ORNL/TM-5456

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OAK RIDGE NATIONAL LABORATORY

UNION CARBIDE

Laboratory Services Series a Programmed Maintenance System

D. C. Tuxbury
B. E. Srite

OPERATED BY
UNION CARBIDE CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A05; Microfiche A01

ORNL/TM-5456

Contract No. W-7405-eng-26

PLANT AND EQUIPMENT DIVISION

LABORATORY SERVICES SERIES
A PROGRAMMED MAINTENANCE SYSTEM

D. C. Tuxbury
MAINTENANCE ENGINEERING

B. E. Srite
COMPUTER SCIENCES

Date Published - January 1980

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
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ACKNOWLEDGMENTS

We wish to acknowledge program coordinator G. H. Johnstone and staff member R. J. Shamblin for their continuing effort to assure program effectiveness through an awareness of changing procedural requirements.

Appreciation is extended to Martha B. Phillips for her programming effort and documentation of the maintenance history program included in this manual.

The authors also extend their appreciation to Shirley Goad for her assistance in handling data for program updating, scheduling, and special reporting.

D. C. Tuxbury
B. E. Srite

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FIGURE LIST

LABORATORY SERVICES SERIES - A PROGRAMMED MAINTENANCE SYSTEM

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ABSTRACT

The diverse facilities, operations and equipment at a major national research and development laboratory require a systematic, analytical approach to operating equipment maintenance. A computer-scheduled preventive maintenance program is described including program development, equipment identification, maintenance and inspection instructions, scheduling, personnel, and equipment history.

INTRODUCTION

The need for a computerized preventive maintenance program was not so obvious during the initial development of the Laboratory. Many of the research projects, and need for related mechanical equipment for those projects, were of relatively short duration. Research projects could be completed or discontinued within a matter of months leaving equipment idle or available for salvage. Building utilities were serviced with some degree of regularity, but the future of the Laboratory was undetermined to the point that a sophisticated preventive maintenance program had not yet been considered as a realistic function.

The growth of the Laboratory through the 1950's with many new facilities and expanded programs resulted in more permanent structures and equipment and a different philosophy in maintenance planning. It was now clear that the maintenance function would have to adjust from a "fire-fighting" operation to a well-organized maintenance activity with long-range planning.

This report summarizes the major elements of a computerized preventive maintenance program, and how it is administered by the Plant and Equipment Division for Oak Ridge National Laboratory.

In addition to this report there is a detailed Plant and Equipment Division procedure, QA-PE-18/D.1.14, covering the use of Programmed Maintenance Schedule Cards and History Cards attached as Appendix D.

PROGRAM DEVELOPMENT

The preventive maintenance project was one of the steps taken to improve the planning function of the existing maintenance operation. In 1961 a survey was completed to determine the scope of a preventive maintenance program for the Laboratory. The items listed below were factors considered in determining the format for an effective maintenance program:

1. What type of equipment should be included in the program?
2. Will the program be of such complexity that computer utilization can be effective?
3. Should a special crew be assigned to handle only preventive maintenance tasks?
4. Who should be assigned the responsibility for the administration of the program including initial start up, updating, and program improvement?

In summary the survey recommended that:

1. Equipment for which the Plant and Equipment Division has primary responsibility, such as, building service equipment, should be covered first on the program.
2. A computer program could be utilized effectively to store and schedule preventive maintenance data for an estimated 20,000 pieces of equipment. Utilizing a computer program resulted in identifying the new maintenance planning function as "programmed maintenance".

3. The programmed maintenance activities of routine inspections, adjustments, and lubrication could be accomplished with the existing personnel. A special crew would obviously have some desirable features but it would not be mandatory to assure the success of the program.

4. A staff function should be created within the Plant and Equipment Division to collect and establish a data base, coordinating with an assigned computer programmer who would be responsible for the program format. The programmed maintenance staff would also be assigned the responsibility of developing the program to whatever level of sophistication was necessary to provide the maintenance line function with a useful and effective management tool.

Programmed maintenance personnel were recruited and oriented to program objectives shortly after the survey had been completed. A computer programmer located at Computer Technology Center (ORGDP) was assigned to write the program format to the requirements specified by the programmed maintenance staff. The original data collection started in October of 1962 after staff personnel and programmer had reached agreement on most of the significant details.

In order to build a significant data base in minimum time, the staff personnel established priorities as to which facilities would be the first ones included on the program. This was done on the basis of the concentration of equipment, consequence of breakdown, and servicing frequency. The Plant and Equipment Division field engineers, whose responsibility includes maintenance of equipment for facilities to which they are assigned, assisted the staff personnel by outlining maintenance needs in their individual areas. A critical area, for example, would be one where the success of a particular project was dependent on

relatively constant temperature. Maintenance of the air-handling equipment for this type of research project would then take preference over less critical items.

A three- to four-year period was required to inventory equipment that could be readily identified as equipment for which the Division had primary responsibility. Equipment that existed only to make the building operable such as air-handling systems, elevators, sump pumps, and electrical distribution systems, was considered the primary maintenance responsibility of the Plant and Equipment Division. A significant amount of research-oriented equipment was added to the program as research personnel learned of the availability of programmed maintenance. The small vacuum pump used in laboratory areas probably accounts for 30 percent of all research equipment now listed on Programmed Maintenance.

The original program format provided the staff with two sets of printed schedule cards, an original and duplicate set. The duplicate set was used to manually match the original card as it returned from the field after the maintenance requests were complete. Those duplicate weekly schedule cards that remained after a "reasonable" period of time constituted the first backlog schedule.

This situation illustrates that even with an organized computerized approach to scheduling routine preventive maintenance it is difficult to anticipate all of the requirements in advance. This procedure has since been modified to take full advantage of the current data processing techniques.

Other program developments include a maintenance history program which is covered in detail in another section of this report. A programmed maintenance auditing function and the integration of preventive and repair maintenance histories are two projects that will be developed in the near future. A formal auditing function will provide the staff more specific information about clarity of instructions, thoroughness of preventive maintenance work, effectiveness of established frequencies, and changes in productivity. An integration of preventive maintenance history with repair history will centralize all costs expended for individual units of equipment and provide a better basis for replacement decisions.

In order to evaluate the effectiveness of programmed maintenance it is necessary to review the objectives that have been established prior to and during the early development of the program. The objectives listed below were published in an earlier report, and as of this date, are recognized as valid criteria:[1]

1. To reduce unanticipated equipment downtime and emergency repair orders through a repetitive maintenance program of inspections, adjustments, replacement of parts, and lubrication.
2. To provide centralized responsibility for repetitive maintenance to ensure consistency in planning, organization, administration, and control of the repetitive maintenance and inspection functions with which the Plant and Equipment Division is involved.
3. To study equipment operating conditions, manufacturer's recommendations and repair histories to determine optimum service frequencies.
4. To standardize lubricants whenever possible.
5. To maintain all necessary records on repetitive maintenance activities.
6. To provide a history of maintenance activities for critical equipment covered by the program.
7. To improve planning, budgeting, and work load leveling for maintenance manpower.
8. To effect economies in the use of maintenance manpower and materials.
9. To review equipment specifications and facility design to provide recommendations affecting

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[1] W. O. Graves and B. S. Bishop, *Programmed Maintenance for Oak Ridge National Laboratory*, ORNL-TM-2161, October 1968.

reliability and maintainability of equipment.

10. To identify materials required for repetitive maintenance to minimize delays in drawing parts and materials from Stores, and to assist with standardization of materials.

If the present level of maintenance performance is satisfying the objectives which have been established, then it would seem reasonable to assume that programmed maintenance is an effective function accomplishing what it was designed to accomplish.

The remainder of the report provides detailed information on techniques and procedures that have been developed by the programmed maintenance staff to meet the above objectives.

EQUIPMENT IDENTIFICATION

Careful consideration was given to developing a method of identifying an equipment item so that it would be relatively easy to locate in one of approximately 120 buildings in an area covering several square miles. In addition to being easy to locate, it was necessary to be able to identify an equipment item so that it could be classified with similar equipment or sorted in a number of ways depending on the reporting requirements.

The first step in identifying the equipment item is to inventory by physically examining the unit and determining the manufacturer, model, size, serial number, property number and any additional information to establish a unique identity that is different from any other similar piece of equipment.

The field data sheet (Fig. 1) was designed to accomplish this step. Notice that the top five lines of this sheet are used specifically for describing the unit and related power source such as an electric motor. The ten-digit location number in the upper left corner of the data sheet is the primary identification number assigned to each individual piece of equipment. The first five digits assigned to each individual piece of equipment designate the building location using a geographical grid. A dash is used in column five for those buildings identified with four

PROGRAMMED MAINTENANCE DATA SHEET

DATE 12/31/79

LOCATION	EQUIPMENT DESCRIPTION	PROPERTY	FOREMAN	JOB ORDER
2001-21 470	CARRIER COMPRESSOR A/C UNIT	X-20146	BURRIS	A2001E-E1 19

EQUIPMENT MANUFACTURER	MODEL	TYPE	SIZE	SERIAL NUMBER	VENDOR
	5F20109		5-TON	73141	

FUNCTION	SHAFT	DIMENSIONS	WARRANTY DATE
BASE MOD 5F20089 SER 73134			

MOTOR MANUFACTURER	HP	RPM	VOLTS	AMPS	PH	CY	AC DC	TYPE	SF
LOUIS ALLIS	5	1750		14.17	3	60		OCB	

PROPERTY	SERIAL NUMBER	FRAME	MODEL	CLASS	STYLE	CODE	DES	TEMP		EQ. CL.
X-20144	238448	254				H				512

ITEM	POINT OF SERVICE	LUB	FTNG	NO	FREQ	START	OR ALT	MINUTES TIME	CRAFT	REMARKS
1	LUB MTR BRNGS	TJ	GF	2	Y	11		9		
2	CK BELT WEAR, TENSION, ALIGNMENT			2	6M	11		6		BELT 5L-630
3	CK CRANKCASE OIL LEVEL	AD			3M	11	4	16		
4	DR, FLUSH, REFL CRANKCASE	AD			Y	11		2715		
5	CLEAN MTR, COMPRESSOR HOUSING				2Y	59		226		
6	CK AUTOMATIC CONTROLS & CLEAN				6M	11		75		
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

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Fig. 1. Field Data Sheet

digits only. The next two digits identify the floor level within a particular building using 01 for the first floor. The last three digits locate the exact position of individual equipment on a specific floor level. Equipment location floor plans (Fig. 2) are maintained by the Programmed Maintenance staff and issued to all work centers to assist craftsmen, engineers, and building services coordinators in locating equipment with minimum difficulty.

The equipment classification number on line five is available to classify similar types of equipment (Fig. 3) and may be requested in report form (Fig. 4) as one of several computer program options. This report summarizes every piece of equipment that has been assigned a specific number, such as, 510 for air-conditioning equipment under two tons. With this sort of flexibility it is possible to review equipment with common maintenance characteristics for the entire Laboratory.

The final step in identifying equipment is to mark each individual piece of equipment so that it can be easily verified with the programmed maintenance card when service is scheduled. A bright orange label is used to identify each unit scheduled for programmed maintenance. The labels are available in continuous form and are printed on a standard data processing printer from the master tape containing location numbers, work order numbers, responsible foremen, work orders, and equipment descriptions. The labels are made with a pressure-sensitive backing, making them easy to apply and are reasonably durable if applied on clean surfaces. Several hundred can be printed in a matter of minutes so that duplicate labels are easily produced when needed. Fast, accurate identification is essential for both locating equipment when scheduled for service and for easy identification when collecting and reporting repair data for maintenance history records.

MAINTENANCE AND INSPECTION INSTRUCTIONS

The next step toward scheduling a piece of equipment for programmed maintenance is to develop the instructions and inspection procedure which are completed under the point of service section on the field data sheet. (Fig. 1)

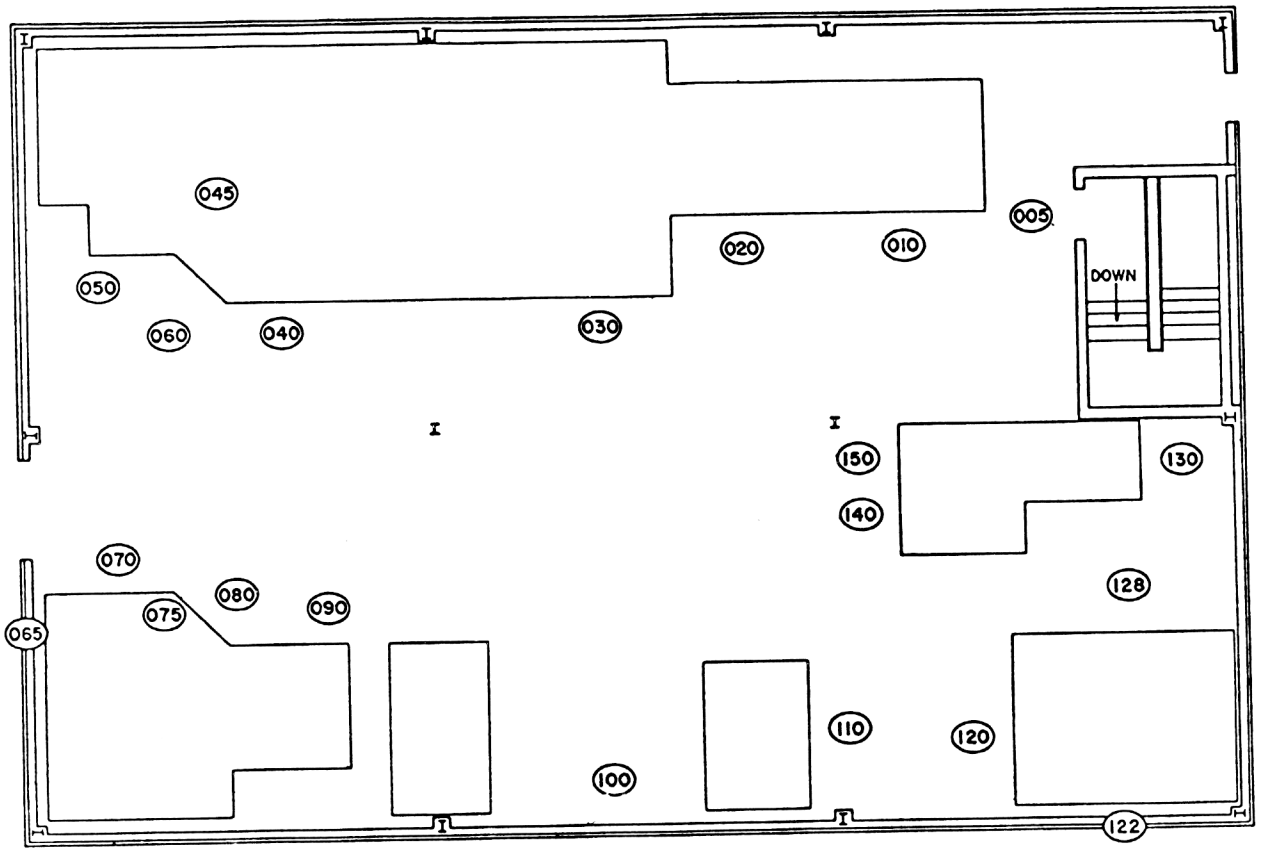

Fig. 2. Equipment Location Floor Plan

EQUIPMENT CLASSIFICATION NUMBERS

AIR COMPRESSOR	400
AIR LINE FILTERS & LUBRICATORS	420
AIR CONDITIONING MISC.	500
Package A/C Units*	
Under 2 ton, including all Window Units	501
2-4 Ton	502
5-10 Ton	503
11-15 Ton	504
Over 15 Ton	505
Heat Pumps	507
A/C Compressor & Condenser Units	
Under 2 Ton	510
2-4 Ton	511
5-9 Ton	512
10-19 Ton	513
20-29 Ton	514
30-69 Ton	515
70-119 Ton	516
120-299 Ton	517
300-700 Ton	518
Over 700 Ton	519
A/C Compressor & Evaporator Units	
Under 5 Ton	521
5 Ton and Over	522
A/C Compressors	
Under 20 Ton	525
20-40 Ton	526
Over 40 Ton	527
A/C Air-Cooled Condensers	
Under 1 hp	530
1-5 hp	531
Over 5 hp	532
A/C Evaporative Condensers	
Under 5 hp	535
5 hp and Over	536
Fan Coil Units	
Under 1 hp	540
1-4 hp	541
5-9 hp	542
10-19 hp	543
20-30 hp	544
31-50 hp	545
Over 50 hp	546
Cooling Towers	
Under 5 hp	550
5-10 hp	551
Over 10 hp	552
Centrifugal Water Pumps	
Under 5 hp	555
5-10 hp	556
11-20 hp	557
21-50 hp	558
51-100 hp	559
Over 100 hp	560
Turbine Water Pumps	
Under 50 hp	565
50-99 hp	566
100 hp and Over	567
A/C Purge Units	
Under 0.5 hp	570
0.5 hp and Over	571
A/C Filters	575
AIR PRESSURE REDUCING STATIONS	600
AUXILIARY GENERATORS (Diesel & Gasoline)	610
AUXILIARY LIGHTS	620
BICYCLES	625
CAFETERIA EQUIPMENT	630
CELL WINDOWS	635
COMPRESSORS FOR SPRINKLER SYSTEMS	640
CONTINUOUS AIR MONITORS	650
CORDED EQUIPMENT	660
CRANES	670
DOORS & GATES	680
ELECTRICAL	690
ELEVATORS	700
EXHAUST FANS	710
Filtered	712
Unfiltered	715
FILTERS, MISC.	717
FLOOR TILE	720
GROUND FAULT INTERRUPTERS	725
HEATERS	730
HEATERS - WATER	735
HOISTS	740
INSPECTIONS	745
LAUNDRY EQUIPMENT	760
MACHINE TOOLS	101-268
MANIPULATORS	765
MOBILE EQUIPMENT	770
MOTOR GENERATOR SETS	790
MOTOR POOL	795
PAINT, EXTERIOR	810
PAINT, INTERIOR	812
PRECISION INSTRUMENTS & TOOLS	820
Balances	821
PRESSURE REDUCING VALVES	
Steam	870
PUMPS OTHER THAN A/C	890
Sump Pumps	895
ROOFS	910
SAFETY SHOWERS	920
STEAM PLANT PROCESS EQUIPMENT (Including Compressed Air Equipment)	930
STEAM VALVE PITS	940
STRUCTURES	943
TRANSFORMERS	945
VACUUM PUMPS	950
VIBRATION ANALYSIS	960
WATER STILLS	970

*Some small split systems are listed as package units.

Fig. 3. Equipment Classification Numbers

PROGRAMMED MAINTENANCE DATA SHEET NOV 12,1979

LOCATION		EQUIPMENT DESCRIPTION	STD. TIME	PROPERTY	EQP CLASS	QUALITY LEVEL	JOB ORDER	FOREMAN
7930- 30	982	BUFFALO EXHAUST FAN 16	18.5		712	4	H7930E-F1	FIELDS
7930- 30	983	DWYER PHULDHELIC GAUGE			500	4	M & C	WALLACE
7930- 30	985	GRAVITY DAMPER THIRD FL. EM-302				4	M & C	WALLACE
7930- 30	986	BUFFALO IND.EXHAUST FAN SYS-E-11		X102335	712	4	H7930E-F1	FIELDS
7930- 30	987	BUFFALO IND EXHAUST FAN SYS-E-6		X102336	712	4	H7930E-F1	FIELDS
7930- 30	988	BUFFALO EXHAUST BLOWER SYS.E-8		X102337	712	4	H7930E-F1	FIELDS
7930- 30	989	BUFFALO A/C H/V SYSTEM S-9			542	4	H7930E-E1	WSTMORLND
7930- 30	990	BUFFALO A/C H/V SYSTEM S-10			542	4	H7930E-E1	WSTMORLND
7930- 30	991	KRANKO CRANE 50 TON			670	4	H7930E-P1	FIELDS
7930- 87	100	INSPECT FLOOR TILE			720	4	H7930E-G1	FIELDS
7930- 88	100	MAINTENANCE OF STRUCTURES			943	4		FIELDS
7930- 89	100	PAINTING OF STRUCTURES (EXTERIOR)			810	4		FIELDS
7930- 90	100	ROOFS, MAINTENANCE OF			910	4	H7930E-B1	FIELDS
7930- 91	100	PAINT INTERIOR OF BUILDING			812	4		FIELDS
7930- 99	440	SHOWER, SAFETY	22.6		920	4	GM018E-06	FIELDS
7930P 00	010	COOLING TOWER PUMP B SPARE PARTS			558	4		WALLACE
7930P 10	210	JOY AIR COMPR 7-1/2 X 5 SPARE PARTS		X102508	925	4	H7930E-C1	FIELDS
7930P 10	230	JOY AIR COMP 11-1/4 X 9 SPARE PARTS		X102505	925	4	H7930E-C1	FIELDS
7930P 20	750	PEERLESS PUMPS MOD 20S-12H PARTS			890	4	H7930E-H1	FIELDS
7930P 20	770	PEERLESS PUMPS MOD 30S-08B PARTS			556	4	H7930E-E1	FIELDS
7930P 20	810	YORK TURBOPAK, 100 TON, SPARE PARTS			516	4	H7930E-E1	WSTMORLND
7931- 00	010	BUFFALO EX FAN SYS E-1(N)STACK AREA	19.3		715	4	H9999E-F1	FIELDS
7931- 00	020	BUFFALO EX FAN SYS E-1(S) STACK ARE	19.3		715	4	H9999E-F1	FIELDS
7931- 10	010	GOULDS FUEL PUMP			890	4	H9999E-K1	FIELDS
7931- 10	020	EMERGENCY LIGHT			620	4	H9999E-K1	BROWN
7931- 10	030	ONAN AUXILIARY GENERATOR UNIT			610	4	H9999E-K1	GENTRY
7931- 10	040	NESBITT SPACE HEATER	55.8		730	4	H9999E-C1	FIELDS
7931- 10	070	G.E. SWITCH GEAR (4EA.)			690	4	H9999E-K1	BROWN
7931- 89	100	PAINTING OF STRUCTURES (EXTERIOR)			810	4	H9999E-M6	FIELDS
7931P 10	030	ONAN AUX GENERATOR SPARE PARTS			925	4	H9999E-K1	GENTRY
7932- 00	010	BUFFALO EXHAUST BLOWERS SYS E-3			712	4	H7930E-F1	FIELDS
7932- 10	005	HONEYWELL WAIST PIT JET CONTROL VLV				4		WALLACE
7932- 10	015	NESBITT UNIT HEATER	66.3		730	4	H7930E-C1	FIELDS
7932- 89	100	PAINTING OF STRUCTURES (EXTERIOR)			810	4	H9999E-MF	FIELDS
7933- 01	110	A/C, ROOM 1, TRAILER #. OF 7930	90.8		501	4	G1791E-AA	WSTMORLND
7933- 01	120	A/C, ROOM 2, TRAILER #. OF 7930	90.8		501		G1791E-AA	WSTMORLND
7933- 01	130	A/C, ROOM 3, TRAILER #. OF 7930	90.8		501	4	G1791E-AA	WSTMORLND
7933- 01	140	A/C, ROOM 4, TRAILER #. OF 7930	90.8		501	4	G1791E-AA	WSTMORLND
7950- 00	001	CORDED EQUIPMENT INSPECTION			660		OP	BROWN
7950- 00	010	CORDED EQUIPMENT INSPECTION			660		OP	BROWN
7952- 00	040	FRANKLN SUMP PUMP LLW P STA HFIR			895	4	G0448E-A1	TODD
7952- 00	050	GOULDS PUMP-EAST UNIT		X-93249	890	4	G0449E-A1	TODD
7952- 00	060	GOULDS PUMP-WEST UNIT			890	4	G0449E-A1	TODD
7952- 01	010	CHROMALOX WALL HEATER			730	4	G0448E-A1	BROWN
7952- 01	020	PENN EXHAUST FAN			715	4	G0448E-A1	BROWN
7952- 01	030	YALE 1-1/2 TON HOIST			740	4	G0448E-A1	TODD
7952P 00	050	GOULDS PUMPS, EAST AND WEST			890	4	G0449E-A1	TODD
7953- 01	110	CONTINENTAL AUX POWER UNIT-GASOLINE			770	4	H9999E-K1	SLUDER
7953- 20	010	PUMP FOR DOSAR (UNIT NO 2)			890	4		KEENEY
7953- 20	025	PUMP FOR DOSAR(UNIT NO.3)			890	4		KEENEY

Fig. 4. Computer Listing of Equipment Classifications

The maintenance instructions determine:

1. What is to be done.
2. When it is to be done.
3. Which craft will do the work.
4. How often each maintenance instruction will be scheduled.
5. What lubricants should be used.
6. How many points should be lubricated.
7. What size belts, filters and other materials should be procured and taken to the job location.

The instructions are developed by careful review of the manufacturers' maintenance recommendations, especially if the piece of equipment is unique or if the equipment is under warranty and must be maintained specifically to manufacturers' recommendations.

A previously developed set of instructions is used if the equipment is identical or similar to another unit already included on programmed maintenance. Most often, the instructions are developed using both experience and manufacturers' maintenance procedures.

The instructions are sequenced in such a way that a craftsman servicing the equipment can start at the power or drive component and service the entire unit from one end to the other with a minimum of back tracking. A lubrication diagram is available to the craftsman for complex equipment.

The primary objective in developing maintenance instructions is to make them as concise and easy to interpret as possible. This goal is accomplished through careful planning and continuous upgrading of the program.

The number under the start column designated (S) on the computer listed data sheet (Fig. 5) represents total number of weeks from the date at the top of the sheet that the item will be scheduled for programmed

maintenance.

The weekly schedule tape is determined by scanning the master tape each week for those items of instruction reading zero under the start column. One week is subtracted from the start figure each time the tape is scanned. When the start figure reaches zero, the maintenance instruction appears on the weekly schedule and the start figure resets according to its designated frequency.

Weekly frequencies reset to	0
2 week frequencies reset to	1
Monthly frequencies reset to	4
3 month frequencies reset to	12
6 month frequencies reset to	24
Yearly frequencies reset to	48

The program utilizes a 48-week calendar for the purpose of sequencing different frequencies so they can be scheduled individually and still coincide with annual service when due. This system allows for scheduling a monthly item every four weeks or a three-month item every twelve weeks and having it coincide with annual service which is due every 48 weeks.

The program has been designed to print on the schedule card only those items which are due for a particular week. The craftsman can then be instructed to do everything on the card and does not need to review the entire schedule to determine which point of service needs to be completed. An alternate computer code is used so that one line of instruction can take priority over another. An item requesting that crankcase oil be drained and replaced with new oil would take priority over checking the oil only. This feature prevents the craftsman from checking the oil level, adding oil, and then reading the next instruction which instructs him to change the oil.

The lubricants are coded according to a Union Carbide Corporation - Nuclear Division procedure which has been developed by a Four-Plant Lubrication Committee. A comprehensive report is available which gives detailed information on the lubrication program at ORNL (Ref. ORNL/TM-5426).

PROGRAMMED MAINTENANCE DATA SHEET DEC 31,1979

LOCATION	EQUIPMENT DESCRIPTION	STD TIME	PROPERTY	QUAL LEVEL	JOB ORDER	FOREMAN
2001- 21 470	CARRIER COMPRESSOR A/C UNIT	304.7	X-20146	4	H2001E-E1	BURRIS

EQUIPMENT MANUFACTURER	MODEL	TYPE	SIZE	SERIAL NUMBER	VENDOR
	5F20109		5-TON	73141	

FUNCTION
BASE MOD 5F20889 SER 73134 SHAFT DIMENSION

MOTOR MANUFACTURER	HP	RPM	VOLTS	AMPS	PH	CY	AC/DC	TYPE	SF
LOUIS ALLIS	5	1750		1417	3	60		DCB	

PROPERTY	SERIAL NUMBER	FRAME	MODEL	CLASS	STYLE	CODE	DES	TEMP	EQ CLASS
X-20144	1238448	254				H			512

ITEM	POINT OF SERVICE	LUB	FTNG	NO	FREQ	S	OR	STD-TIME	CRAFT	SEASON	REMARKS
1	LUB MTR BRNGS	TJ	GF	2	Y	11		.9			
2	CK BELT WEAR,TENSION,ALIGNMENT			2	6M	11		.6			BELT 5L-630
3	CK CRANKCASE OIL LEVEL	AD			3M	11	4	1.6			
4	DR,FLUSH,REFL CRANKCASE	AD			Y	11		271.5			
5	CLEAN MTR,COMPRESSOR HOUSING				2Y	59		22.6			
6	CK AUTOMATIC CONTROLS & CLEAN				6M	11		7.5			

Fig. 5. Computer Listed Data Sheet

The remarks section of the maintenance instructions is a provision that allows for additional information and helps to clarify a particular instruction under point of service. The information may include a catalog number for a V-belt or filter or special instructions such as sending a crankcase oil sample to Analytical Chemistry to check for glycol content.

Craftsmen and foremen are encouraged to improve scheduled maintenance instructions so they can be easily understood. The individual craftsman's advice is sought in many cases in preparing instructions for a particular piece of equipment.

The master tape is updated every two weeks by changing instructions on existing equipment, adding new equipment, and deleting equipment no longer requiring routine maintenance.

Probably the most unique characteristic of ORNL's programmed maintenance is the flexibility that allows for "tailor-made" instructions for each piece of equipment. The amount of flexibility realized causes some significant disadvantages which are described in detail under Equipment History.

SCHEDULING

After the field data sheet has been completed, it is forwarded to the Computer Technology Center (CTC) located at an adjoining facility (ORGDP). The field data sheets are key punched at this point, and the input sorted on to a master tape by programmed maintenance location number.

The master tape is then scanned to determine which pieces of equipment are scheduled for service. The weekly schedules are requested two to three weeks in advance to allow the maintenance crew foremen time to schedule individuals and crew and to order any materials necessary to complete the job.

The weekly schedule cards are printed on continuous format, plain card stock to take advantage of the high rate printing speeds available. The cards are perforated so they can be machine separated prior to distribution via plant mail. Extensive scheduled maintenance instructions such as annual service, are printed on several cards with a note at the

bottom to "see next card" and are stapled together as sorted.

The craftsman reviews the schedule cards making certain that he knows where the job is located, what lubricants or other materials are necessary to complete the job, and that the assigned jobs are geographically arranged to minimize the amount of travel time required. A significant effort has been made to schedule programmed maintenance work geographically by building and by area since the facilities at ORNL cover such an extensive area. Seasonal priorities determine when most of the air handling equipment should be scheduled. Major preventive maintenance jobs for refrigeration compressors, condensers, and fan coil units are obviously scheduled for off-season.

Reactor shutdown schedules determine the scheduling for still another catagory of equipment. Generally, programmed maintenance can only be performed on reactor-related equipment when the reactor is not in operation. Occasionally, it becomes necessary to redistribute part of the work load to a particular work center due to the addition of new facilities in that area or a change in manpower available to complete the work.

Scheduled frequencies for individual points of service are determined, using both manufacturer's data and experience gained from similar pieces of equipment as previously mentioned. The frequencies available for use in the program are as follows:

CODE	FREQUENCY	CODE	FREQUENCY
W	Every Week	3Y	Every 3 Years
2W	Every 2 Weeks	4Y	Every 4 Years
M	Every Month	5Y	Every 5 Years
6W	Every 6 Weeks	6Y	Every 6 Years
3M	Every 3 Months	7Y	Every 7 Years
4M	Every 4 Months	8Y	Every 8 Years
6M	Every 6 Months	9Y	Every 9 Years
8M	Every 8 Months	10Y	Every 10 Years
Y	Every Year	S	Standby - No Service Scheduled
2Y	Every 2 Years		

Since programmed maintenance is scheduled on the basis of a 48-week year, it is necessary to omit the 13th week of each quarter. This "extra" week is then used to catch up on past due work.

A programmed maintenance slide rule (Fig. 6) has been developed to count the number of elapsed weeks between any two dates without including skipped or omitted weeks. It is a convenient aid used to determine the start time (number of weeks that must elapse before a point of service will appear on a schedule card) which appears in the start column (S) on the IBM Data Sheet and which must be computed on the Field Data Sheet.

Standard times have been developed for many of the programmed maintenance jobs and are under the standard time column for each point of service. The times are computed each time scheduled maintenance is due and therefore vary depending on which times are to be serviced. The standard times are compared to actual times (obtained from the programmed maintenance history card) to produce a productivity figure. All computations are performed, utilizing computer programs developed specifically for ORNL programmed maintenance with necessary reports available as requested.

The reschedule report (Fig. 7) is a listing of scheduled programmed maintenance that has not been reported as completed work within a reasonable length of time. The report is actually an accumulation of several original weekly schedule lists with the completed jobs deleted as of a specified cut-off date. The reasonable length of time allowed for completion depends on the frequency printed on the schedule card. The least frequent items establishes priority if several different frequencies appear on the same schedule card. The following table is used as a guide:

SCHEDULED FREQUENCY	TIME ALLOWED FOR COMPLETION
Weekly	Regular day within the week
2 Weeks	± 2 days
Monthly	± 5 days
2 Months	± 8 days
3 Months	± 2 weeks
4 Months	± 2 weeks
6 Months	± 3 weeks
Yearly	± 4 weeks

Allowances are made for shutdowns or other extenuating circumstances.

The reschedule report is distributed to each work center and reviewed by the general foreman to determine why equipment has not been serviced

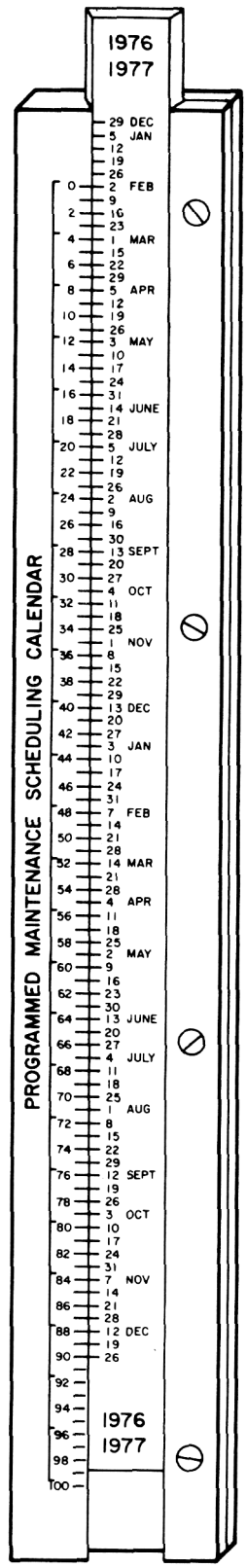

Fig. 6. Programmed Maintenance Slide Rule

RESCHEDULE LIST FOR AUG 28,1979

LOCATION		EQ P NO	DESCRIPTION	PROPERTY	JOB ORDER	FOREMAN	STD TIME	DATE SCHEDULED
4500N 00	025	940	VALVE,P.R.# 517 NORTH, PIT 26		G3637E-AA	KEENEY	72.6	MAR 26 1979
4500N 00	026	940	VALVE,P.R.# 518, NORTH, PIT 26		G3637E-AA	KEENEY	72.6	MAR 26 1979
4500N 00	027	940	VALVE,P.R.# 537, NORTH, PIT 27		G3637E-AA	KEENEY	72.6	MAR 26 1979
4500N 00	028	940	STEAM VALVE PIT NO 28		G3637E-AA	KEENEY		JUN 18 1979
4500N 00	031	940	VALVE,P.R.# 519, EAST, PIT 31		G3637E-AA	KEENEY	72.6	MAR 26 1979
4500N 00	033	940	VALVE,P.R.# 520, EAST, PIT 31		G3637E-AA	KEENEY	396.6	AUG 6 1979
4500N 01	005	725	GROUND FAULT INTERRUPTER NO 72		H9999E-13	GENTRY		JUL 9 1979
4500N 01	048	895	SUMP PUMP		H4500E-D1	WILSON		APR 2 1979
4500N 01	140		UTILITY PIPE TUNNEL WING 1		H4500E-K1	GENTRY		MAY 14 1979
4500N 01	160	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55009	H4500E-C1	WILSON		AUG 6 1979
4500N 01	160	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55009	H4500E-C1	WILSON		JUL 23 1979
4500N 01	160	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55009	H4500E-C1	WILSON		JUL 30 1979
4500N 01	170	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55001	H4500E-C1	WILSON		AUG 6 1979
4500N 01	170	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55001	H4500E-C1	WILSON		JUL 23 1979
4500N 01	170	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55001	H4500E-C1	WILSON		JUL 30 1979
4500N 01	170	950	FULLER VACUUM PUMP,VACUUM PUMP ROOM	X-55001	H4500E-C1	WILSON		JUN 18 1979
4500N 01	200	950	VACUUM PUMP (FULLER) N-CENTER UNIT	X-54992	H4500E-C1	WILSON		AUG 6 1979
4500N 01	200	950	VACUUM PUMP (FULLER) N-CENTER UNIT	X-54992	H4500E-C1	WILSON		JUL 23 1979
4500N 01	200	950	VACUUM PUMP (FULLER) N-CENTER UNIT	X-54992	H4500E-C1	WILSON		JUL 30 1979
4500N 01	205	620	SUBSTATION BATTERIES,CHARGER		H4500E-K1	FAIR		JUN 18 1979
4500N 01	225	610	ONAN AUX ELECT DIESEL GEN UNIT	X-83057	H4500E-K1	GENTRY		AUG 6 1979
4500N 01	225	610	ONAN AUX ELECT DIESEL GEN UNIT	X-83057	H4500E-K1	GENTRY		JUL 23 1979
4500N 01	225	610	ONAN AUX ELECT DIESEL GEN UNIT	X-83057	H4500E-K1	GENTRY		JUL 30 1979
4500N 01	250	544	SUPPLY FAN NO 3 A/C,HEATING WING 2		H4500E-E1	MONTGOMRY		MAY 28 1979
4500N 01	290		UTILITY PIPE TUNNEL WING 2		H4500E-K1	GENTRY		MAY 14 1979

Fig. 7. Reschedule List

and how critical the equipment is to the facility where it is located. This review is significant since the past-due work is not rescheduled for programmed maintenance but must be completed as a non-routine maintenance job if the general foreman determines the risk of waiting for the next scheduled maintenance is too great.

Planning, scheduling, and coordination should be directed toward aiding, complementing and strengthening maintenance supervision. Care must be taken to not encroach upon the authority or responsibility of individual supervisors.[2]

PERSONNEL

The programmed maintenance staff is organized under the Maintenance Engineering Department of the Plant and Equipment Division. A three-man staff is responsible for collecting data, reviewing manufacturer's maintenance manuals, developing programmed maintenance instructions, scheduling facilities and equipment for servicing, distribution of schedule cards, updating program to add new equipment and changing instructions on existing equipment, providing necessary reporting and developing the program for maximum effectiveness.

The group leader determines priorities when not clearly established, acts as liason between CTC programmers and Plant and Equipment staff including programmed maintenance personnel. He is responsible for the continued development of the program and works to satisfy the requests which are submitted by the Division staff.

A maintenance engineer develops programmed maintenance instructions, specifies frequencies, and determines which lubricants best meet the requirements for each application. A significant part of his time is spent on reviewing lubrication requests and determining the best lubricants for specific research-oriented applications as well as for utility-type equipment.

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[2]Borden M. Coulter, *Developing A Sound Maintenance Program*, Plant Engineering, May 29, 1975.

A maintenance planning specialist also develops programmed maintenance instructions, and in addition, prepares data sheets for changing instructions and adding equipment, reviews and validates computer output and schedule cards before distributing to the work centers, provides equipment numbering sequences, and collects and prepares history data to document completion and extent of scheduled work.

Field engineers and engineering specialists are available within the Division to assist programmed maintenance staff personnel with developing maintenance instructions and providing technical expertise when requested. Engineers at adjoining plant facilities within the Nuclear Division are consulted with regularity especially in areas such as lubrication requirements.

The first-line supervisor is the key to satisfactory completion of all programmed maintenance assignments. It is his responsibility to distribute the individual schedule cards to his crew and determine the priority since he is also responsible for repair maintenance. The first-line supervisor will determine the ultimate success of the program because in addition to assigning jobs and supervising his crew, he is responsible for the interpretation of the programmed maintenance function and the attitude toward satisfying the program objectives. Over fifty first-line supervisors participate in programmed maintenance activities, some to a greater extent than others, depending on the type crafts assigned and the facilities for which they are responsible.

With this degree of involvement which includes some 400 craftsmen, it is not difficult to understand why the Division maintains an ongoing supervisory development program with significant emphasis on communication and human relation skills.

EQUIPMENT HISTORY

The manpower, planning, and related efforts expended on the programmed maintenance function would be of limited value without some procedure to measure results and record maintenance activity. An attempt was made when the program first started to control the programmed maintenance effort by using duplicate schedule cards. When the original schedule card returned

from the work center, with items checked off and initialed by the craftsman, it was matched with a duplicate card and both were filed as maintenance history. Those duplicate cards remaining to be filed were regarded as the programmed maintenance backlog and were the input data for the first management report called the "Reschedule List".

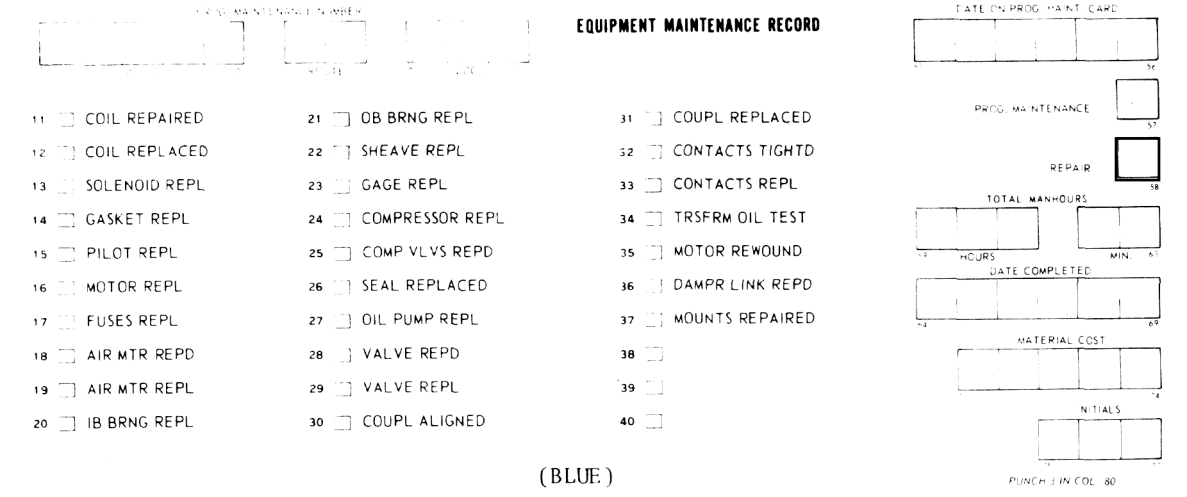
As the program approached its present level of issuing approximately 25,000 schedule cards per year, a more sophisticated program for recording maintenance activity evolved.

A decision was made, during this interim period, to retain the maximum flexibility originally designed into the program. Designing a program with the capability to develop maintenance instructions to fit the individual characteristics of each piece of equipment has some significant disadvantages when reviewing the total system which includes recording maintenance activity.

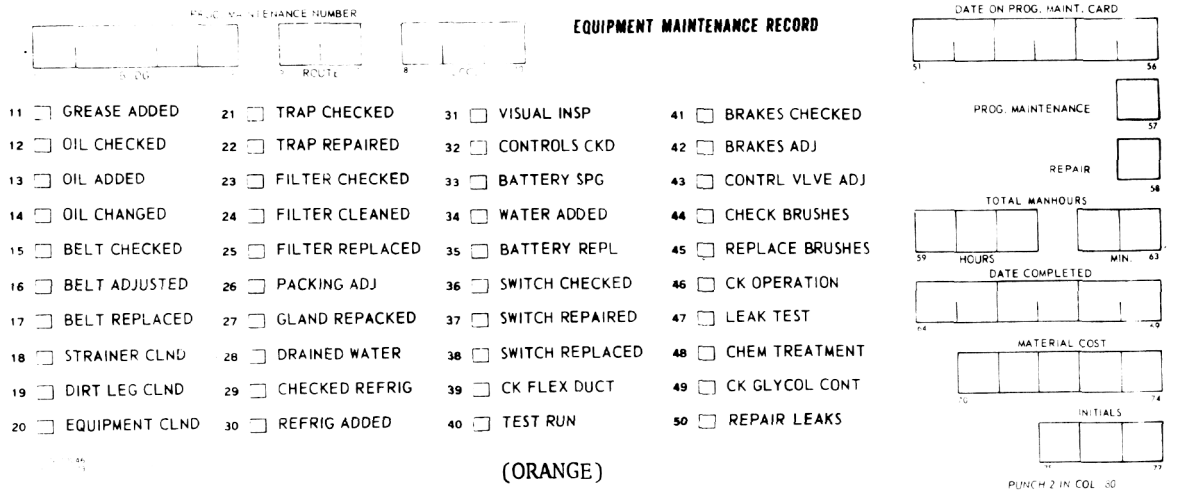
The most obvious disadvantage of not using a standardized set of maintenance instructions becomes more apparent when attempting to design some method for recording maintenance activity. An equipment history card, for recording maintenance activity, had to be designed with enough fexibility to collect meaningful information that documented scheduled programmed maintenance jobs that had been initiated from individualized instructions.

After an exhaustive design and review procedure, a series of three maintenance history cards (Fig. 8) was developed with enough flexibility to record scheduled and non-scheduled maintenance activities. The history cards are distributed to each work center and are designed to be filled in by craftsmen performing either programmed maintenance or non-scheduled repair work. If the maintenance activity is one that is scheduled, the identification number and date are noted on the schedule card and written in the appropriate spaces on the history card. If it is not scheduled maintenance, the identification number can be located on the piece of equipment needing repair.

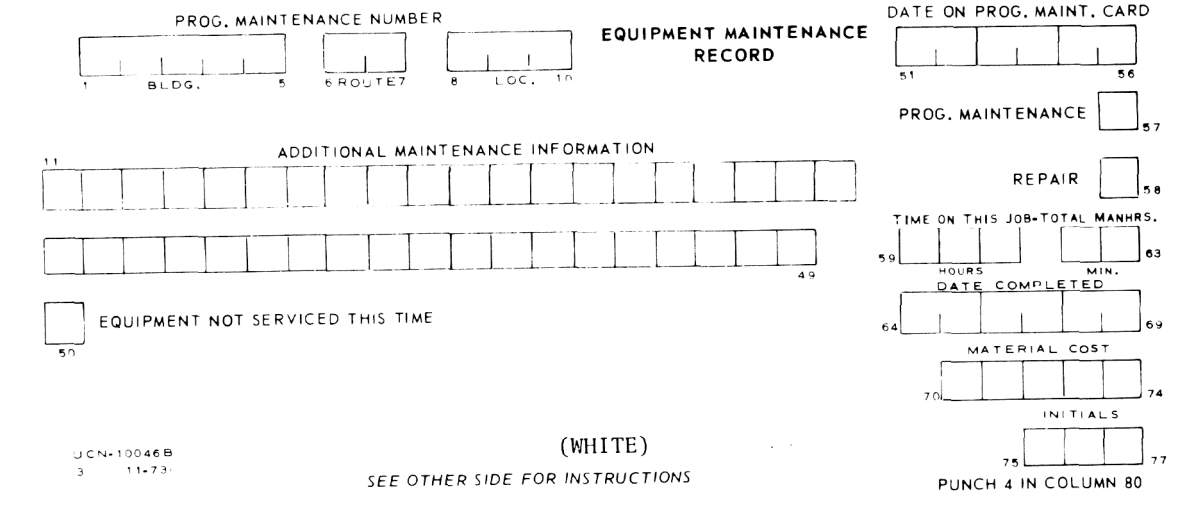
The orange card (UCN-10046) is designed primarily for scheduled maintenance and provides check-offs for inspections and adjustments. The blue



(BLUE)



(ORANGE)



(WHITE)

SEE OTHER SIDE FOR INSTRUCTIONS

Fig. 8. Equipment History Cards

card (UCN-10046A) is designed primarily for repair maintenance and includes mostly check-offs for repairing and replacing parts. The white card (UCN-10046B) is provided as a supplemental card for additional information or when the other cards do not appear adequate for the type of equipment being serviced. The cards may be interchanged; i.e., the repair card (UCN-10046A) may be used for scheduled maintenance although the information collected would not be as complete as it could be if the appropriate card were used.

The manila history card (UCN-10046C) is actually printed on the reverse side of a schedule card (Fig. 9) and at the present time is used only for maintenance of machine shop equipment. It combines several features from the other history cards.

After a maintenance job has been completed and the history card filled in, it is returned to the Programmed Maintenance office and forwarded with scheduling data to CTC for processing. The history information is keypunched and transferred to a disc storage unit located at the Computer Technology Center where equipment history accumulates until a request is made to review a part or all of the available records.

Equipment history can be reviewed from the ORNL site by using a IBM 2740 remote processing unit located in the Plant and Equipment Division office or by submitting a request to personnel at CTC assigned to developing programmed maintenance reports.

The history report is available within minutes when requested from the IBM 2740 which is similar to a teletype unit. After the request is submitted by entering the equipment identification number, the disc unit is searched and transmits the ten most recent maintenance transactions listing them on the Maintenance History Report (Fig. 10). If a complete history report is needed, a request must be submitted to CTC personnel. A complete history report can usually be prepared within the day depending on how many pieces of equipment are included in the request.

The report indicates if the maintenance activity was scheduled or repair work, the completion date, the craftsman completing the work, what work was required, the cost, and manhours required to complete the job.

PROGRAMMED MAINTENANCE FOR WEEK OF OCT 16, 1978 FOREMAN LLOYD
QUALITY LEVEL 4

LOCATION	EQUIPMENT DESCRIPTION	PROPERTY	JOB ORDER
0000- 66 109	LATHE MONARCH 10 IN	X-73737	2525

ITEM	POINT OF SERVICE	LUB	FTNG	NC	FREQ	REMARKS
1	LUB REAR SPINDLE BRNG	DJ			2W	1 PT. CAP.
2	LUB FRONT SPINDLE BRNG	DJ			2W	1 PT. CAP.
3	CK HEADSTOCK RESV OIL LEVEL	BG			2W	3 QT. CAP.
5	LUB TAILSTOCK SPINDLE	BG			2W	
6	LUB TAILSTOCK WAYS	BG		OC	2W	
7	GEARBOX FILLING POINT				2W	
8	CK GEARBOX OIL LEVEL	BG			2W	
10	CK APRON RESV OIL LEVEL	BG			2W	
12	LUB LEADSCREW END BRNG	BG		OC	2W	
15	CK SPEED REDUCING OIL LEVEL	BG			2W	
17	CK COOLANT SUMP LEVEL				2W	3 GAL. CAP.
23	LUB LEADSCREW ADJ MECHANISM	BG		OC	2W	

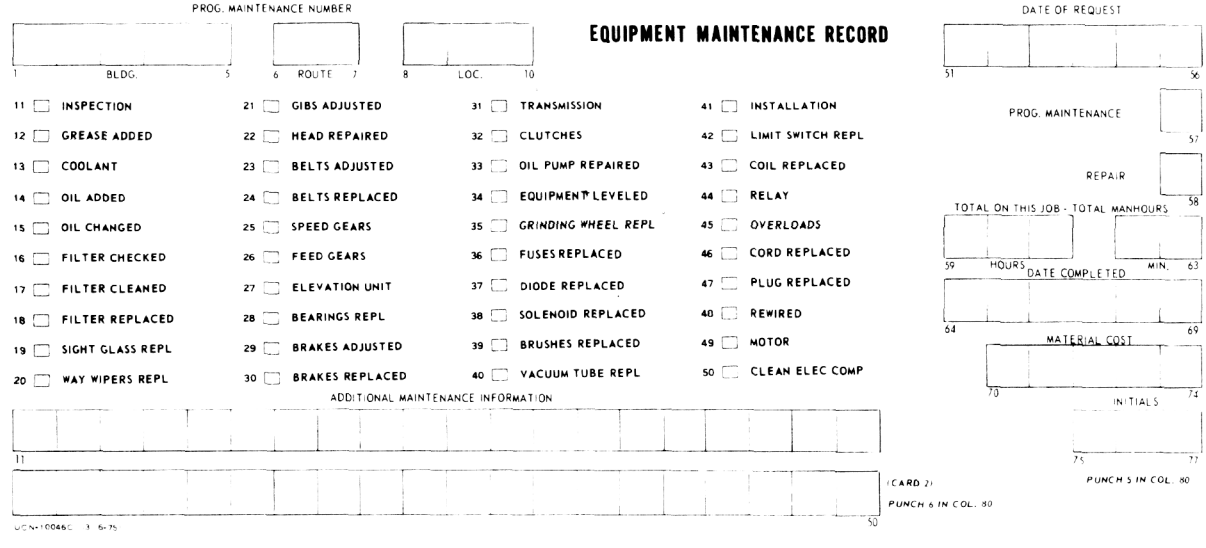


Fig. 9. Fabrication Shop History Card

ORNL EQUIPMENT MAINTENANCE

REPORT NO. 2382 RUN DATE 04/20/79

P.M. NUMBER 7007-01005 DESCRIPTION TRANF TOWRIDOR UNIT HEATER, ATTIC WORK ORDER H70075-01 FOREMAN FIELDS •••••CUMULATIVE TO DATE••••• HOURS 16.5 MATERIAL COST 24

•••••••DATE••••••• SCHEDULED	COMPLETED	BADGE	WORK TYPE	HOURS	MATERIAL COST	WORK PERFORMED		
09-23-74	11-11-74	AEM	PROG MAINT	0.7	0	GREASE ADDED TEST RUN	VISUAL INSP CK OPERATION	CK FLEX DUCT
12-23-74	01-29-75	AEM	PROG MAINT	2.2	6	BELT CHECKED VISUAL INSP	FILTER CHECKED TEST RUN	FILTER REPLACED CK OPERATION
09-22-75	11-11-75	LRN	PROG MAINT	1.0	0	GREASE ADDED CONTROLS CKD	OIL ADDED CK FLEX DUCT	VISUAL INSP CK OPERATION
12-22-75	12-19-75	CMH	PROG MAINT	0.0	0	FILTER REPLACED		
09-20-76	10-08-76	JPH	PROG MAINT	1.0	0	GREASE ADDED FILTER REPLACED CK OPERATION	EQUIPMENT CLND SWITCH CHECKED	FILTER CHECKED TEST RUN
12-20-76	12-20-76	LRN	PROG MAINT	0.5	0	GREASE ADDED CK OPERATION	FILTER CHECKED	VISUAL INSP
- -	01-11-77	CMH	REPAIR	2.0	6	REPL FLTRS		
04-04-77	04-04-77	CMH	PROG MAINT	0.7	0	GREASE ADDED VISUAL INSP CK OPERATION	EQUIPMENT CLND SWITCH CHECKED	FILTER REPLACED TEST RUN
01-30-78	02-02-78	CMH	PROG MAINT	0.7	0	EQUIPMENT CLND SWITCH CHECKED	FILTER REPLACED TEST RUN	VISUAL INSP CK OPERATION
01-02-78	02-02-78	CMH	PROG MAINT	0.7	0	GREASE ADDED SWITCH CHECKED	FILTER REPLACED TEST RUN	VISUAL INSP CK OPERATION
02-27-78	02-27-78	CMH	PROG MAINT	0.3	0	FILTER CHECKED	VISUAL INSP	
10-02-78	10-03-78	CMH	PROG MAINT	1.0	12	GREASE ADDED VISUAL INSP CK OPERATION	OIL ADDED CONTROLS CKD	FILTER REPLACED TEST RUN
10-30-78	10-30-78	FWB	PROG MAINT	1.7	0	FILTER REPLACED	VISUAL INSP	
01-01-79	01-09-79	FWB	PROG MAINT	1.0	0	GREASE ADDED VISUAL INSP	BELT CHECKED TEST RUN	FILTER REPLACED CK OPERATION
01-29-79	01-29-79		PROG MAINT	1.0	0	FILTER REPLACED	VISUAL INSP	
02-25-79	02-26-79	FWB	PROG MAINT	1.0	0	FILTER REPLACED		
02-26-79	02-26-79	FWB	PROG MAINT	1.0	0	FILTER REPLACED		

Fig. 10. Maintenance History Report

The history data, which is being collected on the program at this time, represents an accumulation of less than four years and is therefore somewhat limited when examined for equipment replacement justification. As the history records continue to accumulate, the trends usually sought for equipment and related engineering analysis will become more apparent, increasing the credibility of the Programmed Maintenance function.

COMPUTER PROGRAMMING

The computer program system for the maintenance scheduling is designed to provide, along with the specific programmed-maintenance objectives, a few additional points which served as the original criteria for developing the computer program. The major purposes for which this programming effort was undertaken are as follows:

Original Programming Criteria

1. To provide weekly schedule cards which clearly identify the equipment serviced, its location, the points of service to receive attention, and any material specifications associated with service requirements. Of the listing of total service requirements, only those points of inspection and service to be performed on any specific week of the scheduling appear on the schedule cards for that week. Space must be allowed for the craftsmen to record evidence of the service performed.
2. To provide for a record of equipment specifications and manufacturers nameplate data. These data, along with the listing of service requirements make up the master data sheet and are maintained on magnetic tape as the master data record.
3. To provide counting techniques for a wide range of service frequencies from one week to ten years.
4. To provide for weekly scheduling. No attempt to define the daily work load will be made at this time.
5. To skip scheduling the 13th week of each quarter to correct for the months having five weeks. Neither scheduling for nor counting of these weeks will be required. This establishes 12 scheduling periods

per year with four weeks in each period. Scheduling is therefore performed on a 48-week year.

6. To provide for a "standby" frequency to be used for those units of equipment currently out of service, which will not require maintenance, but which will be reactivated at a later date.

7. To provide flexibility in establishing the time for the first schedule card to appear when new equipment is introduced into the program.

8. To provide for craft designations and time estimates for each point of service. The manpower level of craftsmen assigned to this work is kept flexible, and there will be no need at this time for programmed work-load leveling, but weekly work-load levels by craft will have to be reported.

9. To provide for overriding shorter-term schedules with semiannual, or longer interval schedules. This is necessary when an annual operation, such as the draining and flushing of a crankcase, takes precedence over a monthly schedule of checking the oil level. It is also applicable when a five-year equipment overhaul would take precedence over an annual inspection.

10. To provide for listing spare parts and stock numbers associated with critical equipment items.

11. To issue duplicate sets of schedule cards weekly.

12. To provide coding for seasonal service. Service instructions from November 1 through April 30 may read differently than instructions from May through October 31. This would be the case with seasonal air conditioning and is also applicable when lubricant codes change from summer- to winter-grade viscosity.

13. To maintain a summary-type record of scheduled work that has become delinquent.

14. To provide a method of maintaining and updating of the original data through input data sheets.

15. To provide for optional listings of the master information.

A series of five computer programs named PROMUP, FORLIS, RESKID, RESFOR, and PROMLIS, have been developed to meet the above criteria and make up the Programmed Maintenance System (PROMSYS). The data are maintained on magnetic tape in the form of master records, where a master record is assigned a job number identified by a 12-digit equipment location number containing data fields for a building number, a route within a building, a machine number and a sub-assembly number. The sub-assembly number is used to extend the record when a piece of equipment contains more than 60 items of service. Data are entered in the form of punched cards, and output is in the form of printed lists and printed cards. The current programs are written in ANS COBOL for the IBM OS/360 computer and are briefly described as follows:

Program PROMUP inputs update information in the form of punched data cards which are sorted in job identification sort order. The data are then merged with the master-tape information and a schedule is prepared for each week of requested scheduling. A master-output tape is written with the update information. Two additional tapes are written: 1) the printed schedule cards and 2) a one-line summary list of schedule information. Program FORLIS, run as a second step of the PROMUP run, is used to sort the schedule tape information in foreman sort order and produce a list of the sorted information.

Program RESKID is designed to add the one-line schedule information to a delinquent schedule master. As the work is performed the printed cards are returned and a punched card is prepared as input data to the RESKID program. The data are matched against the delinquent schedule master and are deleted from the master when a match is found. The remaining master information is listed as past due work on an output list, in job identification sort order. Program RESOR prepares the same delinquent master list information in foreman sort order.

Program PROMLIS provides for a variety of optional listings of the master information created by program PROMUP.

Program PROMUP

Program PROMUP is designed in several sections which are used to maintain and update master tape information, scan master tape records and produce the appropriate schedule cards, print associated information lists, and list the entire master tape information upon request. The new master tape is created by blending information from an old master tape with input transactions formed from the programmed maintenance data sheets. The first record on the master tape contains a set of tables used to establish the skip-week data, define and update the calendar date, define the numerical equivalent of the frequency codes, and record the week of the next schedule due to be run on the new tape. The tables are followed by records where each record contains the information pertinent to one job identification. A detailed list of the master tape is given in Appendix A.

An input data set is prepared by punching cards from input data sheets. The first card in the data set is used to control the flow of the program logic. The beginning schedule date, optional data input and optional master list output, along with the master tape control and seasonal item selection are included on the control card. The next set of input data is optional and updates the master tables upon request. The remainder of the data, also optional, are punched from the programmed maintenance data sheets. The data sheet input cards are blocked by the program into transaction records where one transaction contains all the update information for one logical master record. The transactions are sorted by job identification and are merged with the master records in that order. A list of the input data is given in Appendix B.

As the input data are read from the sorted data set they are scanned for some possible errors. If an error is encountered, an error message is printed and the data are deleted. Other errors may be encountered during the master record merge process. Again, an error message is printed and the erroneous data are not transferred to the master record. Some errors may be found in the tape record during the scheduling process, due to faulty tape writes, and are reported with an error message. A list of the possible error messages is given in Appendix C.

For the initial computer run, no old master tape is available for updating. One of the control card parameters may be set to allow for this situation. Thereafter, the parameter is changed to allow the update of an existing master schedule tape.

Start-Up Run

When no old schedule master tape is available, a tape control code of "0" on the control card (See Appendix B) will cause the program to bypass the reading of an old master tape and proceed directly to the reading of input data for the master tables. When the tables have been read, the transaction data are processed. Only record-addition transactions (See Appendix B) are allowed during a start-up run, any other type of transaction constitutes an error. The addition of a record requires 5 header cards and from 1 to 60 item cards.

Update of Master Tape

Records may be added to or deleted from the schedule master tape, or information on an existing master record may be changed as a part of the update procedure. The master tables may be changed by setting the appropriate control card and entering the table cards as shown in Appendix B. If more than one table is entered during one computer run, the cards must be stacked in the order listed in the Appendix. The table cards should be placed immediately behind the control card. The calendar table must be changed each leap year to change the number of days in February from 28 to 29 and changed again the year following leap year to change the February days from 29 to 28. The skip-week table must be entered each year to reset the skip-week dates at the beginning of the week for the four skipped weeks. The frequency-code table will be changed at the request of the program user.

The tape date, which is carried in the tables record, is the date of the next schedule to be run from the tape information. The date is compared with the schedule date given on the control card, and the computer run is aborted with the error message "WRONG CONTROL DATE FOR THE TAPE DATED (Tape Date)" if the dates do not match. The tape date

which is normally calculated during a schedule run (skip-week dates are excluded), but the tape date may be changed by setting the table-read control code on the control card to "7" and including a tape date card as shown in Appendix B. The tape-date card will also be read with the table-read control code is set to "6" which reads all of the table cards.

Each job location record may store the information from 5 header cards and from 1 to 60 work item cards. The header cards contain data that are pertinent only to the equipment at the given job location and have no bearing on the work to be performed on the equipment. The item cards contain the information necessary to request a specified amount of work and are issued at the given point in a periodic schedule. Each item card may contain only one frequency code which determines the periodic cycle for scheduling the work item, however, several items may be entered on one job location containing different frequency codes.

The type of data being entered (addition, deletion, or change) during an update procedure is determined by card-codes in columns 73 and 74 of the first header card and column 73 of the item card. The header card codes (see Appendix B) for column 73 are as follows:

Code	Function
1	Add new record to the master tape
2	Delete old record from the master tape
3	Change header 1 of an existing record
4	Change header 2 of an existing record
5	Change header 3 of an existing record
6	Change header 4 of an existing record
7	Change header 5 of an existing record
8	Read the next card as an item card
9	Change the job location number

When codes 4 to 7 are used, the header cards to be changed should follow header card 1. The card codes for 74 of the first header card are as follows:

Code	Function
1	Change the foreman on master record header 1
2	Change the work order number on master record header 1
3	Change the foreman and work order number on header 1
9	Signal for beginning of a new job location number when 1, 2, or 3 is not used

Since it is necessary for the program to determine which of the input data cards are header cards, any positive number in column 74 is used to indicate a header card 1. No other data card may contain information in column 74. Enough card codes are given in the above list so that no card codes are needed for header cards 2 through 5.

If header card 1 contains an "8" in column 73, the next card read is an item card, and updating is controlled by the item card codes in column 73 of the item card. The item card codes (See Appendix B) are as follows:

Code	Function
1	Add given item number. If an item already exists with the given item number, all the items with that number and higher are given the next highest item number.
2	Delete the given item number. The items with higher item numbers than the given item are given the next lowest item number.
3	Change item. The master information is replaced with the card information for the given item number.
4	Change standard time and craft code. Only the standard time and craft code on the master information are replaced with the card data for the given item number.
5	Change start-schedule counter. The number of weeks before scheduling occurs is replaced with the card data for the given item number.

Code	Function
7	Change frequency-code and start-schedule counter setting. The frequency-code and start counter in the master record are replaced with the card data for the given item number, and a new restart-schedule counter is obtained from the master frequency-code table.

The schedule master tape is arranged by job location number, and the input transactions are sorted in the same order. Master records are read from the master tape until a matching job location number is found for deletion or change transactions or until the job location number for an add-record transaction is in the proper sequential order. As each master record is moved into the computer core memory, it is first updated with the input transaction data (if such data are present) and then checked for scheduling and output instructions. When all the desired action has been performed on the record, it is written on a new master tape, thus the old master tape may be retained for a backup copy.

Scheduling of Work Items

Part of the information obtained from the control card read at the beginning of the program (see Appendix B), is the date of the first week to be scheduled during the computer run and the number of weeks to be scheduled. The computer calculates the actual dates of weeks to be scheduled (starting from the date obtained from the control card) using the calendar table given in Appendix B. As each date is calculated, it is checked against the skip-week table. If a match is found, the date is omitted, and the next date is calculated. The omitted date is not included in the total number of weeks to be scheduled during the computer run. The scheduling procedure of the program scans the work items assigned to each job location number on the schedule master and determines if the item is due to be scheduled.

Work-item scheduling is accomplished through the combined use of the start-schedule counter and restart-schedule counter carried as part of each item is added or changed during the updating procedure.

The frequency-code table used at present is as follows:

Frequency Code	Restart Schedule Counter
W (Weekly)	1
2W	2
6W	6
M (Monthly)	4
2M	8
3M	12
4M	16
6M	24
8M	32
Y (Yearly)	48
2Y	96
3Y	144
4Y	192
5Y	240
6Y	288
7Y	336
8Y	384
9Y	432
10 (10 Years)	480
S (Standby)	- 1

Thus the restart-schedule counter indicates the number of weeks between scheduling the item. A standby item will not be scheduled once the start counter becomes negative.

For each calculated schedule date, the time-start-schedule counter is reduced by 1 until the start schedule counter reaches "0"; the computer then adds the item to the printed card list, adds the standard time for the item to the total standard time scheduled for the job location, and moves the restart-schedule counter to the start-schedule counter in order to repeat the schedule cycle. A standby item may be originally added with a positive start-schedule counter which will allow the item to be scheduled one time; however, once the restart-schedule counter has replaced the start-schedule counter, the item will not be scheduled. The standby item may be reactivated by overriding the start-schedule counter to a positive number or changing the frequency code and start-schedule counter to a different value.

Restraints may be placed on scheduling an item by the use of an alternate item number. For example, maintenance forces would not want

to continue with a weekly schedule of adding oil to a crankcase if, on the same week, they were scheduled to drain and refill the crankcase. If a specified alternative item is due to be scheduled at the same time as a given item, the given item is not added to the schedule list, and the start-schedule counter is replaced by the restart-schedule counter as if the item had been scheduled.

Restraints on scheduling an item may also be based on seasonal designations. The servicing of some equipment is seasonal; for instance, checking antifreeze protection is not done in the summer season and is designated a winter (W) item. The desired season for the upcoming weeks of scheduling is given on the control card so that variations in seasonal changes can be accounted for. A year with a late winter, for instance, requires checking the antifreeze protection for a few weeks longer than those years with an early spring.

When seasonal items are ready for scheduling (indicated by reading a zero on the start-schedule counter), the season for the item is checked against the season on the control card. If the season does not match, the start-schedule counter is replaced with the restart-schedule counter with the item not being scheduled. If the season on the control card is left blank, or set to either an "A" or "0", all items due to be scheduled are scheduled regardless of their seasonal designation. Items with a season of "0" or blank space are not subjected to the seasonal restraint. When all items for one job location number have been examined, the appropriate information is transferred to the printed card list and the one-line schedule tape for use by program RESKID. The printed card information is written on a data set that is sorted in ascending date, foreman and job location number order before they are written on the printed card list tape.

Output

Output from the computer is in the form of printed lists and printed cards. The sorted transactions are listed before updating is performed. The updating procedure lists each update master record after the new data have been placed on the record and all items have

been scheduled. By setting the proper control (See Appendix B) the entire master tape may be listed during the update and schedule procedure. At the end of the run, the one-line schedule tape is rewound and listed in job location number order. The next output is a foreman job summary where the number of jobs for each foreman for each week of scheduling is printed in tabular form with a total given at the end of the table. A list of the job records added and the job records deleted are given followed by the total number of job records on the master tape.

If header card 1 code of "99" (change the job location number) is used, the master must be sorted to maintain the master tape job location number sort order. When this occurs, a summary list of the master is printed after the sort is complete.

The card data are passed to a disk data set during the scheduling procedure and sorted in mechanical equipment or non-mechanical equipment, schedule date, foreman name and job location number order. The sorted data set is written on a magnetic tape and removed to an off-line printing computer, where the mechanical equipment jobs are written on the back of a preprinted continuous card form and the remainder of the schedule is printed on a plain continuous card form. The cards are then torn apart to be sent to the field foremen.

The one-line schedule tape is passed to a second step of the computer run where program FORLIS sorts the information in foreman sort order and prints the sorted data set on an output list.

A flow diagram for program PROMUP is shown in Figure 11.

Program RESKID

Delinquent work lists are listings of programmed-maintenance and assignments that have not been completed by the maintenance crews. Provision has been made for furnishing the delinquent lists on whatever frequency is deemed necessary, although a monthly review of delinquent work is considered desirable. Work that has not been completed within 30 days of its scheduled date is considered delinquent. With the

delinquent lists, foremen and other departmental supervisors can keep current with the status of the work. (Fig. 12)

Program RESKID (Fig. 12) is designed to maintain a master tape of delinquent information on all jobs scheduled that are not considered as work completed. Schedule information is transmitted from program PROMUP through the one-line schedule tape, placed on the delinquent work master tape and deleted from the master tape through punched delete cards.

When the printed cards, produced by program PROMUP, are sent to the field, the work items shown on the card are performed by the maintenance craftsmen. Upon completion of the work, the craftsmen returns the cards to the foreman, who returns the cards to the computer group. A punched card is prepared from the returned printed card and is used as input for the RESKID program (delete card). The delete cards are sorted in job location, schedule date sort order and are matched against the delinquent work master tape until a match is found for both job location number and schedule date. When the match is found, the schedule information is deleted from the master tape. The remainder of the master tape information is printed as the delinquent list and sent to the foreman in charge of the work. A new delinquent work master is created each time information is added from the one-line schedule tape or deleted by the punched delete cards. The information recorded on one master tape record is shown in Appendix A. The punched delete card is shown in Appendix B. The flow of the program logic is controlled by control parameters obtained from the first input data card (control card) as shown in Appendix B.

When no old master tape is available, a master tape is originated by setting the master-tape-control code to "0" on the control card and providing a one-line schedule tape from program PROMUP. The control card schedule-tape control is set to "1" (schedule tape information to be added to the master). The data from the schedule tape is transferred to the delinquent work master tape and a list of the tape is given as output.

It is possible for three separate input conditions to occur during an update run; either the schedule tape is available, the deletion cards

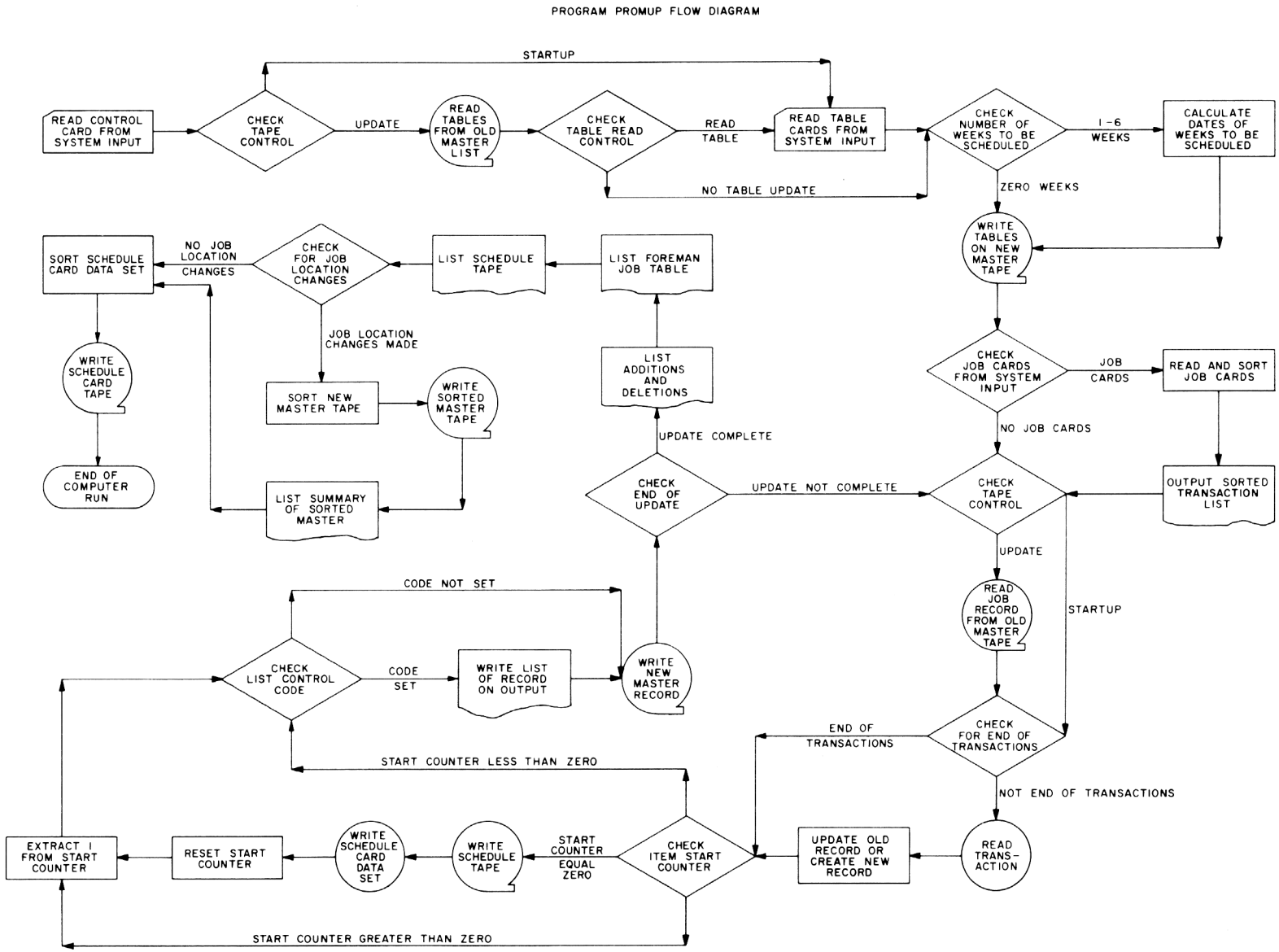


Fig. 11. PROMUP Flow Diagram

are available or both the schedule tape and the deletion cards are available. The tapes and data input are manipulated by the combined use of the card-input-control and the schedule-tape-control code on the control card. If deletion cards are available, they are stacked behind the control card; if the cards are not available, only the control card is entered as data. The master tape is always ordered according to job location number with a subsort on schedule date (dates are in alphabetic order, not calendar order). The deletion cards are sorted by the program in the same order as the master tape before being used to delete master records. If a deletion card is entered and a matching job location number and schedule date cannot be located on the master tape, an error message is printed and a new delete card is punched to be included in a subsequent run. This corrects the situation where a printed data card is returned before the schedule information is added to the master tape information.

Any errors encountered during an update run are listed (see Appendix C for possible errors), and a list of new master information follows the error list. A master-tape-control code of "2" is used to omit the updating function and to list the information contained on the master tape. In this procedure the master tape to be listed is placed in the "new" master tape position for reading, and the new master tape is not created.

A second program RESFOR, is run as a second step of the computer run and is used to sort the newly created master tape in foreman sort order. The information is listed after the sort is complete.

A flow diagram for Program RESKID is shown in Figure 12.

Program PROMLIS

Since the schedule master tape tends to become rather lengthy, it is desirable at times to be able to look at specific portions of the master tape records without taking a full master tape list. Program PROMLIS has been designed to produce optional tape lists, using a punched control card to determine the type of list desired from the schedule master tape produced by program PROMUP. The form of the control card is shown in Appendix B.

One of the parameters on the control card is the list option code and the options are as follows:

Code	Option
0	List all of the master tape records.
1	List selected master records from a beginning job location number through an ending job location number.
2	List the master records containing a selected foreman.
3	List the master records containing a selected work order number.
4	List the master records belonging to a selected equipment class.
5	List the master records with a selected route number.
6	List the master records with a selected route number, sorted by property number.
7	List the master records with a selected work order suffix. (Last two digits of the work order number).
8	List the master records whose work items contain an alternate item number.
9	List the master records whose work items contain a seasonal designation.

When the chosen option requests a selected option list, a selection card must follow the control card to specify the selection. The form of the selection cards is shown in Appendix B.

At times it is necessary to see the full representation of the master record and at other times only a one-line summary list is needed. A second parameter on the control card provides for the output to be a full master record or a summary list. The parameter values are given in Appendix B.

Although space is provided on the control card for a run date to be entered, the date is used for card reference only. The output list

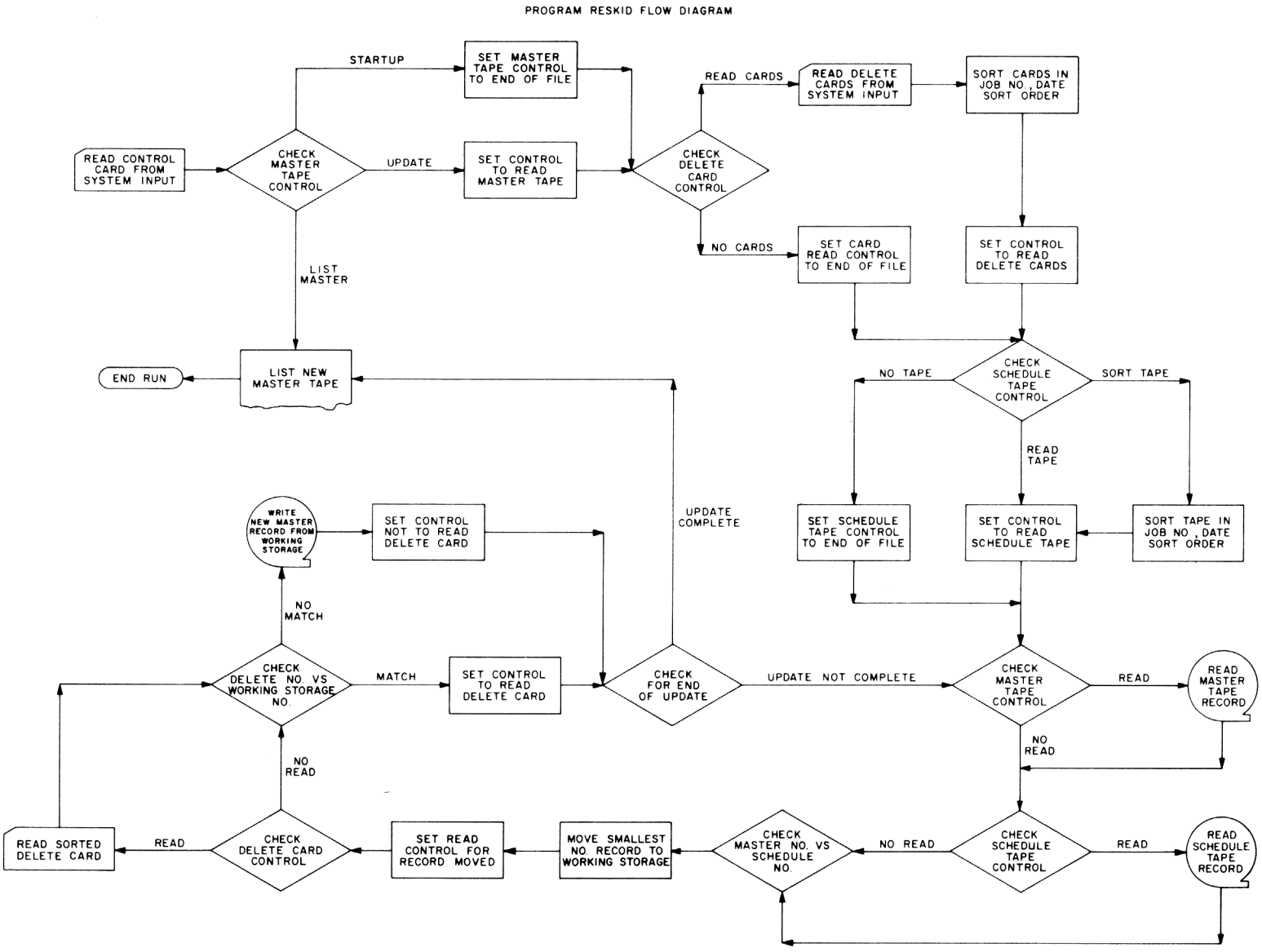


Fig. 12. RESKID Flow Diagram

date is obtained from the tape date in the first record on the master tape.

The only error messages included in the program are for failure to include input control or selection cards and the mounting of a master tape with no records on the tape. The error messages are given in Appendix C.

The flow diagram of program PROMLIS is shown in Figure 13.

Maintenance History Programming

Seven computer programs have been developed to maintain and retrieve history of programmed maintenance and repair work. This history is stored on magnetic tape in the form of a master record which is identified by a ten position equipment number. Each piece of equipment retains up to 52 occurrences of history which contain information about the scheduled and completion dates, the person who performed the work, the type of work, and a description of the work performed (Fig. 14). The current programs are written in ANS COBOL for the IBM OS/360 computer and are described as follows:

BSD02037. The update program reads history information in the form of punched data cards. Each history card is added to its corresponding equipment master record, if there is a corresponding equipment number on the PROMUP master file. An activity report #2380 is printed and an updated programmed maintenance master file is written on magnetic tape. This updated file is the basis for the other programs in the PM history system. (Fig. 14)

BSD02040. This program is used when PM history is needed for selected classes of equipment. The selected classes are fed into the system via punched data cards. The PM history master file is read to pick off the pieces of equipment that are in the selected classes. These selected histories are then sorted in class and PM number order and report #2381 is written. (Fig. 15)

BSD02076. When changing PM numbers, the PM number to be changed and the

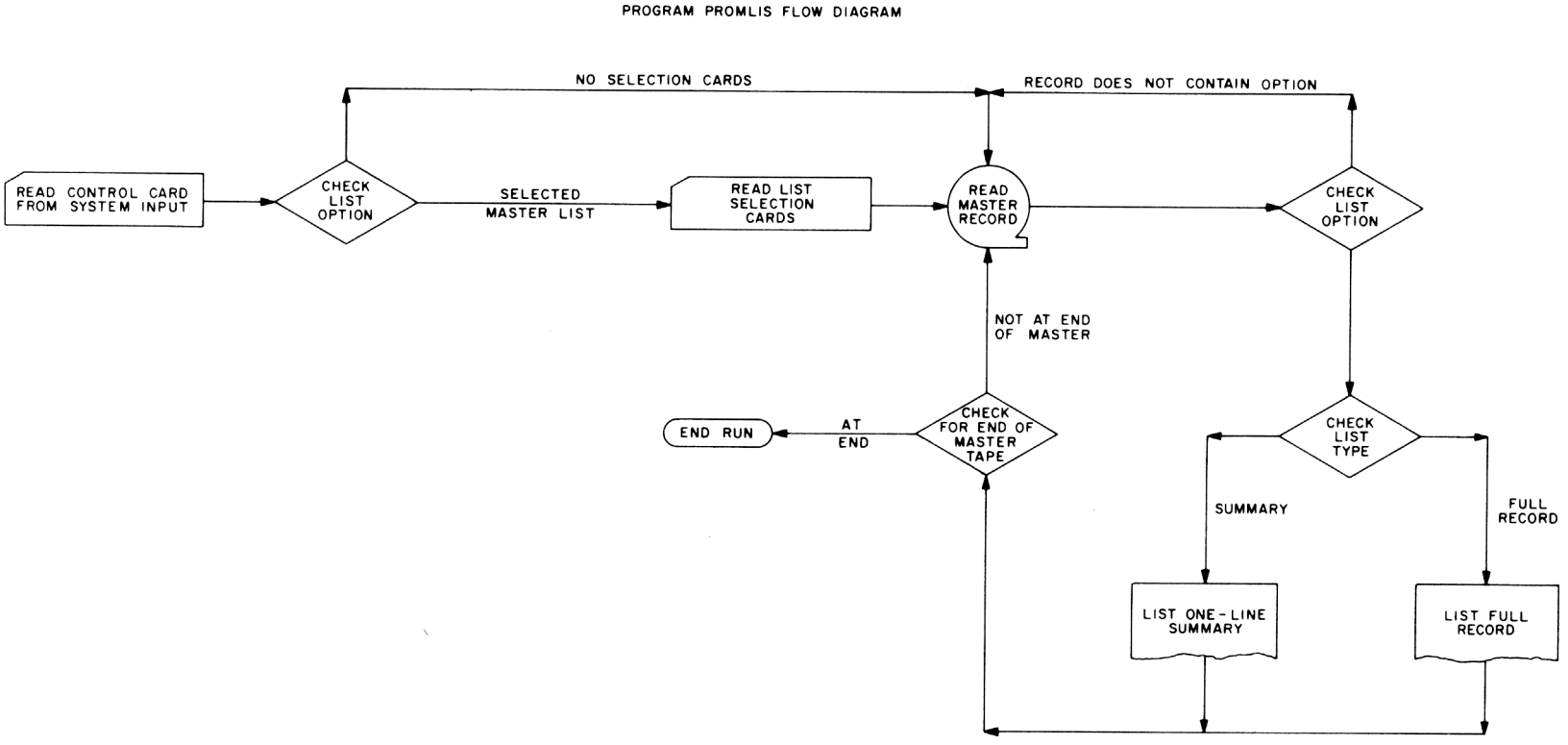


Fig. 13. PROMLIS Flow Diagram

FIG. 14. PM HISTORY MASTER TAPE RECORD

01	MASTER RECORD		
02	EQUIPMENT NUMBER		X(10)
02	EQUIPMENT DESCRIPTION		X(35)
02	FILTER TYPE		XX
02	WORK ORDER NUMBER		X(9)
02	FOREMAN		X(9)
02	CUMULATIVE HOURS OF MAINTENANCE AND REPAIR		9(6)V9 9(7)
02	CUMULATIVE MATERIAL COST		X(7)
02	PROPERTY NUMBER		X(8)
02	MODEL OF EQUIPMENT		X(14)
02	SERIAL NUMBER OF EQUIPMENT		X(4)
02	ROOM LOCATION		X(4)
02	FAN NUMBER		X(3)
02	EQUIPMENT CLASS CODE		X(44)
02	SPACES FOR RECORD EXPANSION		9(3)
02	COUNT OF ELEMENTS IN HISTORY ARRAY		
02	HISTORY ARRAY OCCURS 52 TIMES		
03	DATE WORK WAS SCHEDULED		X(6)
03	DATE WORK WAS COMPLETED		X(6)
03	PERSON PERFORMING WORK (BADGE OR INITIALS)		X(5)
03	TYPE OF WORK (PROGRAM MAINTENANCE/REPAIR)		X(10)
03	MANOMETER AND SPEED READINGS		X(8)
03	MAN-HOURS REQUIRED TO PERFORM JOB		9(4)V9
03	MATERIAL COST OF JOB		9(5)
03	CARD TYPE		9
03	WORK CODE OCCURS 15 TIMES		99
03	WORK REMARKS REDEFINES WORK CODE		X(30)
03	DATE FOR SORTING HISTORY ARRAY (YYMMDD)		X(6)
03	SPACES FOR COMMENTS		X(2)

new PM number are read by this program in the form of punched data cards. The updated PM master is read until the equipment number to be changed is found. The number is then modified, the master file is sorted, and a new PM history master file is written. (Fig. 16)

BSD02041. This program is used when PM history is needed for selected pieces of equipment or a listing of the complete history file. Punched data cards are used to tell the program which pieces of equipment to select from the PM history master file. Report #2382 lists the selected historical data. (Fig. 17)

BSD02052. Labels for PM equipment can be printed for selected pieces of equipment or the entire file. These equipment numbers are read into the program as punched data cards. Descriptive information to be printed on the labels is extracted from the master file and written to magnetic tape. This tape is then processed off-line to print the labels. (Fig. 18)

BSD02038. This program uses the dataset created in BSD02039 (Fig. 19) to retrieve PM history via an IBM 2740 remote terminal. When a request for history is made, this dataset is searched and the ten most recent occurrences of maintenance history are listed on the remote terminal.

CONCLUSIONS

In attempting to evaluate the effectiveness of the programmed maintenance functions, the objectives listed at the beginning of this report are reviewed routinely to determine if the present level of performance meets all program objectives. A recent review confirmed that the present level of performance appears to support the program objectives with possibly one exception. The amount of control over job performance is somewhat limited without a formal programmed maintenance audit procedure to ascertain if all job requirements were completed, if the job instructions are being consistently interpreted as intended, and if the frequency can be extended without any significant loss in equipment reliability. An audit procedure will be developed within the next three months to provide the additional control necessary to maintain an effective program.

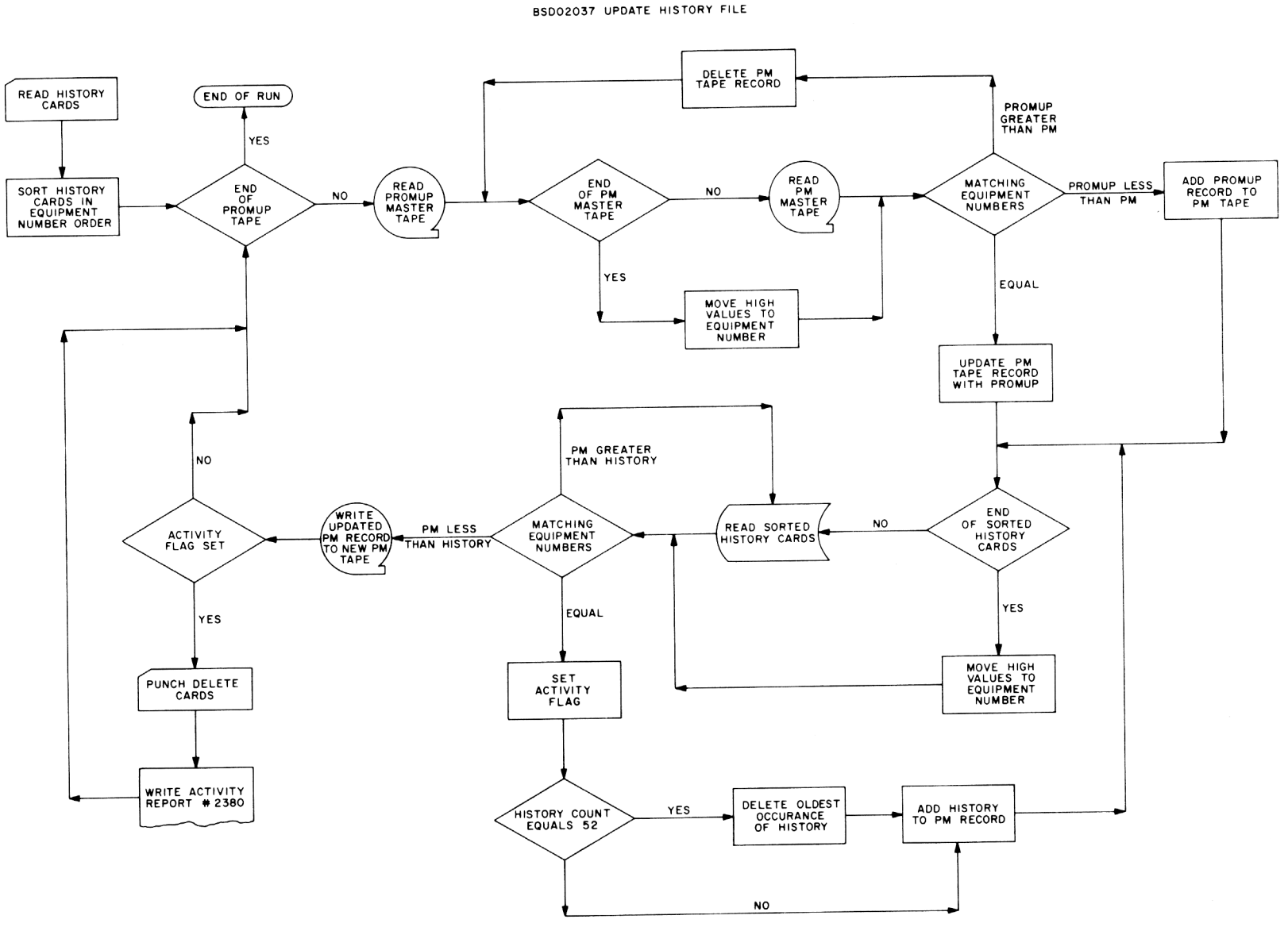


Fig. 15. Update History File Flow Diagram

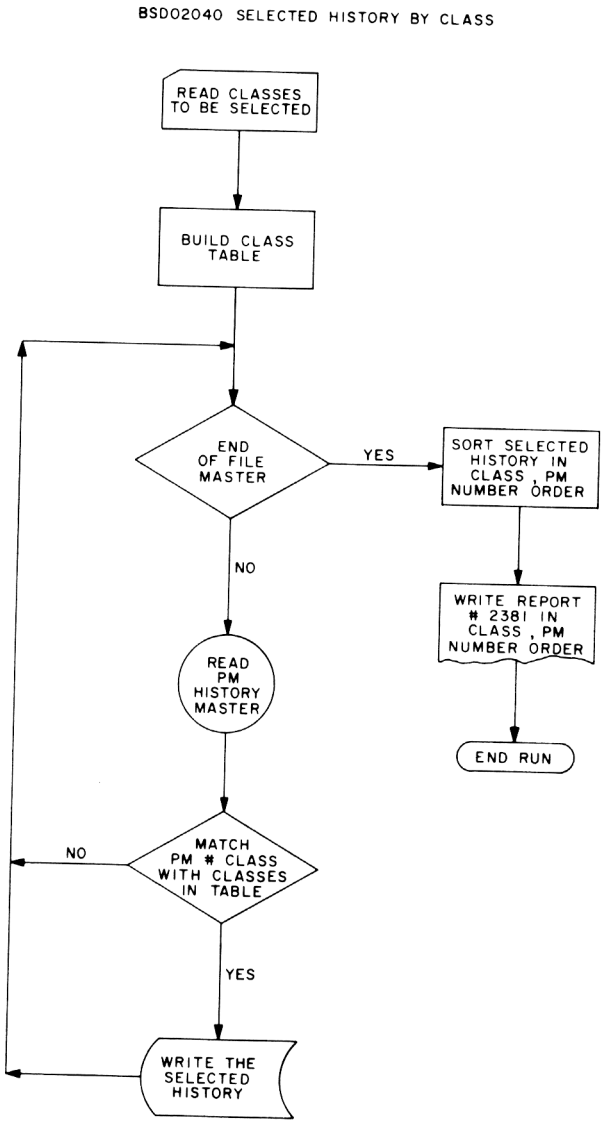


Fig. 16. Selected History By Classification Flow Diagram

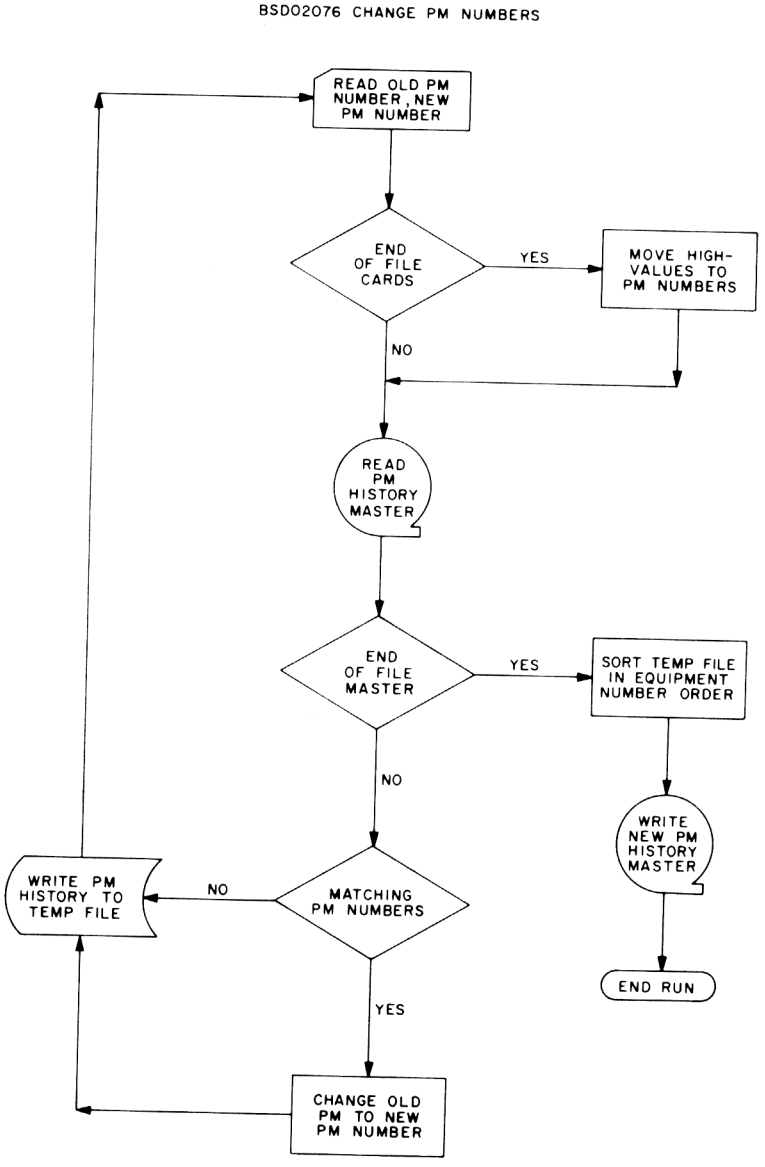


Fig. 17. Change PM Numbers Flow Diagram

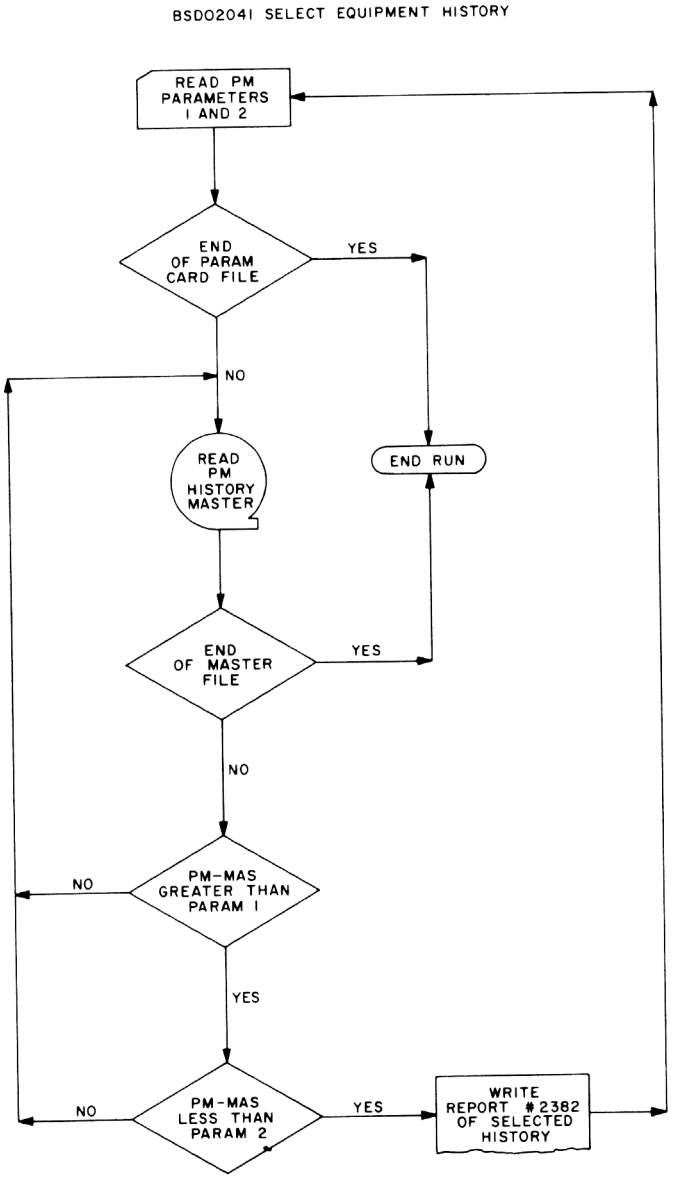


Fig. 18. Select Equipment History Flow Diagram

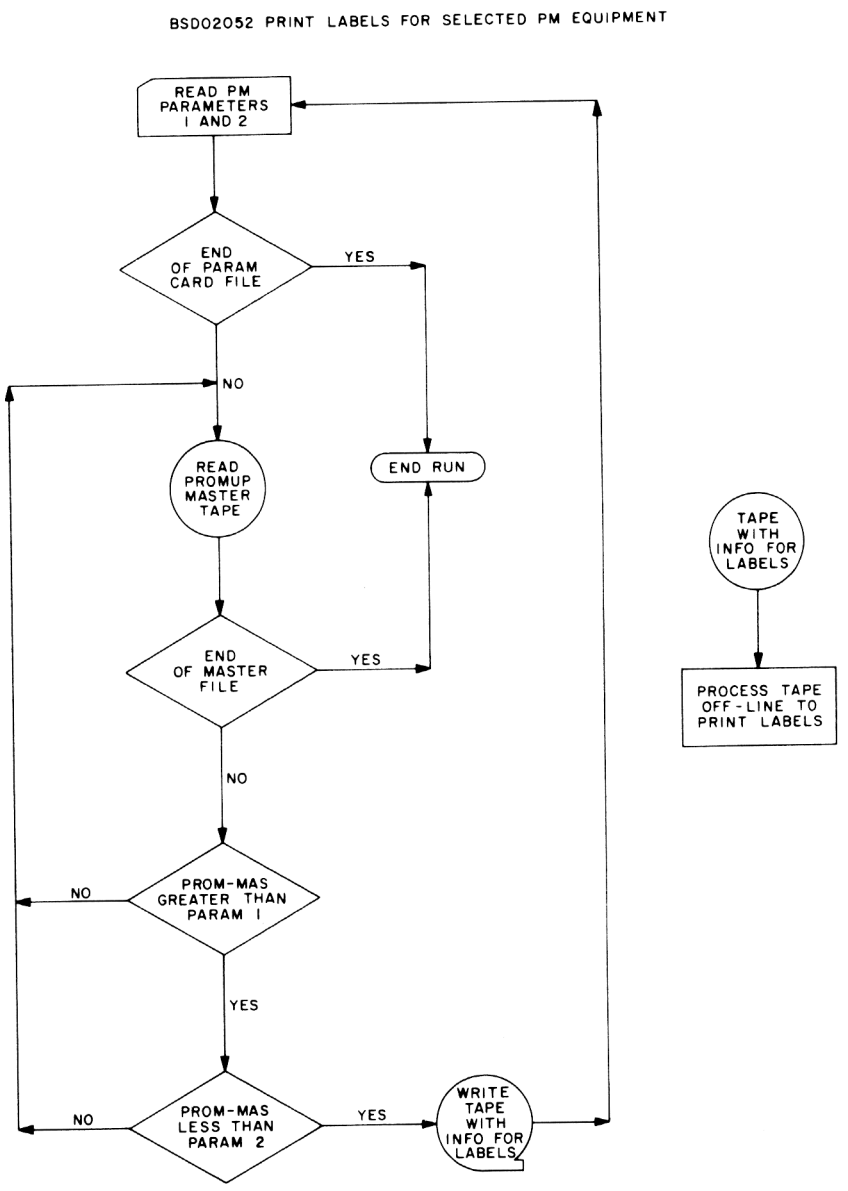
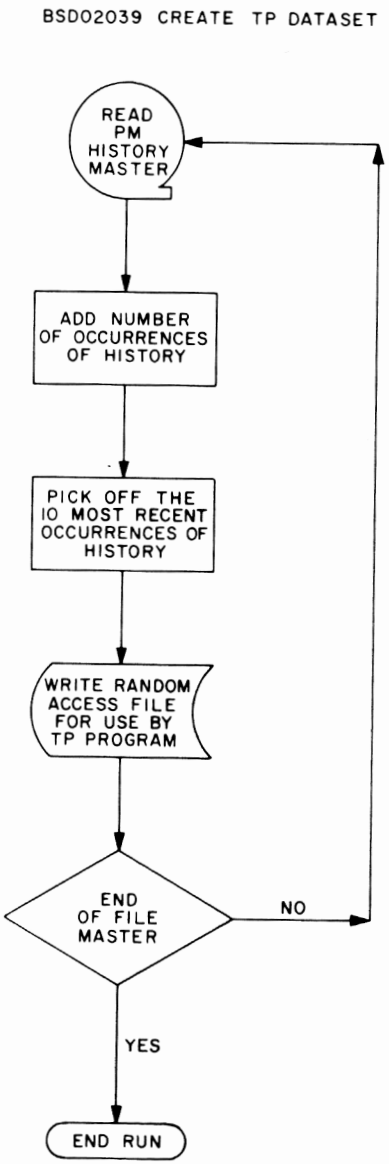


Fig. 19. Print Label Flow Diagram



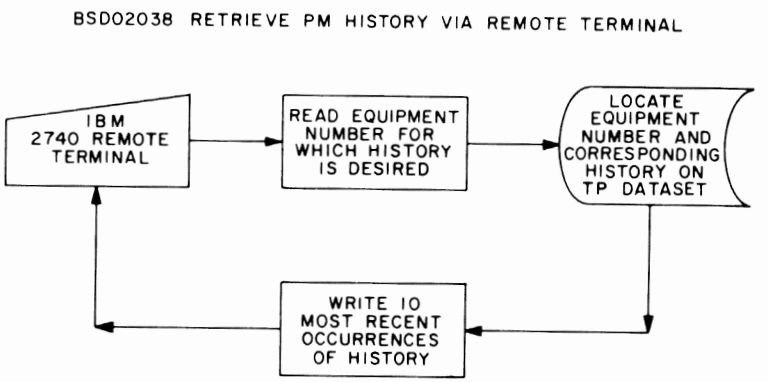


Fig. 20. Create TP Dataset Flow Diagram

Programmed maintenance has been an effective tool for optimizing manpower and providing a high degree of equipment reliability for the past seventeen years. A primary reason for the success of the program is the flexibility designed into the program. The amount of flexibility was required to provide service for unique research equipment in addition to standard industrial equipment.

The responsibility for performing quality work on the schedule requested rests with the first-line supervisor. The supervisor's working in conjunction with the programmed maintenance staff to provide feedback data for the program is essential.[3]

The continued effectiveness of Programmed Maintenance at Oak Ridge National Laboratory will depend not only on improved scheduling and data collecting techniques but will depend just as much, if not more, on the attitude of foremen and craftsmen responsible for completing the assignments. All must understand why the job they are doing is essential and worthy of their best efforts.

---

[3]Graves and Bishop, *op. cit.*

APPENDIX A

MASTER TAPE RECORDS

Program PROMUP (Schedule Master Tape)

TABLES

01	Tables	
02	Table 1	
03	Skip-week occurs 4 times	
04	Date	
05	Month	X(3)
05	Day	99
02	Table 2	
03	Calendar occurs	
04	Date	
05	Month	X(3)
05	Day	99
02	Table 3	
03	Schedule-code occurs 24 times	
04	Codes	
05	Frequency code	XX
05	Frequency time	9(3)
02	Tape-date	X(9)

JOB RECORD

01	Master record	
02	Header 1	
03	Job location	
04	Building	X(5)
04	Route	XX
04	Machine number	X(4)
04	Sub-assembly	X
03	Description	X(35)
03	Property number	X(7)
03	Foreman	X(9)
03	Work-order number	X(9)
02	Header 2	
03	Equipment manufacturer	X(25)
03	Model number	X(8)
03	Type	X(6)
03	Size	X(6)
03	Serial number	X(14)
03	Vendor	X(13)
02	Header 3	
03	Function	X(45)
03	Shaft size	X(6)
03	Dimension	X(15)
03	Quality Level	X
03	Spare data field	X(5)

JOB RECORD - contd.

02	Header 4	
03	Motor manufacturer	X(20)
03	Horsepower	X(6)
03	RPM	X(9)
03	Volts	X(11)
03	Amperes	X(8)
03	Phase	XX
03	Cycles	XX
03	AC or DC	XX
03	Motor type	X(6)
03	Service factor	X(6)
02	Header 5	
03	Motor property number	X(7)
03	Motor serial number	X(16)
03	Frame number	X(6)
03	Motor model	X(10)
03	Motor class	X(6)
03	Motor style	X(6)
03	Motor code	X(4)
03	Design	X(4)
03	Design	X(4)
03	Temperature	X(5)
03	Spare data field	X(5)
03	Equipment class	X(3)
02	Number of work items	
02	Item occurs 1 to 60 times depending on number of work items	
03	Point of service	X(3)
03	Lubrication	XX
03	Fitting	X(3)
03	Number of fittings	99
03	Frequency code	XX
03	Start schedule counter	9(3)
03	Alternate item	99
03	Standard time	9(3)V9
03	Craft code	99
03	Remarks	X(18)
03	Season	X
03	Restart schedule counter	9(3)

Program RESKID (Delinquent Work Master Tape)

RECORD

01	Master	
02	Master number	
03	Location	
04	Building	X(5)
04	Route	XX

RECORD - contd.

```
      04   Machine                                X(4)
      04   Sub-assembly                           X
   03   Schedule date
      04   Month                                  X(3)
      04   Day                                    99
      04   Year                                   9(4)
02   Equipment Class                             X(3)
02   Description                                 X(35)
02   Property number                             X(7)
02   Foreman                                     X(9)
02   Work order number                           X(9)
02   Total standard time                         9(5)V9
```

The numbers to the left of the data description are data-level numbers, where the higher level numbers represent data pertinent to the preceding lower level numbers. The numbers to the right of the data description represent the amount and type of information to be entered in the data field; for instance, a "9" represents one character of numeric information and an "X" represents one character of alphanumeric information. The numbers enclosed in the parenthesis indicate the number of times a "9" or "X" is repeated; thus a 999 or 9(3) will reserve three spaced for numeric data. A "V" inserted in a series of 9's is an assumed decimal point. The data field 99V999 may contain the number 64.92 or 8.56 but cannot contain the number 237.8. The "occurs" clause indicates that all the following higher level numbers of data will be repeated times. For example the term:

```
02   Item occurs 1 to 60 times depending on number of work items
  03   Point of service                          X(30)
   o
   o
  03   Restart schedule counter                  9(3)
```

will reserve a variable number of items and associated data. The minimum number of items will be 1 and the maximum number of items will be 60. The actual number of items stored on the tape will depend on the value in the data field:

```
02   Number of work items                        99
```

APPENDIX B

INPUT DATA CARDS

Program PROMUP

CONTROL CARD

Column	Data
1	Tape control code 0 - Startup (no old master) 1 - Update master and schedule 2 - Schedule only (no input data)
2	Blank
3-5	Month Date of first week to be scheduled
6-7	Day Date should be a Monday
8-11	Year
12	Blank
15	List control code 0 - List updated records only 1 - List all of master tape
16	Blank
17	Table-read control code 0 - Do not read tables 1 - Read skip-week table 2 - Read calendar table 3 - Read frequency table 4 - Read skip-week and calendar tables 5 - Read calendar and frequency tables 6 - Read skip-week, calendar, frequency tables, and tape-date 7 - Read tape-date
18	Blank
19	Season S - Summer W - Winter A, O, or blank - all seasons

TABLE CARDS

Skip-week Table (one card required)

Column	Data
1-3	Month (alphabetic)
4-5	Day (numeric)
6-9	Month
9-10	Day
11-13	Month
14-15	Day
16-18	Month
19-20	Day

NOTE: Four skip-week dates per year will be supplied by the programming maintenance staff. The table should be changed at the beginning of the year. A sample of the skip-week table is:

MAR20JUN19SEP18DEC18

Calendar Table (one card required)

Column	Data
1-3	Month (alphabetic)
4-5	Number of days in month (numeric)
6-8	Month
9-10	Number of days in month
°	
°	
°	
56-58	Month
59-60	Number of days in month

NOTE: The calendar table should be changed at the beginning of each leap year and the year following leap year. The calendar for a non-leap year is:

JAN31FEB28MAR31APR30MAY31JUN30JUL31AUG31SEP30OCT31NOV30DEC31

Frequency Table (two cards required)

Column	Data
1-2	Frequency code (alphabetic)
3-5	Frequency time (numeric number of weeks)
6-7	Frequency code
8-10	Frequency time
°	
56-57	Frequency code
58-60	Frequency time

NOTE: The frequency table should be changed at the request of the programmed maintenance staff. The current table follows:

W0012W0026W006 M0042M008M0124M0166M0248M032
Y0482Y0963Y1444Y1925Y2886Y2887Y3368Y3849Y43210480 S -1

Tape Date Card

Column	Data	
1-3	Month	
4-5	Day	Date of next schedule run
6-9	Year	

JOB EQUIPMENT DATA

Header Card 1 (First line of data sheet)

Column	Data	
1-5	Building	Equipment location number
6-7	Route	Some typical numbers are:
8-11	Equipment number	5408 210285
12	Sub-assembly number	EGCR 010345A
		4500N011011B
13-47	Equipment description	
48-54	Property number	
55-63	Foreman	
64-72	Work order number	
73	First card code on Header Card 1	
	1 - Add this piece of equipment	
	2 - Delete this piece of equipment	
	3 - Change header card 1	
	4 - Change header card 2	
	5 - Change header card 3	
	6 - Change header card 4	

JOB EQUIPMENT DATA - contd.

Column	Data
	7 - Change header card 5 8 - Read item card for this piece of equipment and follow the instructions in column 73 of that card.
74	Second card code on Header Card 1 1 - Change foreman on header 1 2 - Change work order on header 1 3 - Change foreman and work order on header 1 9 - Indicator for header card 1 when code 1, 2, or 3 is not used. If 1, 2, or 3 is used the first code must be 3.

Header Card 2 (Second line of data sheet)

Column	Data
1-25	Equipment manufacturer
26-33	Model number
34-29	Type
40-45	Size
46-59	Serial number
60-72	Vendor
73-74	Blank

Header Card 3 (Third line of data sheet)

Column	Data
1-45	Function of the equipment
46-51	Shaft size
52-66	Dimensions
67	Quality level
68-74	Blank

Header Card 4 (Fourth line of data sheet)

Column	Data
1-20	Motor manufacturer
21-26	Horse power
27-35	Speed, rpm
36-46	Volts
47-54	Load, amp

JOB EQUIPMENT DATA - contd.

Column	Data
55-56	Phase
57-58	Cycles
59-60	AC or DC
61-66	Motor type
67-72	Service factor
73-74	Blank

Header Card 5 (Fifth line of data sheet)

Column	Data
1-7	Motor property number
8-23	Motor serial number
24-29	Frame number
30-39	Motor model
40-45	Motor class
46-51	Motor style
52-55	Motor code
56-59	Design
60-64	Temperature-rise rating
70-72	Equipment classification 1 - Air Conditioning 2 - Pumps 3 - Compressors 4 - Generators 5 - Heaters (heat exchangers) 6 - Valves 7 - Lights 8 - Buildings 9 - Fans 10 - Manipulators 11 - Monitors 12 - Filters 13 - Gates 14 - Air system 15 - Electrical 16 - Motors 17 - Materials-handling equipment 18 - Hoists 19 - Cranes 20 - Elevators 21 - Doors 22 - Mixers 23 - Shop equipment 24 - Strainers
73-74	Blank

Sixth and subsequent lines of data sheet for maintenance instruction

Column	Data
1-2	Item number - up to 60 items of maintenance instruction may be used. When more than 60 items are required, multiple equipment location data sheets should be submitted and coded or numbered sequentially in the subassembly block of the equipment-location section for header card 1.
3-32	Point of service of maintenance instructions
33-34	Lubricant code
35-37	Type fitting: BHF - Button-head fitting CLO - Constant-level oiler GC - Grease cup GF - Grease fitting GFF - Grease flush fitting LS - Lube screw OC - Oil cup OH - Oil hole OR - Oil reservoir SGC - Screw-down grease cup CO - Spring oiler
38-39	Number of points to be serviced, as the number of fittings, the number of drive belts, or the number of filters
40-41	Code for service frequencies: (See Frequency Code Table)

Code	Interpretation	Schedule Counter
W	Every week	1
2W	Every 2 weeks	2
M	Every month	4
6W	Every 6 weeks	6
2M	Every 2 months	8
3M	Every 3 months	12
4M	Every 4 months	16
6M	Every 6 months	24
8M	Every 8 months	32
Y	Every year	48
2Y	Every 2 years	96
3Y	Every 3 years	144
4Y	Every 4 years	192
5Y	Every 5 years	240
6Y	Every 6 years	288
7Y	Every 7 years	336
8Y	Every 8 years	384
9Y	Every 9 years	432
10	Every 10 years	480
S	Standby - no service	-1

As the computer scans the master tape during the scheduling procedure, the schedule counter is reduced by 1 each week until the counter reaches "0", at which time the service item is printed on a schedule card. The computer than resets the counter to the appropriate frequency.

Column	Data
42-44	Start: the number of weeks to elapse before scheduling is to commence for each line item. The weeks are counted from the date in the upper right corner of the data sheet and may start with 0 for immediate scheduling. A negative number is used when the line of data is not to be printed on a schedule card.
45-46	Alternate item: these columns are used when two items of service are related and one should periodically take precedence over the other. To illustrate: if Item 12 states "check oil level and add as required" on a weekly schedule, and Item 13 states "drain and refill crankcase" on a six-month schedule, there would be meaningless duplication if both items of instructions were printed on a six-month interval. By inserting a "13" in columns 45 and 46 of line Item 12, we are giving an instruction to schedule and print Item 12 until Item 13 becomes due on the same week. At that time, Item 13 takes precedence, and Item 12 is not printed out on the schedule card.
47-50	Standard time: man-minute time estimates for each point of service. Minutes are shown in columns 47, 48, and 49. Tenth of minutes are shown in column 50. The decimal is automatically programmed to fall between columns 49 and 50.
51	Blank
52-53	Craft codes

Code	Interpretation
22	Sheet metal
23	Welders
26	Electricians
27	Substation Operators
28	Pipefitters
29	Millwrights

Code	Interpretation
30	Boilermakers
31	Painters
33	Riggers-Iron Workers
34	Laborers
35	Carpenters
38	Auto and Equipment Mechanics

54-71 Remarks: instructions and supplementary information to assist the foreman and craftsman in performing the job assigned. This space is often used for stores stock numbers on replacement parts, for materials specifications information, for trade-name data, and for other miscellaneous data.

72 Season: the letters "W" and "S" are used to specify winter or summer service that is discontinued during the off-season. The programming is set up to print these service items only when seasonally appropriate. To illustrate: requests for monthly checks on antifreeze protection would be designed with a "W" for winter service and would not be required during the summer months. Programming deletes the out-of-season service requests.

73 Item card code: when code 8 (for reading item cards) has been used on the first line of the data sheet, the following codes are used on the appropriate line items of points of service:

Code	
1	Add the item (full line)
2	Delete item (note that remaining item numbers will automatically be renumbered; therefore, multiple deletions must be listed in reverse numerical sequence)
3	Change item (full line)
4	Change time and craft code
5	Change season
6	Change counter start time (show plus or minus the number of weeks change required)
7	Change frequency and counter setting

Program RESKID

CONTROL CARD

Column	Data
1-3	Month
4-5	Day — Date of last schedule entered
6-9	Year — during run
10	Blank
11	Tape control code 0 - Startup (no old master tape available) 1 - Master tape to be read 2 - List master tape only. Place master to be read in position of "new" master.
12	Blank
13	Schedule tape control 0 - Do not add schedule tape in update run 1 - Add schedule tape in update run 2 - Sort schedule tape in job location number, schedule date order and add sorted information in update run.
14	Blank
15	Card Control 0 - No delete cards to be read 1 - Sort input delete cards in job location number, schedule data sort order before reading.
16	Blank
17-25	DMDATE: delete any records previous to this date from the master tape.
26	Blank
27-35	DTDATE: delete any punched cards with a date previous to this date.

DELETION CARDS

Column	Data
1-5	Building
6-7	Route
8-12	Machine number
13-15	Month
16-17	Day — Schedule date
18-21	Year

Program PROMLIS

CONTROL CARD

Column	Data
1-3	Month
4-5	Day
6-9	Year
10	Blank
11-12	List option 0 - List all of the master tape *1 - List selected portion of master tape *2 - List selected foreman *3 - List selected work order number *4 - List selected equipment class number *5 - List selected route number *6 - List selected route number in property number sort order *7 - List selected work order number suffix (last 2 digits) 8 - List records with alternate number in item of service 9 - List records with season in items of service
13	Blank
14	List type 1 - Full record list Any other character - list summary of records

*These options require cards following the control card.

SELECTION CARDS

Selected portion of the master tape

Column	Data
1-12	Start-print location number
13	Blank
14-25	End-print location number

Selected foreman card

Column	Data
1-9	Foreman's name

Selected work order card

Column	Data
1-9	Work Order Number

Selected equipment class card

Column	Data
1-3	Equipment class number

Selected route card

Column	Data
1-2	Route number

Selected work order suffix

Column	Data
1-2	Suffix (last 2 digits of work order number)

APPENDIX C

ERROR MESSAGES

Program PROMUP

NO CONTROL CARD
NO RECORDS ON OLD MASTER TAPE
WRONG CODE TO READ LIBRARY CARDS
INCORRECT NUMBER OF LIBRARY CARDS
WRONG CONTROL DATE FOR TAPE DATED (TAPE DATE)
NO HEADER CARD FOLLOWING LOCATION ____
NO CARD CODE FOR HEADER CARD 1
NO HEADER CARD 2 FOR ADD RECORD
NO HEADER CARD 3 FOR ADD RECORD
NO HEADER CARD 4 FOR ADD RECORD
NO HEADER CARD 5 FOR ADD RECORD
NO HEADER CARDS FOR ADD RECORD
NO HEADER CARD 2 FOR HEADER CHANGE
NO HEADER CARD 3 FOR HEADER CHANGE
NO HEADER CARD 4 FOR HEADER CHANGE
NO HEADER CARD 5 FOR HEADER CHANGE
WRONG CARD FOR STARTUP RUN
RECORD NUMBER IS NOT ON MASTER TAPE
RECORD NUMBER IS ALREADY ON MASTER
MORE THAN 60 ITEMS
FREQUENCY CODE IS NOT IN MASTER TABLE
WRONG ITEM COUNT
ITEM COUNT EXCEEDS 60 - CANNOT ADD ITEM
COUNT WRONG TO DELETE ITEM
NO RESTART COUNTER FOR LOCATION
ALT COUNT BEYOND RANGE
MORE THAN 40 FOREMEN SCHEDULED

Program RESKID

NO CONTROL CARD
SCHED TAPE ALREADY ON MASTER
RECORD IS NOT ON MASTER TAPE
MONTH PUNCHED WRONG ON CARD

Program PROMLIS

NO CONTROL CARD
NO LIST TYPE CONTROL
NO RECORDS ON MASTER TAPE
NO SELECTION CARD FOR SELECTED MASTER
NO FOREMAN SELECTION CARD
NO WORK ORDER SELECTION CARD
NO EQUIPMENT SELECTION CARD
NO ROUTE SELECTION CARD
NO WORK ORDER SUFFIX CARD

Procedure
OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION
QUALITY ASSURANCE
PLANT AND EQUIPMENT DIVISION
APPENDIX D

Number:	QA-PE-18/D.1.14
Issued:	October 15, 1979
Supersedes:	Issue of 4-1-75
Page	1 of 8

Subject: PROGRAMMED MAINTENANCE

I. SCOPE:

This procedure covers Programmed Maintenance (PM) job assignment and job completion utilizing Programmed Maintenance Schedule Cards (PMSC) and Programmed Maintenance History Cards (PMHC) in providing the detailed check list to accomplish lubrication, inspection and similar repetitive maintenance activities. Scheduling is provided by utilizing electronic data processing equipment.

II. GENERAL:

A. Quality Requirements - Each piece of equipment in the PM system shall be assessed to determine QA effort to apply in maintaining the equipment (QA-L-100).

B. Deviations and Non-Conformances - Shall be handled in accordance with QA-PE-6/D.1.11 titled "Nonconformance and Deviation".

C. Quality Assurance Audits - QA audits shall be conducted to ascertain that equipment is being maintained to meet the assigned quality requirements.

D. Documentation - Documentation shall be accomplished through the ORGDP Computer program and information retrieved through the ORGDP program as well as through the computer terminal in Building 2518. Temporary file points shall be maintained at the work centers for PM cards that are in work process. A Master Equipment Listing File for all equipment that is on the PM system shall be maintained by the PM staff in Building 2518 (Refer to P & E Document Control Procedure, QA-PE-3/D.1.12).

E. Definitions and Descriptions

1. Programmed Maintenance (PM) - PM is the detailed planning, scheduling, and accomplishment of inspections, adjustments, lubrication, reconditioning and other repetitive maintenance activities of the Plant and Equipment Division that are carried out according to specific service recommendations intended to prevent failures in service and to retard wear and deterioration of equipment.

2. Programmed Maintenance Schedule Cards (PMSC) Fig. 1.

This is a computer output card containing the following information:

a. Date PM is scheduled.

b. Responsible foreman.

c. Quality Requirements.

d. PM number consisting of a three-part number:

(1) First 4 digits designate the building number.

(2) The next set of digits indicate the floor level where the equipment is located.

(3) The last three digits designate an exact equipment location on that floor level and can be verified by reviewing PM equipment designation route sheets for any particular building.

e. Equipment Description.

f. Property Number.

g. Job Order Number.

h. Item Number.

i. Point of Service.

j. Type of lubricant, type of fitting, number of items to service, frequency of service and remarks.

The following codes and corresponding range of frequencies can vary from weekly to a ten-year interval as shown in table below:

CODE	FREQUENCY
W	Every week
2W	Every two weeks
M	Every month
6W	Every 6 weeks
2M	Every 2 months
3M	Every 3 months
4M	Every 4 months
6M	Every 6 months
8M	Every 8 months
Y	Every year
2Y	Every 2 years
3Y	Every 3 years
4Y	Every 4 years
5Y	Every 5 years
6Y	Every 6 years

CODE	FREQUENCY
7Y	Every 7 years
8Y	Every 8 years
9Y	Every 9 years
10Y	Every 10 years
S	Standby -- no service scheduled

The PMSC's are printed every two weeks and indicated at the top of the card the week for which the work has been scheduled. The time allowed for completion of the job is dependent on the frequency indicated on the schedule card. If the card indicates only weekly service, then the weekly items must be completed within that week. The time allowed for the completion of the established frequencies should be as indicated by the following table unless situations arise, such as shutdown, etc., when maintenance will be performed that will not necessarily follow the PM schedule.

Scheduled Frequency	Time Allowed For Completion
Weekly	Regular day within the week
2 Weeks	± 2 days
Monthly	± 5 days
2 Months	± 8 days
3 Months	± 2 weeks
4 Months	± 2 weeks
6 Months	± 3 weeks
Yearly	± 4 weeks

3. Programmed Maintenance History Cards (PMHC) Figs. 2-4

A PMHC must be completed for any PM job, scheduled or non-scheduled. The PMHCs have been designed to assist the craftsman and foreman in furnishing information pertaining to the maintenance history for a specific piece of equipment. This information is accumulated and stored on computer tape for retrieval as needed.

a. The orange PMHC (Fig. 2) should be used for routine programmed maintenance and has been designed to include items such as checking and adding lubricants, filter replacement, etc.

b. The blue PMHC (Fig. 3) should be used for non-repetitive maintenance such as breakdowns, motor

replacement, and bearing replacement. It is important that a history card be filled out for non-repetitive maintenance so that the history records will be complete.

c. The white PMHC (Fig. 4) is available to furnish history data when additional information would be more appropriate to reflect an accurate history record. This card has several spaces provided for write-in information and can be used in place of the orange or blue cards or used as a supplement to either card which provide a check list only.

III. OBJECTIVES:

A. Reduce equipment downtime.

B. Provide Maintenance costs for individual equipment by retrieval through the P & E computer terminal.

C. Standardization of equipment, parts and lubricants.

D. Provide a history of maintenance activities.

E. To effect economies in the use of manpower and materials.

F. Reveal problems before equipment failure.

G. Provide standard times to perform maintenance.

IV. RESPONSIBILITIES:

A. The Programmed Maintenance staff shall be responsible for the following:

1. Issuing the PMSCs and PMHCs (on request) to the Work Center.

2. Supplying input data to the Central Data Processing Facility when it is necessary to update a PMSC to reflect revised or new information.

3. Check the output and the schedule before submitting schedule cards to the field.

4. Provide floor plans, containing equipment check route to the work center.

5. Provide computer data to check work completed against work scheduled.

6. Maintaining a supply of PMHCs.

7. Supplying input data to Central Data Processing Facility to include new equipment information in the PM Scheduling system.

8. Performing PM audits as required.

9. Standardizing of lubricants.

10. Providing technical assistance in the use of proper lubricants.

B. The work center supervisor shall be responsible for the following:

1. Planning with the foreman in ascertaining that future PM scheduled work, as listed on the PM Data Sheet, will be started and completed in the alloted time.

2. Transmitting PMSC received from PM office to the designated foreman who have specific responsibilities for an area or to a research group.

3. Coordinating work scheduled to complete as required on PMSC.

4. Reviewing PMSC to make certain work has been completed and that a PMHC has been completed for each PMSC.

NOTE: The white PMHC must be completed when equipment is not serviced or additional maintenance information is required.

5. Returning the completed PMHC to PM office.

6. Maintaining a supply of PMHCs.

C. The foreman shall be responsible for the following:

1. Issuing PMSCs and PMHCs to the craftsmen.

NOTE: If for any reason work is not accomplished on a PMSC when its succeeding PMSC is received, the work should not be duplicated; but all work called for should be accomplished and PMHCs completed for both PMSCs. A PMHC must be filled out for the superseded PMSC showing only the PM number and date on the PMHC. This is necessary to delete the superseded PMSC from the backlog list.

2. Ascertaining that PM scheduled for equipment is completed. Completion is noted by checking item on PMSC and PMHC. See Figs. 1-4 (Attached) for sample of completed PMSC and PMHCs.

   NOTE: When Block No. 57 is checked on PMHC, this indicates that all equipment has been serviced as specified on PMSC. Block No. 58 is to be checked when repair work is done to equipment other than scheduled PM.

3. Ascertaining that white PMHC (Fig. 4) is completed listing service performed on equipment not appearing on PMSC.

4. Returning cards to work center supervisor.

5. Reporting equipment not on PM that should be on PM.

6. Maintaining a supply of PMHCs and making certain each craftsman performing PM is issued PMHCs at the time the PMSCs are issued.

7. Notifying PM staff if the information on the PMSC is incorrect or not appropriate or if a change in frequency would be more applicable.

D. The craftsman shall be responsible for the following: (Figs. 1-4)

1. Completing a PMHC for each PMSC. In instances when the craftsman is unable to complete the PMHC, because of insufficient information, the work center supervisor shall finish completing the PMHC.

   Following are some clarifications of instructions appearing on the PMSC:

   a. Check shaft alignment. This is considered a visual check unless tolerances are provided.

   b. Check belt wear, tension, and alignment. This is a visual check unless the equipment may be readily shut down.

   c. Check filters and change as required. (On air conditioning equipment, dust-stop filters should be changed unless it is known that they have been recently changed.)

d. Check and clean motor, fan, etc. This is considered surface cleaning and not a disassembly.

e. Check electrical components. This is the device and its associated starter or switch: Includes cleaning, tightening and adjusting.

2. Recording PM number in proper blocks just as it appears on PMSC.

3. Recording date on PMHC in proper blocks just as it appears on PMSC.

4. Completing all the items listed on the PMSC by checking off each item on PMSC and PMHC as they are completed.

   NOTE: When information is unknown, refer to statement D-1 above.

5. Listing additional maintenance information on white PMHC (Blocks #11-49, Fig. 4).

6. Indicating if work is PM (Block #57) or repair (Block #58), never both.

7. Marking block #50 on white PMHC when equipment is not serviced or scheduled and writing a note of explanation on both cards (PMHC and PMSC).

8. Using lubricants as shown on PMSC. For questions, contact PM office (Phone - 4-4274).

9. Listing on the front of the PMSC the size of belts and filters not already listed. In addition, list unusual conditions, such as vibrations, noises, and changes in environmental conditions not covered by the PMSC instructions.

10. Completing a PMHC on all repair work on equipment that has a PM number.

    NOTE: When information is unknown, refer to statement D-1 above.

11. Recording information in Blocks #59-77 on PMHC.

    NOTE: If material cost, Blocks 70-74, is unknown, estimate or inform supervisor so these blocks can be completed by the supervisor.

12. Recording date completed on PMHC.

13. Returning all cards to foreman when completed.

E. The field engineer shall be responsible for the following:

1. Providing technical assistance in the installation, maintenance and operation of equipment on PM in the area of his responsibility.

2. Assigning Quality Requirements with the assistance of the equipment custodian, to each piece of equipment in the PM system. Consideration of existing reliability studies and the nature of equipment use shall be parameters in establishing the Quality Requirements.

3. Notifying the PM staff when new equipment is installed.

4. Providing technical assistance to the PM staff in establishing points of service and establishing a programmed maintenance schedule for new equipment.

PROGRAMMED MAINTENANCE FOR WEEK OF JUL 9, 1979 FOREMAN FIELDS
QUALITY LEVEL 4

LOCATION	EQUIPMENT DESCRIPTION	PROPERTY	JOB ORDER
2531- 01 335	SHAW BOX GANTRY CRANE- 20 TON		H2531E-P1

ITEM	POINT OF SERVICE	LUB	FTNG	NL	FREQ	REMARKS
1	CONTACT BLDG SUPV AT 4-7038				CM	
2	BEFORE SERVICING UNIT				CM	
3	---HOISTING UNIT---				CM	
4	LUB MTR BRNG			1	CM	
5	CK REDUCER GEARCASE OIL LEVEL				CM	
7	CK DRIVE GEARCASE OIL LEVEL				CM	
9	CK, REPACK DRIVE GEARCASE BRNGS			2	Y	
10	LUB HOISTING CABLE				Y	
11	LUB HOISTING GLIDE SHEAVE	OK	GF	1	CM	
12	LUB HOISTING BLOCK	OK	GF	1	CM	
13	LUB DRUM SHAFT BRNG				CM	
14	CK HYDRAULIC BRAKE CYLIND RESV				CM	

SEE NEXT CARD

FIG. 1

PROGRAMMED MAINTENANCE FOR WEEK OF JUL 9, 1979 FOREMAN GENTRY
QUALITY LEVEL 4

LOCATION	EQUIPMENT DESCRIPTION	PROPERTY	JOB ORDER
3019- 20 550	CHAR AUX POWER UNIT, GASOLINE	X-32680	P3019E-X1

ITEM	POINT OF SERVICE	LUB	FTNG	NL	FREQ	REMARKS
1	NOTIFY TECHNICIAN IN CONTROL				W	
2	RM 112 BEFORE SERVICING				W	
3	NOTIFY TECHNICIAN IN CONTROL				W	
4	RM 112 BEFORE THIS UNIT IS				W	
5	MADE INOPERATIVE DUE TO				W	
6	SERVICE OR MAINTENANCE				W	
7	CK CRANKCASE OIL LEVEL			EL	W	
8	CK ENGINE COOLANT LEVEL, SYSTEM				W	
9	CK, LOG BATTERY SP.G. READINGS				W	BEFORE TEST RUN
10	CK BATTERY CHARGER OPERATION				W	
13	CK OIL PRESSURE				W	
14	CK VOLTAGE, AMPS, FREQUENCY				W	

SEE NEXT CARD

FIG. 1

PROG. MAINTENANCE NUMBER: 2531- (BLDG) 01 (ROUTE) 335 (LOC)

EQUIPMENT MAINTENANCE RECORD

DATE ON PROG. MAINT. CARD: 7 9 7 9

11	☑	GREASE ADDED	21	☐	TRAP CHECKED	31	☐ VISUAL INSP	41	☐ BRAKES CHECKED
12	☐	OIL CHECKED	22	☐	TRAP REPAIRED	32	☑ CONTROLS CKD	42	☐ BRAKES ADJ
13	☑	OIL ADDED	23	☐	FILTER CHECKED	33	☐ BATTERY SPG	43	☐ CONTRL VLVE ADJ
14	☐	OIL CHANGED	24	☐	FILTER CLEANED	34	☐ WATER ADDED	44	☐ CHECK BRUSHES
15	☐	BELT CHECKED	25	☐	FILTER REPLACED	35	☐ BATTERY REPL	45	☐ REPLACE BRUSHES
16	☐	BELT ADJUSTED	26	☐	PACKING ADJ	36	☐ SWITCH CHECKED	46	☑ CK OPERATION
17	☐	BELT REPLACED	27	☐	GLAND REPACKED	37	☐ SWITCH REPAIRED	47	☐ LEAK TEST
18	☐	STRAINER CLND	28	☐	DRAINED WATER	38	☐ SWITCH REPLACED	48	☐ CHEM TREATMENT
19	☐	DIRT LEG CLND	29	☐	CHECKED REFRIG	39	☐ CK FLEX DUCT	49	☐ CK GLYCOL CONT
20	☐	EQUIPMENT CLND	30	☐	REFRIG ADDED	40	☐ TEST RUN	50	☐ REPAIR LEAKS

PROG. MAINTENANCE: ✓
REPAIR:
TOTAL MANHOURS: 2 HOURS 30 MIN.
DATE COMPLETED: 7 / 1 / 7 9
MATERIAL COST:
INITIALS: D C T

FIG. 2

PROG. MAINTENANCE NUMBER: 3019- (BLDG) 20 (ROUTE) 550 (LOC)

EQUIPMENT MAINTENANCE RECORD

DATE ON PROG. MAINT. CARD: 7 9 7 9

11	☐	GREASE ADDED	21	☐	TRAP CHECKED	31	☑ VISUAL INSP	41	☐ BRAKES CHECKED
12	☑	OIL CHECKED	22	☐	TRAP REPAIRED	32	☐ CONTROLS CKD	42	☐ BRAKES ADJ
13	☐	OIL ADDED	23	☐	FILTER CHECKED	33	☑ BATTERY SPG	43	☐ CONTRL VLVE ADJ
14	☐	OIL CHANGED	24	☐	FILTER CLEANED	34	☑ WATER ADDED	44	☐ CHECK BRUSHES
15	☐	BELT CHECKED	25	☐	FILTER REPLACED	35	☐ BATTERY REPL	45	☐ REPLACE BRUSHES
16	☐	BELT ADJUSTED	26	☐	PACKING ADJ	36	☐ SWITCH CHECKED	46	☑ CK OPERATION
17	☐	BELT REPLACED	27	☐	GLAND REPACKED	37	☐ SWITCH REPAIRED	47	☐ LEAK TEST
18	☐	STRAINER CLND	28	☐	DRAINED WATER	38	☐ SWITCH REPLACED	48	☐ CHEM TREATMENT
19	☐	DIRT LEG CLND	29	☐	CHECKED REFRIG	39	☐ CK FLEX DUCT	49	☑ CK GLYCOL CONT
20	☐	EQUIPMENT CLND	30	☐	REFRIG ADDED	40	☑ TEST RUN	50	☐ REPAIR LEAKS

PROG. MAINTENANCE: ✓
REPAIR:
TOTAL MANHOURS: 2 HOURS MIN.
DATE COMPLETED: 7 / 1 / 7 9
MATERIAL COST:
INITIALS: T L M

FIG. 2

PROG. MAINTENANCE NUMBER: 2531- (BLDG) 01 (ROUTE) 335 (LOC)

EQUIPMENT MAINTENANCE RECORD

DATE ON PROG. MAINT. CARD:

11	☐	COIL REPAIRED	21	☐	OB BRNG REPL	31	☐ COUPL REPLACED
12	☐	COIL REPLACED	22	☐	SHEAVE REPL	32	☐ CONTACTS TIGHTD
13	☐	SOLENOID REPL	23	☐	GAGE REPL	33	☑ CONTACTS REPL
14	☐	GASKET REPL	24	☐	COMPRESSOR REPL	34	☐ TRSFRM OIL TEST
15	☐	PILOT REPL	25	☐	COMP VLVS REPD	35	☐ MOTOR REWOUND
16	☐	MOTOR REPL	26	☐	SEAL REPLACED	36	☐ DAMPR LINK REPD
17	☐	FUSES REPL	27	☐	OIL PUMP REPL	37	☐ MOUNTS REPAIRED
18	☐	AIR MTR REPD	28	☐	VALVE REPD	38	☐
19	☐	AIR MTR REPL	29	☐	VALVE REPL	39	☐
20	☐	IB BRNG REPL	30	☐	COUPL ALIGNED	40	☐

PROG. MAINTENANCE:
REPAIR: ✓
TOTAL MANHOURS: 3 HOURS 00 MIN.
DATE COMPLETED: 7 / 1 / 7 9
MATERIAL COST: 4 2
INITIALS: T L M

PUNCH 3 IN COL. 80

FIG. 3

PROG. MAINTENANCE NUMBER: 2531- (BLDG.) 01 (ROUTE) 335 (LOC.)

EQUIPMENT MAINTENANCE RECORD

DATE ON PROG. MAINT. CARD:

ADDITIONAL MAINTENANCE INFORMATION: REPLACED SAFETY LATCH ON HOOK

☐ EQUIPMENT NOT SERVICED THIS TIME

PROG. MAINTENANCE:
REPAIR: ✓
TIME ON THIS JOB-TOTAL MANHRS.: HOURS 30 MIN.
DATE COMPLETED: 7 / 1 / 7 9
MATERIAL COST: 1 0
INITIALS: T L M

UCN-10046B
3 11-73

SEE OTHER SIDE FOR INSTRUCTIONS

PUNCH 4 IN COLUMN 80

FIG. 4

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