE EST. HRS. PLANT COND.		
CLEARANCE REQUIRED WORK ORDER		
1. PERFORM MAJOR DISASSEMBLY AND INSPECTION OF VALVE. REPLACE PARTS AS REQUIRED.		

Fig. 9. Maintenance Requirement Card

The MRC includes the information required by the technicians regarding plant conditions, radiation safety, industrial safety, supplementary procedures, and prerequisites; it also provides a step-by-step approach to the assignment, a check-off for each action, and a space for foreman approval of the work performed.

B. Other Procedures

The MRC may reference a number of other procedures, as described in EBR-II Procedure DP-1, that are used in support of maintenance. They include such procedures as Standard Maintenance Procedures, Special Maintenance Procedures, Safety Procedures, and Test Procedures.

When one or more of the procedures are applicable for performing a certain preventive-maintenance task, the MRC will reference the appropriate procedure(s).

VII. EXPANSION OF COMPUTER PROGRAMS

The EBR-II Instrument and Control Section has been using a successful computerized preventive-maintenance program for about two years. The experience with this program has led to consideration of ways in which it might be expanded, as outlined below. Not only are these possibilities being evaluated for the instrument and control program, but they might also be adapted to the mechanical and power-electrical program as time permits.

A. Spare Parts

The maintenance and calibration of the instrument systems require that an inventory of spare parts be available for repairs and replacements. The present system of stocking spare parts is based on the number of particular instruments and the manufacturers' recommendations. If the spare-parts usage were included in the computer program, a more realistic inventory could be obtained and in most cases the spare-parts requirements would be indicated reliably.

B. Interlock Checks

The operation of EBR-II as an irradiation facility and prototype reactor plant requires approximately 1000 alarm and control functions to be checked. Presently, there is a maintenance and calibration procedure to perform this

task. The integration of these alarm and control checks into a computerized system, similar to the one described, would provide the advantages of decreased time for performance of the checks, ease of revision, a better overall visibility of the checks, and scheduling of the checks along with maintenance.

APPENDIX

Information on Complete Computer-printout Sheet

The purpose of these sheets is to identify all items of equipment or maintenance units on which preventive maintenance is to be performed, with pertinent information about each item of equipment. See Fig. 10 for example. A complete computer-printout sheet is normally produced about twice a month to aid in scheduling of maintenance.

1. Explanation of Columns on Sheet

The following is an explanation of each of the 80 horizontal spaces on the printout sheets:

Master-card Number: Seven spaces are provided to give an identification to the computer for each item of equipment or maintenance unit. This identification will be an alphanumeric designation. Each system will receive a letter prefix of up to three letters, and each item of equipment within the system will receive a number from 001 through 999. The seventh space will be used for an A, B, C type of designator when two or more master cards are required for the same item of equipment, as when there is more than one maintenance interval because of different types of required maintenance.

MRC Number: Four spaces are provided to reference the maintenance-requirement-card (MRC) number on which the specific maintenance steps are listed.

Equipment Number: Nine spaces are provided to list the equipment number as originally specified by the construction architect. Where numbers are missing, they will be assigned at a later date as time permits.

Function: Sixteen spaces are provided to give an abbreviated description of the function of the item of equipment within its system; e.g., "1 HTR STM SAFETY."

Manufacturer: Three spaces are provided for an abbreviated name of the manufacturer of the item of equipment.

Model/Serial Numbers: Seven spaces are provided for the manufacturer's model number and ten spaces are provided for the manufacturer's serial number. If there is insufficient space to include the complete model or serial number, a dash in the last space indicates an incomplete number. The complete number

COMPLETE PRINTOUT OF EQUIPMENT

173

CARD NO	MRC	EQUIPMENT NO	FUNCTION	MFG	MODEL	SERIAL NO	PC	P	MI	SPL	HOURS	LM	UM	REPL	O-HAUL
BOILER FEEDWATER SYSTEM															
BF 2	P59	P3HE707	1 FW HEATER	YUB	NONE	5-8048EA3	4	2	12	0	160	372	0	0	371
BF 4	P59	P5LI624	1FW HTR SGT GLAS	JER	NONE	113R	5	2	6	0	005	372	0	0	0
BF 6	P57		SV-1 HTR WA RLIF	CRO	JRC-A	34966	4	2	12	0	080	972	0	0	972
BF 8	P58		SV-1 HTR ST SAFT	CRO	JO25C	34707	4	2	12	0	080	972	0	0	0
BF 50A	P60	P3HE708	2 FW HEATER	AC	NONE	83659	4	2	12	0	080	972	0	0	0
BF 50B	P60	P3HE708	2 FW HEATER	AC	NONE	83659	4	2	24	0	160	972	0	0	0
BF 52	P60	P5LI623	2FW HTR SGT GLAS	JER	NONE	NONE	0	2	12	0	080	872	0	0	872
BF 54	P61	P3SV1605	SV-2 HTR ST SAFT	FAR	2575-B	1188AA	4	2	12	0	080	1272	1	0	0
BF 56A	P60	NA	2 HTR VACUUM BKR	WAR	200	31959	5	2	6	0	010	872	0	0	0
BF 56B	P60	NA	2 HTR VACUUM BKR	WAR	200	31959	4	2	36	0	120	872	0	0	0
BF 100	P52	P3HE711	3 FW HEATER	YUB	NONE	5-8048EA2	4	2	12	0	080	872	0	0	0
BF 102	P52	P5LI625	3FW HTR SGT GLAS	JER	NONE	NONE	4	2	12	0	080	872	0	0	872
BF 104	P62	NA	SV-3 HTR ST SAFT	CRO	JO56C	70744	4	2	12	0	080	872	0	0	0
BF 106	P63	NA	SV-3 HTR WA RLIF	CRO	JMB-TA	70LA123	4	2	12	0	080	872	0	0	0
BF 150	P52A	P3HE712	4 FW HEATER	YUB	NONE	5-8048EA1	4	2	12	0	080	972	0	0	0
BF 152	P52A	P5LI626	4FW HTR SGT GLAS	JER	NONE	A10423	4	2	12	0	080	972	0	0	1071
BF 154	P64	NA	SV-4 HTR WA RLIF	CRO	JMB-TA	70LA1537	4	2	12	0	080	172	0	971	172
BF 156	P65	P3SV685	SV-4 HTR ST SAFT	CRO	JO56C	40729	4	2	12	0	080	971	0	0	0
BF 200A	P4	P3P709	1 FW PUMP	PAC	8FI	27507	5	2	6	0	010	772	0	0	0
BF 200B	P4	P3P709	1 FW PUMP	PAC	8FI	27507	4	2	12	0	400	272	0	0	0
BF 200C	P4	P3P709	1 FW PUMP	PAC	8FI	27507	4	2	24	0	160	572	0	0	0
BF 200D	P4	P3P709	1 FW PUMP	PAC	8FI	27507	4	2	60	0	560	1163	0	0	1163
BF 202A	P4	PH122	1 FW PUMP MOTOR	WES	CS30A	1-3V1009-T	4	2	6	0	010	772	0	0	0
BF 202B	P4	PH122	1 FW PUMP MOTOR	WES	CS30A	1-3V1009-T	4	2	12	0	080	272	0	0	0
BF 204	P4	P3P709	1 FWP LO PUMP	PAC	8FI	NONE	4	2	60	0	040	1163	0	0	0
BF 206	P4	NA	1FWP LO FLTR PMP	VJK	C432D	082982	0	2	1	0	080	672	0	672	0
BF 208	P66	PF130	VAL-1FWP AUT REC	YAR	5300	147	4	3	3	0	080	672	0	271	0
BF 210	P67		SV-1FWP SUC RLIF	LON	FS-84	507088	4	2	12	0	080	272	0	0	0
BF 250A	P3	P3P710	2 FW PUMP	IR	NONE	4HMTB-7	4	2	6	0	030	972	1	972	0
BF 250B	P3	P3P710	2 FW PUMP	IR	NONE	4HMTB-7	4	2	12	0	240	972	0	972	0
BF 250C	P3	P3P710	2 FW PUMP	IR	NONE	4HMTB-7	4	2	24	0	320	972	0	972	0
BF 250D	P3	P3P710	2 FW PUMP	IR	NONE	4HMTB-7	4	2	60	0	560	972	0	972	0
BF 252A	P3		2 FW PUMP MOTOR	WES	70F677-	1S-71	4	2	6	0	030	972	0	972	0
BF 252B	P3		2 FW PUMP MOTOR	WES	70F677-	1S-71	4	2	12	0	080	972	0	972	0
BF 252C	P3		2 FW PUMP MOTOR	WES	70F677-	1S-71	4	2	24	0	160	972	0	972	0
BF 254	P68	PF151	VAL-2FWP AUT REC	YAR	5304	202	4	2	3	0	080	972	0	972	0
BF 260	P119	P5SV1524B	SV-2FWP SUC RLIF	LON	FSS2	714586	4	2	12	0	080	1272	0	1272	0
BF 300A	P36	P3P725	SUFW PUMP	WOR	VTE-2	2P2261	4	2	3	0	030	1272	0	0	270
BF 300B	P36	P3P725	SUFW PUMP	WOR	VTE-2	2P2261	4	2	12	0	120	272	0	0	270
BF 300C	P36	P3P725	SUFW PUMP	WOR	VTE-2	2P2261	4	2	36	0	320	270	0	0	270

Fig. 10. Example of an Individual Complete Computer-printout Sheet

can be found in the equipment history file.

Plant Condition (PC): Two spaces are provided to list a number for various plant conditions under which maintenance can be performed. A list of the numbers and associated plant conditions is attached.

Priority (P): One space is provided to list a number for the relative priority for maintenance of the item of equipment. A priority of one indicates the highest priority. This highest priority will be reserved for assurance limits or maintenance mandatory for reactor operation.

Maintenance Interval (MI): Two spaces are provided for indicating the time in months between scheduled maintenance: i.e., annual - 12; semiannual - 6; triennial - 36.

Special Maintenance Date (SPL): Two spaces are provided for insertion of a specific month of the year that an item is due for maintenance. This column is for those items requiring a fixed maintenance date, regardless of last maintenance, and will be utilized as a call-out for maintenance due.

Time (HOURS): Three spaces are provided to list the estimated time, in hours and tenths of hours, for the completion of maintenance; the time will range from 0.1 hr to 99.9 hr. A 99.9 in these three spaces indicates more than 100 hr required. The actual hours required in such an instance can be obtained from the maintenance-requirement analysis sheet.

Last Maintenance (LM): Four spaces are provided to list the month and year that the last maintenance was completed. (For equipment with a specified maintenance interval, this date is the reference point for producing maintenance-due printout listings.)

Unscheduled Maintenance (UM): Two spaces are provided to show the number of unscheduled maintenances the item of equipment has had since the last replacement or overhaul.

Replacement/Overhaul (O-HAUL): Four spaces each are provided for replacement and overhaul, to show the month and year of the last replacement or overhaul.

2. Plant-condition Code

The spaces are provided for calling out the plant conditions that must exist for performance of maintenance. The following is a list of the various plant conditions and the numerical code for those conditions:

<u>Code</u>	<u>Plant Conditions</u>
0	Any
1	Reactor Shut Down
2	No Unrestricted Fuel Handling
3	No Restricted Fuel Handling
4	Steam Heater Depressurized - Steam Drum Pressurized
5	Plant at Power
6	Secondary Drained
7	Sequence A - Fuel Handling
8	No Fuel Handling
9	Fuel Handling in Progress
11	Purification System Shut Down
22	Bulk Sodium Temp. 350 ⁰ F

3. Master-card Numbering

The master-card numbering system for the computerized preventive-maintenance program includes letter prefixes to provide a visible means of grouping the equipment or maintenance units. The prefix will normally contain letters that will abbreviate the commonly used name of the system. If it becomes desirable to further divide a system or add new systems to the program, a new prefix can easily be added as long as it does not repeat an existing prefix.

Numbers will be assigned sequentially to the letter prefixes in each prefix group. The major pieces of equipment will be initially assigned the lowest numbers, e.g., 1 through 10. Minor pieces of equipment such as valves within the same prefix grouping will be identified and assigned numbers starting with 50, or at least 20 blank spaces after the last major piece of equipment.

All files relative to an item of equipment or maintenance unit will carry its master-card number.

The letter prefixes will be assigned to systems according to the following table:

Mechanical Systems

<u>Letter Prefix</u>	<u>System</u>
BF	Boiler Feedwater
C	Main Condensate
SP	Steam - Power Plant
SG	Steam Generation
BD	Blowdown
CW	Condenser Cooling Water
TG	Main Turbine - Generator
TLO	Turbine Lube Oil
DW	Demineralized Water
CTA	Main Tower Acid
ATA	Auxiliary Tower Acid
CR	Chromate
HY	Hydrazine
H	Hydrogen
SD	Sulphur Dioxide
MO	Morpholine
SI	Silicone
IA	Instrument Air
PA	Plant Air
NAS	Sodium - Secondary System
SSP	Secondary Sodium Purification
ARS	Argon - Secondary System
SGM	Secondary Gas Monitoring
CWB	Cooling Water - Sodium Boiler Plant
DT	Dowtherm
FS	Fire Protection - Secondary
FH	Fuel Handling
RC	Reactor Control
PSP	Primary Sodium Purification
NAP	Sodium - Primary
FED	FERD Loop
RSL	Radioactive Sodium Chemistry Loop

<u>Letter Prefix</u>	<u>System</u>
RE	Reactor Experimental or Test System (Instrumented Subassembly, INCOT, etc.)
AR	Argon Supply
RCG	Reactor Cover Gas
RAP	Reactor Argon Purification
ACS	Argon Cooling System
PT	Primary Tank
SDC	Shutdown Coolers
RSC	Reactor Shield Cooling
ITC	Instrument Thimble Cooling
RBC	Reactor Building Containment
FP	Fire Protection - Primary
NAC	Sodium Cleanup
CV	Conveyance - Cranes/Rigging Equipment
PTA	Primary Tank Annulus
PVR	Primary Tank Vacuum Relief
CP	Constant Power Supply
MPS	Miscellaneous Plant Systems

Electrical Systems

<u>Letter Prefix</u>	<u>System</u>
E1	13.8-kV Switchgear
E2	2400-V Switchgear
E3	480-V Main Switchgear
E4	480-V Main Switchgear
E5	Lighting Distribution Center E2
E6	MCC-P1A*
E7	MCC-P1B
E8	MCC-P2A
E9	MCC-P2B
E10	MCC-R1A
E11	MCC-R1B
E12	MCC-R2
E13	MCC-R3

The MCC's are motor-control centers.

<u>Letter Prefix</u>	<u>System</u>
E14	Panel R3A
E15	Panel R-5
E16	Panel R-6
E17	Panel R-7
E18	Panel RE-3
E19	MCC-S1A
E20	MCC-S1B
EDC	DC Distribution Center
ECP	Constant Power System