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MAIN-RING MAGNET DATA SYSTEM

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I. Introduction

The Main-Ring magnet data system consists of up-to-date data on the assembly, inspection, magnetic measurements, tunnel location, hi-potting, failure, salvage, and/or tearing-apart of each main ring bending magnet and quadrupole. The data is readily available on one comprehensive history tape[1] on the PDP-10 computer in the Village. The system further consists of a program for adding new data to update the magnet history tape, as new magnets are built or new measurements are made on existing magnets, as well as a set of subroutines and programs for analysis of the data. These routines make it relatively easy for anyone interested in analyzing some part of the data to access the information interesting to him.

II. Contents and Organization

Table I shows the contents and organization of a magnet history record on the tape. The data are divided into 14 groups:

Group	Title
1	Assembly
2	Miscellaneous (future)
3	Backleg gaps and step at faces

---

[1]Magnet histories are ordered by serial number. In the very near future, there should be a tape ordered by position in the ring.

4 Inspection

5 Quad straightness and water flow

6 Detailed straightness measurement (if done)

7 Bending magnet straightness and water flow

8 Magnetic measurements-bending magnets

9 Magnetic measurements-quadrupoles

10 Installation

11 Hi-potting (magnet-by-magnet)

12 Removal from tunnel

13 Salvage

14 Tear apart

Any group may be repeated any number of times in order to store repetitions of a given set of measurements. Among the repetitions of a group one distinguishes by means of the "generation number", the first word in the group. See Table II. The most recent set of measurements occurs first in the group, and has the highest generation number. Thereafter follow earlier sets of measurements with decending generation numbers, ending with the first set of measurements, with a generation number of 0.

The pointer to a group points to word 1 of the latest repetition of the group. Word 2 of each group is the date of the measurement or event (in form year-month-day, e.g., 20103 for Jan. 3, 1972)

In order to distinguish missing data from quantities equal to zero, the input data cards are scanned for blank fields and the corresponding data words are filled with the octal constant 377777777777. (This constant is the largest positive constant in either fixed-or floating-point representation on the PDP-10.)

A zero pointer to a group means that the group has not been measured for the given magnet.

The first record on the tape is a tape label. It has a fixed length of 50 words. It contains the history file serial number and the date and time of creation of the file.

III. Comments on Data Accuracy

The data on ring installation and removal has been kept very carefully and can be trusted in almost all cases. The inspection and straightness data (group 4, 5 and 7) were made under difficult factory conditions and should be used with caution. The estimated uncertainites for the magnetic measurement data are given in the notes to Table I.

IV. File Use and User Aids

The history file maybe read with subroutine READTP Table III. This subroutine places the history record for one magnet into a buffer and also returns a list of pointers to the data groups and a list of lengths of the data groups (see Comments, Table III). If a pointer is zero, there is no data for that group. A non-zero pointer points to the first word of the group. For example: Let IBEGN(9) be the pointer to group 9, and let it equal N. Then IBUFF(N) will have the generation number of the latest repetition of the quad magnetic measurements. IBUFF(N+1) will have the date, and IBUFF(N+2) through IBUFF(N+107) will have the data. If the generation number was >0, another group 9 will follow, starting with IBUFF (N+108) (which will contain the next earlier generation number).

Normally, one would be interested in the latest data, in which case one could ignore generation numbers. However, the following example will show how to access an earlier generation. Suppose one wishes to access the data in group IG, word IW, generation number IGN. One writes

```
IF(IBEGN(IG).EQ.0) branch out
IPOINT = IBEGN(IG)
NGEN = IBUFF(IPOINT)
IF(NGEN.LT.IGN) branch out
LENGTH = LEN(IG)/(NGEN + 1)
IPOINT = IPOINT + (NGEN - IGN) * LENGTH +  IW-1
IDATA = IBUFF (IPOINT)
```

If one is interested in floating-point data, then one writes

```
EQUIVALENCE (IBUFF(1), BUFF(1))
      .
      .
      .
DATA = BUFF (IPOINT)
```

We have written a standard main program, called WORK, to take care of the tape handling for a wide class of operations on the data. The user can write a subroutine ACTION(K) to perform his required analysis of the data. The sequence in work is as follows:

(1) WORK readies the tape and calls ACTION(1) for initialization of any arrays, reading of control information, etc.

(2) WORK loops on reading the history record for one magnet at a time and calls ACTION(2) each time. The data is passed through COMMON/INFO/IBUFF(2000), IBEGN(20), LEN(20).

(3) When the upper serial number limit or the end of file is reached, WORK calls ACTION(3) for sorting, summarizing or whatever. Following (3) WORK returns to (1). Table IV is a listing of WORK and a typical subroutine ACTION. The other main programs and subroutines available are given in Table V. They are all available in source form on the disk of the PDP-10 in area 12003, 234522. (Due to the possibility of updating, the author suggests that the user make a copy in his disk area of the routines he wishes to use.)

V. Acknowledgements

The author wishes to thank E. Malamud and A. Brenner for valuable suggestions. The program which processes data cards and updates the history tape was written by K. Lee, as was the tape reading subroutine READTP.

Table I

MAGNET HISTORY RECORD ARRANGEMENT

Group	Word	Item
0	1	Number of words in this record
	2	Magnet serial number
	3	Number of data groups (NGR)
	4 to NGR+3	Pointer to the beginning of each group (pointer is zero if group is empty).

N.B. - When "Ohm" appears in the Notes column, it means that the quantity has been obtained from the other two quantities by Ohm's Law.

MAGNET HISTORY RECORD ARRANGEMENT

Item

ASSEMBLY

Group	Word	Item		Notes
1	1	Assembly Repetition Number		
	2	Assembly data		
	3	Contruction specification		1
	4	Assembly epoxy system		2
	5	Upper core manufacturer		3
	6	Upper core serial		
	7	Upper core re-use		4
	8	Lower core manufacturer		3
	9	Lower core serial		
	10	Lower core re-use		4
	11	Manufacturer	Coil #1	5,8
	12	Nominal position	Coil #1	2
	13	Serial	Coil #1	
	14	Re-use	Coil #1	6
	15	Epoxy System	Coil #1	7
	16	Manufacturer	Coil #2	5,8
	17	Nominal position	Coil #2	2
	18	Serial	Coil #2	
	19	Re-use	Coil #2	6
	20	Epoxy	Coil #2	7
	21	Manufacturer	Coil #3	5,8
	22	Nominal position	Coil #3	2
	23	Serial	Coil #3	
	24	Re-use	Coil #3	6

25	Epoxy	Coil #3	7
26	Manufacturer	Coil #4	5,8
27	Nominal position	Coil #4	2
28	Serial	Coil #4	
29	Re-use	Coil #4	6
30	Epoxy	Coil #4	7
31	Vacuum Chamber Manufacturer		9
32	Vacuum Chamber Stainless Steel		
33	Vacuum Chamber Serial		
34	Vacuum pump manufacturer		10
35	Vacuum pump serial		
36	Peculiarities		11

MAGNET HISTORY RECORD ARRANGEMENT

Group	Word	Item	Notes
		MISCELLANEOUS	
2	1	Repetition number	
	2	Date	
	3-39	Data	
		ASSEMBLY SUPPLEMENT	
3	1	Repetition number	2
	2	Date	
	3	Maximum backleg gap (inch)	
	4	Length measured over (inch)	
	5	Average backleg gap (inch)	
	6	Length measured over (inch)	
	7	Maximum step at faces (inch)	
		INSPECTION	
4	1	Repetition number	
	2	Date of inspection	
	3	Lower core length (inch)	
	4	Upper core length (inch)	
	5	Vacuum chamber aperture (bellows end) (inch)	
	6	Vacuum chamber aperture (pump end) (inch)	
	7	Vacuum chamber resistance-to-ground (units of 10,000 ohms)	
	8	Voltage for manifold resistance-to-ground (volts)	
	9	Manifold current-to-ground (mA)	Ohm
	10	Manifold resistance-to-ground (megohm)	
	11	Leak check pressure (psi)	

Group	Word	Item	Notes
		WATER FLOW AND DIAL GAUGES (QUADRUPOLES)	
5	1	Repetition number	
	2	Date of water flow and structural alignment measurements	
	3	Water flow (percent)	
	4	Water flow-pressure used (psi)	
	5	Plus-side height reading (inch) conductor end	
	6	Plus-side height reading (inch) center 1	
	7	Plus-side height reading (inch) center 2	
	8	Plus-side height reading (inch) return end	
	9	Minus-side height reading (inch) conductor end	
	10	Minus-side height reading (inch) center 1	
	11	Minus-side height reading (inch) center 2	
	12	Minus-side height reading (inch) return end	
	13	Radial reading (inch) conductor end	
	14	Radial reading (inch) center 1	
	15	Radial reading (inch) center 2	
	16	Radial reading (inch) return end	
		DETAILED VERTICAL STRAIGHTNESS MEASUREMENTS	
6	1	Repetition number	
	2	Date	
	3	Starting reading (inch)	
	4-12	"B"-side readings, 9 thru 1	
	13-21	"A"-side readings, 9 thru 1	

Group	Word	Item	Notes
		WATER FLOW AND DIAL GAUGES (BENDING MAGNETS)	
7	1	Repetition number	
	2	Date	
	3	Water flow	
	4	Water pressure	
	5	Plus-side height reading (inch) conductor end	
	6	Plus-side height reading - center	
	7	Plus-side height reading - return end	
	8	Minus-side height reading - conductor end	
	9	Minus-side height reading - center	
	10	Minus-side height reading - return end	
	11	Radial reading - conductor end	
	12	Radial reading - center	
	13	Radial reading - return end	

Group	Word	Item	Notes
		MAGNETIC MEASUREMENTS (BENDING MAGNETS)	
8	1	Repetition number	
	2	Date - bend magnet measurements	
	3	+ side back leg gap (inch)	
	4	- side back leg gap (inch)	
	5	Inductance (mH)	
	6	Impedance ( )	
	7	Q	
	8-13	Currents	12
	14-19	Amp factors	12
	20-25	D C Magnetic length x = +1.5 inch	13

Group	Word	Item	Notes
8	26-31	D C magnetic length x = +1.0	
	32-37	D C magnetic length x = 0.0	
	38-43	D C magnetic length x = -1.0	
	44-49	D C magnetic length x = -1.5	
	50-55	A C magnetic length x = +1.5	14
	56-61	A C magnetic length x = +1.0	
	62-67	A C magnetic length x = 0.0	
	68-73	A C magnetic length x = -1.0	
	74-79	A C magnetic length x = -1.5	
	80-139	Future use	

MAGNETIC MEASUREMENTS (QUADRUPOLES)

Group	Word	Item	Notes
9	1	Repetition number	
	2	Date - quad magnetic measurement	
	3-10	Currents	15
	11-18	Horizontal center error	16
	19-26	Vertical center error at x = +2	16
	27-34	Vertical center error at x = 0	16
	35-42	Vertical center error at x = -2	16
	43-50	Unbucked gradient length	17
	51-58	Gradient length difference (fractional)	18
	59-66	DG/G at x = +2 inch	19
	67-74	DG/G at x = +1 inch	
	75-82	DG/G at x = 0 inch	
	83-90	DG/G at x = -1 inch	
	91-98	DG/G at x = -2 inch	

Group	Word	Item	Notes
9	99-10	Gradient D C calibration x = 0	20
	101-102	Gradient D C calibration x = +2	
	103-104	Gradient D C calibration x = +1	
	105-106	Gradient D C calibration x = -1	
	107-108	Gradient D C calibration x = -2	

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INSTALLATION

Group	Word	Item	Notes
10	1	Repetition number	
	2	Date of installation	
	3	Location installed	21
	4	Replacement status	22
	5	Surveyed if replacement	23

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HI-POTTING (INDIVIDUALLY IN RING)

Group	Word	Item	Notes
11	1	Repetition number	
	2	Date of hi-potting	
	3	Volts	
	4	Milliamps	
	51	Megohms	Ohm

- -

FAILURE, REMOVAL

Group	Word	Item	Notes
12	1 1	Repetition number	
	2	Date of removal	
	3	Reason	24
	4	Type of failure	25
	5	Failure Date	
	6	Volts	
	7	Amps (milliamps if reason is hi-pot)	

Group	Word	Item		Notes
	8	Megohms if hi-pot		Ohm
	9	Radiation class		

SALVAGE

Group	Word	Item		Notes
13	1	Repetition number		
	2	Date of salvage		
	3	Repair specification number		26
	4	Volts after salvage		
	5	Milliamps after salvage		Ohm
	6	Megohms after salvage		

TEAR APART, FAILURE ANALYSIS

Group	Word	Item		Notes
14	1	Repetition number		
	2	Date torn apart		
	3	Reason (1=mechanical damage,2=short)		
	4	Volts	1st Coil	8
	5	Milliamps	1st Coil	Ohm
	6	Megohms	1st Coil	
	7	Volts	2nd Coil	8
	8	Milliamps	2nd Coil	Ohm
	9	Megohms	2nd Coil	
	10	Volts	3rd Coil	8
	11	Milliamps	3rd Coil	Ohm
	12	Megohms	3rd Coil	
	13	Volts	4th Coil	8
	14	Milliamps	4th Coil	Ohm
	15	Megohms	4th Coil	
	16	Volts	Vac. Chamber to Inner Coil	
	17	Milliamps	Vac. Chamber to Inner Coil	Ohm
	18	Megohms	Vac. Chamber to Inner Coil	

Group	Word	Item	Notes
14	19	Located?: (l=yes, 2=no)	
	20	1st coil	8
	21	2nd coil	8
	22	3rd coil	8
	23	4th coil	8
	24	Location (feet from lead end)	
	25	Side (l=lead, 2=opposite)	
	26	Face (l=top, 2=bottom, 3=edge)	
	27	Conducter (l=inside, 2=middle, 3=outside)	
	28	Layer (l=top, 2=bottom)	
	29	Shorted to vacuum chamber (l=yes, 2=no)	
	30	Method (l=burned, 2=disassembled)	
	31	Upper core salvaged (l) or scrapped (2)	
	32	Lower core salvaged (l) or scrapped (2)	

Table I Notes

1. Construction specification codes:

   1 Prototype
   2 Plaster stick period
   3 Epoxy stick period
   4 Experimental original impregnation (using reject coils)
   5 Original impregnation
   6 Integral impregnation - coils not separately encapsulated

2. Not filled in at time of writing

3. Core manufacturer codes:

   1 NAL
   2 Sanderson
   3 Northern
   4 Heinze

4. Code 1 means re-used; 0 or octal 377 777 777 777 means new

5. Coil manufacurer codes:

   1 NAL
   2 Westinghouse
   3 Lintott
   4 Alsthom
   5 Everson
   6 English Electric
   7 National Electric Coil
   8 MagnaTek

6. A 0 or 377 777 777 777 means new.

   Other codes are:

   1 Reused - as is
   2 Rework - insulation removed and coil reinsulated
   3 Repair - patching done to coil
   4 Rejected coil

7. A 0 or 377 777 777 777 means usual resin system.
   A 1 means "radiation hard" 204-E

8. Arrangement of coil data:

Coil number	Bending Magnet	Quad
1	Inner	Upper left
2	Upper	Upper right
3	Lower	Lower left
4		Lower right

9. Vacuum chamber manufacturer codes:

   1 NAL
   2 DK Aerospace

10. Vacuum pump manufacturer codes:

   1 Varian

11. Magnet peculiarity codes:

   <u>Bending Magnets</u>

   0 Tapered pole tip
   1 Square pole tip
   3 Non-standard

   <u>Quadrupoles</u>

   0 New backleg dimension (one half-core)
   1 Machined half-core (one)
   2 Old backleg dimension (both half-cores)
   3 Non-standard, e.g.,
      7016 holes in pole tip
      4010 partially new
      7038 two new half-cores

12. Six currents are given. The first and second are 0 and 86 amps, respectively, and are standard. The remaining four are measured quantities at 9, 18, 21 and 22.5 kG respectively. The corresponding ampfactors are derived from them.

13. The magnetic lengths are in groups of 6, corresponding to the currents. The first of each sextet is in Gauss, the remaining five in per cent difference. Each difference is with respect to the signal from the reference magnet. The uncertainties are: a) in the remanent field ± 0.8G, b) in the differences ± 0.03 per cent. (These uncertainties do not include systematic errors.)

14. These measurements had not been made at the time of writing.

15. The eight currents are almost always standard values: 100, 1000, 2000, 3000, 4000, 5000, 6000, 6500 Amps.

16. Uncertainty is perhaps ± 0.010 inch, but the variation for a given quad as a function of current is probably accurate to ± 0.001 inch.

17. Unit is kG/m for a quadrupole exactly seven feet long. That is, the gradient length is divided by 7 feet. The uncertainty has not been determined.

18. With respect to the reference magnet.

19. Referred to DG.G at x = 0.0. The values at x = 0.0 are (words 75-82) merely a check on the stability of the measuring system.

20. Not yet being measured.

21. Five ASCII characters, left justififed, e.g. A1062

22. Replacement status codes:

    1 OK
    2 Low field
    3 Incorrect series

23. Survey codes:

    1 yes
    2 no

24. Reason for removal, codes:

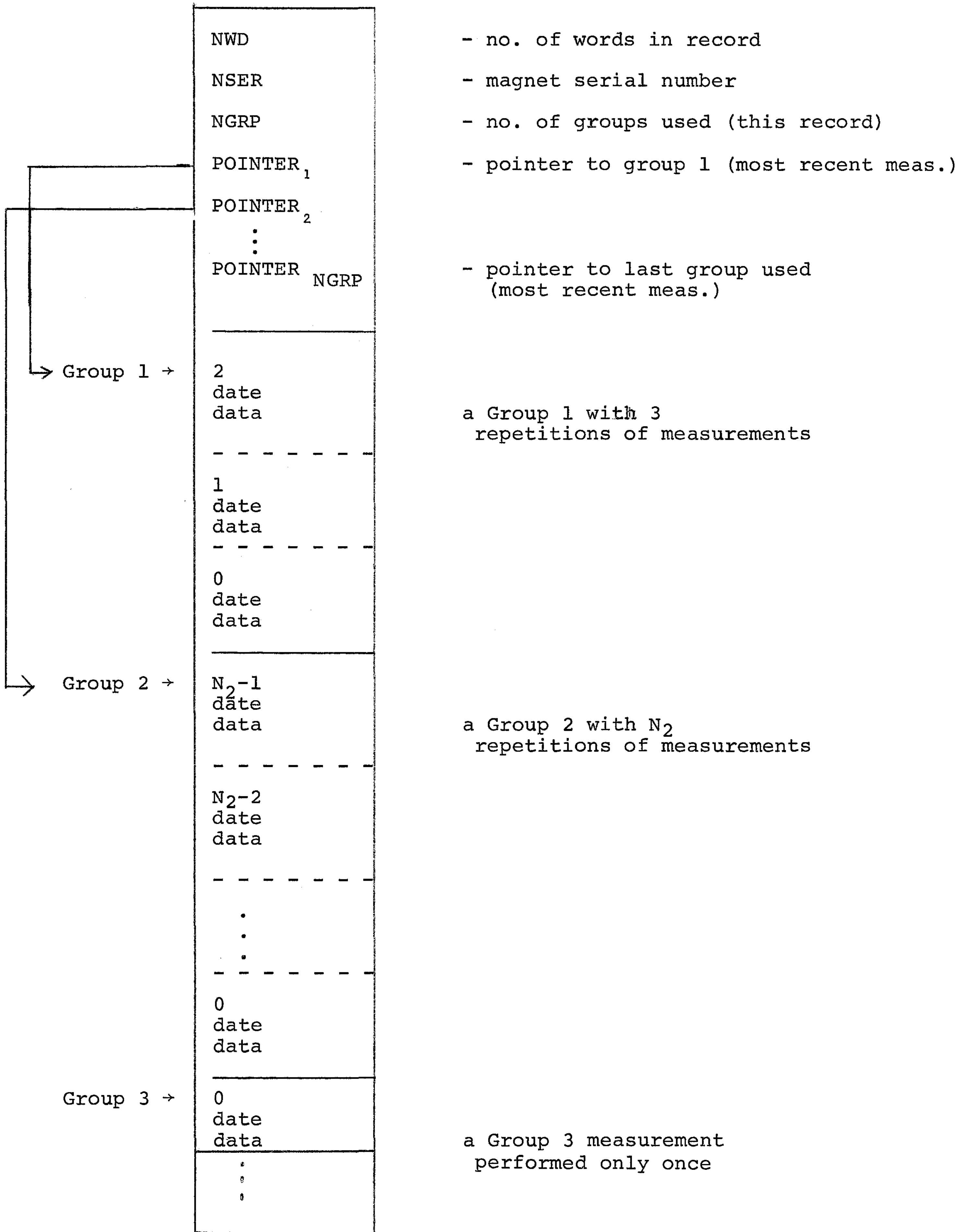
    1 Short
    2 Hi-pot
    3 Convenience
    4 Vacuum leak

25. Not yet in use

26. Type-of-salvage codes:

Code	Description	Factory Code
1	Impregnated West Chicago	IW
2	Ind. Bldg. no vacuum	BC
3	Ind. Bldg. with vacuum	AC
4	Originally impregnated	IO
5	Dip impregnation	DV

Table II Record layout on tape



```
      SUBROUTINE READTP(IDREC,IBUFF,IBEGN,LEN,NGRP,IERR,IEOF)
      DIMENSION IBUFF(1),IBEGN(NGRP),LEN(NGRP)
      DATA NERR/Ø/,NPAR/Ø/
C
C   READS A MAIN RING MASTER FILE TAPE RECORD AND RETURNS POINTERS AND
C   LENGTHS OF THE GROUP INFORMATION THE USER WISHES TO PROCESS.
C
C   IDREC----RECORD ID TO BE PROCESSED.  IF Ø, RECORDS ARE PROCESSED
C            SEQUENTIALLY FROM THE BEGINNING.
C   IBUFF----RETURNS THE COMPLETE INFORMATION OF THE RECORD.  MUST BE
C           DIMENSIONED PROPERLY---ABOUT 2ØØØ.
C   IBEGN--ENTERS WITH THE GROUP NO.S TO BE PROCESSED AND RETURNS THE
C           BEGINNING ADDRESS OF THAT GROUP.  MUST BE DIMENSIONED AT
C           LEAST NGRP. IF DUMMY GROUP(NO ACTUAL DATA), Ø IS RETURNED.
C   LEN------ENTERS WITH THE NUMBER OF GENERATIONS OF HISTORY DATA TO
C           BE PROCESSED AND RETURNS THE LENGTHS OF THE GROUP.
C       LEN=Ø--ALL
C           =N--N GENERATIONS STARTING WITH THE LATEST DATA.
C           =-N--N GENERATIONS STARTING WITH THE (N+1)ST DATA
C   NGRP-----NUMBER OF GROUPS
C   IERR---RETURNS ZERO IF SUCCESSFUL
C   IEOF RETURNS 1 IF END OF FILE SENSED,  OTHERWISE Ø.
C   K.Y.LEE/NAL COMPUTING CENTER...12/2Ø/71
C           VERSION 2/1Ø/72
C
      IEOF=Ø
      IERR=Ø
   6Ø READ(1,ERR=8ØØ,END=13Ø)NWD,(IBUFF(J),J=2,NWD)
        JGMX=IBUFF(3)+3
      IBUFF(1)=NWD
      IF(IDREC.EQ.Ø)GO TO 7Ø
      IF(IDREC.NE.IBUFF(2))GO TO 6Ø
   7Ø DO 11Ø J=1,NGRP
      IF(IBEGN(J).GT.IBUFF(3))GO TO 72
      INDEX=IBEGN(J)+3
      IBEGN(J)=IBUFF(INDEX)
      GO TO 73
   72 IBEGN(J)=Ø
      GO TO 11Ø
C   IF NO ACTUAL DATA RETURN Ø POINTER.
   73 IF(IBEGN(J).EQ.Ø)GO TO 11Ø
      NGEN=IBUFF(IBEGN(J))+1
C   TOTAL NUMBER OF GENERATIONS IN THIS GROUP
      IF(INDEX.GE.JGMX)GO TO 77
C   LENGTH OF EACH GENERATION
        KYL=INDEX+1
        DO 74 KL=INDEX,JGMX
        IF (IBUFF(KYL).NE.Ø) GO TO 75
74      KYL=KYL+1
   77 J2=IBUFF(1)+1
        GO TO 76
75      J2=IBUFF(KYL)
   76 NLEN=(J2-IBEGN(J))/NGEN
        KP=75
      IF(LEN(J))8Ø,1ØØ,9Ø
   8Ø INDEX=NGEN+LEN(J)
      NGEN=-LEN(J)
      IBEGN(J)=IBEGN(J)+INDEX*NLEN
      GO TO 1ØØ
   9Ø NGEN=LEN(J)
```

Table III   Subroutine READTP

```
  100 LEN(J)=NGEN*NLEN
        KP=100
  110 CONTINUE
  120 RETURN
C  END OF FILE SENSED
  130 IEOF=1
      GO TO 120
  800 NPAR=NPAR+1
      IERR=1
      IF(NPAR.GT.10)STOP
      WRITE(6,850)
  850 FORMAT(' PARITY ERR IN THE TAPE----STOP AFTER 10 ERRORS')
      GO TO 120
  820 NERR=NERR+1
      IERR=1
      IF(NERR.GT.100)GO TO 120
      WRITE(6,860)NGRP
  860 FORMAT(' TOO MANY GROUPS',I5,'  STOP MESSAGES AFTER 100')
      GO TO 120
  810 WRITE(6,870)LABEL1
  870 FORMAT(' BOTH TAPES HAVE SAME LABEL',I10,'  STOP')
      STOP
      END
```

Table III   page 2

```
C         GENERAL PURPOSE MMDS MAIN PROGRAM
C
C                 J. F. SCHIVELL
C
C                 MAR. 9, 1972
C
          COMMON /INFO/IBUFF,IBEGN,LEN
          DIMENSION LABEL(4)
          DIMENSION IBUFF(2000), IBEGN(20), LEN(20)
1         NGRP=14
2         CALL HEAD
          WRITE (6,1000)
1000      FORMAT (' ENTER LOW AND HIGH SERIAL NUMBER DESIRED'/)
          READ (5,1001) NLO, NHI
1001      FORMAT (2I)
          WRITE (6,1001) NLO, NHI
          REWIND 1
          READ (1) LABEL
          WRITE (6,1002) LABEL
1002      FORMAT (/' TAPE LABEL = ',I5,5X,2A5,5X,A5//)
          CALL ACTION(1)
10        DO 11 I=1,NGRP
          IBEGN(I)=I
11        LEN(I)=0
          CALL READTP(0,IBUFF,IBEGN,LEN,NGRP,IERR,IEOF)
          IF (IEOF.NE.0) GO TO 50
          IF (IBUFF(2).LT.NLO) GO TO 10
          IF (IBUFF(2).GT.NHI) GO TO 50
          CALL ACTION(2)
          GO TO 10
C
50        CALL ACTION(3)
          GO TO 2
          END
```

Table IVa. Program WORK

```
      SUBROUTINE ACTION(KONTRL)
      DIMENSION ISTORE(500,2), ITEMP(2)
      DIMENSION IBUFF(2000), IBEGN(20), LEN(20)
      COMMON /INFO/IBUFF, IBEGN, LEN
C
1     GO TO (100,200,300), KONTRL
C
100   DO 110 I=1,500
      DO 110 J=1,2
110   ISTORE(I,J)=0
      IMG=0
      RETURN
C
200   CALL RING(IBUFF,IBEGN,LEN,KIN,LOCA)
      IF (KIN.EQ.0) RETURN
      IX=IBEGN(1)+2
      IF (IBUFF(IX).GT.2) RETURN
      IF (IBEGN(13).GT.0) RETURN
      IMG=IMG+1
      ISTORE(IMG,1)=LOCA
      ISTORE(IMG,2)=IBUFF(2)
      RETURN
C
300   WRITE (6,1000) IMG
1000  FORMAT (' NUMBER OF PLASTER AND PROTOTYPE MAGNETS IN RING ='
     1 , I6///)
      DO 350 I=1,IMG
      DO 350 J=I,IMG
      IF (ISTORE(J,1).GT.ISTORE(I,1)) GO TO 350
      DO 340 K=1,2
      ITEMP(K)=ISTORE(J,K)
      ISTORE(J,K)=ISTORE(I,K)
340   ISTORE(I,K)=ITEMP(K)
350   CONTINUE
      DO 360 I=1,IMG
360   WRITE (6,1001) (ISTORE(I,K), K=1,2)
1001  FORMAT (1X,A5,I6)
      RETURN
      END
```

Table IVb.

Version of ACTION which finds plaster magnets in ring and sorts them by location

Table V Analysis Routines Available

File	Main or Sub	Name	Description
READTP.F4	sub	READTP	Reads history records and picks up pointers and group lengths
WORK.F4	main		General-purpose data analysis main program
AQAV.F4	sub	ACTION (K)	Finds average quadrupole strength for new, old, 4-ft, 7-ft.
APLS.F4	sub	ACTION (K)	Finds unimpregnated plaster stick magnets in ring and sorts them by location.
RSS.F4	main		Lists magnets in ring by position, gives peculiarity flags, field strengths and errors, aperture or center errors, and alignment errors.
RING.F4	sub	RING	Returns KIN=0 if magnet not in ring, KIN=1 and location if magnet in ring.
FLOC.F4	sub	FLOC	Given a ring position, returns position indices for RSS and magnet type required.
HDUMP.F4	main		Dumps all or part of history file
RDUMP.F4	sub	RDUMP	Writes out history record - formatted
PRFR.F4	main		Production, failure, and repair summary
FALGR.F4	main		Produces 3 histrograms of magnet removals: 1) Identified by type of failure 2) Identified by type of manufacturer 3) Identified by magnet type

HSCK1.F4	main		Checks histories for sensible sequence of events
HSEQ.F4	sub	HSEQ	Produces list of events by date in a magnet's history
CMODA.F4	sub	CMODA	Converts year and day of year to year-month-day form; or does reverse
CDAY.F4	sub	CDAY	Converts number of days, starting with Jan. 1, 1970=1 into year-month-day form; or does reverse
HEAD.F4	sub	HEAD	Heads output page with time and date when called.
QSORT.F4	main		Sorts magnets on any quantity or desired quantity. Makes 2 lists, one of magnets in ring, one of magnets not in ring.
DSS.F4	sub	DERIVE	Derives side-to-side quad gradient differences. (called by QSORT)