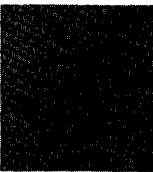
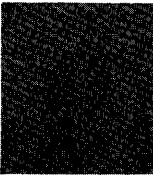


## Systems Reference Library

### Report Program Generator IBM 1401 Card and Tape Systems

This reference publication contains, language specifications for Report Program Generator for IBM 1401 Card and Tape Systems. The descriptions of the specifications sheets and the rules and conventions for writing them constitute the major portion of this publication. Also included, is information about machine processing of the source deck to produce the object program and machine processing of the input data file to produce a report.

For titles and abstracts of associated publications, see the *IBM 1401/1460 Bibliography*, Form A24-1495.



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## Introduction

The IBM 1401 Report Program Generator produces programs that write reports of variable format from card or tape input files. Instead of writing a specific program for each report, the user writes a set of specifications which he supplies to the Generator. The process of producing any desired report can be separated into four phases as shown in Figures 1 and 2.

Object programs can be *produced* on a 1401 card system equipped with a minimum of 4,000 positions of core storage. No special features are required.

The amount of storage required for executing an object program is dependent upon the complexity of the report specifications. An object program can be *executed* on any 1401 system whose storage capacity will accommodate the object program. Some object programs can be *executed* on a 1401 system equipped with less than 4,000 positions of core storage. The printer can be an IBM 1403, Model 1 or Model 2. No special features are required.

During the first phase (descriptive phase) the user describes information relevant to the report according to certain rules and conventions. He then punches the specifications into cards that constitute the source deck for the Generator.

The second phase is generating the object program in the language of the IBM 1401 Symbolic Programming System (see *IBM 1401 Symbolic Programming System*, Form J24-0200). In phase three the 1401 SPS processor or the 1401 Autocoder (see *Autocoder for the IBM 1401*, Form J24-1434) processor converts the symbolic object program into the machine-language instructions required to write the report. Before the object program is converted from symbolic language to machine language, the user can incorporate any of his own subroutines into the program and then assemble the augmented object program.

The fourth (final) phase of report generating is the execution of the object program to produce the report. The input data must be in either card or tape files.

Object programs produced by the Report Program Generator can process magnetic-tape input files having:

1. Fixed-length records with fixed blocking.
2. Variable-length records that are unblocked (single-record blocks).

The maximum allowable block-length for input tape records varies with the size of the object program generated. After an object program is assembled in machine language, the user can readily determine how

much storage remains for the input tape-record block (see *Third Phase of Report Generating: Program Storage Requirements*).

A tape file is the data contained between tape marks. A tape reel can contain any number of tape files. All or only some of the files on a tape may be considered part of the input data to a program. Thus, the ability to process or bypass files as well as the ability to restart the program after an end-of-file condition has been sensed are included in the generated object program. Because the program always halts on an end-of-file condition, input data may be contained on more than one reel of tape.

If the user specifies that there is a header label at the beginning of an input tape, the generated object program bypasses the first record on the input tape, including any tape mark following that record. The user can choose to have the label processed if it meets the specifications for record and block size pertaining to the entire data file.

As mentioned earlier, the output of the object program can be a printed report, punched cards, tape records or some combination of the three. Card input can be processed to produce printed and/or punched output. Tape input can yield tape output as well as printing and punching in any combination. Only unblocked, fixed-length tape records no longer than 132 characters can be produced as output. Although these records must compose a single file, that file can be written on more than one reel of tape. (The generated program halts on an end-of-reel condition to allow a new tape to be mounted.)

This bulletin is concerned mainly with a description of the first phase of report generating, i.e., stating the specifications of the report and compiling a source deck. Accordingly, the descriptions of the sheets on which the specifications will be written and the rules and conventions for writing them constitute the major portion of this bulletin. Also included, however, is information about machine processing of the source deck to produce the object program (phases 2 and 3) and machine processing of the input data file to produce a report (phase 4).

Requests for the Card or for the Tape Report Program Generator program deck and write-up (which includes program listings and operating instructions) should be made to the local IBM sales representative or sales office.

Figure 3 shows a few input cards for a report produced using the IBM 1401 Report Program Generator. Figure 4 shows the report. Description of the specifications for this report appears throughout this bulletin.

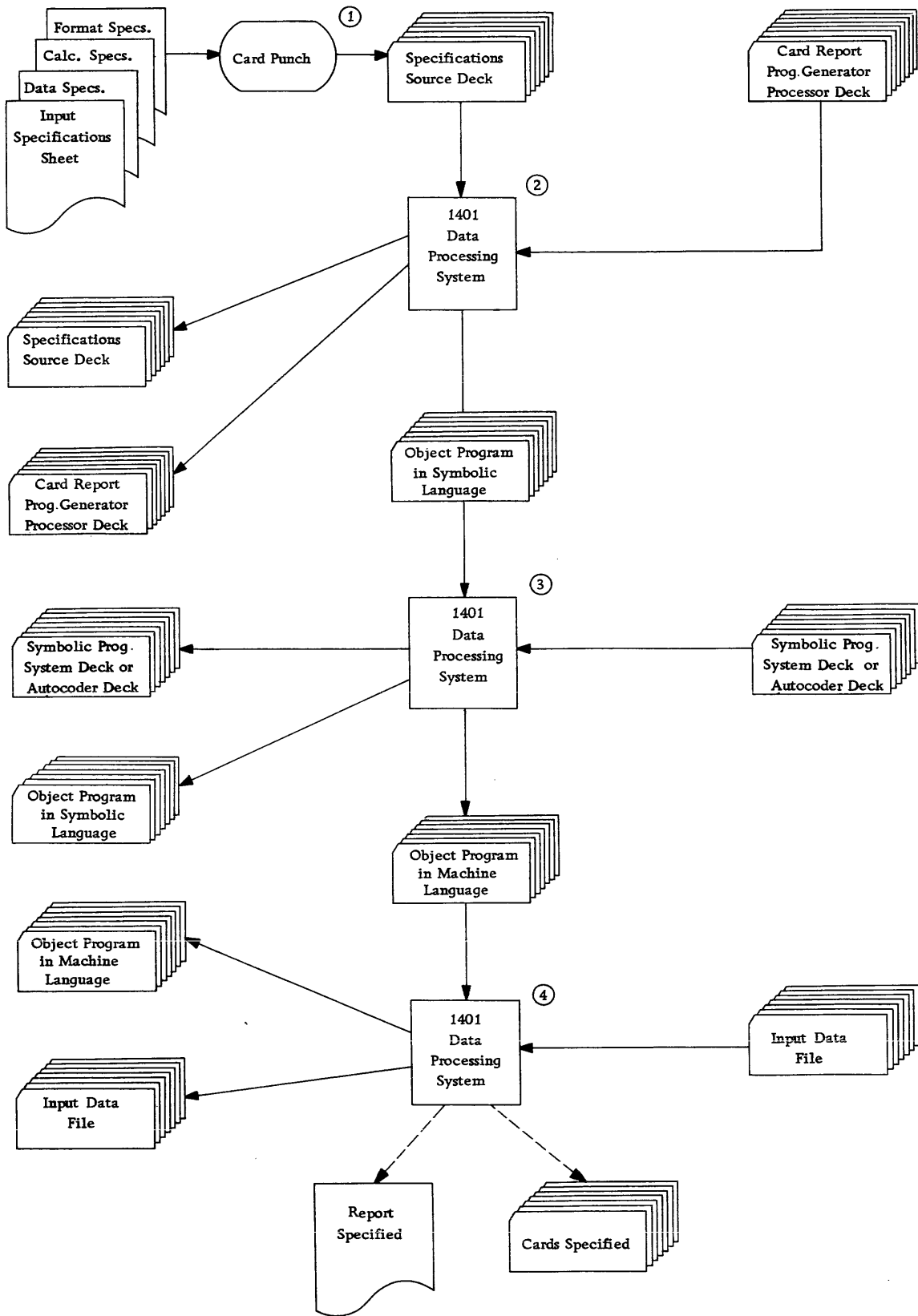


Figure 1. Generating a Report on a 1401 Card System

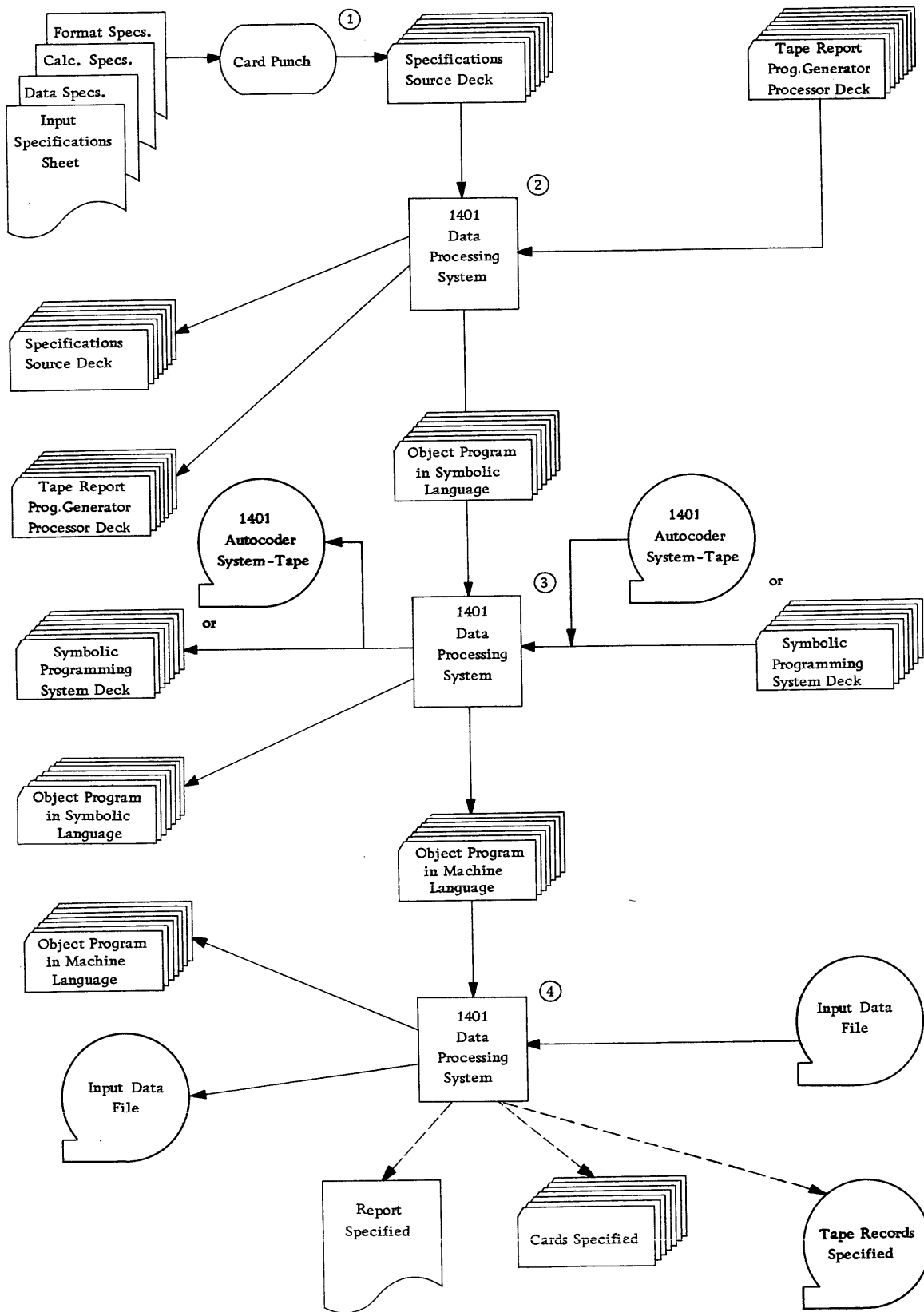


Figure 2. Generating a Report on a 1401 Tape/Card System

SDAY		INVOICE		VENDOR		OUR		GEN.		SUB.		MATERIAL		ORDER		DEPT.		SDAY		QUANTITY		ITEM		CODE	
ENTR	DATE	ENTR	DATE	ABBREVIATION	NUMBER	INVOICE	NUMBER	ENTR	ACCOUNT	LEGG	LEGG	OR PART	NUMBER	NUMBER	USING	DATE	USING	DATE	QUANTITY	UNIT	AMOUNT	AMOUNT	CODE	CODE	
12086	915760041																								4
12125	913700041																								4
12084	913660041																								4
12042	913660041																								4
07-18-60																									4
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 3. Cards from Input File for Monthly Expense Distribution Report

MONTHLY EXPENSE DISTRIBUTION REPORT

REPORT DATE 07-18-60 PAGE 1

	OUR INVOICE NUMBER	DATE MO DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT
*** DEPT. NO. 041					
** GEN. LEDGER NO. 913					
* SUB. LEDGER NO. 660					
	12042	4 07	687.50		
	12084	2 14	721.92		
			1,409.42 *		
* SUB. LEDGER NO. 700					
	12125	11 23	675.95		
			675.95 *		
				2,085.37	
** GEN. LEDGER NO. 915					
* SUB. LEDGER NO. 760					
	12086	12 15	2,119.50		
			2,119.50 *		
				2,119.50	
					4,204.87

Figure 4. Monthly Expense Distribution Report (Part 1 of 3)

MONTHLY EXPENSE DISTRIBUTION REPORT

REPORT DATE 07-18-60 PAGE 1

OUR INVOICE NUMBER	DATE MO DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT
*** DEPT. NO. 042				
** GEN. LEDGER NO. 901				
* SUB. LEDGER NO. 615				
12095	5 08	125.03		
		125.03 *		
* SUB. LEDGER NO. 623				
12091	6 10	571.00		
12088	5 16	685.94		
		1,256.94 *		
* SUB. LEDGER NO. 629				
12080	5 03	24.15		
12073	5 02	1,631.17		
		1,655.32 *		
* SUB. LEDGER NO. 636				
12109	7 03	1,725.54		
		1,725.54 *		
			4,762.83	
** GEN. LEDGER NO. 906				
* SUB. LEDGER NO. 643				
12150	6 08	402.00		

Figure 4. Monthly Expense Distribution Report (Part 2 of 3)



					REPORT DATE 07-18-60	PAGE 2
OUR INVOICE NUMBER	DATE MO DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT		
12090	5 23	331.96				
12106	7 03	95.65				
		829.61 *				
* SUB. LEDGER NO. 650						
12093	8 09	806.00				
		806.00 *				
			1,635.61			
				6,398.44		

Figure 4. Monthly Expense Distribution Report (Part 3 of 3)

## First Phase of Report Generating

### General Description

To generate an object program, the IBM 1401 Report Program Generator (RPG) requires certain information. The information answers these questions:

1. What are the characteristics of the file from which the report data is obtained?
2. What type of information is to be extracted from the input file? From which records can these source fields be obtained?
3. What types of calculations are to be performed during the execution of the object program? How are the results of these calculations to be manipulated?
4. What is the format of the report? What headings and constants must it contain? How should the data composing the report be edited?

As shown in Figures 1 and 2, four forms are required for writing the report specifications. The forms contain answers to the preceding questions. The information is punched into cards (Figure 5) with one card punched for each line. These cards comprise the specifications source deck. The RPG program processes the source deck to produce the object program.

Before the actual report specifications can be written, the user must have a clear image of what he wants as the final product. That is, he must know the contents of each line of the report, the spacing between lines, and the positioning of the information within each line of the report. He uses the IBM 1403 *Spacing Chart*, Form X24-6436, before writing specifications. Preparing this chart consists of laying out the complete format of the report to obtain a pictorial representation of the final product. Although no cards for the source deck are punched directly from the entries on this chart, the pictorial representation serves as a guide to completing the four specifications sheets. It thus plays an important role in writing report specifications.

The spacing chart and the four forms required during phase one are listed here in the order in which they are used. A brief description of the functions of each form is also given. Later sections will explain their use in more detail.

#### 1. IBM 1403 SPACING CHART, FORM X24-6436

This chart was described earlier as the form on which the user's image of the report is projected. Define the position of each field on each line of the report and include constant information, headings, and editing symbols, where applicable.

#### 2. INPUT SPECIFICATIONS, FORM X24-1336

A description of the data file, from which the information required for the report will be extracted, must be specified on this form. Describe each type of record in the data file, with its distinguishing record codes and control fields.

#### 3. DATA SPECIFICATIONS, FORM X24-1337

On this form the user lists the data fields necessary for processing the report. These data fields may be output fields or factors in calculations. Each field described is associated with the input record or records that contribute to it. It is also associated with any conditions that govern the processing of those input records. Any number of fields from one or more input records can be listed as the sources of a data field. The input sources can be added and subtracted as well as moved to the data field. Furthermore, the user can state that the status (positive, negative, zero, or blank) of a data field will be needed to govern subsequent processing. For example, a line can be conditioned to print only if a particular data field is positive.

#### 4. CALCULATION SPECIFICATIONS, FORM X24-1338

Although a limited amount of calculation is available through entries on the *data specifications* sheet, the *calculation specifications* sheet must be used for more extensive calculations including multiplication, division, and comparing. This form accommodates calculations on data fields described on the *data specifications* sheet, as well as constants and the results of previous calculations. Half-adjusting, position-adjusting, and the conditions governing the performance of a calculation can all be shown on this sheet. Furthermore, the user can define status conditions based upon the sign of the calculated result or the comparison of two fields.

#### 5. FORMAT SPECIFICATIONS, FORM X24-1339

The final step in writing report specifications is describing the format of output lines. Name each line by its type and relation to other lines. Specify the medium of output (printing, punching, writing on tape) as well as the conditions for output. Stacker selection of punched output or forms control of printed output can be specified. Having named a line, list all the constants, data fields, and edit control-words that compose the line. (Control words specify where commas, decimals, and conditional credit CR or minus symbols are to print and where zero suppression is to stop.) Provision is made for description of conditions, if any, governing the inclusion of a field within a line.

RECORD SEQUENCE		RECORD CODES				CONTROL FIELDS				PAGE CARD					
C	SEQ.	NUMBER	OPTION	POSITION	NOT	Z	D	POSITION	NOT	Z	D	PAGE	CARD		
1	2	3	4	5	6	7	8	9	10	11	12	13	14		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
<b>IBM 1401 REPORT PROGRAM GENERATOR</b>															
INPUT SPECIFICATIONS CARD															
IBM A35864															
<b>IBM 1401 REPORT PROGRAM GENERATOR</b>															
DATA SPECIFICATIONS CARD															
IBM A35865															
<b>IBM 1401 REPORT PROGRAM GENERATOR</b>															
CALCULATION SPECIFICATIONS CARD															
IBM A35863															
<b>IBM 1401 REPORT PROGRAM GENERATOR</b>															
FORMAT SPECIFICATIONS CARD															
IBM A35862															

Figure 5. Cards for Report Specifications

## Correlating the Report Specifications

When completed, the five forms are an interrelated statement of the problem being specified as shown in Figure 6. The spacing chart represents the output lines described in the format specifications sheet. The same line names are used on both forms.

The names given to various input records on the input specifications sheet are the same names used as *field sources* on the data specifications sheet to indicate the record from which a data field is taken during report writing. Each input record is assigned a unique two-digit number called a *resulting condition* number. During report processing, this condition is fulfilled whenever a record with the *record codes* specified for that resulting condition is present in the input area. The fulfillment of such a condition can govern the processing of a source field in the data specifications, the performance of a calculation specification, the placement of a field within a line or the output of that line as stated in the format specifications. The fulfillment of a resulting condition can be compared to the transferring of a selector on an accounting machine during the presence of a particular card. It can also be compared to the setting of a programming switch on a stored-program machine to indicate the presence of a particular record type. The change of a *control field* specified for input records can also govern the processing of source fields (e.g., to provide group indication), the performance of a calculation, the printing of lines, and the punching of cards.

Thus, the input specifications describe the kinds of records in the input data file according to the coding and control fields that are significant in these records. These specifications inherently determine many conditions for processing the data to be extracted from the input file.

The fields named on the data specifications sheet can be used as factors in calculations or as fields in lines. The fields named on the calculation specifications sheet can also be placed in lines on the format specifications sheet. Sometimes the status of a field (positive, negative, zero, or blank) is important in the processing of that or other fields. It may be that calculations should not be performed on zero or blank fields or it may be that a field should be printed in different positions depending upon whether it is positive or negative. Perhaps a line should be printed only when a certain field is not blank. Whenever the status of a field is important to processing, that status can be specified on the data sheet or calculation sheet beside the field name. Then, the status is assigned a unique two-digit resulting-condition number to represent it. The fulfillment of that condition during processing can govern further processing, as just indicated.

Thus, fields from the data and calculation sheets contribute to the lines on the format sheet. Conditions representing the presence of a record in the input area, the change in control between that record and the previous record, or the status of certain fields that have been processed can govern the presence and placement of fields within a line or the printing, punching, or writing on tape of that line. Furthermore, a line can be included in the output because the output conditions were met for a previous line. This relationship is described by a *next line* specification on the format sheet.

Considered together, the five forms represent the input file, the significant data fields within that file, the manipulations necessary to obtain the required output fields, and the line formats in which the fields are to appear.

This summarizes briefly the elements that enter into report specifications during the first phase of report generating. In the sections that follow, each of the forms will be examined in greater detail. The rules and conventions governing report specifications are presented. Two sample applications are used to illustrate pertinent parts of the description. For complete documentation of these sample reports, see Figures 52 to 65.

## IBM 1403 Spacing Chart

The purposes of laying out the report on the IBM 1403 Spacing Chart are:

1. to establish the positions at which the various data will be printed, punched, or written on tape, as well as to indicate the spacing between printed lines, and
2. to assign each line a unique identification code representing
  - a. the type of line,
  - b. the level of the line, and
  - c. the number of the line within its level.

## Layout of Lines and Fields

The numbers across the top and bottom of the spacing chart represent the IBM 1403 print positions. The numbers down the left side are line numbers. The user selects the line number and print positions for a particular field and makes his notation in the selected positions. In the sample layout (Figure 7) note that headings and other constant information are spelled out completely in the print positions assigned to them. Variable information is represented by X's and includes, where applicable, credit symbols, punctuation, etc. The position in an amount field where zero suppression ends is indicated by a zero rather than an X.





### Line-Identification Code

The column at the left on the spacing chart is used to assign each line a three-character identification code. This code identifies the line later on the format sheet where each line is described according to type and content.

#### TYPE

The first character of the identification code is H for a heading line, D for a detail line, or T for a total line. All lines must be identified as belonging to one of these categories.

#### LEVEL

The second character of the identification code can be a number from 1-8 or a letter. A heading or total line within a hierarchy is assigned a number to represent its level. A heading or total line that is independent (not in a hierarchy) is assigned a letter. A detail line can be assigned either a number or a letter to represent its level.

#### NUMBER

Lines within a level can be numbered according to their appearance in the output. Lines with *numerical-level* designations must also have numerical line-number designations. Lines with *alphabetic-level* designations can have numerical or alphabetic line-number designations.

### Classification of Lines

The classification of a line by type is usually self-explanatory. Note, however, that total lines differ significantly from heading and detail lines. Heading and detail lines can contain information from the record in the input area at the time when the lines are produced; total lines can not. An input record can effect the control-field change that causes total lines to be written, but that input record cannot contribute data to these lines. A detail line has a direct relationship to the input record in that most or all of the data in a detail line, including calculated fields, comes from the input record. A heading line generally contains constant information, although it can have some information from input records, including the record present at the time the line is assembled.

The concept of line *level* is based upon the relationship of a line to other lines. Heading or total lines that are independent of each other should be given alphabetic-level designations. Heading or total lines that are related in a hierarchy should be given numerical-level designations corresponding to their positions in the hierarchy. A hierarchical relationship can be likened to total operation on an accounting machine, i.e., major lines force minor and inter-

mediate lines. The principle underlying a hierarchical relationship is that lines of higher level govern lines of lower level. Thus, when the object program is running, a total line with a numerical-level designation such as T3x will force T1x and T2x to come before it whenever the output conditions are fulfilled for T3x.

In the *Monthly Expense Distribution Report* (Figure 4) there are three related levels of total. The lowest level is associated with sub-ledger number, the next level with general ledger number, and the highest level with department number. When the general ledger number changes, the sub-ledger total line prints before the general-ledger total line. When the department number changes, the sub-ledger and general-ledger total lines print before the department total line. Because this hierarchical relationship exists, these lines have been given the numerical-level designations T11, T21, and T31. (See the spacing chart in Figure 7.)

Study of the Monthly Expense Distribution Report reveals a difference in the hierarchical relationships for total and heading lines. Total lines appear in *ascending* order by level; heading lines appear in *descending* order by level. On that report the heading lines associated with department number print before the general-ledger number lines which, in turn, precede the sub-ledger lines. Thus, when department number changes, the H3x lines precede the H2x and H1x lines. When general ledger number changes, the H2x lines print before the H1x lines.

In addition to the three related levels of heading and total lines in the Monthly Expense Distribution Report, there are independent heading and total lines. Page headings printed as a result of page overflow, page totals, and final totals are all examples of lines that are independent of the minor, intermediate, and major relations governing a hierarchy. The illustrated report has both page heading lines (HB1-HB4) and a final total line (TAA). All of these have alphabetic-level designations because they do not relate to lines of other levels.

Page heading lines may be printed because of control-field changes, because of page overflow, or because of both conditions. The latter case is true in the Monthly Expense Distribution Report. Just as the IBM 407 Accounting Machine distinguishes between normal programming and overflow programming, the 1401 Report Program Generator considers normal heading lines distinct from overflow heading lines, even when the lines are alike in format. Thus, some of the heading lines in Figure 7 have two names reflecting their status as both overflow and normal page-heading-lines. The normal heading lines are H3x, H2x, and H1x. The overflow lines are HBx. On a change in department number there is a skip to a new page of the report

and the numerical-level heading lines (H3x-H1x) print. On page overflow the alphabetic-level heading lines HBx print.

When there is a single detail-line format in a report, that line can be given an alphabetic-level designation to reflect its independent status. Such is the case in the Monthly Expense Distribution Report in which the detail line is named DAA. Other applications might have any number of detail-line formats which, when they do not relate to one another, are classified alphabetically by level. It is conceivable that some applications might contain hierarchies of detail lines necessitating numerical-level designations.

Note that the *level* of a line is not necessarily equal to the *number of the control field* with which the line is associated. For instance, a total or heading line of level three may not relate to control field three in the input data file. In the invoice operation described later the level-one heading lines relate to a change in control-field two. In other applications, lines with alphabetic-level designations might relate to control fields. Thus, even though six is the maximum number of control fields that can be specified, there can be eight numerical levels for each type of line specified.

The *line number* permits scheduling lines within a level. The Monthly Expense Distribution Report has six heading lines in the highest level. That level is associated with department number. Whenever the department changes, the six heading lines composing level three print in line-number sequence within that level, i.e., H31, H32, H33, H34, H35, and H36. Even though there is only one line in each of the lower levels of heading line in that report (H21 and H11), the lines have numerical line-number designations because they are hierarchical. The same principle applies to the total lines, T11, T21, and T31, in the same report. Application of the line-number concept to hierarchical total lines corresponds to special programming on the IBM 407 Accounting Machine. For instance, four minor total lines could be named T11, T12, T13, and T14.

Analysis of the independent lines in the Monthly Expense Distribution Report reveals that both numerical and alphabetic line-number designations can be used in classifying lines with alphabetic *level* designations. When page overflow occurs, four heading lines (HB1-HB4) print, and the line number reflects the place of each line in the sequence. If there is only one line in an alphabetic level, that line can have a letter as its line number (DAA and TAA in the example report).

Multiple-line-print (MLP) cards might cause three detail lines to print, and these lines could be named DA1, DA2, and DA3 to reflect the place of each line

in the sequence. Two final total lines in a report might well be named TC1 and TC2.

Line classification is explained further in the description of the format specifications sheet.

### **Input Specifications**

This form (Figure 8) specifies the input file from which the report is to be prepared. The user describes each type of input record in the file. He specifies the record codes (i.e., the characters used to uniquely identify the records) and the control-data fields significant in that record type. Records that must be processed in sequence within a control group can be given numbers representing their place in the sequence. The following paragraphs describe the information entered on the form.

### **Record Sequence**

*Column 1* must contain a C for every line-entry that specifies a record type. The C identifies the information as an input specification (as opposed to a data, format, or calculation specification).

*Columns 2-3* specify two numerical or two alphabetic *sequence* characters. The Report Program Generator can accommodate a maximum of 20 unique two-character sequence specifications. If, to ensure proper processing, certain types of input data records must be in an established sequence within a control group, columns 2-3 of the input specifications sheet can contain numerical sequence entries in ascending order.

If input data records do not have an established sequence within a control group, or if it is not desirable to halt processing when the records are out of sequence, alphabetic sequence designations should be used. Some applications contain both sequential and non-sequential records. For example, the invoice form shown in Figure 9 is prepared from the file of cards shown in Figure 10. The source of the invoice date is a date card preceding the entire file. Because this date card has no sequence relationship in a control group in the input file, it is given the alphabetic record sequence AA in columns 2-3 of the input specifications sheet (see Figure 11).

For proper invoice preparation the other input data cards must be arranged within customer number in the sequence shown in Figure 10. Therefore, the *Invoice To* header card's record-sequence number is 01, the *Shipped To* header card is 02, the *Shipped Via* is 03, the *Order Data* is 04, and the *Item* detail is 05. Each time the customer number changes, this sequence begins again.

For sequential records *column 4* indicates the number (either a 1 or N) of that type of record in a control





REPRESENTATIVE COMPANY

ANY CITY - ANY STATE

INVOICE TO  
E C BROWN & CO  
2364 MICHIGAN BLVD  
CHICAGO 27, ILL

SHIPPED TO  
X-Y-Z SERVICE CORP  
222 WESTERN AVE  
INDIANAPOLIS, IND

INVOICE  
NUMBER PAGE  
26115 1  
JUL 25,60  
29045

SHIPPED VIA  
WESTERN TRUCKERS

PLEASE REFER TO  
OUR INVOICE NUMBER  
WHEN REMITTING  
TERMS: 2% TEN DAYS  
F.O.B. FACTORY

ORDER DATE ORDER NO.  
03/15/60 AK-71423 DE

D NORTON

ITEM NUMBER	DESCRIPTION	QUANTITY & UNIT OF MEAS.	UNIT PRICE	AMOUNT
115/278	LAG SCREWS 1 x 1/2	2 C	5.25	10.50
115/282	LAG SCREWS 3 x 1/2	5 C	5.30	26.50
SBN- 02	HAMMER-ADZE EYE,BELL POLL,RND NECK	12 DOZ	10.50	126.00
369-2HF	HAMMER-BALL PEEN 2/0,3/4 LB	4 DOZ	12.64	50.56
101-224	WASHING MACHINE	8 EACH	165.00	1,320.00
21-564	NAILS-STEEL WIRE 60-2 IN	6 CWT	8.30	49.80
21-572	NAILS-STEEL WIRE 100-3 IN	4 CWT	7.80	31.20
143-210	BRUSH,FLAT WALL 3 x 2 5/8 x 13/16	6 EACH	.95	5.70
743D217	GROMMETS	720 EACH	.01	7.20
216-210	PAINT, FLAT WHITE	12 GAL	2.85	34.20

REPRESENTATIVE COMPANY

ANY CITY - ANY STATE

INVOICE TO  
E C BROWN & CO

SHIPPED TO

INVOICE  
NUMBER PAGE  
26115 2

SHIPPED VIA

PLEASE REFER TO  
OUR INVOICE NUMBER  
WHEN REMITTING  
TERMS: 2% TEN DAYS  
F.O.B. FACTORY

ORDER DATE ORDER NO.

ITEM NUMBER	DESCRIPTION	QUANTITY & UNIT OF MEAS.	UNIT PRICE	AMOUNT
216-418	PAINT, WALL UNDERCOAT	1 GAL	2.95	2.95
	INV TOT			\$ 1,664.61*
	2% DISC			\$ 33.29 CR
	NET AMT			\$ 1,631.32*

FIN TOT JUL 25,60 \$ 74,921.35\*\*

Figure 9. Invoice Example









**Field Status**

Columns 11-19 are explained later when their purpose is more meaningful.

**Sources of Field**

Columns 20-70 specify three sources of the report field. If more than three sources must be specified for a report field, use more than one line.

Columns 20-22 define the first source of the field. Possible sources are input records, serial numbers, page number, and record-count numbers. The entries are Cxx for input record sources, SER for serial numbers, PAG for page number, and RCT for record-count numbers. When the field source is an input record, the appropriate entry must come from columns 1-3 of the input specifications sheet.

Column 23 contains an N if the field is a numerical field that has zoning in positions other than the units position. The object program will then strip the zero-, 11-, or 12-zones from all positions except the units in the field for which an N is specified. If the units position contains no zone, this specification will create a 12-zone in that position.

The other entry permitted in column 23 is an M. This identifies the entry as a month-field conversion specification. (See *Data Specifications: Month-Field Conversion* for an explanation and example of this entry.) Otherwise leave this column blank.

Columns 24-26 contain the location of the low-order position of the field in the source record. (For IBM 1401 Data Processing Systems using 51-column input data cards, see *Special Feature Specifications*.) For fields whose sources are SER, PAG, and RCT, these columns should be left blank.

Columns 27-29 must contain the field-length in the source record only if that length is different from the unedited (report) field-length specified in columns 8-10. For example, in Figure 15 the entry on the data specifications sheet for SOLDTO gives the unedited field-length in columns 8-10 as 020. Because the source field-length is the same, columns 27-29 are left blank for that field. The entry for AMOUNT specifies an unedited field-length of 006 in columns 8-10. This provides sufficient positions for the largest total expected although the source field-length specified in columns

D	FIELD NAME	FIELD STATUS										SOURCES																						
		FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION													
12		7	8	10		11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	29	30	31	33	34	36	37	39	40	41	43	44	46	
	SOLDTO	0,2,0																																
	PAGENO	0,0,1																																
	AMOUNT	0,0,6																																

Figure 15. Data Specifications for Field Sources

27-29 is 005. The source field length should be left blank when the source is SER, PAG, or RCT.

One of the following seven operation characters must be specified in column 30:

- Blank – Move the source field to the data field.
- A – Add the source field to the data field.
- S – Subtract the source field from the data field.
- 0̄ – Reset the data field to zero before adding the source field to it. (Punch 12, 0 for 0̄)
- 0̄ – Reset the data field to zero before subtracting the source field from it. (Punch 11, 0 for 0̄)
- D – Move the numerical portion of the single-character source field to the units position of the data field. The zone portions are undisturbed in both fields.
- Y – Move the zone portion of the single-character source field to the units position of the data field. The numerical portions are undisturbed in both fields.

Figure 16 illustrates the use of the single-character move-numerical and move-zone operations. Each line-entry is explained as follows:

1. The first line-entry specifies that the six-character field at position 074 in input record C05 should be moved to the data field, AMOUNT. Furthermore, the zone portion of the single-character source field in column 69 of the same record is to be moved to the units position of the data field, AMOUNT. By using an entry such as this, the high-order position of the source field can contribute the sign to the units position of the data field.
2. The second line specifies that the five-column source field in columns 49-53 of record type CBB is to be moved to the five-position data field, FLDR. The zone portion of the single-character source field in column 70 of CBB is to be moved into the units position of the data field, FLDR. By using an entry such as this, a data field can acquire its units-position sign from any position in a record. By choosing a one-position field source containing no zones for the Y operation, an unwanted sign in the units position of the data field can be removed.

D	FIELD NAME	FIELD STATUS										SOURCES						OF																	
		FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD LENGTH UNEDITED	STATUS	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D		FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION													
12		7	8	10		11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	29	30	31	33	34	36	37	39	40	41	43	44	46		
	AMOUNT	0,0,6																																	
	FLDR	0,0,5																																	
	FLDR	0,0,1																																	

Figure 16. Single-Character Move-Numerical and Move-Zone Operations

- The third line specifies that the numerical portion of the one-column source field in column 35 of card type C02 is to be moved into the one-position data field, FLDS. By using an entry such as this, a single-column source field that contains an unwanted sign can be moved into the data field without the unwanted sign.

Because the Y and D operations are single-character move operations, there should be no field length specified for them. When Y or D operations are specified on the same lines as another operation, they should follow the other operation. This ensures the proper sequence of operation in the object program. For example, in the first two line-entries in Figure 16, the Y-entries are made to the right of the blank (move) operation entries.

The same principle of ordering source entries on a line applies in some arithmetic specifications. This is because the object program performs the operations specified in the order of entry on the sheet from left to right.

For example, if a field being described is the result of adding or subtracting more than one field from the same source record, and if that field must be reset prior to the first operation, then the source field described first (in columns 20-36) should be the one that is reset-added or reset-subtracted.

Columns 31-33 can be used to specify a condition that is to govern the operation upon the source field. It can be either a positive condition, such as F3 to indicate a change in control field 3, or a negative condition, such as NF3 to indicate no change in control field 3. The conditions specified on this sheet are the resulting conditions of the input specifications sheet, control-field changes (F1-F6), sense switch settings (SB, SC, and SD), resulting conditions specified by other entries on the data sheet, or the negation of any of these when preceded by an N.

In the Invoice Report shown in Figure 9, the minor group-indicative information (Item Number, Description, Unit of Measure, and Unit Price) is to be obtained from the first card of each minor control group. Hence the specification for ITEMNO is condition F1 in columns 32-33 of the data specifications sheet (Figure 17).

D	FIELD NAME	FIELD STATUS										SOURCES									
		FIELD IDENTIFIED	RESULTING STATUS	RESULTING CONDITION	RESULTING STATUS	RESULTING CONDITION	RESULTING STATUS	RESULTING CONDITION	FIELD SOURCE	FIELD NUMBER	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D	FIELD SOURCE	FIELD NUMBER	FIELD END	FIELD LENGTH		
1	ITEMNO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	CDTOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	CSCNT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	PAGENO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Figure 17. Conditioning Operations on Source Fields

This entry specifies that the source field is to be moved to ITEMNO only from the first card after a change in control field 1.

If the field-source entry on a given line is RCT or SER, the entries in columns 31-36 specify the conditions to be met for increasing the record- or serial-count. All input records can be counted by an entry such as the second line of Figure 17. Selective record counting can be done by the third line-entry in Figure 17 where 02 in columns 32-33 represents the resulting-condition number of a record type defined on the input sheet. For the Invoice Report, Figure 13, condition 02 was assigned to a *Sold To* card. Thus, this count in that application will be increased one for each first card in the intermediate group controlled by customer number.

If the field source entry is PAG, the conditions are for reset of page count. In Figure 9 the pages of each customer's invoice are to be numbered at the top of each invoice form. With a control change in customer number (field 2), page numbering is to begin again at one. Therefore the proper entry for PAGENO as shown on the fourth line of Figure 17 includes F2 as the condition for reset. When no condition is described for a PAG source, the object program numbers the report pages consecutively from beginning to end.

Columns 34-36 can be used to specify a second condition governing the operation upon the source field. If two conditions are specified, they are considered in an *and* relation. That is, both conditions specified must be met before the operation specified in column 30 is performed upon the source field.

When the field being specified has more than one source, the second source is specified by entries in columns 37-53 in the same manner as the first source in columns 20-36. The third is specified in columns 54-70. If more than three sources exist for a field, more than one line-entry is required to specify the sources. In such instances, the first line-entry for the field is prepared as previously described. The second and succeeding line-entries for the field have a D entered in column 1. Columns 2-19 are blank. Columns 20-70 are used, as required, to enter the information for the remaining sources of the field. Figure 18 is an example.

### Field Status

The user can govern subsequent processing according to the status (positive, negative, zero, or blank) of a particular field. Columns 11-19 of the data sheet are used to assign resulting-condition numbers to represent one, two, or three possibilities for the status of the field. If the field's status is not significant in the control







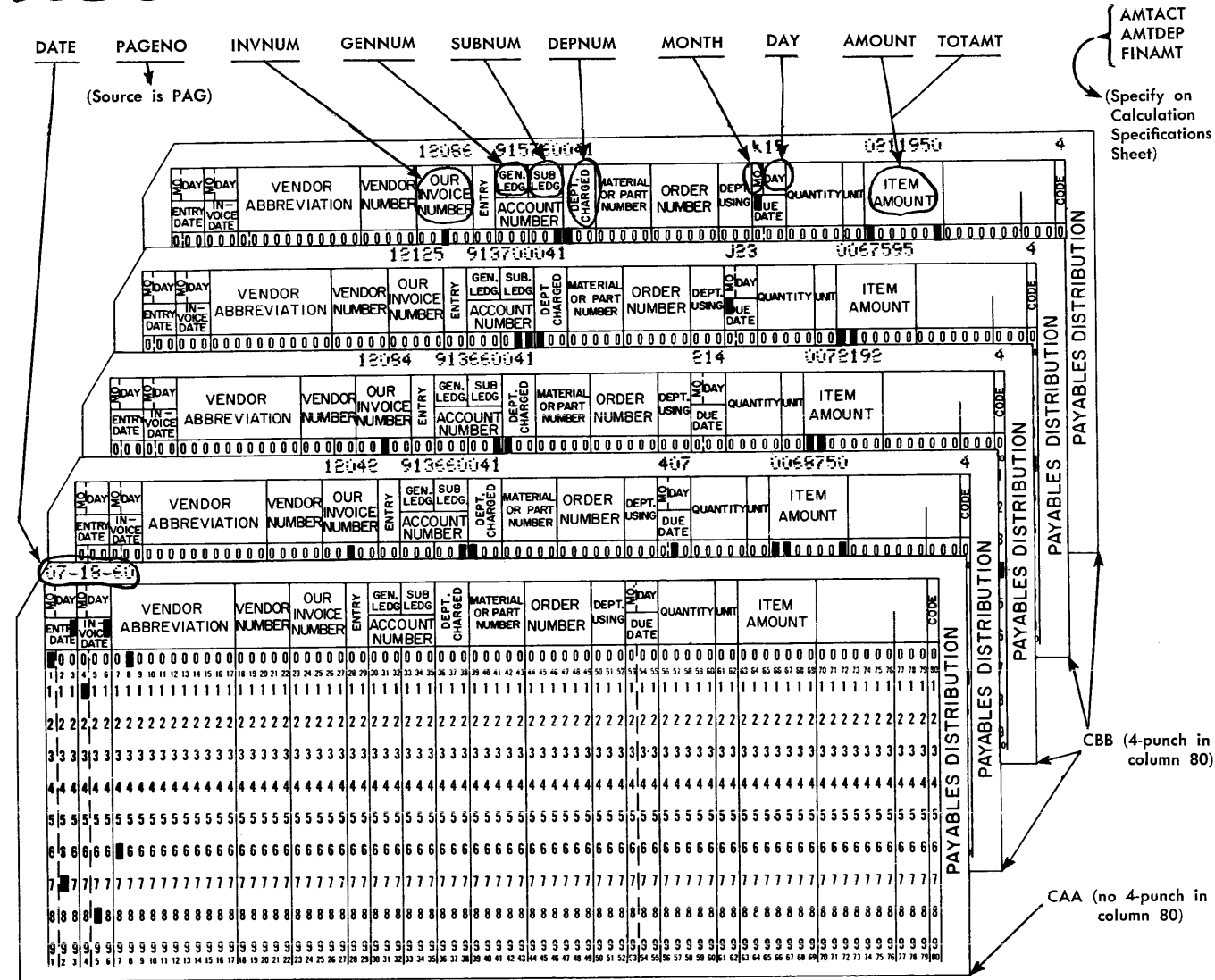
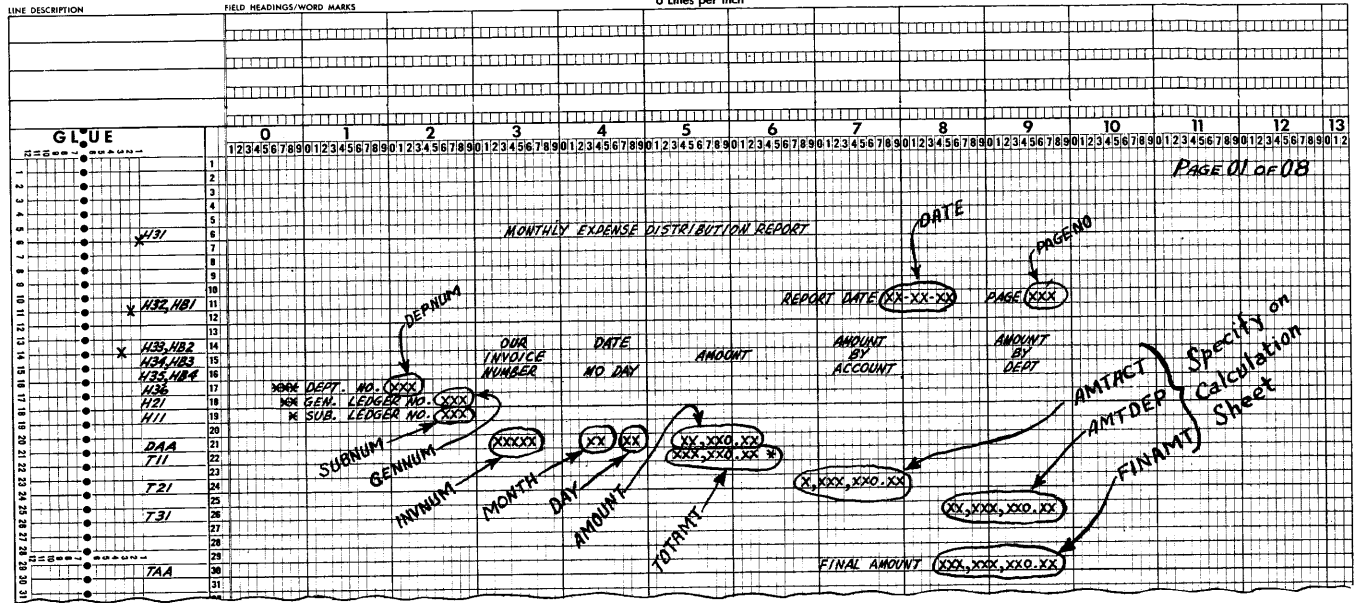


Figure 23. Assigning Data Field Names and Determining Their Sources for the Monthly Expense Distribution Report



## Calculation Specifications

This form (Figure 25) specifies calculations that are more extensive than those that can be defined on the data specifications sheet. For example, comparison, multiplication, and division can be specified, as well as arithmetic operations to be performed upon resulting fields from either the data specifications sheet or from prior entries on the calculation specifications sheet.

For 1401 Data Processing Systems not equipped with the multiply-divide optional feature, the Report Program Generator will incorporate subroutines in the object program to enable the user to perform multiplication and division. The following paragraphs explain the entries on the calculation specifications sheet.

### A (Arithmetic)

In *column 1* an A (punched as a 12- and a 1-punch) identifies the entry as a calculation specification as opposed to an input, data, or format specification.

### Field Name

The name of the field that will contain the result of the calculation specified is entered in *columns 2-7*. Numbers and special characters cannot be used. Field names of less than six characters must be left-justified.

For a compare specification (C in column 29), columns 2-7 *must* be blank. These columns can also be left blank if the result of this calculation affects the last data field specified as the result of a preceding calculation.

### Field Length Unedited

Columns 8-10 must contain the unedited length of the field. See the corresponding paragraph under *Data Specifications* for further explanation of unedited field-length.

### Field Status

As in the case of data specifications, the user may want to govern later processing (as defined by format specifications and subsequent calculation specifications) according to the status of a particular field. *Columns 11-19* of the calculation specifications sheet can be used for this purpose. The allowable entries in columns 11, 14, and 17 are those given for the field status of the data specifications sheet (B, Z, N, and P), as well as the following entries which are related to the comparison of two fields:

- E — Factor 2 is equal to factor 1.
- U — Factor 2 is unequal to factor 1.
- H — Factor 2 is higher in the collating sequence than factor 1.
- L — Factor 2 is lower in the collating sequence than factor 1.

**IBM**

## 1401 REPORT PROGRAM GENERATOR

CALCULATION SPECIFICATIONS

FORM X24-1338

PRINTED IN U.S.A.

Report \_\_\_\_\_

Programmed by \_\_\_\_\_

Page 11 of     

Date 76 77

A	FIELD NAME	FIELD LENGTH UNEDITED	FIELD STATUS	FACTOR 1		FACTOR 2		COND. N	COND. D	COND. N	COND. D	HALF ADJUST	POSITION ADJUST	CARD NUMBER
				MULTIPLICAND ADDEND, OR MINUEND	DIVIDEND SUBTRAHEND	MULTIPLIER DIVISOR ADDEND, OR SUBTRAHEND	DIVIDEND SUBTRAHEND							
1		7 8												75 78 80
2														0, 1, 0
														0, 2, 0
														0, 3, 0
														0, 4, 0
														0, 5, 0
														0, 6, 0
														0, 7, 0
														0, 8, 0
														0, 9, 0
														1, 0, 0
														1, 1, 0
														1, 2, 0
														1, 3, 0
														1, 4, 0
														1, 5, 0
														1, 6, 0
														1, 7, 0
														1, 8, 0
														1, 9, 0
														2, 0, 0

Figure 25. Calculation Specifications Sheet

NOTE: The H and L entries are valid only if the IBM 1401 Data Processing System being used is equipped with the high-low-equal compare special feature.

As mentioned under *Field Status* for the data specifications sheet, each status entry (columns 11, 14, and 17) should be defined by a corresponding unique resulting-condition number (columns 12-13, 15-16, and 18-19). These resulting-condition numbers can be used to govern other operations.

**Factor 1**

Columns 20-25 are used to state the field name or literal that is the multiplicand, dividend, augend, minuend, or the field with which another field is compared. A field name thus entered must have been specified either by an appropriate entry in columns 2-7 of the data specifications sheet, by a previous line-entry on the calculation specifications sheet, or by a W-entry on a format specifications sheet (see *Format Specifications*). The alphabetic name of factor 1 is left-justified when it is less than six letters long, the first letter being entered in column 20.

If factor 1 is a literal in the range from 00000<sup>±</sup>1 through 99999<sup>±</sup>, the entry in columns 20-25 is the numerical value of that literal with its sign indicated over the units position, as shown above. When punched into a specifications card, the sign of the constant is overpunched in the units position as a 12-punch if plus or an 11-punch if minus. In the absence of a sign overpunch, the constant is treated as a positive number. A constant whose value can be expressed in less than six digits need not be entered with leading zeros. Thus, the constant +1 can be entered as a 1 in column 25, with columns 20-24 left blank. Literals of less than six digits are right-justified, the units position being entered in column 25.

Columns 26-28 must contain the unedited field-length of factor 1.

**OP (Operation) + - X / C**

Column 29 can be used to identify the operation to be performed using the two factors. The entries and the operations they represent are:

Operation	Entry on Specifications Sheet in Column 29	Punch in Card in Column 29
Plus	+	12-zone
Minus	-	11-zone
Multiplied by	X	0 and 7
Divided by	/	0 and 1
Compare factor 2 with factor 1	C	12-zone and 3

Plus and minus specifications on this sheet provide for addition and subtraction operations upon data developed by the data specifications sheet or prior entries on the calculation specifications sheet.

**Factor 2**

Columns 30-35 are used for the name of the field (or the numerical value of the constant) that is being specified as one of the following: multiplier, divisor, addend, subtrahend, or the field compared with factor 1. The explanation given for factor 1 applies to factor 2.

Columns 36-38 must contain the unedited field-length of factor 2.

**A S 0̄ (Add, Subtract, Reset Add, Reset Subtract)**

Column 39 must contain an A, an S, 0̄ (12, 0), or 0̄ (11, 0), depending upon whether the result of the calculation being specified by this line-entry is to be added to, subtracted from, or substituted for the previous contents of the field named in columns 2-7 of this line-entry. Figure 26 illustrates various multiplication operations. Plus, minus, and divide operations can be similarly specified. An explanation of the entries in Figure 26 follows:

- The first line-entry specifies that the product of FLDB × FLDC be added to the contents of FLDA and that the sum be placed at FLDA.
- The second line specifies that the product of FLDB × FLDC be subtracted from the contents of FLDD and that the difference be placed at FLDD.
- The third line-entry specifies that the product of FLDB × FLDC be reset-added into FLDE.
- The fourth line specifies that the product of FLDB × FLDC be reset-subtracted into FLDF.
- The fifth line specifies that the product of FLDB × WORD03 be subtracted from the contents of FLDG and that the difference be placed at FLDG. WORD03 is the field name of a 9-position constant that must be defined on the format specifications sheet by a W-entry.

FIELD NAME	FIELD LENGTH	FIELD STATUS						FACTOR 1			FACTOR 2			COND. N			COND. H		COND. L		HALF ADJUST	POSITION ADJUST
		1	2	3	4	5	6	MULTIPLICAND	DIVIDEND	ADDEND, OR MINUEND	MULTIPLIER	DIVISOR	ADDEND, OR SUBTRAHEND	A	D	S	A	D	S			
FLDA	0.6							FLDB	0.4	X	FLDC	0.2	A									
FLDD	0.6							FLDB	0.4	X	FLDC	0.2	S									
FLDE	0.6							FLDB	0.4	X	FLDC	0.2	0̄									
FLDF	0.6							FLDB	0.4	X	FLDC	0.2	0̄									
FLDG	0.13							FLDB	0.4	X	WORD03	0.9	S									

Figure 26. Multiplication Specifications

Figure 27 illustrates a means of obtaining progressive totals. Note the absence of an entry in the factor 1 field and in the OP field (column 29). This is the explanation of the entries in Figure 27:

1. The first line specifies that the field AMOUNT be added to the contents of TOTAMT and that the sum be placed at TOTAMT.
2. The second line specifies that the field AMOUNT be subtracted from the contents of TOTAL and that the difference be placed at TOTAL.

Figure 28 illustrates a comparison specification that causes factor 2, the literal 123456, to be compared with factor 1, FLDNAM. FLDNAM must have been defined on either the data specifications sheet or a prior entry on the calculation specifications sheet. An equal result of the comparison can be referred to in other operations as condition 07.

A	FIELD NAME	FIELD STATUS								FACTOR 1			FACTOR 2						OPERATION			HALF ADJUST	POSITION ADJUST															
		FLD	LEN	UN	RES	CON	OP	COND	COND	COND	MULT	DIV	ADD	SUB	LEN	UN	RES	CON	OP	COND	COND			COND	COND	COND												
1	TOTAMT	0	6																																			
1	TOTAL	0	6																																			

Figure 27. Progressive-Total Specifications

A	FIELD NAME	FIELD STATUS								FACTOR 1			FACTOR 2						OPERATION			HALF ADJUST	POSITION ADJUST																	
		FLD	LEN	UN	RES	CON	OP	COND	COND	COND	MULT	DIV	ADD	SUB	LEN	UN	RES	CON	OP	COND	COND			COND	COND	COND	COND	COND	COND	COND										
		0	7																																					

Figure 28. Comparison Specification

### Conditions

Columns 40-48 can be used to specify a maximum of three conditions in an *and* relation to govern whether the calculation specified is to be performed. The conditions that can be entered are any of the resulting conditions previously defined on the input, data, and calculation specifications sheets as well as LC, F1-F6, SB-SD, and negations of each of these. For example, if one condition to be specified is *no change in control field number 3*, the entry in columns 40-42 will be NF3.

### Total/Detail

Column 49 must contain the letter T or D, depending upon whether the line-entry specifies a total or a detail calculation.

A total calculation is performed after the test for a control-field change is made, but before information is removed from the record in the input area. The record just read cannot, therefore, contribute to the

results of a calculation specified as a total-time calculation. A total calculation is similar to a group total on an IBM 407 Accounting Machine application, where the card at the first reading station that initiates a control change does not contribute to group totals for the previous group.

A detail calculation is performed after the test for a control-field change is made and after information is removed from the record in the input area. The record just read can, therefore, contribute to the results of a calculation specified as a detail-time calculation.

When a detail calculation is to be performed for every record in the input file, the D in column 49 may be sufficient to condition the calculation. Selected detail calculations and all total calculations must be governed by specifications in columns 40-48 as well as T or D in column 49.

### Half-Adjust

Columns 50-51 are used to specify the position of the result that will be half-adjusted (have 5 added to it). The *result* just referred to is the data developed by the calculation specification before the operation specified in column 39 of this specifications sheet. If half-adjusting were specified in the first line-entry in Figure 26, it would be accomplished after multiplying FLDB by FLDC but before adding the result to FLDA. If half-adjusting were specified on the first line in Figure 27, the field AMOUNT would be half-adjusted just before being added to TOTAMT. Whenever the units position of the result is to be half-adjusted, the entry in columns 50-51 is 01; if the tens position, 02; if the hundreds position, 03; etc.

### Position-Adjust

Columns 52-53 are used to specify the number of positions to be *dropped* from the result of the calculation. The *result* referred to is the same as explained in the preceding paragraph. If the units position of the result is to be dropped, the entry in columns 52-53 is 01; if the units and tens positions are to be dropped, 02 is entered; if units, tens, and hundreds, 03; etc.

Half-adjusting, position-adjusting, or both can be specified separately from any other calculation. For example, if field A has the form 31415926 and the user wants to retain only the five high-order digits of field A with the units position rounded (to yield 31416) the appropriate entries are shown in Figure 29.

A	FIELD NAME	FIELD STATUS								FACTOR 1			FACTOR 2						OPERATION			HALF ADJUST	POSITION ADJUST																	
		FLD	LEN	UN	RES	CON	OP	COND	COND	COND	MULT	DIV	ADD	SUB	LEN	UN	RES	CON	OP	COND	COND			COND	COND	COND	COND	COND	COND	COND										
	FLDA	0	8																																					

Figure 29. Half-Adjust and Position-Adjust Specifications

		Decimal Positions in Factor 1						
		0	1	2	3	4	5	6
Decimal Positions in Factor 2	0	00	00	00	01	02	03	04
	1	00	00	01	02	03	04	05
	2	00	01	02	03	04	05	06
	3	01	02	03	04	05	06	07
	4	02	03	04	05	06	07	08
	5	03	04	05	06	07	08	09
	6	04	05	06	07	08	09	10

Example: xxx.xxx X xx.xx =

xxxxx.xx(xxx)

Round this position. (points to the 5th decimal place)

Drop these positions. (points to the 6th, 7th, and 8th decimal places)

Factor 1 has 3 decimal places;  
factor 2 has 2 decimal places.

By looking in the vertical labeled 3 and in the horizontal line labeled 2, the number at the intersection is 03. This is the number to specify in the Half-Adjust and in the Position-Adjust columns of the Calculation sheet.

NOTE: For a three-decimal product rounded to the nearest thousandth, subtract 01 from the table values.

For a one-decimal product rounded to the nearest tenth, add 01 to the table values

Figure 30. Number of Positions to Half-Adjust and Position-Adjust to Yield a Two-Decimal Product Rounded to the Nearest Hundredth

In most commercial applications involving multiplication, the product should be rounded to the nearest hundredth, and positions to the right of the hundredths should be dropped. Figure 30 is a chart to aid the user in selecting the proper half-adjust (columns 50-51) and position-adjust (columns 52-53) entries for the calculation sheet.

**Page Number**

Columns 76-77 are used for page numbering. The numbers are punched in the cards from the page-number entry in the upper right-hand corner of the calculation specifications sheet. As previously mentioned, the sheets are numbered consecutively beginning with the spacing chart as page number 01.

**Card Number**

The first twenty lines of the sheet have preprinted card numbers (see *Input Specifications: Card Number*). The cards punched from the calculation specifications must be arranged in order by page number (columns 76-77) and card number (columns 78-80).

**Leaving "Field Name" Blank**

Figure 31, which illustrates a withholding-tax calculation specification, shows how the field name (columns 2-7) and its length (columns 8-10) can properly be left blank. In that figure, the problem is:

Weekly withholding tax = [gross pay - (tax class × 13.00)] × 18%.

The line-entries in Figure 31 perform the following operations at total-time following a change in control field 1:

1. The first line resets to zero the five-position field in core storage labeled WHTAX and adds to the WHTAX field the five-position amount, GROSS.
2. The second line multiplies TAXCL by the literal 1300, subtracts the product from the WHTAX field, and then tests the sign of WHTAX. If the sign is negative (meaning that the employee's non-taxable income for the week exceeds his gross earnings), resulting-condition indicator 10 is set ON.
3. If WHTAX is not negative (resulting-condition indicator 10 is not ON), the third line multiplies the result of the previous calculation, WHTAX, by the literal 18 to produce a seven-position product. The object program then half-adjusts the tens position of the product, drops the units and tens position of the product (leaving the five high-order positions), resets to zero the five-position WHTAX field, and adds the five-position product to the WHTAX field.

FIELD NAME	FIELD LENGTH	FIELD STATUS	FACTOR 1					FACTOR 2					COND. A	COND. B	COND. C	COND. D	COND. E	COND. F	COND. G	COND. H	COND. I	COND. J	COND. K	COND. L	COND. M	COND. N	COND. O	COND. P	COND. Q	COND. R	COND. S	COND. T	COND. U	COND. V	COND. W	COND. X	COND. Y	COND. Z	COND. AA	COND. AB	COND. AC	COND. AD	COND. AE	COND. AF	COND. AG	COND. AH	COND. AI	COND. AJ	COND. AK	COND. AL	COND. AM	COND. AN	COND. AO	COND. AP	COND. AQ	COND. AR	COND. AS	COND. AT	COND. AU	COND. AV	COND. AW	COND. AX	COND. AY	COND. AZ	COND. BA	COND. BB	COND. BC	COND. BD	COND. BE	COND. BF	COND. BG	COND. BH	COND. BI	COND. BJ	COND. BK	COND. BL	COND. BM	COND. BN	COND. BO	COND. BP	COND. BQ	COND. BR	COND. BS	COND. BT	COND. BU	COND. BV	COND. BW	COND. BX	COND. BY	COND. BZ	COND. CA	COND. CB	COND. CC	COND. CD	COND. CE	COND. CF	COND. CG	COND. CH	COND. CI	COND. CJ	COND. CK	COND. CL	COND. CM	COND. CN	COND. CO	COND. CP	COND. CQ	COND. CR	COND. CS	COND. CT	COND. CU	COND. CV	COND. CW	COND. CX	COND. CY	COND. CZ	COND. DA	COND. DB	COND. DC	COND. DD	COND. DE	COND. DF	COND. DG	COND. DH	COND. DI	COND. DJ	COND. DK	COND. DL	COND. DM	COND. DN	COND. DO	COND. DP	COND. DQ	COND. DR	COND. DS	COND. DT	COND. DU	COND. DV	COND. DW	COND. DX	COND. DY	COND. DZ	COND. EA	COND. EB	COND. EC	COND. ED	COND. EE	COND. EF	COND. EG	COND. EH	COND. EI	COND. EJ	COND. EK	COND. EL	COND. EM	COND. EN	COND. EO	COND. EP	COND. EQ	COND. ER	COND. ES	COND. ET	COND. EU	COND. EV	COND. EW	COND. EX	COND. EY	COND. EZ	COND. FA	COND. FB	COND. FC	COND. FD	COND. FE	COND. FF	COND. FG	COND. FH	COND. FI	COND. FJ	COND. FK	COND. FL	COND. FM	COND. FN	COND. FO	COND. FP	COND. FQ	COND. FR	COND. FS	COND. FT	COND. FU	COND. FV	COND. FW	COND. FX	COND. FY	COND. FZ	COND. GA	COND. GB	COND. GC	COND. GD	COND. GE	COND. GF	COND. GG	COND. GH	COND. GI	COND. GJ	COND. GK	COND. GL	COND. GM	COND. GN	COND. GO	COND. GP	COND. GQ	COND. GR	COND. GS	COND. GT	COND. GU	COND. GV	COND. GW	COND. GX	COND. GY	COND. GZ	COND. HA	COND. HB	COND. HC	COND. HD	COND. HE	COND. HF	COND. HG	COND. HH	COND. HI	COND. HJ	COND. HK	COND. HL	COND. HM	COND. HN	COND. HO	COND. HP	COND. HQ	COND. HR	COND. HS	COND. HT	COND. HU	COND. HV	COND. HW	COND. HX	COND. HY	COND. HZ	COND. IA	COND. IB	COND. IC	COND. ID	COND. IE	COND. IF	COND. IG	COND. IH	COND. II	COND. IJ	COND. IK	COND. IL	COND. IM	COND. IN	COND. IO	COND. IP	COND. IQ	COND. IR	COND. IS	COND. IT	COND. IU	COND. IV	COND. IW	COND. IX	COND. IY	COND. IZ	COND. JA	COND. JB	COND. JC	COND. JD	COND. JE	COND. JF	COND. JG	COND. JH	COND. JI	COND. JJ	COND. JK	COND. JL	COND. JM	COND. JN	COND. JO	COND. JP	COND. JQ	COND. JR	COND. JS	COND. JT	COND. JU	COND. JV	COND. JW	COND. JX	COND. JY	COND. JZ	COND. KA	COND. KB	COND. KC	COND. KD	COND. KE	COND. KF	COND. KG	COND. KH	COND. KI	COND. KJ	COND. KL	COND. KM	COND. KN	COND. KO	COND. KP	COND. KQ	COND. KR	COND. KS	COND. KT	COND. KU	COND. KV	COND. KW	COND. KX	COND. KY	COND. KZ	COND. LA	COND. LB	COND. LC	COND. LD	COND. LE	COND. LF	COND. LG	COND. LH	COND. LI	COND. LJ	COND. LK	COND. LL	COND. LM	COND. LN	COND. LO	COND. LP	COND. LQ	COND. LR	COND. LS	COND. LT	COND. LU	COND. LV	COND. LW	COND. LX	COND. LY	COND. LZ	COND. MA	COND. MB	COND. MC	COND. MD	COND. ME	COND. MF	COND. MG	COND. MH	COND. MI	COND. MJ	COND. MK	COND. ML	COND. MM	COND. MN	COND. MO	COND. MP	COND. MQ	COND. MR	COND. MS	COND. MT	COND. MU	COND. MV	COND. MW	COND. MX	COND. MY	COND. MZ	COND. NA	COND. NB	COND. NC	COND. ND	COND. NE	COND. NF	COND. NG	COND. NH	COND. NI	COND. NJ	COND. NK	COND. NL	COND. NM	COND. NN	COND. NO	COND. NP	COND. NQ	COND. NR	COND. NS	COND. NT	COND. NU	COND. NV	COND. NW	COND. NX	COND. NY	COND. NZ	COND. OA	COND. OB	COND. OC	COND. OD	COND. OE	COND. OF	COND. OG	COND. OH	COND. OI	COND. OJ	COND. OK	COND. OL	COND. OM	COND. ON	COND. OO	COND. OP	COND. OQ	COND. OR	COND. OS	COND. OT	COND. OU	COND. OV	COND. OW	COND. OX	COND. OY	COND. OZ	COND. PA	COND. PB	COND. PC	COND. PD	COND. PE	COND. PF	COND. PG	COND. PH	COND. PI	COND. PJ	COND. PK	COND. PL	COND. PM	COND. PN	COND. PO	COND. PP	COND. PQ	COND. PR	COND. PS	COND. PT	COND. PU	COND. PV	COND. PW	COND. PX	COND. PY	COND. PZ	COND. QA	COND. QB	COND. QC	COND. QD	COND. QE	COND. QF	COND. QG	COND. QH	COND. QI	COND. QJ	COND. QK	COND. QL	COND. QM	COND. QN	COND. QO	COND. QP	COND. QQ	COND. QR	COND. QS	COND. QT	COND. QU	COND. QV	COND. QW	COND. QX	COND. QY	COND. QZ	COND. RA	COND. RB	COND. RC	COND. RD	COND. RE	COND. RF	COND. RG	COND. RH	COND. RI	COND. RJ	COND. RK	COND. RL	COND. RM	COND. RN	COND. RO	COND. RP	COND. RQ	COND. RR	COND. RS	COND. RT	COND. RU	COND. RV	COND. RW	COND. RX	COND. RY	COND. RZ	COND. SA	COND. SB	COND. SC	COND. SD	COND. SE	COND. SF	COND. SG	COND. SH	COND. SI	COND. SJ	COND. SK	COND. SL	COND. SM	COND. SN	COND. SO	COND. SP	COND. SQ	COND. SR	COND. SS	COND. ST	COND. SU	COND. SV	COND. SW	COND. SX	COND. SY	COND. SZ	COND. TA	COND. TB	COND. TC	COND. TD	COND. TE	COND. TF	COND. TG	COND. TH	COND. TI	COND. TJ	COND. TK	COND. TL	COND. TM	COND. TN	COND. TO	COND. TP	COND. TQ	COND. TR	COND. TS	COND. TT	COND. TU	COND. TV	COND. TW	COND. TX	COND. TY	COND. TZ	COND. UA	COND. UB	COND. UC	COND. UD	COND. UE	COND. UF	COND. UG	COND. UH	COND. UI	COND. UJ	COND. UK	COND. UL	COND. UM	COND. UN	COND. UO	COND. UP	COND. UQ	COND. UR	COND. US	COND. UT	COND. UY	COND. UZ	COND. VA	COND. VB	COND. VC	COND. VD	COND. VE	COND. VF	COND. VG	COND. VH	COND. VI	COND. VJ	COND. VK	COND. VL	COND. VM	COND. VN	COND. VO	COND. VP	COND. VQ	COND. VR	COND. VS	COND. VT	COND. VY	COND. VZ	COND. WA	COND. WB	COND. WC	COND. WD	COND. WE	COND. WF	COND. WG	COND. WH	COND. WI	COND. WJ	COND. WK	COND. WL	COND. WM	COND. WN	COND. WO	COND. WP	COND. WQ	COND. WR	COND. WS	COND. WT	COND. WY	COND. WZ	COND. XA	COND. XB	COND. XC	COND. XD	COND. XE	COND. XF	COND. XG	COND. XH	COND. XI	COND. XJ	COND. XK	COND. XL	COND. XM	COND. XN	COND. XO	COND. XP	COND. XQ	COND. XR	COND. XS	COND. XT	COND. XY	COND. XZ	COND. YA	COND. YB	COND. YC	COND. YD	COND. YE	COND. YF	COND. YG	COND. YH	COND. YI	COND. YJ	COND. YK	COND. YL	COND. YM	COND. YN	COND. YO	COND. YP	COND. YQ	COND. YR	COND. YS	COND. YT	COND. YY	COND. YZ	COND. ZA	COND. ZB	COND. ZC	COND. ZD	COND. ZE	COND. ZF	COND. ZG	COND. ZH	COND. ZI	COND. ZJ	COND. ZK	COND. ZL	COND. ZM	COND. ZN	COND. ZO	COND. ZP	COND. ZQ	COND. ZR	COND. ZS	COND. ZT	COND. ZY	COND. ZZ	COND. BA	COND. BB	COND. BC	COND. BD	COND. BE	COND. BF	COND. BG	COND. BH	COND. BI	COND. BJ	COND. BK	COND. BL	COND. BM	COND. BN	COND. BO	COND. BP	COND. BQ	COND. BR	COND. BS	COND. BT	COND. BU	COND. BV	COND. BW	COND. BX	COND. BY	COND. BZ	COND. CA	COND. CB	COND. CC	COND. CD	COND. CE	COND. CF	COND. CG	COND. CH	COND. CI	COND. CJ	COND. CK	COND. CL	COND. CM	COND. CN	COND. CO	COND. CP	COND. CQ	COND. CR	COND. CS	COND. CT	COND. CU	COND. CV	COND. CW	COND. CX	COND. CY	COND. CZ	COND. DA	COND. DB	COND. DC	COND. DD	COND. DE	COND. DF	COND. DG	COND. DH	COND. DI	COND. DJ	COND. DK	COND. DL	COND. DM	COND. DN	COND. DO	COND. DP	COND. DQ	COND. DR	COND. DS	COND. DT	COND. DU	COND. DV	COND. DW	COND. DX	COND. DY	COND. DZ	COND. EA	COND. EB	COND. EC	COND. ED	COND. EE	COND. EF	COND. EG	COND. EH	COND. EI	COND. EJ	COND. EK	COND. EL	COND. EM	COND. EN	COND. EO	COND. EP	COND. EQ	COND. ER	COND. ES	COND. ET	COND. EU	COND. EV	COND. EW	COND. EX	COND. EY	COND. EZ	COND. FA	COND. FB	COND. FC	COND. FD	COND. FE	COND. FF	COND. FG	COND. FH	COND. FI	COND. FJ	COND. FK	COND. FL	COND. FM	COND. FN	COND. FO	COND. FP	COND. FQ	COND. FR	COND. FS	COND. FT	COND. FU	COND. FV	COND. FW	COND. FX	COND. FY	COND. FZ	COND. GA	COND. GB	COND. GC	COND. GD	COND. GE	COND. GF	COND. GG	COND. GH	COND. GI	COND. GJ	COND. GK	COND. GL	COND. GM	COND. GN	COND. GO	COND. GP	COND. GQ	COND. GR	COND. GS	COND. GT	COND. GU	COND. GV	COND. GW	COND. GX	COND. GY	COND. GZ	COND. HA	COND. HB	COND. HC	COND. HD	COND. HE	COND. HF	COND. HG	COND. HI	COND. HJ	COND. HK	COND. HL	COND. HM	COND. HN	
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**Field Length Specification for Multiplication and Division**

If multiplication is specified in column 29 of the calculation specifications sheet, the field length (columns 8-10) must be no less than the sum of the number of digits in the multiplier and the multiplicand, minus the number specified for position-adjusting. For example, in multiplying a five-digit number by a two-digit number and dropping the units position of the product, the field length must be at least six characters.

If division is specified, the field length (columns 8-10) must be no less than the number of digits in the dividend minus the number specified for position-adjusting. Thus, for dividing a seven-digit number by a divisor and dropping the units and tens positions of the quotient, the field length must be at least five characters.

**Summary of Calculation Specifications**

After completing the data specifications sheet, the user can determine the data-field calculations that are yet to be specified. Figure 23, which indicates the procedure for writing the data specifications of the Monthly Expense Distribution Report shown in Figure 24, shows that three calculations have not yet been specified. The three calculate the data fields AMTACT, AMTDEP, and FINAMT. These three calculations are shown in Figure 32.

Having determined the calculation specifications that are required, the user makes the following entries on the calculation specifications sheet:

COLUMNS	NAME	EXPLANATION
1	A	Always an A.
2-7	Field Name	Name to identify the data field that will contain the result of this calculation, with two exceptions. It is blank if the line-entry is a comparison specification (C in column 29), or the result is to be contained in the

8-10	Field Length	Unedited data-field length.
11, 14, 17	Status	B, Z, N, P, U, E, H, or L in one, two, or all three of these columns to establish a field status. The entries H and L can be used only if the object program is to be executed on an IBM 1401 Data Processing System equipped with the high-low-equal compare special-feature.
12-13, 15-16, 18-19	Resulting Condition	Used only in conjunction with the status columns 11, 14, and 17. A unique two-digit number represents each status specified.
20-25	Factor 1	Either the field name or the literal that is factor 1. The field name must have been specified on the data specifications sheet, in a prior entry on the calculation specifications sheet, or in a W-entry on a format specifications sheet.
26-28	Length	Factor 1 unedited field-length.
29	OP	Operation to be performed using the two factors. Addition, subtraction, multiplication, division, and comparison are represented by +, -, ×, /, and C.
30-35	Factor 2	Either the field name or the literal that is factor 2.
36-38	Length	Factor 2 unedited field-length.
39	A S 0 0	A, S, 0, or 0, depending upon whether (1) the result of a two-factor calculation is to be added, subtracted, reset-added, or reset-subtracted into the data field specified in columns 2-7, or (2)

**IBM**

**1401 REPORT PROGRAM GENERATOR**

FORM X24-1339  
PRINTED IN U.S.A.

Report Monthly Expense Distribution Report  
Programmed by \_\_\_\_\_

**CALCULATION SPECIFICATIONS**

Page 104 of 08  
Date \_\_\_\_\_

FIELD NAME	FIELD LENGTH UNEDITED	FIELD STATUS							FACTOR 1		FACTOR 2		COND. N COND. D	COND. N COND. D	HALF ADJUST	POSITION ADJUST	CARD NUMBER	
		RESULTING CONDITION	RESULTING STATUS	RESULTING CONDITION	RESULTING STATUS	MULTIPLICAND AUGEND, OR MINUEND	FIELD LENGTH UNEDITED	MULTIPLIER DIVISOR AUGEND, OR SUBTRAHEND	FIELD LENGTH UNEDITED									
AMTACT	09										TOT AMT	008	A	E1				0,1,0
AMTDEP	10										AMTACT	009	A	E2				0,2,0
FINAMT	11										AMTDEP	010	A	E3				0,3,0
																		0,4,0

Figure 32. Calculation Specifications for Monthly Expense Distribution Report



output line, the conditions under which the field will be placed in the line prior to printing, punching, or writing on tape, the edited field-length, and information controlling zero-suppression and editing.

Much of the information for the entries on the format specifications sheet is taken from the spacing chart previously described.

*Entries for hierarchical line specifications must be in the same order as they will appear on the report. Entries for all of the fields within a line must follow the entry for that line specification. The field entries may, however, be in any order after the line specification.*

### Format

In *column 1* a letter must be entered that designates the entry as a format specification. An L in that column identifies the entry as a format specification for a line.

### Line

*Columns 2-4* identify the line being specified. Entries for these columns are taken from the spacing-chart entries that define the line by *type*, *level*, and *number*, as explained previously under *IBM 1403 Spacing Chart*.

The entry in *column 2* specifies the *type* of the line. It must be H for a heading line, D for a detail line, or T for a total line. An important consideration in assigning *type* to a line is the difference between a total line and a heading or detail line with regard to the record in the input area when the line is formed. This difference can be noted from the block diagrams of the object programs generated by the RPG. Figures 48 and 49 illustrate that the test for control-field changes, the performance of total-time calculations, and the formation of total lines precede the function of removing fields from the input record. Thus, an input record that causes a control change *cannot* contribute data to total lines that result from that control change.

The block diagrams also illustrate that detail calculations, heading lines, and detail lines follow the removal of fields from the record in the input area, and thus that record can contribute to these calculations and lines. Therefore, the naming of a line according to type is not arbitrary, particularly with regard to total and detail lines.

*Column 3* specifies the level of the line, as explained under *IBM 1403 Spacing Chart*. *Column 4* specifies the number of the line within a given level. For example, in the invoice application spacing chart shown in Figure 60, there is one hierarchical (numerical) level of heading lines that includes five lines. Those lines have the line-identification codes H11, H12, H13, H14, and H15. Although these heading lines are associated

with customer number, which is the intermediate control field (F2), the lines are *level one* because there are no heading lines of lower level. This illustrates the principle that *line level* is not necessarily equal to the *number of the control field* with which the line is associated. Because the level is numerical, the line numbers must be numerical to reflect their sequence within the level.

As mentioned in the spacing chart explanation of the *Classification of Lines*, report lines to be used as output when a page-overflow condition occurs must be identified by an alphabetic-level character to reflect their independence from a hierarchy. The overflow heading line in the invoice application (see Figure 9) is similar to the first normal heading line. For this reason there are two line-identification codes in Figure 60 for the first heading line (H11 and HAA). As previously mentioned, the line-number entry in *column 4* for a line with an alphabetic-level character, such as HAA, can be a number or a letter. Because there is only one page-heading line rather than a sequence, an alphabetic line-designation was used in the example.

The entries on the format specifications sheet pertaining to lines must be in *descending level-order for heading lines*, and in *ascending level-order for total lines*. This is the normal order of printing related report lines, as can be noted on the spacing chart in Figure 7 and on the printed report in Figure 4.

### Output

*Column 5* must contain an alphabetic X if the line is to be printed; otherwise it is left blank.

*Column 6* must contain an alphabetic X if the line is to be punched into an output card; otherwise it is left blank.

If both printing and punching are being specified for the line, an X must be entered in both *columns 5 and 6*.

*Column 7* must contain an alphabetic X if the line is to be written on magnetic tape; otherwise it is left blank.

If printing, punching, and writing on tape are being specified, an X must be entered in each of the three *columns, 5-7*.

### Next Line

*Columns 8-10* define the next line to be printed, punched, or written on tape. This entry is made only if the *next line* specified in these columns should come unconditionally in the output after *this line* (the line being described in this entire line-entry). Otherwise *columns 8-10* should be left blank. When a *next line* is specified in *columns 8-10*, that next line must be of





CONDITION 1P (FIRST PAGE)

1P is a condition unique to the format specifications. It is fulfilled at the beginning of processing before any input records have been read. The purpose of this condition is to cause the printing of a cover sheet or page heading lines on the first sheet that print as a result of OF on the following sheets. Thus, lines that contain *only constant information* and that appear in the output before any input records are processed can be printed, punched, or written on tape as a result of condition 1P. Because this condition precedes any input record, no information from the input file can appear in a line conditioned by 1P. Thus, a page heading line that contains a date from the first record in a file will not contain that date on the first sheet if the line is conditioned by 1P. The line should be conditioned by the resulting-condition number that represents the date header record.

VARIABLE LINE-OUTPUT CONDITIONS

Some applications require that varying conditions govern the appearance of a line in the output. A line that is governed by *or* conditions must be specified with a separate line-entry for each *or* condition. The first line-entry made in the normal manner will specify the first *or* condition. Each succeeding line-entry consists of an L in column 1 and the *or* condition in columns 20-28 as required.

For example, if a detail line called DAA is to be written on tape when any one of the following three conditions is met: (1) condition 02 and not condition 05; (2) condition 06, or (3) condition 09; the proper entries on the format specifications sheet are as shown in Figure 36.

FORM	LINE	OUTPUT	NEXT LINE	SPACE	SKIP	LINE OUTPUT CONDITIONS			FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS			ZERO SUPPRESS	FIELD LENGTH
						COND. N	COND. N	COND. N			COND. N	COND. N	COND. N		
L	DAA	X				0,2	N	0,5							
L						0,6									
L						0,9									

Figure 36. Or Line-Output Conditions

A line whose output is governed by conditions in an *or* relation can be governed by OF only if OF is part of every *or* condition. For example, if a heading line identified as H25 is to be printed upon occurrence of overflow and either conditions 07 or 13, the proper entries on the format sheet are as shown in Figure 37. NOTE: Columns 29-75 are left blank for line specifications (L in column 1). As explained later, columns 76-80 pertain to both line and field specifications.

FORM	LINE	OUTPUT	NEXT LINE	SPACE	SKIP	LINE OUTPUT CONDITIONS			FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS			ZERO SUPPRESS	FIELD LENGTH
						COND. N	COND. N	COND. N			COND. N	COND. N	COND. N		
L	H25	X				0,3			0,7						
L						0,7			1,3						

Figure 37. OF as an Or Line-Output Condition

Format

In the description of a field within a line or the definition of a constant *column 1* contains an F, B, K, or W. The meaning of these entries is as follows:

- F – identifies the entry as a *field* specification for a data field that *will not be blanked* after it is placed in an output line.
- B – identifies the entry as a *field* specification for a data field that *will be blanked* after it is placed in an output line. This entry causes processing similar to a readout and reset total operation on an accounting machine.
- K – identifies the entry as a *field* specification that uses a constant.
- W – identifies the entry as a *field* specification that *defines* a constant or an edit control-word.

NOTE: Columns 2-28 are blank in a line-entry that specifies a field or a constant.

Field Name

Columns 29-34 state the name of the field to be inserted in the line whose specification immediately precedes the field entry. An entry with a B in column 1 must contain a field name from columns 2-7 of the data or calculation specifications sheets. An F entry in column 1 can also contain a field named in the data or calculation specifications, or it can have a WORDxx defined by a W-entry elsewhere in the format specifications. Those field names that are less than six characters long must be left-justified. The entry of a K in column 1 requires a blank field name. The entry of a W in that column must have a field name of the form WORDxx, where xx is a number in the range 00-99. W-entries are fully explained later in this section.

Field End

Columns 35-37 contain the number of the rightmost position of the field in the output line as shown on the spacing chart. These columns are left blank for a W-entry.

Field Output Conditions

Columns 38-46 provide for a maximum of three conditions, considered in an *and* relation, under which the field being specified is to be placed in the output line.



Figure 39. Using Constant and Edit Control-Word

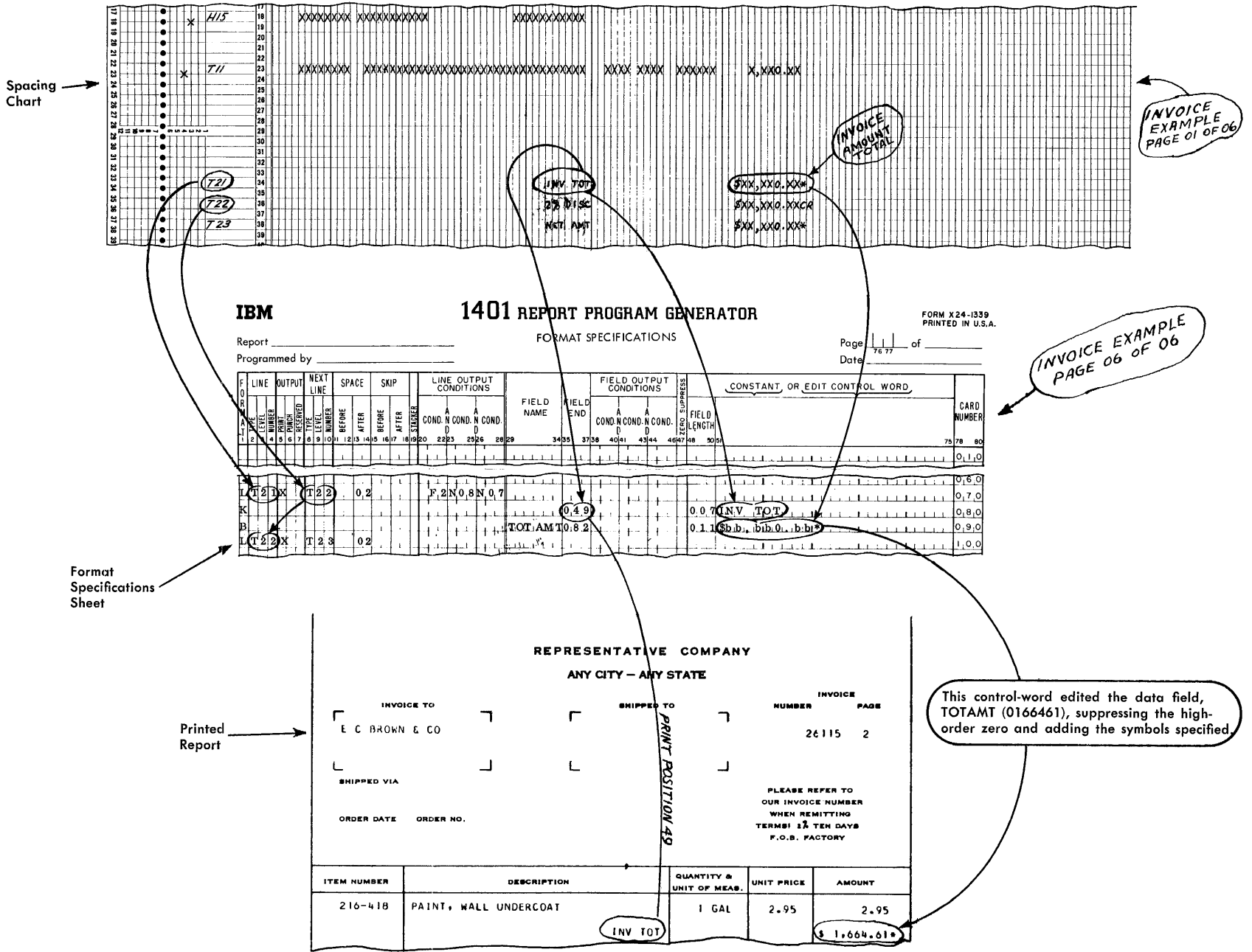
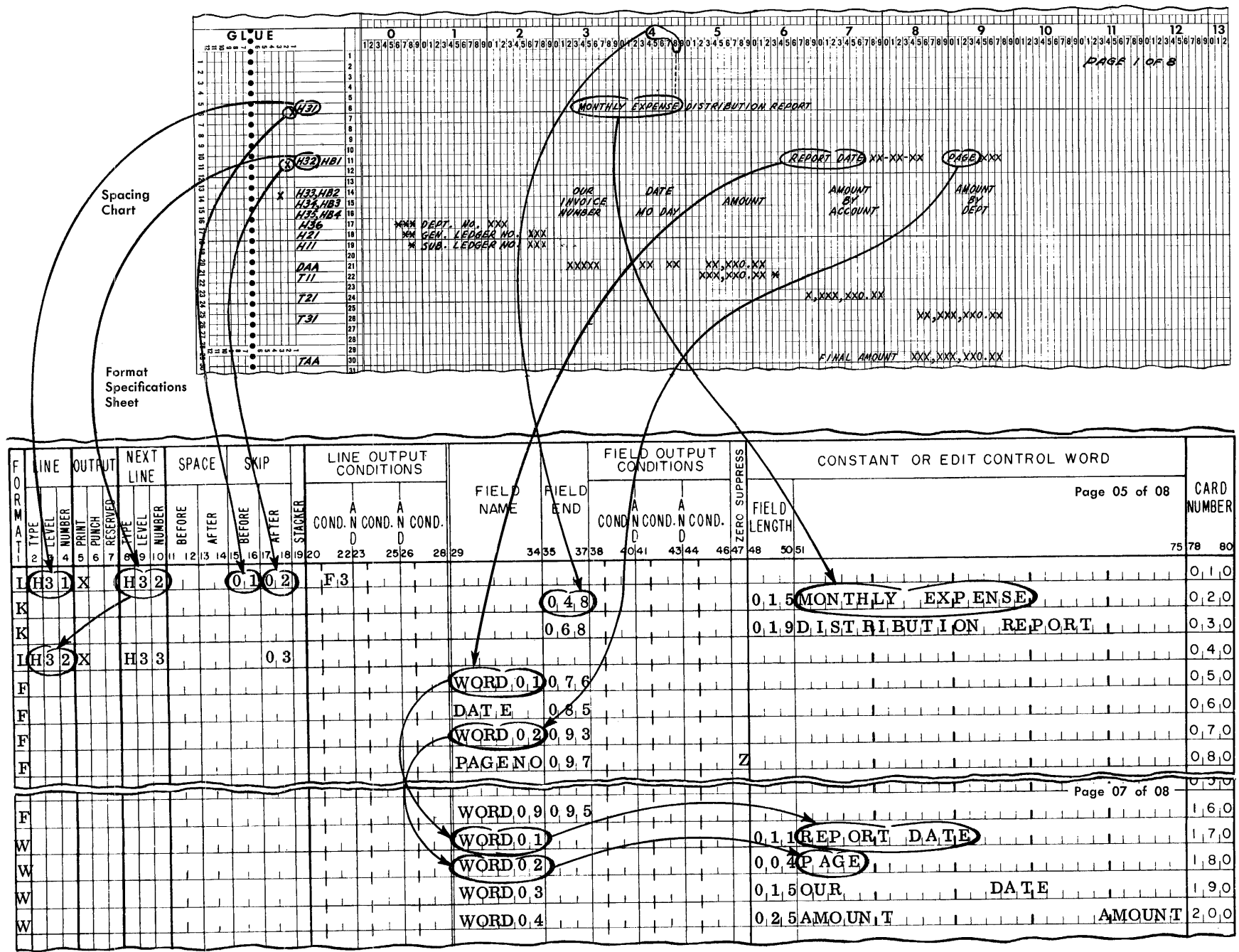




Figure 40. Using Constants





### Summary of Format Specifications

Having completed the spacing chart showing the layout of the desired lines and the input, data, and calculation (if required) sheets, the user writes the format specifications for the output lines.

The following general rules govern the order of the entries on the format sheet:

1. The first entry must be a format specification for a *line*.
2. An entry made for a given line must be followed by entries for each field that must appear in that line.
3. Entries for lines should be specified in the order in which the lines must appear in the output.

The following is a summary of entries on the format specifications sheet.

COLUMNS	NAME	EXPLANATION
1	Format	Letter (L, F, B, K, or W) to identify the line-entry as a format specification.
Columns 2-28 apply to line-specification entries only.		
2-4	Line	Line-identification code for this line (taken from the spacing chart).
5	Print	X if this line is to be printed.
6	Punch	X if this line is to be punched.
7	Reserved	X if this line is to be written on magnetic tape.
8-10	Next Line	Line-identification code of the next line provided that it is to be used as output under the same output conditions as those governing the line being specified. The next line must be of the same type and level as the line calling for a next line.
11-12	Space Before	Numbers 01, 02, or 03 for single, double, or triple line-spacing <i>before</i> printing this line.
13-14	Space After	Same as columns 11-12, except for spacing <i>after</i> printing.
15-16	Skip Before	01-12 for skipping to carriage-tape channel 1-12 <i>before</i> printing.
17-18	Skip After	Same as columns 15-16, except for skipping <i>after</i> printing.
19	Stacker	4 or 8 to select the card representing this line into either the 4 or the 8 punch-stacker pocket. Blank when not selecting.

20-22 Line Output Condition First condition to govern the appearance in the output of this line. The following can be entered: any resulting-condition number defined on the input, data, and calculation sheets; OF, LC, 1P, F1-F6, SB-SD, and negations of these.

23-28 (Two other conditions) Two other conditions to govern the appearance in the output of this line. Output conditions for a given line are considered in an *and* relation. A line will be used as output only if: (1) its line-output conditions are specified and fulfilled, or (2) the line is specified as the *next line* in the L-entry of the preceding line, and that preceding line's output conditions are fulfilled, or (3) the line is of a lower level in a hierarchy than another line of the same type for which the output conditions are fulfilled.

Columns 29-75 pertain to field specifications only.

29-34 Field Name If the field is not a constant, the name of the field. That name must appear in columns 2-7 of either the data or calculation sheet or be a WORDxx. If the field is a constant defined by a W-entry, the name is WORDxx. If the field is a constant not defined as WORDxx, these columns are blank.

35-37 Field End Print position of the units position of the field.

38-40 Field Output Condition First condition to govern the inclusion of the field in the output line. The same conditions are accepted here as are accepted in columns 20-22.

41-46 (Two other conditions) Two other conditions with the same function as the first condition in columns 38-40. The field-output conditions for a given field are considered in an *and* relation. If a field must be included unconditionally in an output line, columns 38-46 are blank.

47	Zero Suppress	Z to zero-suppress a field without using an edit control-word.
48-50	Field Length	Length of either an edit control-word used with the field or a constant that is defined in columns 51-75.
51-75	Constant or Edit Control Word	Either a constant (numerical or alphameric) or an edit control-word that is being used or defined.
76-77	Page	Page number of this specifications sheet, located in the upper right-hand corner.
78-80	Card Number	The first twenty lines of each sheet are prenumbered.

### Control Card

The Report Program Generator requires one control card. The user prepares the card and places it, as explained under *Second Phase of Report Generating*, in the RPG processor deck. Figure 42 shows the control card format.

### Special Feature Specifications

An IBM 1401 Data Processing System equipped with a special feature to read 51-column cards reads either standard 80-column or 51-column cards, depending upon the operating mode. When operating in the 51-column mode, columns 1-51 correspond to columns 15-65 of an 80-column card. Thus, in any specifications of card columns for 51-column input data file cards, the entry is the column number plus 14. For example, if a minor control field in the 51-column cards of the input data file is punched in columns 2-7, the proper entry in columns 44-46 of the input specifications sheet is 021.

COLUMNS	PUNCHES	EXPLANATION
1-4	CNTL	Identifies the card.
5	One of these: 3-6	Core-storage capacity of 1401 system to be used to generate object program. See Note 1.
6	One of these: 1-6	Core-storage capacity of 1401 system to be used to execute object program. See Note 1.
7	1 or blank	1 if sense switches B-G are used; blank otherwise.
8	1 or 2	1 for IBM 1403, Model 1 (100 print positions); 2 for IBM 1403, Model 2 (132 print positions).
9	M or blank	M if multiply-divide special feature is installed on 1401 system used to execute object program; blank otherwise.
10-12	Tape input record-length	Length for fixed-length records, or VVV for variable-length records.
13-14	Tape input blocking factor or blank	For fixed-length, blocked input records, the number of data records per input tape block (input blocking-factor); for variable-length input records, blank.
15	1 or blank	1 if header label on tape input is to be bypassed; blank otherwise.
16	2-9 or blank	Number (2-9) of tape data files to be processed; blank if only one.
17-19	Output tape record length or blank	Length of output tape records; blank if 132 characters.
20-75 76-80	Blank Identification	(Not used) If program identification is to be punched in the symbolic object-program deck, that identification; blank otherwise.

NOTE 1: The core-storage capacity of a 1401 system is represented by the following numbers:

1 — 1400	4 — 8000
2 — 2000	5 — 12000
3 — 4000	6 — 16000

### Summary of First Phase of Report Generating

After the information relevant to the desired report has been described on the spacing chart and the four specifications sheets, the user prepares the cards that constitute the source deck for the Report Program Generator. He punches one card for each line-entry on the specifications sheets. The control card, prepared as described, is placed ahead of the specifications cards. The sections of the source deck are now in the order:

1. control card,
2. input specifications cards,
3. data specifications cards,
4. calculation specifications cards, and
5. format specifications cards.

Figure 42. Format of RPG Control Card

## Second Phase of Report Generating

The second phase is developing the object program in symbolic language. This is done by a machine pass through the IBM 1401 of the specifications source deck and either the Card or the Tape Report Program Generator processor deck. Both the Card and the Tape RPG processor decks contain comments cards in five appropriate places in each deck. They identify where the user must insert both the control card and each group of specifications cards. For example, in the first part of each deck there are two comments cards punched *\*Place Control Card After This Card* and *\*Place Control Card Before This Card*. At four other places in each deck there are two comments cards between which the user places the appropriate specifications cards.

The output of this machine pass is

1. the specifications source deck, which is selected into the 1 stacker pocket,
2. the Card or the Tape RPG processor deck, which falls into the NR stacker pocket, and
3. the object program deck in symbolic language, which falls into three pockets. The first part of the object program falls into the NP stacker pocket, the second part falls into the 4 pocket, and the last part of the program falls into the 8/2 pocket.

Because proper order of the cards in the object program deck must be maintained, these cards should be removed from the stackers and placed face-down in the following order: NP stacker, stacker 4, and stacker 8/2.

## Checking the Specifications

During the generation of the object program certain errors, if present in the specifications source deck, cause the RPG processor to halt. Because a halt necessitates the correction of the error and restart of the generation phase from the beginning, check the specifications carefully for the following errors before beginning generation.

KIND OF SPECIFICATION	REASON FOR PROGRAM HALT
Control Input	Control card missing. Column 1 not C, S, or *. Resulting condition (columns 42-43) blank.
Data	Column 1 not D or *. Field source not defined in the input specifications. Status (column 11, 14, or 17) not B, Z, N, or P.
Calculation	Status (column 11, 14, or 17) not B, Z, N, P, U, L, E, or H. Total/Detail (column 49) not T or D.
Format	First format card not a line specification (column 1 not an L). Column 1 not L, F, B, K, or W. Type of line (column 2) not H, T, or D. Output medium (columns 5-7) not specified. Final (normal) halt.

### **Third Phase of Report Generating**

The third phase of report generating converts the output of phase two, which is the object program in symbolic language, to an object program in 1401 machine language. Either a Symbolic Programming System deck or a 1401 *Autocoder* system tape can be used to perform the assembly. When using 1401 *Autocoder*, the user must provide the proper control cards to enter the SPS phase.

If the user wishes to incorporate his own symbolic subroutines in the object program, he places them in the proper place in the object deck before phase three begins. See *Inserting Subroutines in Object Program*.

### **Program Storage Requirements**

After the object program has been assembled in machine language, the user can determine from the assembly listing how much storage the program requires. With regard to programs that process tape input records, the maximum block length that the object program can accommodate is directly related to the size of the program. After assembly, the user can subtract the address associated with the label RILSS1 (located two lines before the END card) from the maximum storage address minus two. For a machine equipped with 4,000 positions of core storage, the maximum storage address minus two is  $3999 - 2$ , or 3997. The result is the amount of available storage for an input tape block.

## Fourth Phase of Report Generating

The fourth (final) phase of report generating is the execution of the object program to produce the desired output. The input is a data file of cards in the 1402 read feed or magnetic tape on tape unit 3. The output produced is the output the user has specified. The following list includes the output that can be produced when processing card-input data files:

- A printed report.
- A report punched into cards.
- A printed report and a report punched into cards.
- A printed report with selected information punched into cards.
- A printed report with summary totals punched into cards.

For processing tape-input data files, the following list describes the output that can be produced:

- A printed report.
- A report punched into cards.
- A report written on magnetic tape mounted on tape unit 4.
- A combination of any or all three listed above.
- A printed report with certain selected information punched into cards and other selected information written on magnetic tape.
- A printed report with summary totals punched into cards and exception records written on magnetic tape.

## Sense Switches

The object program produced by the RPG permits using certain sense switches that have specified functions. For programs that process card files, only sense

switch A (last card) is necessary. Tape object programs require sense switches E, F, and G. Sense switches B, C, and D can be used to govern processing at the user's discretion. Except for switch E in a tape application, the object program tests the switch settings at the beginning of the run and maintains that setting throughout the run. Manually changing a switch other than E during processing is not recognized by the object program. In tape object programs there is a halt after each file has been processed. If the next file is to be processed, sense switch E must be set OFF (down) and the start key must be pressed. If the next file is to be bypassed, sense switch E must be set ON (up) and the start key pressed.

Sense switches F and G are used in tape object programs to control the action of the tape error routine. If an error in reading a tape record occurs, the object program automatically attempts to read the record ten times. If the tape validity error persists, the program tests switch F. If F is ON, the program processes the record, disregarding the validity error. If F is OFF, the program halts. If switch G is ON, the user can press the 1401 start key for nine more read attempts. If G is OFF, the user can attempt to correct the error record manually by setting the IBM 1401 console tape select switch to the D-mode and pressing the start key. The record will be read once more. After scanning storage to locate the erroneous character, the user can attempt to correct the error from the console. When the correction has been made and the tape select switch has been returned to the N-position, processing can be continued by pressing the console start key.

A tape validity error while writing a tape record results in a maximum of fifty attempts to write the record. If the error persists, the program halts. A new tape should be mounted and the program restarted.

## Suggestions and Recommendations

### Split Control-Fields in Input Records

Most control fields consist of several contiguous character-positions in each record. The explanation given under *Control Fields in Input Specifications* is based upon this usual arrangement. However, when a control field is "split," that is, when all of its characters are not located in adjacent character-positions, further consideration is required to specify the control field and the condition that represents a change in that field.

For example, input records contained in a card file might have the minor control field punched in columns 2-7, the intermediate control field in columns 35-36 and 10-12, and the major control field in columns 16-19. The input specifications sheet for this example would include the control-field entries shown in Figure 43.

Operations to be performed when there is a change in the minor control field would use the condition entry F1. Operations to be performed when there is a change in the *split* intermediate control field would use the condition F2 (*not* F3). Operations to be performed upon a major control-field change would use the condition F4.

Consider the action that results from a change in the control-data of the split intermediate control-field. If a change occurs in columns 35-36, conditions F1 and F2 are fulfilled. If a change occurs in columns 10-12, conditions F1, F2, and F3 are fulfilled. Thus, any operation whose performance is conditioned by F2 will be executed upon a change in either of the two parts of the intermediate control-field. But, should the condition F3 be used to condition an operation, that operation will occur only upon a change in the major control field or a change in the portion of the intermediate control field punched in columns 10-12. Thus, no intermediate change will be recognized when there is a change only in columns 35-36.

The order of specifying the parts of the split control field is not fixed. In the example, it does not matter whether card columns 35-36 are specified as field 2 or field 3. The important points are that all portions of the split control field must be specified in adja-

CONTROL FIELDS														CARD NUMBER																				
SITIO	NOT	CH	CODE	RESULTING	FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6	END	LENGTH	END		LENGTH																			
38	33	04	1	A243	44	46	47	48	49	5	02	53	54	56	57	58	59	61	62	63	64	66	67	68	69	71	72	73	74	75	78	80		
					0,0	7	0,6	0,3	6	0,2	0,1	2	0,3	0,1	9	0,4																	0,1	0

Figure 43. Control-Field Entries, Including One Split Field

cent fields on the sheet (fields 2 and 3 are beside one another) and only the lowest-numbered field must be used to represent a change in the split control field. (See paragraph 1 in the section *Description of the General Block Diagrams* for another approach to split control fields.)

### Program Efficiency

Certain alternatives exist in writing the specifications for a report. By making appropriate choices, the user can save both storage capacity and program execution time.

### Input Specifications

Sequence checking, although a valuable and sometimes necessary function, uses a considerable amount of storage space and execution time. It should be used only when necessary.

Arranging the line-entries for non-sequential input records (such as CAA and CBB) so that the ones with the same control fields are consecutively-specified saves storage space.

Types of input records that occur most frequently in the input file should be specified first. For example, in the input specifications of the Monthly Expense Distribution Report the line-entry specifying detail cards, type CBB, precedes that for the report date card, type CAA (there is only one type CAA card in the file).

When a digit that could never have a zone over it or a zone that could never have a digit under it is specified as a record code, describing that digit or zone as a character (C in column 10) produces fewer instructions than describing it as a digit or a zone (D or Z in column 10).

### Data Specifications

The order of writing the lines on the data sheet is unrestricted, unless there are more than three sources of a field. On the data sheet for the Invoice Report, shown in Figure 62, the entries for the data fields are in the order of their appearance on the report. Both storage space and execution time can be saved in this application by re-arranging the order of the specifications so that those having the same field source (columns 20-22) are together. Such re-arrangement can be done even after the specifications cards are punched. Figure 44 shows the re-arranged data specifications for the Invoice Report.

For data fields with multiple sources, storage space and execution time are saved if the consecutive lines or the source-field entries are arranged so that like



Figure 44. Re-arranged Data Specifications for Invoice Report

D	FIELD NAME	FIELD LENGTH UNEDITED	FIELD STATUS						SOURCES OF FIELD																CARD NUMBER																																		
			STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION	A COND.	N COND.	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION	A COND.	N COND.	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION		A COND.	N COND.																																
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	29	30	31	33	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	56	57	58	60	61	63	64	65	67	68	70	71	75	78	80						
D	DATE	0,0,9												C	A	A																																								0,1,0			
D	PAGENO	0,0,1												P	A	G							F	2																																	0,2,0		
D	NUMBER	0,0,5												S	E	R							F	2		C	A	A	0,1,4																												0,3,0		
D	SOLD TO	0,2,0												C	0,1	0,2,6																																								0,4,0			
D	SOLD ST	0,2,0												C	0,1	0,4,6																																									0,5,0		
D	SOCIETY	0,2,0												C	0,1	0,6,6																																									0,6,0		
D	CUST NO	0,0,5												C	0,1	0,0,6																																									0,7,0		
D	SHIP TO	0,2,0												C	0,2	0,2,6																																										0,8,0	
D	SHIP ST	0,2,0												C	0,2	0,4,6																																										0,9,0	
D	SHCLTY	0,2,0												C	0,2	0,6,6																																											1,0,0
D	CARRIE	0,2,0												C	0,3	0,2,6																																										1,1,0	
D	ORDATE	0,0,8												C	0,4	0,1,4																																									1,2,0		
D	ORNUMB	0,1,1												C	0,4	0,2,6																																										1,3,0	
D	SALESM	0,1,1												C	0,4	0,5,0																																										1,4,0	
D	DESCRI	0,3,4												C	0,5	0,5,0							F	1																																		1,5,0	
D	MEASUR	0,0,4												C	0,5	0,5,8							F	1																																			1,6,0
D	PRICE	0,0,6												C	0,5	0,6,4							F	1																																			1,7,0
D	ITEMNO	0,0,8	E	0,7										C	0,5	0,1,4							F	1																																		1,8,0	
D	QUANTITY	0,0,4												C	0,5	0,5,4	A																																								1,9,0		
D	AMOUNT	0,0,6												C	0,5	0,6,9	0,0,5	A																																								2,0,0	

field sources follow one another. In a hypothetical example there are four data fields to be specified. If written in the order of field A, B, C, and D on the data sheet, they might appear as shown in Figure 45.

Re-arranging the line-entries and transposing the field sources of FLDC as shown in Figure 46 would save storage capacity and execution time in the object program.

If a data field has both a status condition and multiple field sources, storage space and execution time are saved by arranging the field sources so that the same sources with the same conditions are together (Figure 47).

D	FIELD NAME	FIELD STATUS										SOURCES OF FIELD																																									
		FIELD LENGTH UNEDITED	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	FIELD SOURCE NUMERIC	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D	FIELD SOURCE NUMERIC	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D																																	
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	29	30	31	33	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	56	57	58	60	61	63	64	65	67	68	70	71			
	FIELD A	0.0	3												C0.1	0.5	9										C0.3	0.7	3																								
	FIELD B	0.0	2												C0.2	0.2	4										C0.2	0.4	8																								
	FIELD C	0.0	4												C0.1	0.5	7										C0.3	0.3	5																								
	FIELD D	0.0	5												C0.1	0.6	4										C0.2	0.1	7																								

Figure 45. Data Specifications for Multiple Field Sources

D	FIELD NAME	FIELD STATUS										SOURCES OF FIELD																																								
		FIELD LENGTH UNEDITED	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	FIELD SOURCE NUMERIC	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D	FIELD SOURCE NUMERIC	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D																																
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	29	30	31	33	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	56	57	58	60	61	63	64	65	67	68	70	71		
	FIELD A	0.0	3												C0.1	0.5	9										C0.3	0.7	3																							
	FIELD C	0.0	4												C0.3	0.3	5										C0.1	0.5	7																							
	FIELD D	0.0	5												C0.1	0.6	4										C0.2	0.1	7																							
	FIELD B	0.0	2												C0.2	0.2	4										C0.2	0.4	8																							

Figure 46. Re-arranged Data Specifications for Multiple Field Sources

D	FIELD NAME	FIELD STATUS										SOURCES OF FIELD																																							
		FIELD LENGTH UNEDITED	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	FIELD SOURCE NUMERIC	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D	FIELD SOURCE NUMERIC	FIELD END	FIELD LENGTH	OPERATION	COND. N	COND. D																															
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	22	23	24	26	27	29	30	31	33	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	56	57	58	60	61	63	64	65	67	68	70	71	
	FIELD E	0.0	9	N	0										C0.2	0.1	5									C0.1	0.0	9																							

Keep together, as shown here.

Figure 47. Data Specifications with Same Field Sources Arranged Together

The *Numeric* entry (N in column 23) should not be used when the user knows that his source field does not contain zone information in positions other than the units position. Using the N-entry unnecessarily, wastes both storage space and execution time.

### Calculation Specifications

When possible, specify detail-time calculations (those with a D in column 49) consecutively, and total-time calculations (T in column 49) consecutively, to save both storage space and execution time. Also, whenever order permits, calculations governed by the same conditions in columns 40-48 should be specified together.

### Format Specifications

Data fields should not be blanked after use unless blanking is essential. Unnecessary use of a B instead of an F in column 1 wastes storage capacity.

If the Next-Line specification in columns 8-10 is applicable, using it will save both execution time and storage space.

## Description of the General Block Diagrams

### Object Program to Process Card Input Files

The following explanation applies to Figure 48, the block diagram of an object program generated by the Card Report Program Generator. The paragraph numbers correspond to the circled numbers in that figure.

1. One read instruction is generated in the entire object program. This instruction (READ1) is followed by an instruction labeled ENTRY1. This is the first point where a user can insert his own subroutine in the symbolic deck before assembly. Peculiar manipulation of data fields, for example, might be more efficiently done at this time by inserting hand-coded instructions. The instructions to combine the portions of a split control field into one field located at storage location 0090, for instance, could be inserted at ENTRY1. This field could then be specified on the input sheet as one field ending in 090.
2. For each non-sequential record (i.e., a record assigned an alphabetic sequence designator, such as CAA on the input specifications sheet), a test routine exists in the object program. The first such routine is labeled DA0100; the second, DA0200; and so on. As many of these routines are generated in a given object program as there are non-sequential records specified for the input file. The function of each routine is to check the record in the input area for the record codes specified in one entry of the input sheet. If the first routine finds that the codes in the input record are different from the codes for which the routine is checking, it branches to the second routine, where a similar test is made using the next set of record codes specified. This testing process continues until either the input record is found to be one of the non-sequential records specified, or it becomes necessary to check for one of the sequential records specified. If a non-sequential record is present, the routine sets a corresponding resulting-condition indicator ON and modifies SWICH4 to branch to the proper routine that removes the data fields from the record (see block 8 in Figure 48). The resulting-condition indicator remains ON until another input record is read. If testing is to begin for a sequential record, the program enters SWICH1.
3. For each sequential record (i.e., a record assigned a numerical sequence-number on the input sheet), a routine exists to which SWICH1 branches. The first portion of the routine is labeled RNxxxx. This sets SWICH1 to branch to the routine for the next record in sequence. This is followed by instructions labeled DNxxxx, which test for the presence in the input record of the record codes specified for this record on the input sheet. If the record is in its proper place in the numbered sequence within its control group, SWICH4 is modified to branch to the routine to remove the fields of data from this type of record. If, however, the input record is not acceptable to the object program at this point, a check is made to determine if there is another record specified in an *or* relationship. For instance, should two C01s be specified, if the routine for the first one did not find the proper record codes, it would branch to check for the second C01 record. If, however, only one C01 record is specified and that record is not present after a control-field change, the program comes to a halt (ERR5EQ). All other errors in sequence come to the same halt to allow the user to insert a common error routine under the label ERR5EQ, if he desires. In the invoice application the second record in the sequence, C02, is an optional record. The routine for this type of record includes a branch to a routine that properly processes optional record-types not present. This operation is described in paragraph 14.
4. When the object program has determined which record is in the input area, it branches to a routine to test for control-field changes between that record and the previous record. The routine that checks for control-field changes in a non-sequential record is labeled TAxxxx. The routine that checks for control-field changes in sequential records is labeled TNxxxx. When the control fields in all non-sequential records are alike, there will be only one such routine for all non-sequential records that are consecutively specified on the input sheet. The same is true for all sequential records.
5. Calculations specified to be performed at total time are routines labeled TCALxx. Total calculations do not contain any information from the record in the input area. This is because total calculations are performed before information is removed from that record. Note that ENTRY2 precedes the total-calculation routine. This permits the user to insert under this label in the symbolic program any calculation routine that he prefers to hand-code rather than to specify on the calculation specifications sheet.
6. Total calculations are followed by the printing or punching of total lines whose conditions are fulfilled. Numerical-level total lines (total lines in a hierarchy) whose routines are labeled T11Txx precede alphabetic-level total lines (total lines not in a hierarchy) whose routines are labeled TTxxxx. Page overflow is tested during the printing of total

Figure 48. Block Diagram Guide to Object Program Generated by Card RPC

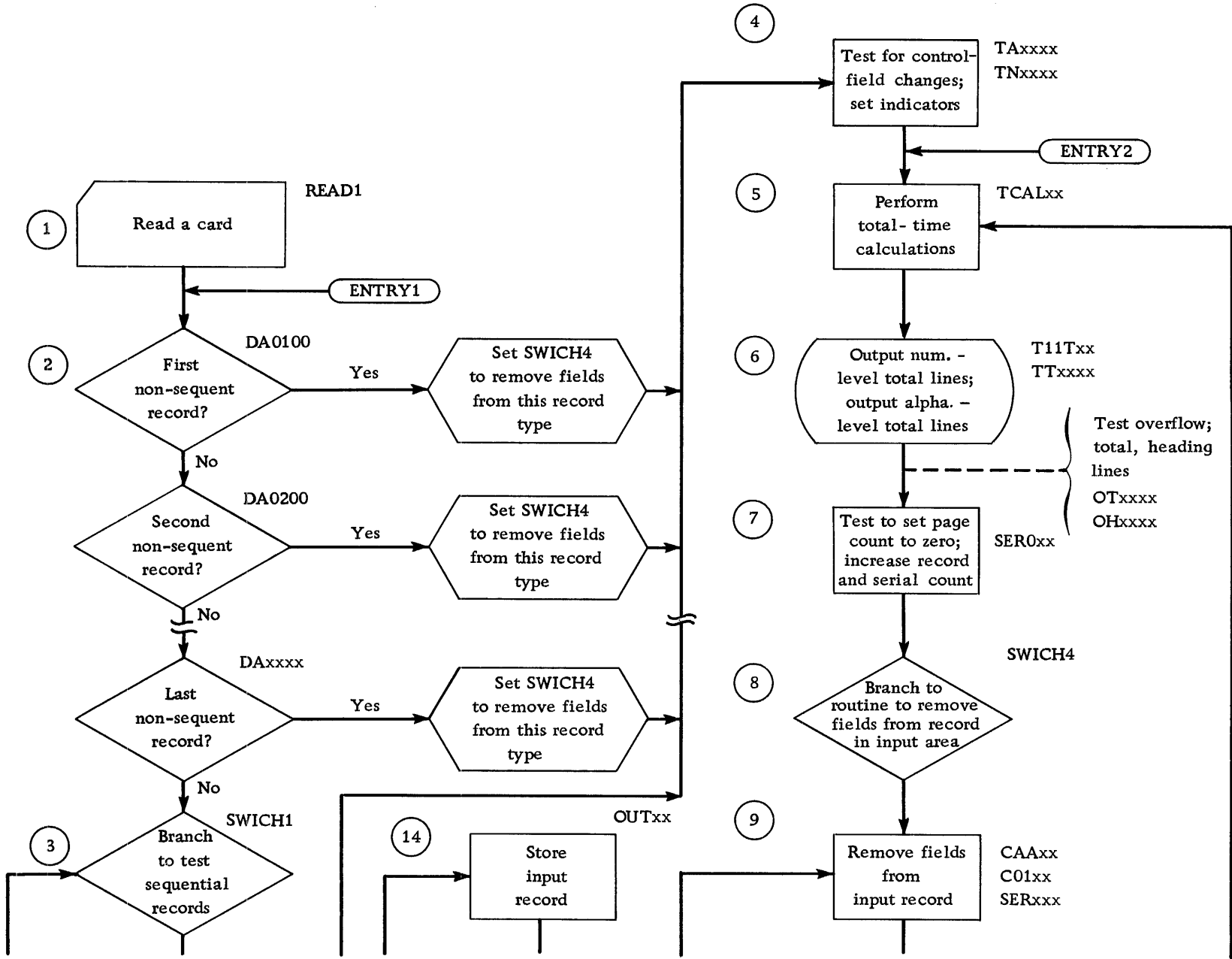
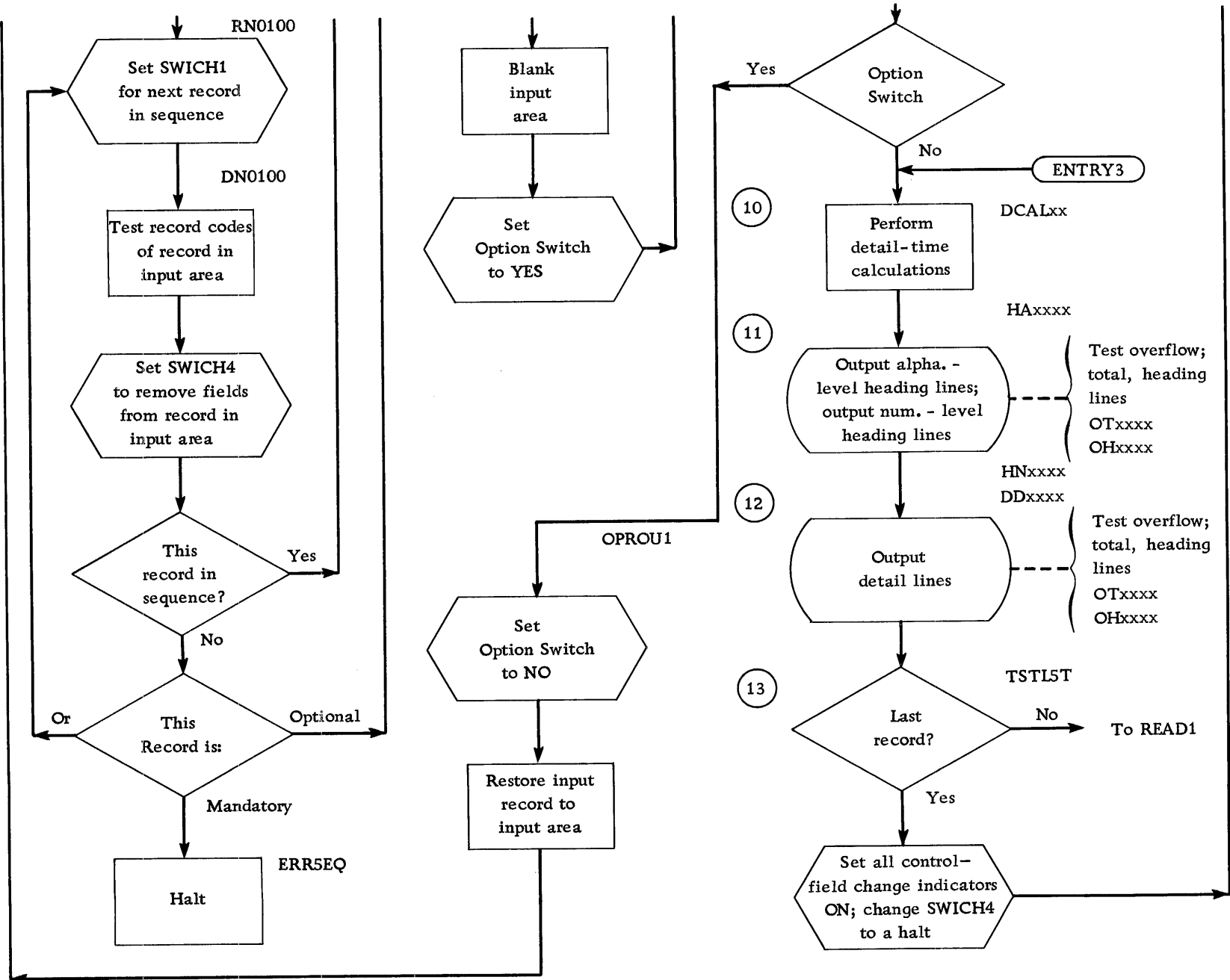


Figure 48. Block Diagram Guide to Object Program Generated by Card RPG (Continued)



- lines. Overflow total lines (labeled OTxxxx) are printed after normal total lines if an overflow condition exists. Note that all normal total lines whose conditions are fulfilled *precede* overflow total lines.
7. If a page number must be reset on the basis of a control-field change, that operation occurs at this time. Furthermore, record counts and serial numbers are increased at this point if the conditions for increasing them are met. Record counts are increased because of the type of record in the input area. Serial numbers are usually increased because of control-field changes.
  8. SWICH4 is a branch instruction, modified in the routines for both the non-sequential and the sequential records, to branch to the proper routine for processing the record in the input area.
  9. For each record specified on the input specifications sheet there exists a routine whose first label might be CAAxx for a non-sequential record and C01xx for a sequential record. Furthermore, there is a routine labeled SERxxx to process page number, record counts, and serial numbers. When a sequential record is optional, its absence in the sequence will cause a branch to the optional routine labeled OPROU1. Otherwise the program will branch to perform detail calculations.
  10. Just as ENTRY2 provides for a calculation subroutine before total calculations, ENTRY3 provides this facility before detail calculations. Detail calculations are routines labeled DCALxx. Calculations that require entry to multiply or divide subroutines have a linkage to these subroutines, which are incorporated when necessary in the generated calculation routine.
  11. Because heading lines sometimes require information from the record in the input area, they are printed or punched at this point in the object program. The routine for alphabetic heading lines (heading lines not in a hierarchy) is labeled HAxxxx. The routine for numerical heading lines (heading lines in a hierarchy) is labeled HNxxxx. When block 11 is compared with block 6, it is apparent that the order in which heading lines are produced as output is the reverse of that for total lines. As previously stated, when the conditions are fulfilled for heading lines not in a hierarchy, those lines are produced before heading lines in a hierarchy whose conditions are fulfilled. Heading lines in a hierarchy appear in descending level-number order, but in ascending line-number order within each level.
  12. Detail lines whose output conditions are met follow heading lines. Both heading and detail line-output routines include tests for overflow. The overflow-heading-lines routine is labeled OHxxxx.
  13. The test for last-card condition is labeled TSTL5T in the symbolic program. When the result of this test is YES, the object program sets all control-field-change indicators ON, modifies SWICH4 to a halt and branch to READ1. The program branches to perform total calculations, prints or punches total lines, including total lines containing LC output conditions, and halts at SWICH4. When the result of the test for last card is NO, the program branches back to READ1.
  14. For each type of sequential record that is specified as optional (e.g., record C02 for the invoice application), there is an optional routine labeled OUTxx. If, upon checking for the presence of an optional record the object program does not find it, the program branches to OUTxx. This routine stores the record contained in the input area, blanks the input area, and sets the option switch below block 9 to YES. Then the object program branches to block 9, which removes the fields from the optional record-type in the input area just as if it were present. The fields thus removed consist of blanks. In the invoice application the optional routine causes the *Shipped To* information from the previous invoice to be set to blanks in storage when the present invoice has no *Shipped To* information (when record C02 is missing). This operation prevents the printing of the previous customer's *Shipped To* information in the heading of an invoice that has no such information of its own. After removing the blank fields, the object program branches on the YES setting of the option switch to restore to the input area the record saved (record C03) in the optional routine, OUTxx. After setting the option switch to NO, the object program branches back to SWICH1 to test for the record that should be next in the sequence. The next record in the sequence of the invoice application is C03, which should be the record present in the input area.

### **Object Program to Process Tape Input Files**

The following explanation applies to Figure 49, the block diagram of an object program generated by the Tape Report Program Generator. The paragraph numbers correspond to the circled numbers in that figure.

#### **1. For Blocked Input Tape Records:**

The routine to get the next record, labeled NX7-REC, causes either a tape read instruction (READ1) to be executed or the next sequential record in the block to be positioned for processing, depending upon where the next record is located. After each tape read instruction, the test for end-of-file is made. When the last record has been processed, the program branches to the end-of-file routine, described in paragraph 13.

1. For Unblocked Input Tape Records:  
The instruction labeled NX7REC is the tape read instruction (there is no instruction labeled READ1). The end-of-file test is made. If the last record has been processed, the object program branches to the end-of-file routine, described in paragraph 13. If the last record has not been processed, the object program proceeds to block 2. The function, *Position Next Record for Processing*, does not exist for an object program to process unblocked tape records.
- 2-12. Program operation is the same as in Figure 48, except that after block 12 in Figure 49 the object program returns to block 1.
13. After processing the last record of a given file, the object program enters the end-of-file routine (EOF). The program determines whether all input files have been processed. If not, the object program halts to permit the user to mount the next reel if the files are contained on more than one reel. At this point the user can bypass the next file by first setting sense switch E ON and then pressing the 1401 start key. If he wants to process the next file, he leaves sense switch E OFF and presses the 1401 start key. The program branches to NX7REC to resume processing. However, if all files have been processed, the object program sets all control-field-change indicators ON, modifies SWICH4 to a halt, and branches to block 5 to perform total-time calculations (TCAL<sub>xx</sub>).

Figure 49. Block Diagram Guide to Object Program Generated by Tape RPG

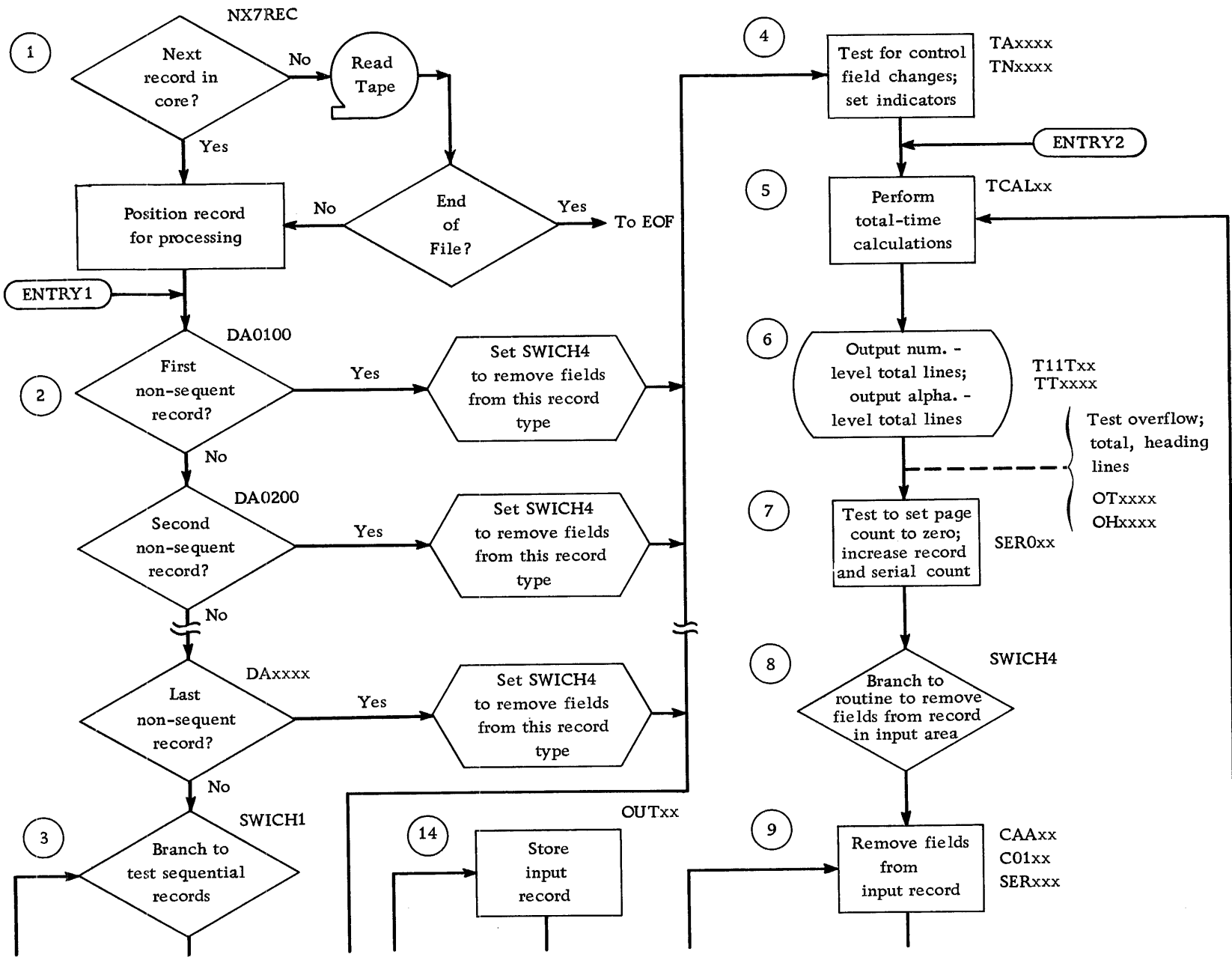
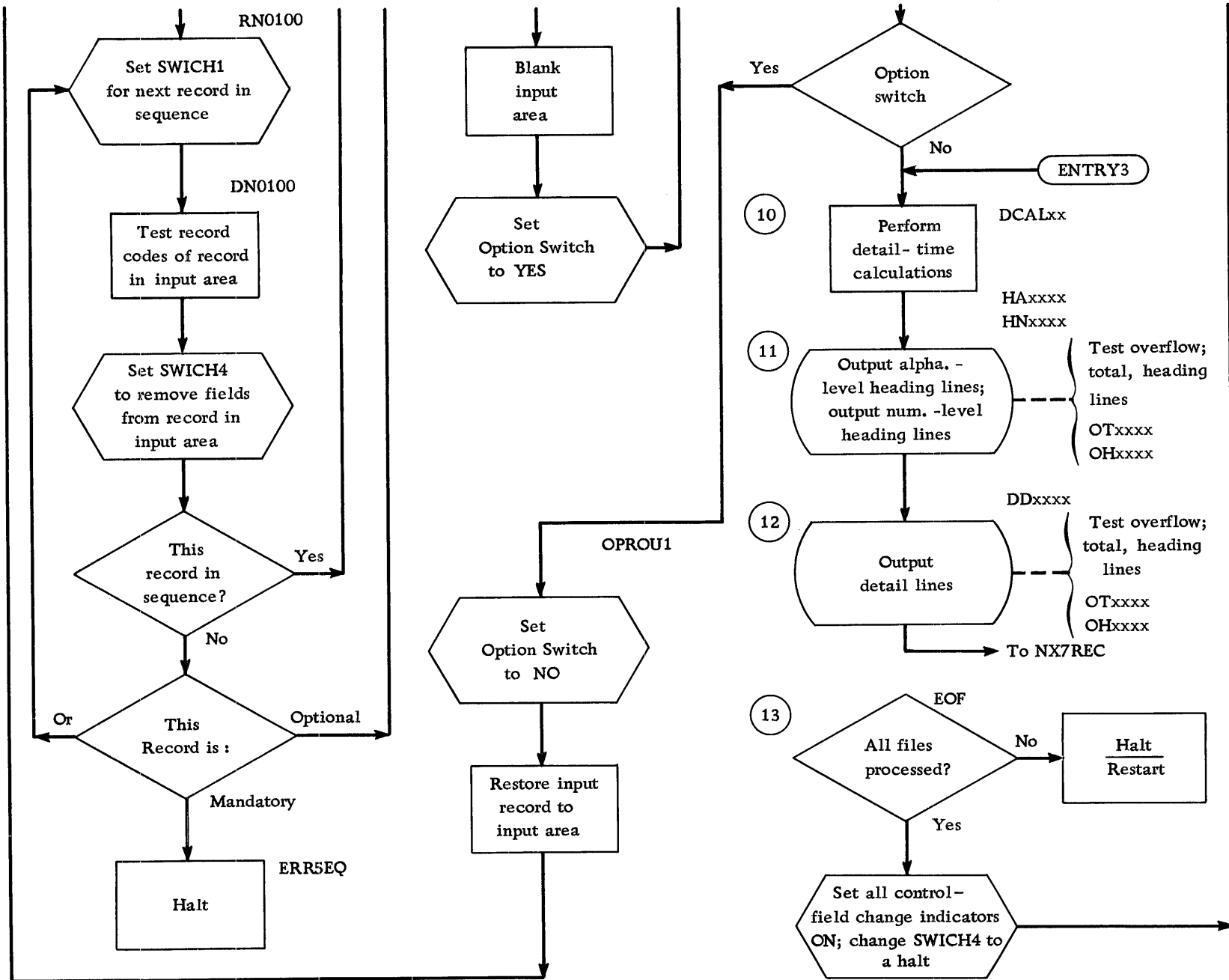




Figure 49. Block Diagram Guide to Object Program Generated by Tape RPG (Continued)



## Inserting Subroutines in Object Program

After the generation of the object program in the language of the IBM 1401 Symbolic Programming System, subroutines written in SPS can be inserted in the object deck before assembly begins. The three insertion points for subroutines are ENTRY1, ENTRY2, and ENTRY3, as indicated in Figures 48 and 49. These entry points appear in the symbolic object program in the form shown in Figure 50.

LABEL	OPERATION	(A) OPERAND			
		ADDRESS	±	CHAR. ADJ.	
8	13 14	16 17	21	23	
ENTRY 1	M	C.O.N.F.1			
ENTRY 2	B	T.C.A.L.O.O			
ENTRY 3	B	D.C.A.L.O.O			

Figure 50. Entry Points in Symbolic Form

To insert a subroutine at ENTRY1, the user must change the instruction into two instructions. ENTRY1 should be a branch to the beginning of the subroutine. The instruction to clear a word mark in CONF1 should follow ENTRY1. If the first instruction to be executed in the subroutine had the label SUBROU, the instructions at ENTRY1 would be as shown in Figure 51.

LABEL	OPERATION	(A) OPERAND			
		ADDRESS	±	CHAR. ADJ.	
8	13 14	16 17	21	23	
ENTRY 1	B	S.U.B.R.O.U			
	M	C.O.N.F.1			

Figure 51. Modifying ENTRY1 Instruction

The instruction that exits from the subroutine branches to ENTRY1 + 004. This allows a return to the main line of the program. The subroutine, punched in cards, should be placed immediately in front of the END card in the symbolic object-program deck before assembly (phase three).

A subroutine inserted in the program at ENTRY2 requires simply that the instruction labeled ENTRY2 be changed to branch to the beginning of the subroutine. The exit from the subroutine should be a branch to TCAL00. ENTRY3 requires a similar change with a branch to DCAL00 as the exit from the subroutine.

ENTRY1 allows manipulation of data fields immediately after a record is read. Split control fields can readily be combined at this point. ENTRY2 and ENTRY3 allow for complicated calculations such as square-root functions or a table-searching operation. It is not necessary to provide multiply or divide subroutines; the RPG provides either or both in programs that require them.

### Subroutine Labels

Use caution in assigning labels in subroutines. The labels must be *strictly alphabetic*. Do not duplicate any of the field names assigned on the data and calculation specifications sheets. Because all labels produced by the RPG processor are field names from those sheets or are numerical in at least one position, processing errors can be avoided if this principle is followed.

## Suppressing Total Lines and Calculations

Analysis of the block diagrams (see Figures 48 and 49) shows that total calculations, total lines, and heading lines conditioned by control-field changes will be processed whenever a record causes those changes. Ordinarily such processing results in proper operation, but there are instances when control-field changes alone are not sufficient to govern calculations and line output. For example, at the beginning of a run a record whose control fields are compared with blanks causes changes in control. Although it is usually proper to process heading lines at the beginning of a run, it is not desirable to have total lines produced as output. Further, it may not be desirable to perform total calculations on blank fields. Thus, it is necessary to doubly-condition total-line output and calculations that must not be performed due to a control-field change on the run-in.

The suggested way to suppress these total operations is to govern their performance by the condition that a field is not blank as well as a control-field change. If a blank status is specified for a field that will contain valid information only after the first record has been processed, total operations can be suppressed on the run-in when that field is blank.

Any object program produced by the RPG begins processing by checking the heading lines (block 11 in the diagrams) to determine whether any of them should become output on the condition 1P. The program then continues through the last-record test (block 13) to the instruction that reads a record. This first record causes control-field changes for all the fields specified on the input sheet for this particular record. If the first record is a date header it may not have any control fields, and so no control-field changes can occur. This is true in both the Monthly Expense Distribution Report and the Invoice Report illustrated in this bulletin.

In the Monthly Expense Distribution Report the second record in the input file is an item record having three control fields. All three fields change when that record is compared with blank control fields preceding it in processing. Thus, all total calculations, total lines, and heading lines that are conditioned by only control-field changes will be processed. In the case of heading lines this is proper processing, but no total calculations or total lines are desirable at this point.

Because no fields have been removed from the first item record when total operations occur, the blank status of a field whose source in the data specifications is that record can condition these operations. DEPNUM is blank before the processing of the first item record, and it is a significant field throughout the remainder of the run. Therefore the blank status of this field (condition 03) is used to prevent total lines from printing at the beginning of the run. All total lines are conditioned by their respective field changes and N03 (DEPNUM not blank).

In the invoice application the problem of total suppression is more extensive. The date header at the beginning of the run has no control fields. The second record in the input file is the SOLD TO header, which has only field 2 specified as a control field. Comparison of field 2 in that record with the blank field preceding it in processing produces a control change in field 2 (and incidentally, in field 1). If the total lines on the invoice were conditioned only by control-field changes, those lines would be printed before the heading lines of the first invoice. The total lines are, however, also conditioned by the blank status of the field ITEMNO (condition 07), so that the lines can be printed only when that field is not blank (N07). Because this field is blank until the first item record is processed, no total lines can be printed at the beginning of the run.

Suppressing totals at the beginning of an invoicing run is only part of the problem. For each invoice there is a change in control field 1 whenever an item record appears with a new item number. Between item-number groups this change causes the total line for the last group to print. A problem in total suppression occurs, however, when the first item record of an invoice causes a change in control field 1. If T11 were conditioned only by the field change, a T11 line would appear when the first item record was checked for control changes. To prevent this unacceptable operation, the T11 line is also conditioned by N07 (ITEMNO not blank) and ITEMNO is blanked in the format specifications to ensure that it will be blank at the beginning of a new invoice. ITEMNO is blank, therefore, until after data fields are removed from the first item record of an invoice. These fields are removed (block 9 of the diagrams) after the comparing for control-field changes (block 4) and the processing of total lines (block 6).

---

## Sample Report Documentation

Figures 52 through 59 show the specifications for the Monthly Expense Distribution Report. A few cards of the input file are shown in Figure 3, and the printed

report is shown in Figure 4.

Figures 60 through 65 show the specifications for the Invoice Report. A few cards of the input file are shown in Figure 10, and the report is shown in Figure 9.

Figure 52. Spacing Chart for Monthly Expense Distribution Report



INTERNATIONAL BUSINESS MACHINES CORPORATION  
**IBM 1403 SPACING CHART**  
 6 Lines per inch

LINE DESCRIPTION	FIELD HEADINGS/WORD MARKS													
GLUE	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														
34														
35														
36														
37														
38														
39														
40														
41														
42														
43														
44														
45														
46														
47														
48														
49														
50														
51														

DUAL-SPEED CARRIAGE		
Punch only one channel per line. Holes in the same channel should be punched at least 8 lines apart.		
MEASUREMENTS Horizontal spacing 1/10" Vertical spacing 1/6"	FORM WIDTHS Min. 3 1/2" Max. 18 3/4"	COMMONLY USED FORM DEPTHS 3 1/2", 3 3/4", 3 7/8", 5 1/2", 6" 7", 7 1/2", 8 1/2", 11"
NOTE: This chart is subject to inaccuracies from variations in humidity. Dimensions of form should be calculated from measurements shown and not scaled from this chart.		

FOLD TO HERE





Figure 55. Calculation Specifications for Monthly Expense Distribution Report



# 1401 REPORT PROGRAM GENERATOR

## CALCULATION SPECIFICATIONS

FORM X24-1338  
PRINTED IN U.S.A.

Report Monthly Expense Distribution Report

Page 04 of 08

Programmed by \_\_\_\_\_

Date \_\_\_\_\_

A	FIELD NAME	FIELD LENGTH UNEDITED	FIELD STATUS			FACTOR 1			O P	FACTOR 2			A	COND. N	COND. D	COND. N	COND. D	TOTAL ADJUST	HALF ADJUST	POSITION ADJUST	CARD NUMBER																	
			STATUS	RESOLVING CONDITION	STATUS	RESOLVING CONDITION	STATUS	RESOLVING CONDITION		MULTIPLICAND DIVIDEND AUGEND, OR MINUEND	FIELD LENGTH UNEDITED	+									x	/	-	COND. N	COND. D	COND. N	COND. D	75	78	80								
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	25	26	28	29	30	35	36	38	39	40	42	43	45	46	48	49	50	51	52	53	54	75	78	80
A	AMTACT	0,0,9																																			0,1,0	
A	AMTDEF	0,1,0																																			0,2,0	
A	FINAMT	0,1,1																																		0,3,0		
																																				0,4,0		
																																				0,5,0		
																																				0,6,0		
																																				0,7,0		
																																				0,8,0		
																																				0,9,0		
																																				1,0,0		
																																				1,1,0		
																																				1,2,0		
																																				1,3,0		
																																				1,4,0		
																																				1,5,0		
																																				1,6,0		
																																				1,7,0		
																																				1,8,0		
																																				1,9,0		
																																				2,0,0		









# 1401 REPORT PROGRAM GENERATOR

Report Monthly Expense Distribution Report  
Programmed by \_\_\_\_\_

## FORMAT SPECIFICATIONS

Page 08 of 08  
Date \_\_\_\_\_

FORM TYPE	LINE OUTPUT				NEXT LINE				SPACE				SKIP				LINE OUTPUT CONDITIONS				FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS				ZERO SUPPRESS	CONSTANT OR EDIT CONTROL WORD				CARD NUMBER															
	TYPE	LEVEL	NUMBER	PRINT	NUMBER	PRINT	NUMBER	RESERVED	TYPE	LEVEL	NUMBER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	STAGGER	COND.	A			COND.	A	COND.	COND.		COND.	A	COND.	A		COND.	COND.	COND.	FIELD LENGTH											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	25	26	28	29	34	35	37	38	40	41	43	44	46	47	48	50	51	75	78	80						
W																																			007											0,1,0	
W																																														0,2,0	
W																																															0,3,0
W																																															0,4,0
W																																															0,5,0
																																															0,6,0
																																															0,7,0
																																															0,8,0
																																															0,9,0
																																															1,0,0
																																															1,1,0
																																															1,2,0
																																															1,3,0
																																															1,4,0
																																															1,5,0
																																															1,6,0
																																															1,7,0
																																															1,8,0
																																															1,9,0
																																															2,0,0

Figure 59. Format Specifications for Monthly Expense Distribution Report









# 1401 REPORT PROGRAM GENERATOR

## CALCULATION SPECIFICATIONS

FORM X24-1338  
PRINTED IN U.S.A

Report Invoice Example  
 Programmed by \_\_\_\_\_

Page 04 of 06  
76 77  
 Date \_\_\_\_\_

Figure 63. Calculation Specifications for Invoice Report

A	FIELD NAME	FIELD LENGTH UNEDITED	FIELD STATUS			FACTOR 1			OPERATOR	FACTOR 2			A S +	COND. N	COND. N	COND. N	HALF ADJUST	POSITION ADJUST	CARD NUMBER																				
			STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION		MULTIPLICAND DIVIDEND AUGEND. OR MINUEND	FIELD LENGTH UNEDITED	MULTIPLIER DIVISOR ADDEND. OR SUBTRAHEND								FIELD LENGTH UNEDITED	COND. N	COND. N	COND. N																
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	25	26	28	29	30	35	36	38	39	40	42	43	45	46	48	49	50	51	52	53	54	75	78	80	
	ATOTAMT	0.07																																					
	ADISCNT	0.07																																					
	ANETAMT	0.07	Z	0.8																																			
	AFINAL	0.11																																					







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