IBM Technical Newsletter

File Number 1410-33

Re: Form No. C28-0343

This Newsletter No. N28-2006

Date September 20, 1963

Previous Newsletter Nos. None

IBM 1410 Tape Sorting/Merging Programs: Sort/Merge 12

This newsletter contains replacement pages and notes for corrections to the publication, IBM 1410 Tape Sorting/Merging Programs: Sort/Merge 12, Form C28-0343.

Pages 7, 8, 21 - 26, 99, 100, 107, 108 have been replaced because of extensive changes. A new cover page is also included to correct the revision notice on page 2. Text changes are indicated by a vertical bar at the left of the lines affected; figure changes by a dot (•) at the left of the figure title.

Other changes are to be made as shown below:

Page	Amendment
6	In column 2, the first line of the Note under "Collating Sequence" should be changed to read: Note: A record mark (≠, 0-2-8 punch) should
12	In column 1, the first entry under "Initial Loc" should be changed to read: ~02580
102	In column one, the message at the bottom should read: ERROR IN CF SPECIFICATION, CF-CD<0

International Business Machines Corp., Programming Systems Publications, P. O. Box 390, Poughkeepsie, N. Y.

PRINTED IN U.S.A.

File No. 1410-33
Form C28-0343

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IBM 1410 Tape Sorting/Merging Programs: Sort/Merge 12

This publication describes the functions and features of the IBM 1410 Sort/Merge 12 Program, a tape sorting and merging program using the Processing Overlap and Priority special features. It provides the programmer and operator with complete information for best use of the program. It presents substantial modifications and expansions to material in the previous Sort/Merge 12 publication, Form J28-0253. It also includes the 1410 Sorting times contained in Form C28-0293.

In addition to complete program specifications, the publication furnishes control card formats, detailed operating instructions, and information on the use of modification exits.

Form C28-0343
Page Revised 9/5/63
by TNL N28-2006

PREFACE

This publication provides detailed information for programmers, systems analysts, and machine-room personnel on the use of the IBM 1410 Tape Sorting/Merging Program: Sort/Merge 12.

Sort/Merge 12 is an efficient tape sorting and merging program which is directed by user-supplied control cards. It makes use of the Overlap and Priority special features to permit overlap of the read/write and processing operations, and so provides most efficient use of computer time. The program can perform the following functions:

1. Sort and merge files composed of Form 1, Form 2, Form 3, or Form 4 data records (see "Record Formats").
2. Sort on one through ten control data fields; each field can contain from one through 9990 characters.
3. Merge two through five sequenced files.
4. Reblock and/or sequence check a sequenced file.
5. Label output tapes, as directed through control cards.
6. Provide automatic checkpoint and restart facilities.
7. Provide exit points to link Sort/Merge 12 to user-supplied routines to perform editing, summarizing, and other functions.

Major Revision (July, 1963)
This publication supersedes the preliminary reference manual, IBM 1410 Tape Sorting/Merging Programs: Part II, Sort/Merge 12, Form J28-0253, with its associated Technical Newsletters (N28-1018 and N28-1020); and the Systems Reference Library publication, IBM 1410 Tape Sorting Programs, Sort/Merge 12: Sorting Times for the IBM 1410 with 7330, 729II, 729IV or 729V Tape Units, Form C28-0293, with its associated Technical Newsletter (N28-1056).

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The only characters that are invalid for this purpose are the record mark and the group mark. Figure 2 gives the minimum and maximum parameters for control data fields. The fields can be in any order, separate or adjacent, but may not overlap (see Figure 3).

Major and Minor Fields

The first control data field specified is the major field. All subsequent fields are minor fields whose relative rank is determined by the order in which they are specified in control card 2.

Major control fields are compared first; if they are unequal, the data records are sorted in the ascending or descending sequence specified in control card 1. If the major fields are equal, the first minor control fields are compared. If the first minor fields are unequal, the data records are sequenced; if equal, the next minor control fields are compared. This action continues until the records are sequenced, or until all control data fields are equal.

The input order is not necessarily maintained for those records in which all control data fields compare equal; in that case, the two records are sequenced in arbitrary order, determined by the program.

USER-INSERTED ROUTINES

The user has the option of adding his own closed subroutines to Sort/Merge 12. These subroutines may perform nonstandard sorting functions, or those not related to such as editing. Exits which provide linkage to the user's subroutines are supplied at logical points within Sort/Merge 12. The user must specify in control card 3 where his programming is to start. Space will be reserved for it from that specified location to the end of core storage. For full details on the exits available, linkages, programming considerations and suggested modifications, see "Modifications: User-Inserted Routines."

	Minimum	Maximum
Number of Fields	1	10
Characters per Field	1	999
Total Number of Control Data Characters	1	9,990

Figure 2. Control Data Parameters

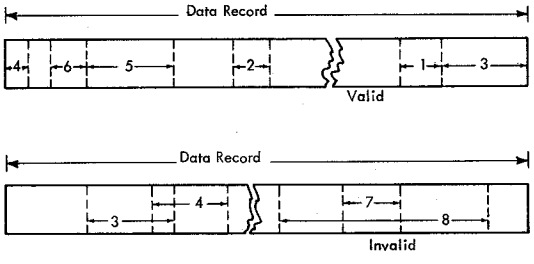


Figure 3. Control Data Field Configurations

CHECKPOINT AND RESTART

The term checkpoint refers to periodic recording on tape of the contents of core storage to provide convenient points for subsequently restarting the program.

Checkpoint records are automatically written for each pass of Phase 2 and for the Phase 3 pass. These checkpoint records are written on the output tape unit specified last on control card 1. For example, if five units are specified in columns 2-6 and 11-15 of control card 1, checkpoint records in Phase 2 will always be written on the unit specified in column 6, for odd numbered passes; and in column 15, for even numbered passes. In Phase 3, only a checkpoint record will appear on the unit in column 6, if Phase 2 ended on an even pass, or in column 15, if Phase 2 ended on an odd pass; no data records will be written on it.

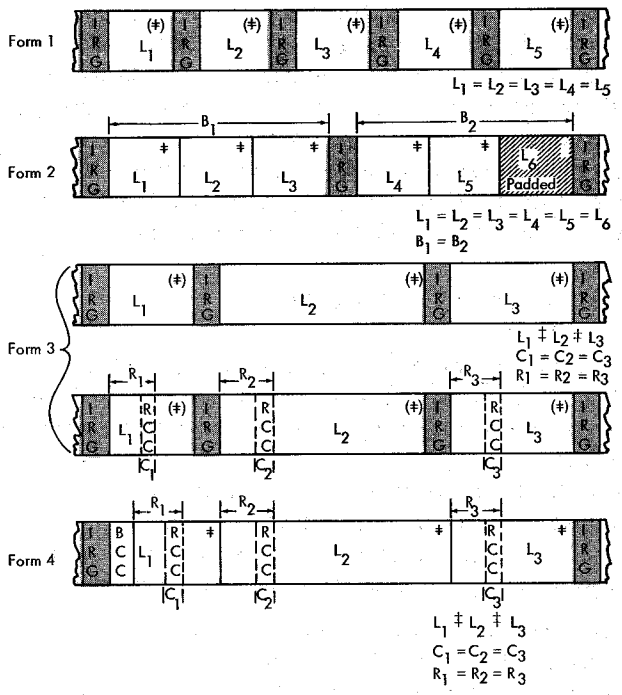
Sort/Merge 12 uses checkpoint records to reinitialize each pass of Phase 2 and for Phase 3. When it is necessary for the user to restart the program after a halt, the last recorded checkpoint is read into core storage, and the program is reinitialized to commence processing at the beginning of the pass during which the halt occurred.

FILES AND RECORDS

The Sort/Merge 12 Input/Output Control System is based on the IOCS described in IBM 1410 Input/Output Control System for Card and Tape Systems, Form C28-0334. The following information is essentially an abstract from that publication, combined with other material pertinent to Sort/Merge 12.

Record Formats

The four classes of record formats that can be handled by Sort/Merge 12 are summarized in Figure 5. Figure 4 is a schematic representation of each format.



Notes:
1. IRG = Inter-Record Gap
   RCC = Record Character Count
   BCC = Block Character Count
2. Record Marks, (≠), in Parentheses, are optional.

Figure 4. Record Formats, Schematics

		With Record Marks	Without Record Marks
Fixed-Length	Unblocked	Form 1	
	Blocked ①	Form 2	
Variable Length	Unblocked ②	Form 3	
	Blocked ③	Form 4	

① With padding of short-length blocks.
② With or without Record Character Count fields.
③ With Record Character Counts and Block Character Count fields.

Figure 5. Record Formats

Form 1: If the input file consists of Form 1 records without record marks, a record mark is added at the end of each record by Sort/Merge 12 for internal processing. If Form 1 records are specified for output, the added record marks are deleted and the records are restored to their original length. If Form 2 records are specified for output, the added record marks are retained. If the input file consists of Form 1 records with record marks, and Form 1 is specified for output, the record marks are retained throughout.

Form 2: If both input and output record format is Form 2, record marks are retained and short-length blocks are padded. For a merging application, if the input is Form 2 records, the output may not be Form 1 records.

Form 3: If the input file consists of Form 3 records without record marks and/or without record character count fields, record marks and record character counts (if necessary) are added for internal processing. If the output format is the same as the input format, the added record marks and the added record character count fields are deleted. If the output format is blocked records with a blocking factor greater than 1, the added record marks and record character count fields are retained.

Form 4: If both input and output format is Form 4, record marks and record character counts are retained for each record; and a proper block character count field is computed for each block. If Form 3 records are specified for output, the record marks and the record character count fields are retained. For a merging application, if the input is Form 4 records, the output cannot be Form 3 records.

Block Character Count Field

The block character count field consists of the first four characters of each Form 4 block of records. This field is a count of the total number of characters in the block, including the four characters of the block character count field, itself.

The block character count field has AB zone bits over the units position.

Record Character Count Field

The record character count field consists of two to four characters within a data record; and is a count of the total number of characters in the record, including those in the record character count field and the record mark, if any.

The record character count field must be in the same relative position in each record, and must be of the same length for each record (Figure 4).

Card Column	Contents	Sorting	Merging
60		HEADER LABELS: OUTPUT TAPES	
	blank	Output tapes are not to contain header labels.	
	1	Information in the input header label control card also defines output header labels. If this option is chosen, column 58 must be punched 1 (Note 3).	
	2	Output tapes are to contain a new header label as specified in the output header label control card. If this option is chosen, an output header control card is required, and should be the last control card entered.	
61		TAPE MARKS: OUTPUT TAPES	
	blank	Output tape header labels (if any) are not to be followed by tape marks.	
	1	Each output tape header label is to be followed by a tape mark.	
62		TEMPORARY TAPE LABEL HANDLING: PHASES 1 and 2	
	blank	Phase 1 and Phase 2 output tapes are not to contain labels.	Always blank
	0	Phase 1 and Phase 2 output tapes are to contain labels.	
	1	Phase 1 and Phase 2 output tapes are to contain labels and tape marks.	
63		HALT OPTION: PHASE 3	
	blank	Program is not to halt prior to Phase 3.	Always blank
	0	Program is to halt prior to Phase 3.	
64		RETENTION CYCLE CHECK: PHASE 1 AND PHASE 2 OUTPUT LABELS	
	blank	Retention Cycles on Phase 1 and Phase 2 output labels are not to be checked.	Always blank
	0	Retention Cycles on Phase 1 and Phase 2 output labels are to be checked. This option requires that column 62 contain 0 or 1 and that control card 3 be included in the control card package.	
65		PADDING	
	blank	Padding records, when required to fill out short length blocks, to consist of blanks	
	9	Padding records to consist of 9s	
66		CORE STORAGE SIZE	
		Specifies the number of core-storage positions available:	
	2	20,000 positions	
	3	40,000 positions	
	4	60,000 positions	
	5	80,000 positions	

Figure 17. Control Card 1 (page 5)

Card Columns	Contents	Sorting	Merging
67		RECORD COUNT/HASH TOTAL	
		Indicate whether record counts and/or hash totals are to be made.	
		Record Count / Hash Total	
	blank	No / No	
	0	Yes / No	
	1	No / Yes	
	2	Yes / Yes	
		If the output file is to consist of Form 2 records, either 0 or 2 should be punched to insure that blocks created internally which consist entirely of the specified padding records are not written in the final output file.	
68-72		OPTIONAL INPUT TAPE UNITS	
	all blanks	Input is from the units specified in columns 2-6.	Always blank
	nnnnn	Input is from the tape unit(s) specified. in column 7.	
		(See also columns 2-6.)	
73-75	blank	These columns must be blank	
76		CONTROL CARD 3	
	blank	Control card 3 is not included.	
	0	Control card 3 is included	
77-80	CTL1	CONTROL CARD 1 IDENTIFIER	

Notes:

1. If fewer than five units are specified, their identifying numbers are written left-justified, with the remaining field positions left blank.
2. The total number of input reels; that is, the sum of columns 21-22, 23-24, 25-26, 27-28, and 29-30, must be equal to or less than 495.
3. Control card 3 must be supplied in the control card package, with the current date specified in columns 18-22.
4. The final output file is written on the units specified in columns 2-6 or in columns 11-15. The group of units used is dependent upon the number of passes required by Phase 2. If the number of passes required in Phase 2 is even, the final output file is written on the units specified in columns 2-6; if the number of passes required is odd, the output is written on the units specified in columns 11-15.

   For the special case where no passes are required by Phase 2, the output is written on the units specified in columns 2-6.

• **Figure 17. Control Card 1 (page 6)**

Card Columns	Contents	Sorting and Merging
1-2	nn	NUMBER OF CONTROL DATA FIELDS nn can be from 01 to 10
3-6	nnnn	TOTAL LENGTH OF CONTROL DATA FIELDS nnnn can be from 0001 to 9990
7-10	nnnn	FIELD 1 (MAJOR FIELD): LOCATION (Note 1)
11-13	nnn	FIELD 1: SIZE (Note 2)
14-17	nnnn	FIELD 2: LOCATION (Note 1)
18-20	nnn	FIELD 2: SIZE (Note 2)
21-24	nnnn	FIELD 3: LOCATION (Note 1)
25-27	nnn	FIELD 3: SIZE (Note 2)
28-31	nnnn	FIELD 4: LOCATION (Note 1)
32-34	nnn	FIELD 4: SIZE (Note 2)
35-38	nnnn	FIELD 5: LOCATION (Note 1)
39-41	nnn	FIELD 5: SIZE (Note 2)
42-45	nnnn	FIELD 6: LOCATION (Note 1)
46-48	nnn	FIELD 6: SIZE (Note 2)
49-52	nnnn	FIELD 7: LOCATION (Note 1)
53-55	nnn	FIELD 7: SIZE (Note 2)
56-59	nnnn	FIELD 8: LOCATION (Note 1)
60-62	nnn	FIELD 8: SIZE (Note 2)
63-66	nnnn	FIELD 9: LOCATION (Note 1)
67-69	nnn	FIELD 9: SIZE (Note 2)
70-73	nnnn	FIELD 10: (MOST MINOR FIELD): LOCATION (Note 1)
74-76	nnn	FIELD 10: SIZE (Note 2)
77-80	CTL2	CONTROL CARD 2 IDENTIFIER

Notes:

1. This is the location of the low-order (last) character of the field; for example: if this field consists of the 27th, 28th and 29th characters of each record, nnnn should be punched 0029.

2. This specifies the number of characters in the appropriate control data field; nn can be from 001 to 999.

Figure 18. Control Card 2

Card Columns	Contents	Sorting	Merging
1-7		EXPECTED FILE SIZE	
	all blanks	Number of records in input file unknown.	High-order padding will complete last block of Form 2 output, or output is Form 1, 3 or 4.
	nnnnnnn	Exact or approximate number of records in input file. nnnnnnn can vary from 0000001 to 9999999.	Exact number of records in input files if Form 2, and low-order padding is specified.
8-12		USER AREA: PHASE 1	
	all blanks	User-supplied routines are not incorporated.	Always blank
	nnnnn	Starting address of core-storage area to be reserved for user-supplied routines to be incorporated into Phase 1 (Note 1).	
13-17		USER AREA PHASE 2, PHASE 3, MERGE	
	all blanks	User-supplied routines are not incorporated.	
	nnnnn	Starting address of core-storage area to be reserved for user-supplied routines to be incorporated into Phases 2 and/or 3 (Note 1).	Starting address of core-storage area to be reserved for user-supplied routines to be incorporated into the merge program (Note 1).
18-22		DATE	
	yyddd	yy specifies the year (00-99); ddd specifies the day (001-366). The date should be punched if the retention cycle is to be checked for Phase 2 or Phase 3 output tape labels of a sort, or on temporary tape labels that are retained. Date should also be punched, for both sorting and merging applications, if this information is to be retained on output header labels.	
	all blanks	This field is left blank if none of the above options has been chosen.	
23-26			MAXIMUM RECORD LENGTH: FORM 3 RECORDS
	all blanks	Always blank	Merge is performed on Form 1, Form 2, or Form 4 records, or size of output area for Form 3 records is equal to the input block length (BiL) (Note 2).
	nnnn		Size of longest record where output consists of Form 3 unblocked records; nnnn can be from 0001 to 9999.
27-76	all blanks	This field is not used.	
77-80	CTL3	CONTROL CARD 3 IDENTIFIER	

Notes:

1. Core storage is reserved from this address to the last core-storage location of the machine (see control card 1, column 66).
2. For example, if the input block length is 9999 characters, the merge program will specify an output area of 9999 characters, even though the longest record of the file does not, for instance, exceed 250 characters. If 9999 core-storage locations are not available for this output area, the particular merge cannot be processed.

Figure 19. Control Card 3

Card Columns	Contents	Input Files	Output Files
1-3	nnn	TAPE-LABEL HANDLING	

nnn is determined by the appropriate table, below. "Yes" means that the item is to be checked or written; "No" that the option is not selected. In cases of conflict, YES has priority over NO.

		Header Labels				Trailer Labels
Card Column	Contents	File Serial Numbers	Reel Sequence Numbers	File Name	Creation Date	Block Character Count
1	0	Yes	Yes	Yes	Yes	Yes
	1	No	No	No	No	No
	2	No	No	Yes	No	Yes
2	0	Yes				
	1	No				
3	0		Do Not Update			
	1		Increment by 1*			

*Optional for multi-reel input files.

Card Column	Contents	File Serial Numbers	Reel Sequence Numbers	File Name	Creation Date	Retention Cycle
1	0	No	No	No	No	Yes*
	1	No	No	No	No	No
2	0	Specified in Cols. 4-8				
	1	Replace by Tape Serial Number				
3	0		Do Not Update			
	1		Increment by 1**			

*Current date must be supplied in control card 3 (columns 18-22).

**Successively for each output reel.

4-8		FILE SERIAL NUMBER	
	nnnnn	Specifies file serial to be checked if checking is specified in columns 1 or 2.	Specifies file serial if "0" is punched in column 2.
	all blanks		If "1" is punched in column 2.

• Figure 20. Header Label Control Card (page 1)

Card Columns	Contents	Input Files	Output Files
9	-	Hyphen, 11-punch (Note)	Hyphen, 11-punch (Note)
10-12		REEL SEQUENCE NUMBER	
	nnn	nnn can be from 001 to 999	
13	blank	(Note)	(Note)
14-23		FILE NAME	
	aaa...a	Any combination of the 64 valid 1410 characters (including blank) that identify the file.	
24-28		CREATION DATE	
	ddyyy		This field need not be punched if control card 3 is included in the control card package.
29	-	Hyphen, 11-punch (Note)	Hyphen, 11-punch (Note)
30-32		RETENTION CYCLE	
	nnn	Always blank	The number of days after the date specified in columns 24-28 (or in control card 3) that this file is to be preserved.
33	blank	(Note)	(Note)
34		Record Mark, ≠, 0-2-8 Punch (This character must be punched)(Note)	
35-76	all blanks	This field is not used.	
77-79	HDR	HEADER LABEL CONTROL CARD IDENTIFIER	
80		APPLICATION/FILE IDENTIFIER	
	I or O	Letter I, 12-9 punch. This card is for the input file in a sorting application.	Letter O, 11-6 Punch. This card is for the output file in either a sorting or merging application.
	1, 2, 3, 4, 5	This card is for the input file in a merging application. The input file is to be mounted on the unit as specified in the following columns of control card 1:	

Card 1	for Column 11
2	12
3	13
4	14
5	15

Note: For compatibility with format accepted by IOCS.

Figure 20. Header Label Control Card (page 2)

OPERATING PROCEDURES

The Program Deck

The Sort/Merge 12 program deck consists of:

1. The Assignment Phase
2. Phase 1 (the internal sort): 9 blocks
3. Phase 2 (the internal merge passes): 9 blocks
4. Phase 3 (the output merge pass): 11 blocks

A block is defined as a portion of the program deck ending with an execute card.

Figure 28 shows the proper order of the program deck and the control card packages required by the program.

Tape Requirements

The tape units that must be available for a particular application are those specified in control card 1, columns 2-6, 11-15 and 68-72.

Program Loading

The Sort/Merge 12 program deck, as distributed, is designed primarily for loading from the card reader; however, the deck may also be adapted to loading from tape.

From the Card Reader

1. Clear storage
2. DISPLAY: 00247
3. ALTER: V L%1100257R V.
4. ADDRESS SET: to location 00247
5. START

From Tape

To read in the program from the systems tape, the X control fields of the read instructions contained in the first and third cards of the five-card load program must be modified. The X control fields are contained in columns 11-13 and 45-47 of the first card, and in columns 48-50 of the third card. The original contents of each of these sets of three columns are %11 (the read is to be from the channel 1 card reader). Each field must be changed to %B0 to indicate that the read is to be from tape unit 0 on channel 1. (Unit 0 on channel 1 must be used, or the tape reread routine will not work.)

1. Clear storage
2. DISPLAY: 00247
3. ALTER: V L%B000257R V
4. ADDRESS SET: to location 00247
5. START

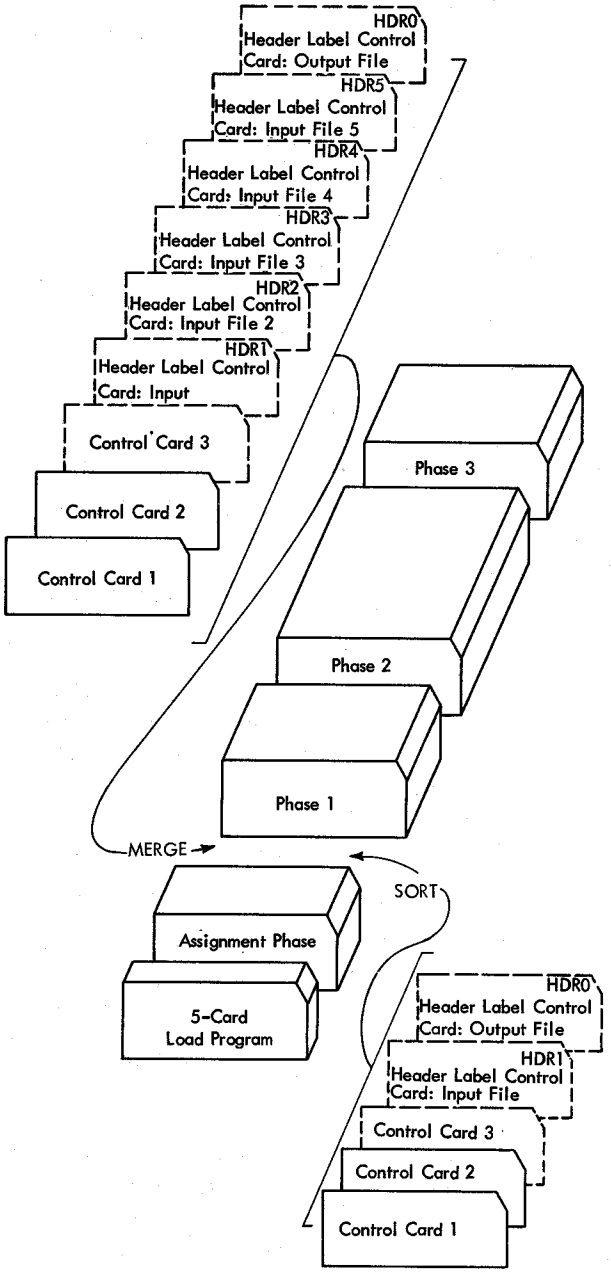


Figure 28. The Program Deck

If a tape parity error occurs during the loading of the program from tape, the load program halts at location 00397 and the channel 1 DATA CHECK light is turned on. The record that is in error may be reread by pressing COMPUTER RESET, then START. If after several attempts, the record has not been read successfully, the program tape may have to be regenerated.

Placing the Sort/Merge 12 program on tape does not affect the procedures for control card loading.

If the control cards are to be read from the card reader, they should be placed in the hopper in the proper order, and the card reader should be placed in the ready status. The following section describes how control cards are loaded from magnetic tape.

Control Card Loading

From the Card Reader

To load control cards from the card reader, follow the procedure indicated above for program loading from the card reader.

From Tape

To load control cards from tape, core-storage locations 15138-15142 must be overlaid with the information described below. The required patch card must precede the execute card for the Assignment Phase (card 999S1200).

Location 15138, labeled TAPEIN, must contain the character T.

Location 15139-15142, labeled PROGTAPE, must contain the address of the tape unit from which the control card information is to be read, the parity, and the operation code of an error test on the corresponding channel.

For example, if control cards are to be read in from tape unit 5 on channel 2, in even parity, locations 15138-15142 contain T⊟U5X.

The patch card is punched 1513800005T⊟U5X.

If the control cards are on the systems tape, they are on channel 1, unit 0, in odd parity. The corresponding patch card is punched 1513800005T%B0R.

Operation of the Restart Program for Card Input: Sorting Applications

The Sort/Merge 12 program deck contains a restart program for use with the checkpoint feature. A checkpoint record is automatically written at the beginning of each merging pass of a sorting application; that is, at the beginning of each pass of Phase 2 and at the beginning of the Phase 3 pass. If a halt occurs during one of these merging passes, the user can take advantage of the restart program, and the last recorded checkpoint record, by restarting the application at the beginning of the pass that precedes the one during which the halt occurred.

The procedure for a restart operation is as follows:

1. Remove any portion of the program deck that is still in the card reader.
2. Place the restart program in the card reader. Place on top of the restart program the portion of the program deck previously removed from the card reader.
3. Clear core storage and load the restart program. (See the standard card loading procedure outlined under "Program Loading - From the Card Reader.")
4. Press INQUIRY REQUEST as the program is being loaded.
5. After the request has been made, and the console I/O printer has typed an I and spaced, type in the mode, channel, parity and unit on which the checkpoint was written, in that order. (Each time a checkpoint is written, the message CHKPT XXXN is typed out, where XXXN indicates the mode, channel, parity and unit that are specified in step 5.) For example, M%B1 would be typed to specify that the checkpoint has been written on channel 1, unit 1, in the Move mode, and in odd parity.
6. Press INQUIRY RELEASE to give control to the restart program. The sorting application will continue from that stage of the program at which the last checkpoint was taken.

The restart program must be removed from the Sort/Merge 12 program deck after a restart has been effected.

To restart the last pass of Phase 2, it may be necessary to reread part of the program deck. If this action is required, a message will inform the operator. If the program is loaded from tape, the restart program performs this function automatically.

The restart program can be loaded from a magnetic tape unit on channel 1 by inserting the following program change card immediately preceding execute card 999S12RS.

Initial Location	Length	Contents	Seq No.	Block
00091	00002	⁓BU	998	S12RS

The tape unit number (0, 1, .. or 9) must be punched in column 15, to specify the tape unit from which the restart program will be read.

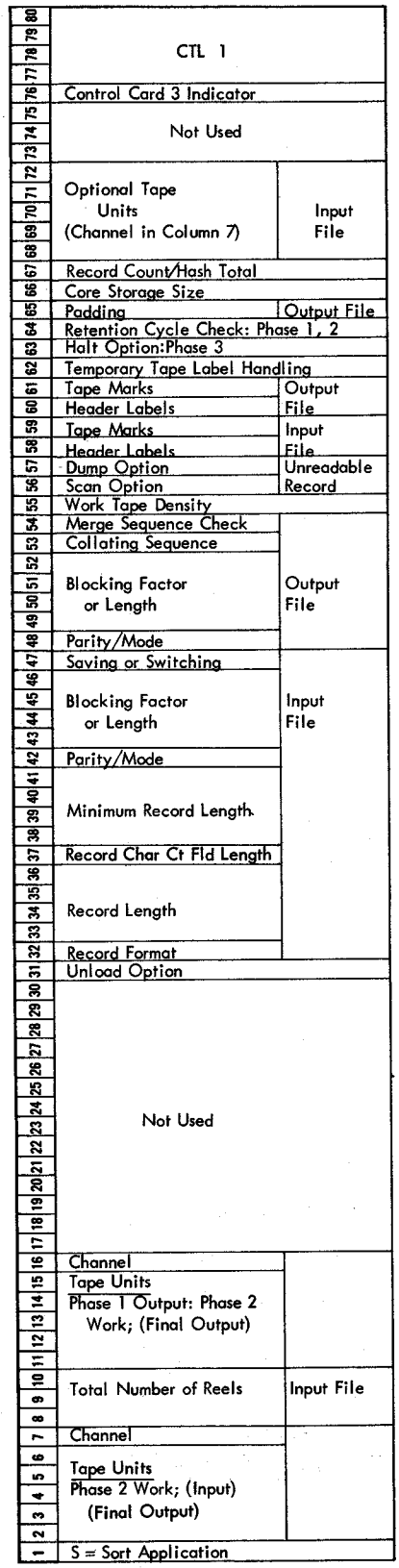
If both the Sort/Merge 12 program and the restart program are read from tape, the restart program must be on a unit other than "0".

HALTS, MESSAGES, AND CORRECTIVE ACTION

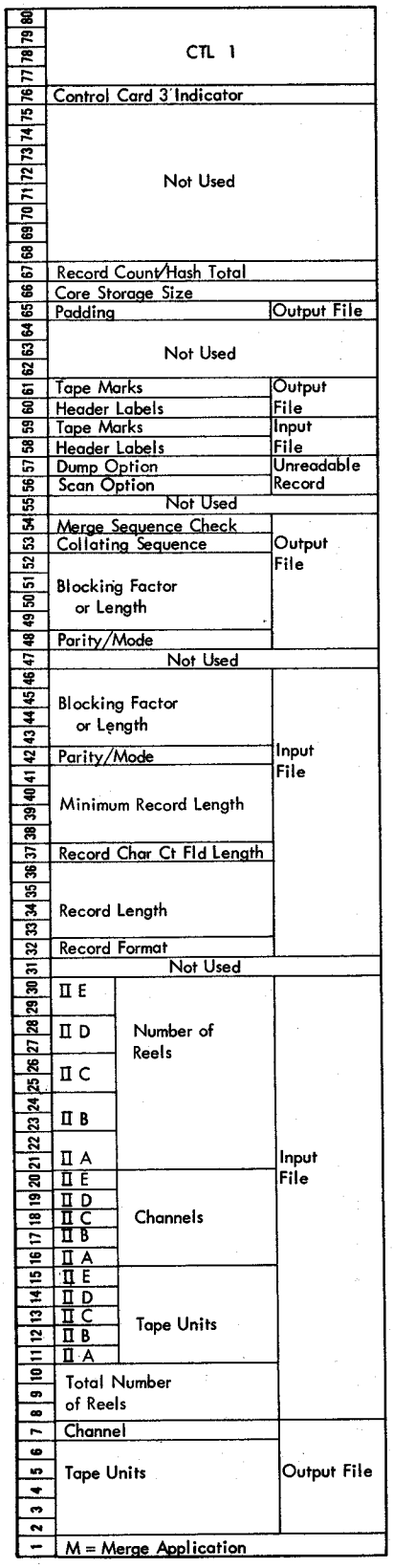
Sort/Merge 12 Messages are divided into the following groups:

1. Messages which primarily indicate current program status. These may help the operator to make his particular application run more efficiently; for example, an analysis of the messages concerning BMAX, B and G might lead to a better choice of Bi for a future run.

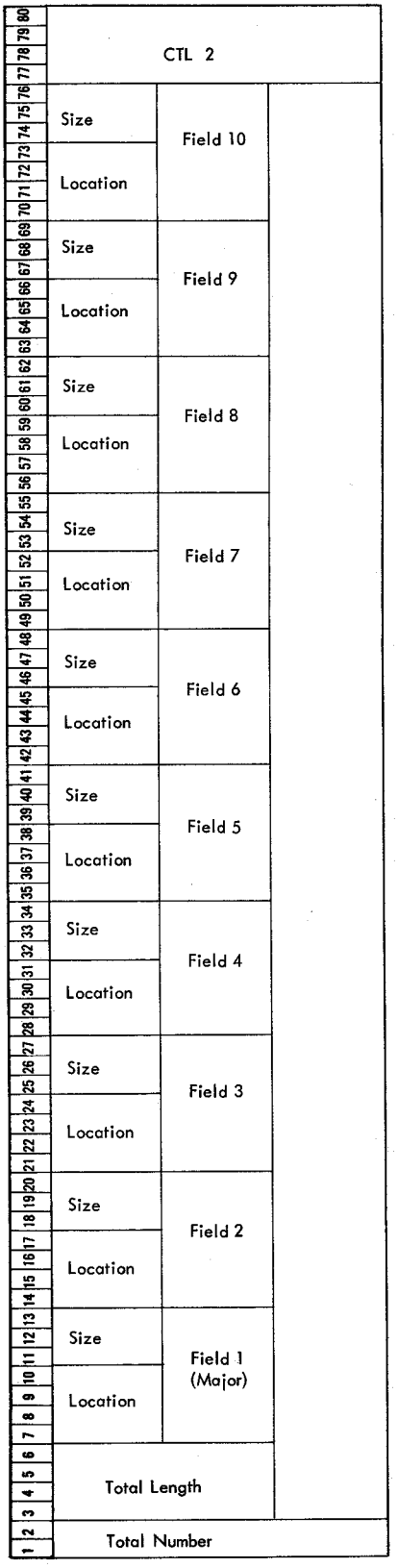
APPENDIX B



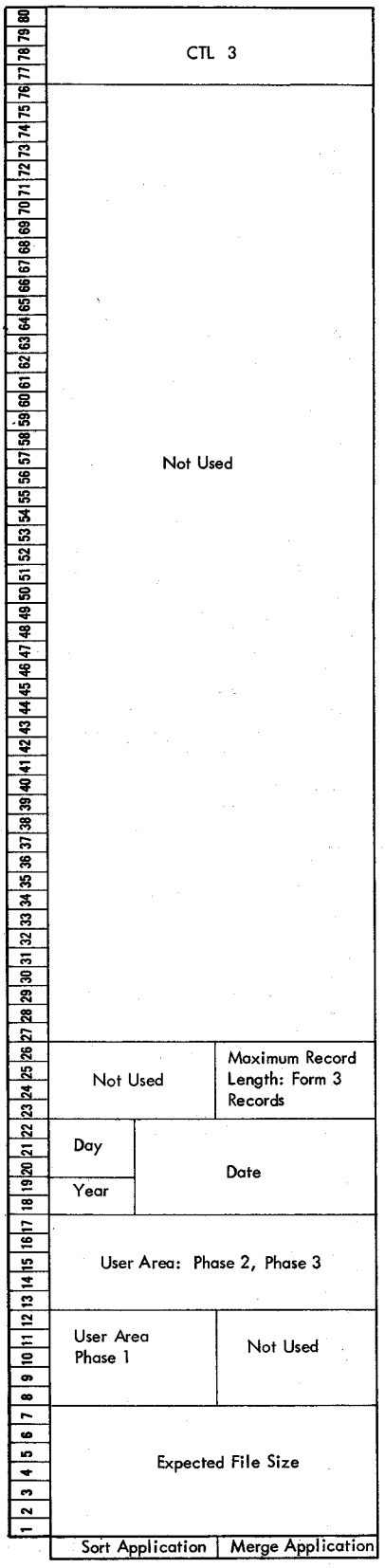
A



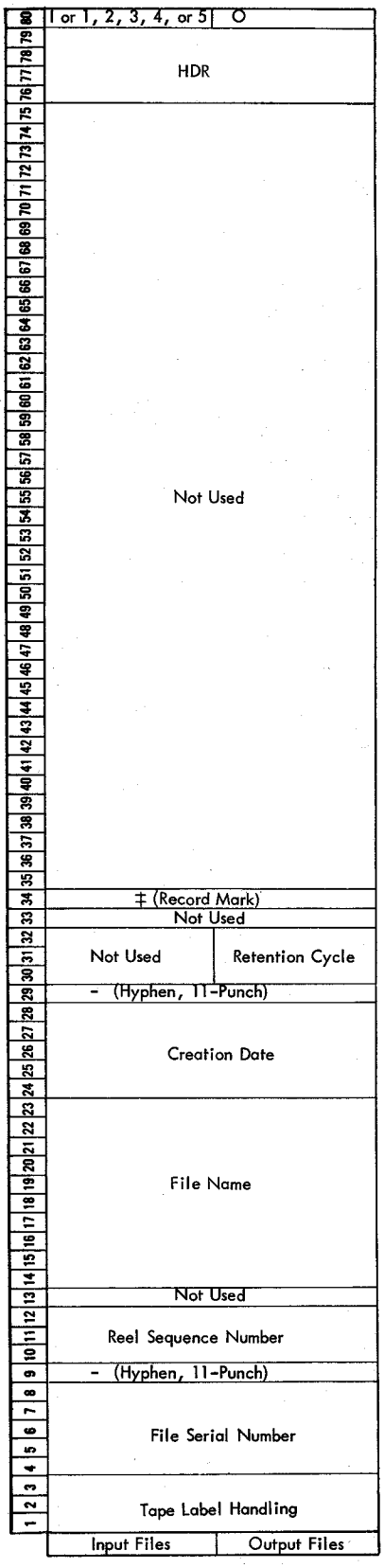
B


CTL 2
Size
Location
Field 10
Size
Location
Field 9
Size
Location
Field 8
Size
Location
Field 7
Size
Location
Field 6
Size
Location
Field 5
Size
Location
Field 4
Size
Location
Field 3
Size
Location
Field 2
Size
Location
Field 1 (Major)
Total Length
Total Number

C


CTL 3
Not Used
Not Used
Maximum Record Length: Form 3 Records
Day
Year
Date
User Area: Phase 2, Phase 3
User Area Phase 1
Not Used
Expected File Size
Sort Application
Merge Application

D


1 or 1, 2, 3, 4, or 5
O
HDR
Not Used
‡ (Record Mark)
Not Used
Not Used
Retention Cycle
- (Hyphen, 11-Punch)
Creation Date
File Name
Not Used
Reel Sequence Number
- (Hyphen, 11-Punch)
File Serial Number
Tape Label Handling
Input Files
Output Files

E