Laboratory Services Series
An Electrical Outlet and
Corded Equipment Inspection Program

E. A. Davis

MASTER

OAK RIDGE NATIONAL LABORATORY

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PLANT AND EQUIPMENT DIVISION

LABORATORY SERVICES SERIES
AN ELECTRICAL OUTLET AND CORDED EQUIPMENT INSPECTION PROGRAM

E. A. Davis

APRIL 1976

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ABSTRACT

A research and development laboratory has thousands of electrical outlets providing power to laboratories, offices, shops, and service areas. These outlets provide power for a wide variety of portable equipment and tools that are equipped with cord and plug. Electric safety requires a periodic check of outlet grounding capability and continuing inspection and repair of corded equipment. Personnel, equipment, reports, procedures, and schedule requirements are reported.

BACKGROUND

Promotion of safety awareness in regards to hazards associated with corded equipment and grounded convenience outlets has always been a policy of the Laboratory. Prior to 1958, the standard outlet was a 3-prong grounding device (crowfoot receptacle). The inspections were made by the Safety Department or using division with a list of necessary corrections submitted to the Electrical, Air-Conditioning, and Heating Services Department. This type of inspection created wide fluctuations in craft demand. During 1959, the program was changed to provide one man working continuously on inspections and repairs. This became unsatisfactory because problems developed and more deficiencies were found than one man could correct.

The problems that developed were associated with a new type of plug and receptacle that was adapted by industry in 1957 and by AEC in 1959. This new U-blade grounding device required an adapter to the crowfoot receptacle. This adaption required special attention to assure ground continuity and polarity.

A decision was made in 1960 to convert existing crowfoot receptacles to the new standard U-blade receptacle. This program to change approximately 14,000 receptacles and 20,000 plugs was to proceed on a fill-in

basis with inspection and correction being done as an area was completed. The program was reviewed in 1963, and a decision was made to continue on a fill-in basis.

The changeout of crowfoot-type receptacles was completed in early 1967; however, another problem had developed. Following some tests, it was disclosed that a number of U-blade receptacles that had been installed were equipped with an inadequate mating ground pin. Immediately, efforts were directed toward backtracking to correct the inadequate U-blade receptacles. This effort was completed in late 1968 with the understanding that any isolated or overlooked receptacle would be changed during the regular inspection program.

CURRENT PROGRAM

The current program is based on the ORNL Safety Manual, Electrical Safety Guides No. 1.5.D7.

"7. The Electrical Departments of the Plant and Equipment Division at X-10 and Y-12 Maintenance Division shall at least annually inspect all power cords, power tools, and other portable electrical equipment to ensure the use of proper grounding techniques and adherence to the National Electric Code. For the use of these Guides, portable electrical equipment is defined as that equipment capable of being readily moved from one place to another in normal use and connected to its source of current by means of a single cord and suitable attachment plug."

The Guides refer to portable equipment; however, the inspection and correction effort is not limited to portable equipment. As such, it encompasses all equipment connected with cord and plug.

SCHEDULE

The inspection schedule was developed to level the work load over a 12-month period (Attachment 1). Also, the larger areas were broken down into smaller segments, such as first floor, second floor, Wing 1, Wing 2, etc. Consideration also was given to the probable number of items to be inspected in an area. Laboratories and shop areas have a

significantly larger number of items than do offices and operating areas. An estimate of the probable number of items (20,000 to 25,000) to be inspected was developed. A typical programmed maintenance card is shown in Attachment 2.

PROCEDURE

The procedure is not detailed (Attachment 3). It specifies visual inspection that requires the craftsperson to exercise a considerable judgment factor. This type procedure allows for decisions based on the situation encountered.

REPORTS

Two reports are used. The IBM report (Attachment 4) is historical record and summary. The field report (Attachment 5) is continued because it shows items in a particular room, and it solicits remarks from the craftsperson. Also, the report assists the supervisor in his day-to-day control. The field reports are summarized for a calendar year total.

EQUIPMENT

The tools and equipment required to conduct this program are minor-- a buzzer or test light to check continuity, Daniel-Woodhead checker for polarity and ground check, ground impedance analyzer to apply load to the receptacle ground, megger for some detailed checking, and inspection stickers to be applied to corded equipment after inspection. Several types of stickers have been used; however, in 1976, the sticker to be used is red with a black bar signifying the quarter. In 1977, the sticker will be blue. Colors were selected to provide easy recognition of current status of equipment. Attachments 6 and 7 show examples of the above items being used on specific jobs.

ACTIVITY 1975

Following some lean years of manpower and budget curtailment, the corded equipment and ground check program experienced very good activity

in 1975. On occasions, six men were required to meet the schedule. The average for 1975 was approximately three man-years.

The 1975 summary sheet (Attachment 8) shows approximately 24,000 items checked; 1,400 items repaired; and 21,000 receptacles checked. The ratio of repair to inspected items was approximately 6 percent; this is very good. In 1969, the ratio of repair was running close to 25 percent. This significant drop in the percent of repair may indicate a need to extend the inspection period. The most common repairs are defective cord, loose prong on plug, and cord pulled out of plug or equipment. A significant hazard is usually detected and repaired at times other than during routine inspection. These items are not included in the total numbers reported.

COST

The combined 24,000 items of equipment checked; 21,000 receptacles checked; and 1,400 repairs for a total of 46,400 items cost approximately \$34,000. This compares favorably with the \$30,000 estimated cost. The total cost included labor and material. Our estimate for material was \$2,000. This cost also reflects any repairs made outside the regular inspection and not reported in the totals.

BARRIERS TO CONTINUING EFFECTIVENESS

The enthusiasm for a routine inspection program is difficult to maintain without a uniform opinion that the work is essential. Some of the depressing agents are listed below.

1. General apathy of personnel being served. Some of the burden should be on the user.
2. Craftsperson's reluctance to perform this menial level of craft work.
3. Supervisor's reluctance to assign his better craftspeople to nondemanding work.
4. The ease with which work can be stopped because it is looked upon as nonpriority work.

5. Incoming material and equipment are put into use without prior inspection.
6. Tools and equipment that are stored in benches, cabinets, etc., are used intermittently without inspection.

In a research-oriented community, the most effective countermeasure to the above barriers is a continuing emphasis on the using division(s) of the potential safety hazards inherent in the use of electrical devices. Managerial emphasis should indicate to supervisors that this program is important, should be priority work, and requires conscientious craft effort.

PROGRAMMED MAINTENANCE DATA SHEET

MAR 1, 1976

LOCATION	EQUIPMENT DESCRIPTION	STD TIME	PROPERTY	EQP CLASS	QUALITY LEVEL	JOB ORDER	FOREMAN
3074- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3074E-N1	GRUBB
3104- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3104E-N1	GRUBB
3114- 13 100	CORDED EQPT INSPECTION	28		4		H9999E-N1	GRUBB
3115- 13 100	CORDED EQPT INSP	28		4		H9999E-N1	GRUBB
3500- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3500E-N1	GRUBB
3502- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3502E-N1	GRUBB
3503- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3503E-N1	GRUBB
3504- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3504E-N1	GRUBB
3505- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H9999E-N1	GRUBB
3508- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3508E-N1	GRUBB
3517- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3517E-N1	GRUBB
3518- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H9999E-N1	GRUBB
3525- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3525E-N1	GRUBB
3550- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3550E-N1	GRUBB
3567- 13 100	CORDED EQPT INSPECTION	28		4		H9999E-N1	GRUBB
3592- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H3592E-N1	GRUBB
4500N 13 050	CORDED EQPT INSP 1ST FLR NM	28		4		H4500E-N1	HARTMAN
4500N 13 075	CORDED EQPT INSP 2ND FLR NM	28		4		H4500E-N1	HARTMAN
4500N 13 110	CORDED EQPT INSP WING 1	28		4		H4500E-N1	HARTMAN
4500N 13 210	CORDED EQPT INSP WING 2	28		4		H4500E-N1	HARTMAN
4500N 13 310	CORDED EQPT INSP WING 3	28		4		H4500E-N1	HARTMAN
4500N 13 410	CORDED EQPT INSP (WING 4)	28		4		H4500E-N1	HARTMAN
4500N 13 510	CORDED EQPT INSP WING 5	28		4		H4500E-N1	HARTMAN
4500S 13 090	CORDED EQPT INSP. ROOMS T1 & T2	28		4		H4502E-N1	HARTMAN
4500S 13 100	CORDED EQPT INSP. WING 1 BASEMENT	28		4		H4502E-N1	HARTMAN
4500S 13 110	CORDED EQPT INSP WING 1 1ST FL	28		4		H4500E-N1	HARTMAN
4500S 13 120	CORDED EQPT INSP WING 1 2ND FLR	28		4		H4500E-N1	HARTMAN
4500S 13 200	CORDED EQPT INSP. WING 2 BASEMENT	28		4		H4502E-N1	HARTMAN
4500S 13 210	CORDED EQPT INSP WING 2 1ST FLR	28		4		H4500E-N1	HARTMAN
4500S 13 220	CORDED EQPT INSP WING 2 2ND FLR	28		4		H4500E-N1	HARTMAN
4500S 13 300	CORDED EQPT INSP. WING 3 BASEMENT	28		4		H4502E-N1	HARTMAN
4500S 13 310	CORDED EQPT INSP WING 3 1ST FLR	28		4		H4500E-N1	HARTMAN
4500S 13 320	CORDED EQPT INSP WING 3 2ND FLR	28		4		H4500E-N1	HARTMAN
4500S 13 400	CORDED EQPT INSP. WING 4 BASEMENT	28		4		H4502E-N1	HARTMAN
4500S 13 410	CORDED EQPT INSP WING 4 1ST FLR	28		4		H4500E-N1	HARTMAN
4500S 13 420	CORDED EQPT INSP WING 4, 2ND. FLOOR	28		4		H4502E-N1	HARTMAN
4500S 13 500	CORDED EQPT INSP. 1ST. FLOOR MAIN	28		4		H4502E-N1	HARTMAN
4500S 13 510	CORDED EQPT INSP. 2ND. FLOOR MAIN	28		4		H4502E-N1	HARTMAN
4501- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H4501E-N1	HARTMAN
4505- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H4505E-N1	HARTMAN
4507- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H4507E-N1	HARTMAN
4508- 13 110	CORDED EQPT INSP 1ST FLOOR	28		4		H4508E-N1	HARTMAN
4508- 13 120	CORDED EQPT INSP 2ND FLOOR	28		4		H4508E-N1	HARTMAN
4509- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H4509E-N1	HARTMAN
5000- 13 100	CORDED EQUIPMENT INSPECTION	28		4		H5000E-N1	HARTMAN
5500- 13 100	CORDED EQPT INSP BASEMENT	28		4		H5500E-N1	HARTMAN
5500- 13 110	CORDED EQPT INSP 1ST FLOOR	28		4		H5500E-N1	HARTMAN
5500- 13 210	CORDED EQPT INSP 2ND FLOOR	28		4		H5500E-N1	HARTMAN
5505- 13 100	CORDED EQPT INSP	28		4		H5505E-N1	HARTMAN
5507- 13 100	CORDED EQPT INSP	28		4		H9999E-N1	HARTMAN

Typical Work Authorization and Schedule Card

PROGRAMMED MAINTENANCE FOR WEEK OF DEC 1, 1975 FOREMAN GRUBB
QUALITY LEVEL 4

LOCATION 2001-13 100 EQUIPMENT DESCRIPTION CORDED EQUIPMENT INSPECTION PROPERTY JOB ORDER
H2001E-N1

ITEM	POINT OF SERVICE	LUB	FTNG	NO	FREQ	REMARKS
1	CK EQUIPMENT PER				Y	
2	ELECTRICAL PROCEDURE				Y	
3	COMPLETE INSPECTION FORM				Y	
4	AND RETURN WITH CARD				Y	

PORTABLE OR CORDED EQUIPMENT INSPECTION AND/OR CORRECTION PROCEDURE

1. Visual inspection of all metal enclosed portable apparatus to determine the following:
 - a. Does device have good attachment cord?
 - b. Is device equipped with grounding wire and proper polarized cap to assure grounding of enclosure when plugged into convenience outlet?
2. Electrical Inspection
 - a. Test with ohmmeter or test light to determine continuity to ground of enclosure through grounding wire and ground termination on cap.
 - b. Check equipment ground with 2- or 3-amp. load.
3. Correction
 - a. Replace all defective attachment cords and caps as found.
 - b. Make needed corrections to ensure equipment ground.
 - c. Attach inspection sticker.

NOTE:

1. There are some devices--such as amplifiers, oscilloscopes, etc.--enclosed in metal housings on which research personnel will not permit the installation of normal grounding cord and cap. If this situation is encountered, refer it to your supervisor.
2. In many laboratories, there may be an assembly of equipment that is adequately grounded through means other than cable; in this case, individual cord grounds are not necessary.

4500N131001
4500S134001
6025-131001

3 HISTORY RECORDS AVAILABLE

RUN DATE 02/26/76

P.M. NUMBER		DESCRIPTION		CUMULATIVE TO DATE.....		WORK ORDER	FOREMAN	HOURS	MATERIAL COST
4500N13110		CORDED EQPT INSP WING 1		H4500E-N1	HARTMAN	155.0		80	

DATE		BADGE	WORK TYPE	HOURS	MATERIAL COST	WORK PERFORMED
SCHEDULED	COMPLETED					
04-24-72	02-27-73	15160	PROG MAINT	60.0	0	1932 ITEMS INSPECTED
04-22-74	02-07-75	FAH	PROG MAINT	73.0	30	EOP INSP 712 REC CKD859 REPAIR 25 DS 12
04-21-75	12-09-75	FAH	PROG MAINT	82.0	50	EOP INSP 799 REC CKD 1056 REPAIR 22DS13

2 HISTORY RECORDS AVAILABLE

RUN DATE 02/26/76

4500S13400		CORDED EQPT INSP. WING 4 BASEMENT		H4502E-N1	HARTMAN	91.0		50	
------------	--	-----------------------------------	--	-----------	---------	------	--	----	--

DATE		BADGE	WORK TYPE	HOURS	MATERIAL COST	WORK PERFORMED
SCHEDULED	COMPLETED					
02-03-75	- -	DRP	PROG MAINT	34.0	20	EOP INSP 295 REC CKD227 REPAIR 7 DEST 3
02-04-74	12-05-74	JAS	PROG MAINT	57.0	30	EOP INSP 191 REC CKD161 EOP REP 13 DS 5

2 HISTORY RECORDS AVAILABLE

RUN DATE 02/26/76

6025-13100		CORDED EQUIPMENT INSPECTION		H6025E-N1	HARTMAN	18.0		20	
------------	--	-----------------------------	--	-----------	---------	------	--	----	--

DATE		BADGE	WORK TYPE	HOURS	MATERIAL COST	WORK PERFORMED
SCHEDULED	COMPLETED					
10-01-75	- -		PROC MAINT	0.0	0	EQUIP NOT SERVICED
09-30-74	09-27-74	16406	PROG MAINT	18.0	20	EQUIP INSP 80 RECEIPT CKD 169 EQ REP 3

PHMAINT 0003.28

CORDED EQUIPMENT INSPECTIONPage 2 of 3
PagesP.M. NO. 4500 N-13-110DATE OF CARD 4-21-75

INSPECTED BY:

DATE COMPLETED 12-9-75R. [Signature]4500 N WING 1. 1st Floor

ROOM NO.	EQUIPMENT INSPECTED	EQUIPMENT REPAIRED	CORDS DESTROYED	RECPT. CKD.	REMARKS
A-36	5	0	0	3	
A-34	3	0	0	2	
A-32	4	0	0	7	
A-30	3	0	0	3	
A-28	2	1	0	4	
A-26	1	0	0	3	
CORR. A	3	0	0	5	
A-22	2	0	0	1	
A-20	6	0	0	3	
A-18	4	0	0	3	
A-16	6	0	0	9	
A-14	1	0	0	2	
A-12	2	0	0	2	
A-10	4	0	0	4	
A-8	3	0	1	4	
A-6	1	0	0	4	
A-4	1	0	0	3	
A-1	28	0	0	49	
A-5	48	2	1	56	2 EQUIPMENT WITH 2 WIRE CABLE COULD NOT TURN OFF
A-9	76	2	2	70	
A-13	40	0	0	70	
A-17	12	0	1	50	
A-21	29	1	1	52	
A-25	37	2	1	29

Buzzer for Continuity Check

Daniel Woodhead Polarity Check

Impedance Analyzer for Load Check of Receptacle Ground

Sticker Application

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