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Systems Reference Library

Report Program Generator (on Disk) Specifications IBM 1401, 1440, and 1460

This reference publication contains specifications for IBM 1401/1460 Report Program Generator (on Disk) and IBM 1440 Report Program Generator (on Disk). The publication explains the writing of report specifications and the preparation of control cards, to produce object programs.

Examples and sample programs illustrate the applications of the Report Program Generator language.

For a list of related publications and abstracts, see the IBM bibliography for the associated data processing system.

Major Revision - September, 1964

This publication, C24-3261, consolidates and obsoletes Report Program Generator for IBM 1401/1311, Preliminary Specifications, Form C24-1487-1, and Report Program Generator For The IBM 1440; Preliminary Specifications, Form C24-3001-1. Technical Newsletters N24-0099, N24-0159, N24-0055, N24-0100, N24-0110, and N24-0158 are also obsoleted.

Extensive changes and additions have been made throughout. Included in this publication is a description of Alphabetic Classification of Lines, RPG Control Cards, and specifications for IBM 1301 Disk Storage with RPG programs. The description of processing-order records has been expanded.

Copies of this and other IBM publications can be obtained through IBM Branch Offices.
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PREFACE

Speed in preparing reports is achieved by rapid processing of input data and also by rapid preparation of programs to produce reports. The Report Program Generator (RPG) provides easier and faster preparation of programs.

Instead of writing a particular program for a report, the user states his problem and its solution, which are the report specifications, in RPG language. RPG processes the report specifications and generates a program to write the reports. By relieving the user of most of the machine coding and program testing, RPG permits him to concentrate his efforts on the best solution to the problem. Thus, RPG is essentially problem-oriented rather than machine-oriented.

The programs produced by RPG write reports in varying formats. Source (input) data for programs produced by RPG may be contained in card, magnetic-tape, or disk-storage files. Output from programs produced by RPG is prepared in any combination of three forms:

- Printed report
- Punched cards
- Magnetic disk records or magnetic tape records (but not both)

The reports produced by programs generated by RPG can range from a simple listing of items from the input file to complex reports that incorporate editing and calculations upon the input data. RPG includes such capabilities as printing various kinds of lines (heading lines, detail lines, total lines controlled by control-field changes, and offset total lines), serial and page numbering, crossfooting, and summary punching. Along with the report, exception records can be produced.

MACHINE REQUIREMENTS

Figure 1 shows the minimum machine requirements necessary to generate an RPG object program. Figure 2 shows the minimum machine requirements necessary to execute an RPG object program. The system configuration required to execute an RPG object program depends on the object program. Each system must have a card read-punch. The minimum requirements for card, tape, and disk RPG programs are listed in Figure 2. Additional features that an RPG program can use, if they are installed on the object machine, are also listed in Figure 2. The amount of core storage required to execute an RPG object program depends on the complexity of the report.

INTRODUCTION

RPG produces programs that write reports of variable format from card, magnetic tape, or magnetic disk input files. Instead of writing a specific program for each report, the user writes a set of specifications and the necessary control cards, which he supplies to RPG (Figure 3). At this point, the user's choice determines which form of the program is produced. He has three options for the form of generated output:

1. the object program in machine language punched in cards,
2. the object program in machine language stored in disk storage, or

3. the report program in symbolic (Autocoder) language punched into cards.

In each of the three options, RPG produces an edit listing along with the program. The edit listing is a printed record of the source deck, as well as an analysis of the specifications and control cards. Certain kinds of errors, for example, unacceptable entries in the report specifications, will produce error messages.

If the user selects the first option, the RPG and Autocoder processors generate a machine-language object program. The object program is punched into cards, and an Autocoder program listing is produced.

The second option for the form of generated output permits load-and-go RPG operation. Under the load-and-go option, RPG prints the edit listing and generates the report program in Autocoder language. Autocoder assembles the report program, producing the object program in machine language, and stores it on the system pack in an Autocoder disk area. When it completes assembly, Autocoder prints an appropriate message and halts. (The user can begin loading and executing his object program by pressing the start key.)

Under the third option, RPG produces a symbolic language (Autocoder) source deck and an edit listing. The user can modify this source deck by adding additional Autocoder instructions. The symbolic program must be further processed by Autocoder to produce the object program in machine language.

Having chosen one of the three options, the user can proceed with the next step, which is the last

System	Disk	Core Storage	Card Reader-Punch	Printer	Special Features
IBM 1401	One IBM 1311	4K	One IBM 1402 Card Read-Punch	One IBM 1403 or One IBM 1404	High-Low-Equal Compare
IBM 1440	One IBM 1301 or One IBM 1311	4K	One IBM 1442 Card Read-Punch, Model 1 or Model 2 or One IBM 1442 Card Reader, Model 4 and One IBM 1444 Card Punch, Model 1	One IBM 1443	None
IBM 1460	One IBM 1301 or One IBM 1311	8K	One IBM 1402 Card Read-Punch	One IBM 1403 or One IBM 1404	None

Figure 1. Minimum Machine Requirements to Generate an RPG Object Program

System	Card Reader-Punch (Required)	For Disk Input/Output	For Printed Output	For Tape Input	For Tape Output	Required Special Feature	Additional Features RPG can use if they are installed on the object machine.
IBM 1401*	One IBM 1402 Card Read-Punch	One IBM 1311 (Disk output can use the same drive used for disk input, or it can use another drive.)	One IBM 1403 or One IBM 1404	One IBM 729 Magnetic Tape Unit or One IBM 7330 Magnetic Tape Unit	One IBM 729 Magnetic Tape Unit or One IBM 7330 Magnetic Tape Unit	Blocked tape input records or blocked disk or tape output records require the Advanced Programming special feature.	One to Four additional IBM 1311 Disk storage drives. Advanced Programming special feature. Multiply-divide special feature. Modify Address. Direct Seek special feature. Sense Switches.
IBM 1440*	One IBM 1442 Card Read-Punch, Model 1 or 2; or One IBM 1442 Card Reader, Model 4, and One IBM 1444 Card Punch, Model 1.	One IBM 1301+ or One IBM 1311+	One IBM 1443	One IBM 7335 Magnetic Tape Unit Model 1 (For tape input only) (For both tape input and output: One IBM 7335, Model 2.)	One IBM 7335 Magnetic Tape Unit Model 1 (For tape output only)	None	One to Four additional IBM 1311 Disk Storage Drives or One to Four additional Modules of IBM 1301 Disk Storage. One additional IBM 1442 Card Read-Punch, Model 1 or 2. Indexing and Store Address Register special feature. Multiply-divide special feature. Direct Seek special feature (IBM 1311). Selective Stacker special feature on IBM 1442, Model 1. (This feature is standard on models 2 and 4.) Modify Address. Sense Switches.
IBM 1460*	One IBM 1402 Card Read-Punch	One IBM 1301+ or One IBM 1311+	One IBM 1403 or One IBM 1404	One IBM 729 Magnetic Tape Unit or One IBM 7330 Magnetic Tape Unit	One IBM 729 Magnetic Tape Unit or One IBM 7330 Magnetic Tape Unit	Blocked tape input or blocked disk or tape output records require the Indexing and Store Address Register special feature.	One to Four additional IBM 1311 Disk Storage Drives, or One to Four additional modules of IBM 1301 Disk Storage. Indexing and Store Address Register special feature. Multiply-divide special feature. Direct Seek special feature (IBM 1311). Sense Switches.

* The amount of core storage depends on the complexity of the report.

+ Disk output can use the same 1311 drive or 1301 module used for disk input, or it can use another drive or module. The disk input data file can use either a 1311 drive or a 1301 module, but it must not use both. The same is true for disk output. It is permissible, for example, for the disk input data file to use a 1301 module, and a disk output to use a 1311 drive.

Figure 2. Minimum Machine Requirements for Executing an RPG Object Program

one. He loads his object program into the system, supplies his processing-order file, if one is required, and supplies his input file. See Processing Order of Disk Input Records for information about the processing-order file. The input file can be a card file, a magnetic tape file, or a disk file. The output from the object program can be any combination of these: a printed report, punched cards, and either disk records or tape records.

RPG Translator

IBM provides the RPG Translator program for present users of 1401 RPG (program number 1401-RG-048) who will have IBM 1401's equipped with IBM 1311's. The function of this program is to translate programs written for 1401 RPG to corresponding programs acceptable to 1401-1311 RPG. A description of this translator program may be found under RPG Translator Program in this publication.

INPUT FILES

Programs generated by RPG can process input data contained in card, disk, or magnetic tape files. However, any one program can process input from

only one source. That is, either card or disk or tape may contain the input file, but it must not be in more than one of these.

Card Files

A card file consists of all the cards in the deck. The order in which records are processed is determined by the card order. Processing the last card indicates the end of the file.

Disk Files

When the input is from disk storage, the user can process any number of records in any order. Furthermore, a disk file need not consist of consecutively stored records. Thus, the processing order of disk records is not restricted by record-storage order. Because of the random-access ability of disk storage, the user must specify the processing order of his disk records. RPG provides for three methods to specify the processing order. Each method (or mode) defines a different way of selecting the sequence of the desired records in the disk file. The three modes are explained under Processing Order of Disk Input Records.

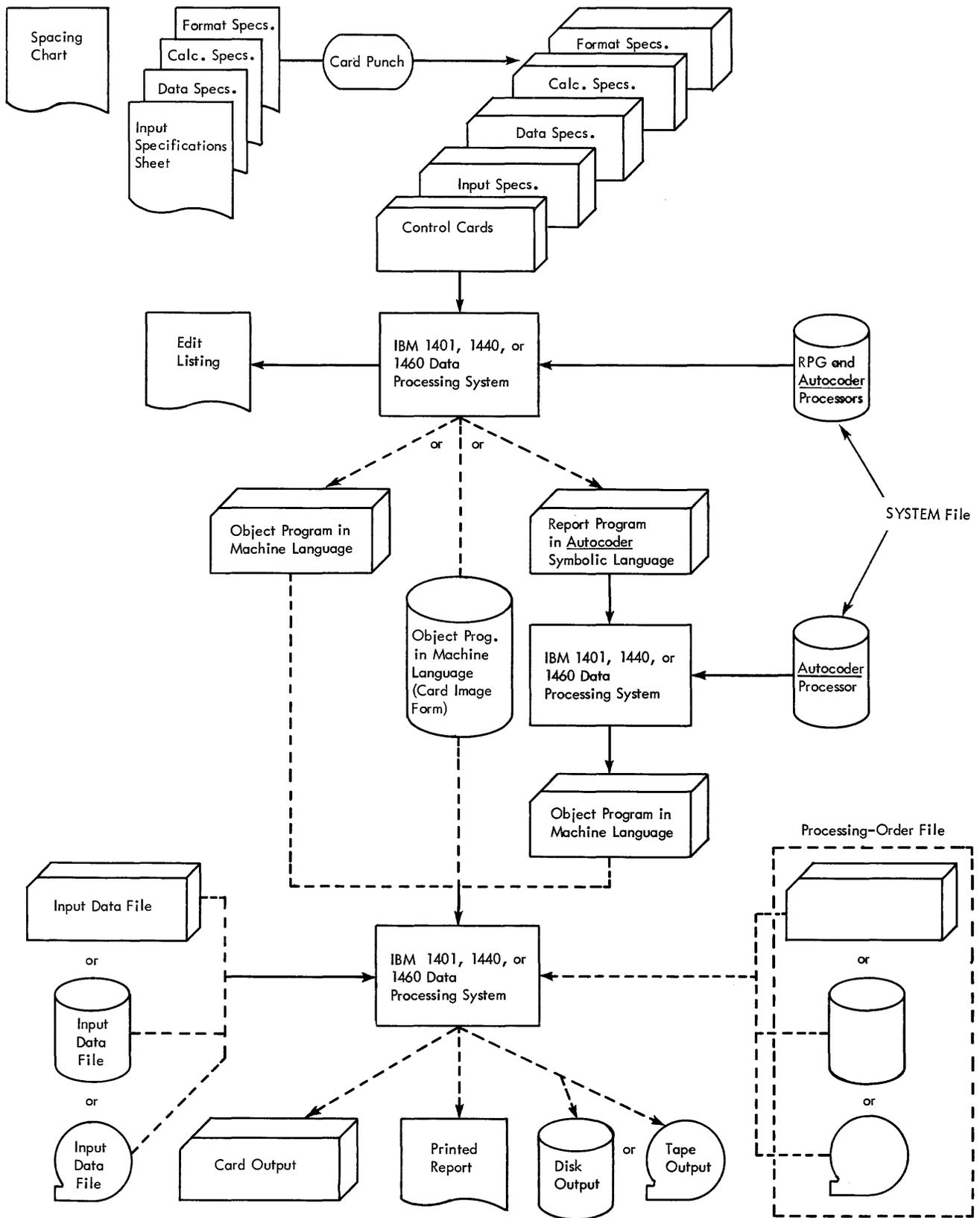


Figure 3. Producing Reports Using the Report Program Generator

RPG provides for several types of automatic header-label checking of disk files that have IBM standard header labels. Details are given in MAS Card under Control Cards.

With disk input, at least one card always follows the program deck. This card defines the processing order (or limits) of the disk data. This is true even with processing order records stored on the disk file. (The limits of the processing order records must be defined.) Processing the last such card indicates the end of the disk input file.

Organization

Programs produced by RPG can process files organized as explained in Disk File Organization Routines Specifications: IBM 1401, 1440, 1460 (1311 and 1301), Form C24-3185, Systems Reference Library File No. Gen1-34. Record formats applicable to the file-organization routines, described in that publication, apply for applications using RPG. In general, RPG provides for processing these disk-record arrangements:

- Fixed-length, without trailers
 - Blocked
 - Unblocked
- Masters and trailers, variable length (a variable number of trailers per master)
 - Unblocked masters, unblocked trailers
 - Unblocked masters, blocked trailers
 - Blocked masters, unblocked trailers
 - Blocked masters, blocked trailers
- Maximum record length is 1,000 characters of data. (The maximum combined length of a master and its trailers is 1,000 characters.)

- For blocked records, the maximum block length is 9,900 characters. (Master records and trailer records can each have a maximum of 9,900 characters.)
- For blocked records, the maximum blocking factor is 99 records per block. (The maximum blocking factor for trailer records is ten records per block. For master records, the maximum is 99.)

Tape Files

Programs generated by RPG can process magnetic-tape input files that have these characteristics:

- Maximum record length is 1,000 characters of data.
- Records are either fixed-length, unblocked; or fixed-length, blocked.
- For blocked records, the maximum blocking factor is 99 records per block.
- For blocked records, the maximum block length is 9,999 characters.
- For blocked records, the last character in each record must be a record mark (A82).
- Padding character can be any one of the 64 valid characters except these:

<u>Graphics</u>	<u>Character Name</u>	<u>BCD Code</u>
*	Asterisk	B84
␣	Substitute Blank	A
≡	Group Mark	BA8421
‡	Record Mark	A82
√	Tape Mark	8421
∨	Word Separator	A841

RPG provides for several types of automatic header-label checking of tape files that have IBM standard header labels. For details, see TAPIN Card under Control Cards.

GENERAL DESCRIPTION

To generate an object program, 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?
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 Figure 3, four forms are required for writing the report specifications. The forms contain answers to the preceding questions. The information is punched into cards with one card punched for each line. These cards comprise the specifications source deck for the RPG program.

Before the actual report specifications can be written, the user must have a clear image of what he wants as the final product. If he desires a printed report, 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 either the IBM 1403 Printer Spacing Chart, Form X24-6436, or the IBM 1443 Printer Spacing Chart, Form X24-6596, before writing specifications.

The user must also plan the format for other types of output (card, tape, or disk). Then he can make appropriate entries on the Format Specifications Sheet.

Preparing the appropriate 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 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.

Printer Spacing Chart

The user's image of the report is projected on either the IBM 407, 408, 409, 1403, and 1404 Printer Spacing Chart, Form X24-6436; or IBM

1443 Printer Spacing Chart, Form X24-6596. He must define the position of each field on each line of the report and include constant information, headings, and editing symbols, where applicable.

Input Specifications, Form X24-6590

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

Data Specifications, Form X24-6591

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.

Calculation Specifications, Form X24-6592

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 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.

Format Specifications, Form X24-6593

The final step in writing report specifications is describing the format of output lines. Each line is named by its type and relation to other lines. The medium of output (printing, punching, writing on disks or magnetic tape) is specified 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, the user lists 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.

CORRELATING THE REPORT SPECIFICATIONS

When completed, the five forms are an interrelated statement of the problems specified as shown in Figure 4. 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. The spacing chart represents the output lines described in the format specifications sheet. The same line names are used on both forms.

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 determine the conditions for processing data which is extracted from the input file.

The names assigned to various input records on the input specifications sheet are also used as field sources on the data specifications sheet. These field sources indicate the record from which a data field is taken during report writing.

Each input record is assigned a unique two-digit number (from 01 to 99) called a resulting condition number. As the report is processed, the resulting condition is fulfilled when a record is present in the input area which has the record codes specified for that resulting condition. The fulfillment of such a condition can govern the processing of a source field in the data specifications, performance of calculation specifications, or the output of a 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. This switch will be turned off when the record has been processed. The change of a control field specified for input records can also govern the processing of source fields, the performance of a calculation, the printing of lines, and the punching of cards.

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. 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. 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 specifications sheet. A condition for a line (representing the presence of a new record in the input area, for example) can govern the printing, punching, or writing on disks or tape for that line.

This summarizes briefly the elements that enter into report specifications. In the sections that follow, each of the rules and conventions governing report specifications is presented. Sample applications are used to illustrate pertinent parts of the description.

Six sample programs and their accompanying control cards are shown in Sample Program Documentation.

PRINTER SPACING CHART

The purposes of laying out the report on the spacing chart are:

1. to establish the positions at which the various data will be printed, as well as to indicate the spacing between printed lines, and
2. to assign each line a unique identification code.

Layout of Lines and Fields

The numbers across the top and bottom of the spacing chart represent the IBM 1403, 1404, or 1443 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 5) 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 by 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.

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. Heading and detail lines can contain information from the record in the input area at the time when lines are produced; total lines cannot.

Classification of Lines

Two methods of classifying lines may be used. Because it does not require a consideration of established order or rank, alphabetic level classification is a quick and efficient method of assigning an identification code to each line. See Numeric Level Classification for a detailed explanation of the hierarchical relationship between line-levels. However, all examples in Format Specifications and in the illustrations will be given as alphabetic classification.

Alphabetic Level Classification

Assign letters to heading lines, detail lines, and total lines as shown in Figure 5. The first heading line in Figure 5 is assigned HAA. The second heading line is assigned HBB; the third, HCC, etc. The first detail line is assigned DAA. The first total line is assigned TAA. The second total line is assigned TBB; the third, TCC, etc. For convenience, these lines are assigned pairs of letters, but if printing occurs on a large number of lines, the lines may be classified as HAA, HAB, HAC, etc.

INPUT SPECIFICATIONS

This form (Figure 6) 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 (that is, 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, D, or T for every line-entry that specifies a card, disk, or tape-record type. For a given program, all input records must be the same type.

Columns 2-3 specify two numeric 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 numeric 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 7 is prepared from the file of cards shown in Figure 8. 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 (Figure 9).

For proper invoice preparation, the other input data cards must be arranged within customer number in the sequence shown in Figure 8. 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 group in the input data file. If there is only one record of a type per group, enter a 1 in column 4. If there is more than one record of a type, enter an N in column 4.

Except for detail cards, there is only one card of each type in the control group in the invoice example. Therefore, for the Invoice To card a 1 is entered on the sheet in column 4. For the detail card an N is specified. Column 4 can be left blank for non-sequential records.

Column 5 must contain the letter X if the presence of a sequential record in the input data file is optional. If a record type is required for proper processing, leave column 5 blank. In Figure 7, the Shipped To entry is optional because that record appears only if the customer to whom the invoice is

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 26115	PAGE 1 JUL 25, 64 29045	
SHIPPED VIA WESTERN TRUCKERS		PLEASE REFER TO OUR INVOICE NUMBER WHEN REMITTING TERMS 2% TEN DAYS F. O. B. FACTORY		
ORDER DATE 03/15/64	ORDER NO. 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 26115	PAGE 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			\$ 33.29CR
	NET AMT			\$ 1,631.32*
REPRESENTATIVE COMPANY				
FIN TOT		JUL 25, 64	\$	74,921.35**

Figure 7. Invoice Example

Figure 8. Input Data Cards for Invoice Preparation

RECORD SEQUENCE	RECORD CODES																FIELD LENGTH		
NO.	SEQ. NUMBER	POSITION	NOT	RESULTING CONDITION	END														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CAA	0,8,0	Z																0,1	
C0.1.1	0,8,0	CJ																0,2	
C0.2.1.X	0,8,0	CJ																0,3	
C0.3.1	0,8,0	CI																0,4	
C0.4.1	0,8,0	CM																0,5	
C0.5.N	0,8,0	C																0,6	0,1,4,0,8
SC.F.2																			

Figure 9. Excerpt from Input Specifications for Invoice Report

When all input records are to be processed alike without regard for their record codes, a single record type may be specified without any entry in

the record code fields. (Columns 6-41 will be left blank.) When certain input records are present which are to be merely read and bypassed, the records to be processed are listed first with their identifying record codes.

The last record type entered on the Input Specifications sheet can be left blank in columns 6-41. Any record not satisfying the preceding specifications will satisfy this condition. No processing need be performed for this particular type of record.

Columns 6-8 state the position number (input card column, disk-record position, or tape-record position) that contains the record-code character.

Column 9 must contain an N if a negation condition is intended; otherwise it is left blank. A

RECORD SEQUENCE	RECORD CODES																				CON			
NO.	SEQ.	NUMBER	POSITION	FIELD 1	FIELD 2	FIELD 3																		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
CAA		0,8,0																						
C01	1	0,8,0																						
C02	1	X0,8,0																						
C03	1	0,8,0																						
C04	1	0,8,0																						
C05	N	0,8,0																						
SCF	2																							

Figure 11. Input Specifications for Invoice Report

If there are more than six record codes in a record type, the control-field entries are made only on the last line-entry for that record type.

Sequence Control

A special entry applies when the records of an input file are required to be in a fixed sequence within a control group. This is the SCFx entry in columns 1-4, which is used for numerically designated types of records. The x is the number of the control field. A change in this control field means that the sequence is to begin again. In the invoice example the sequence of records specified relates to customer number. Every change in customer number means that the sequence of records begins again with an Invoice To record. Because customer number is field 2 (Figure 11), the proper entry for this Invoice Report is SCF2 in Columns 1-4 on the line below the last sequential record specification. Every application that has sequential-record specifications must have an SCFx entry at the end of the input specifications.

A break in the control field which is specified in the SCF entry means that the sequence of input is to begin again starting with C01. Therefore, C01 should never be designated as an optional entry.

There are three causes for an out-of-sequence condition:

1. A control break occurred on a type of input other than a C01.
2. A required numeric type of input in a control group was missing.
3. A non-optional card was missing. However, if a C01 type of input is designated N (one or more of this type is allowed), then a control break will take precedence over a missing non-optional card.

Page Number

Columns 76-77 are used for page numbering. The page-number entry is in the upper right-hand corner of the input specifications sheet. The pages are

numbered consecutively beginning with the spacing chart as page 01.

Card Number

A three-character card number in Columns 78-80 establishes the order of entries on the specifications sheet. The first 20 lines of the sheet are prenumbered 010-200. The six unnumbered lines at the bottom of the sheet are for the entry of statements inadvertently omitted and for sheet extension. Insertions can be referenced by numbering the statement with the hundreds and tens digits of the statement it is to follow and with any one of the units digits 1-9. This allows up to nine insertions between two consecutive prenumbered statements.

DATA SPECIFICATIONS

The Data Specifications sheet (Figure 12) describes the fields that appear in the output and those used in processing.

D (Data)

Column 1 must contain a D for every line-entry on the sheet. The D identifies each entry as a data specification.

Field Name

Columns 2-7 must contain a name for each of the data fields necessary to process the report. Numbers and special characters should not be used in a field name to avoid conflict with field names and instruction labels used by the RPG processor. Any name must be left-justified. The alphabetic field name CONTD must not be used on the data specifications sheet. To use the field name PAGENO, see Serial, Record, and Page Numbers under Data Specifications.

Note: Any number of line-entries for the same data field (same Field Name) is permitted. In these cases, write the line-entries in the order in which the data manipulations should occur.

Field Length Unedited

Columns 8-10 contain the unedited field length of the report field. Unedited length means the length not counting punctuation supplied by program editing. For example, in Figure 7 the date on the second printed heading line is contained in a card as Jul 25, 64. Because the date field desired on the report is the same, the unedited field length entry for DATE is 009. If the date were contained in a card as Jul2564 and the date field desired in the

The field status refers to the condition of the data field after the operation has been accomplished by the object program. For example, if a source field is added into a data field with a zero status defined as Z25 in columns 13-15, condition 25 will be fulfilled by the program whenever the specified addition results in a zero data field. This condition can then be used to govern other operations in the program such as the performance of a calculation.

Refer to the first line of Figure 15. The source field ITEMNO from C05 will never be blank. It will be blank in the data field ITEMNO only before printing the first set of total lines. (This condition takes place before the input file information has been transferred to the fields in the data specifications.) By setting the resulting condition 07 when ITEMNO is blank, total printing can be suppressed. See Suppression of Output from Run-In Control Breaks under Format Specifications.

Each resulting condition specified under Field Status must be different than any other resulting condition specified here or elsewhere. Any attempt to set the same resulting condition under either of several different conditions will usually yield inconsistent results. For example, a resulting condition can be set as a result of one specification, and yet it can be turned off by a subsequent specification.

Columns 16-21, if necessary, specify two more sets of status conditions for the data field.

Page Number

Columns 76-77 are used for page numbering. The entry is made in the upper right-hand corner of the data sheet. The pages are numbered consecutively beginning with the spacing chart as page number 01.

Card Number

Although the entries on the data specifications sheet can be in any order, a card number (Columns 78-80) aids identification of line entries.

Conversion of Month Field

In many applications a month field is a single character with the months January through September represented by the numbers 1 through 9, and the months October through December each represented by a zone or a combination of a zone and a number. In these applications the single-character representation of the months can be converted automatically at object-program time to the corresponding two-character representation. January through September are then 01 through 09; the months

October, November, and December are 10, 11, and 12.

Figure 17 shows the specification for month-field conversion used in the Monthly Expense Distribution Report. Columns 8-10 contain 002, the data field-length after conversion. Columns 11-12 contain 00, because the numeric data field contains no decimals. The M in Column 25 identifies a month-field conversion specification. Columns 29, 30, and 31 contain the specific single-characters used in the source field to represent (in the user's input file) the months October, November, and December, respectively. The other entries on the line are as previously explained.

D	FIELD NAME	FIELD LENGTH	LENGTH USED	FIELD STATUS										SOURCES OF																					
				STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	STATUS	RESULTING CONDITION	FIELD SOURCE	FIELD END	FIELD LENGTH	OPERATION																		
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	28	29	31	32	33	35	36	38	39	41	42	43	45	46	48	49
	DMONTH	0,0	2,0	0												C	B	B	M	0	5	3	-	J	K										

Figure 17. Specification for Month-Field Conversion

Serial, Record, and Page Numbers

Any number of serial or record-count numbers can be specified in a single application. Each has the source SER or RCT and a unique data-field name in columns 2-7. It is also possible to maintain a single tally for more than one record type by specifying multiple RCT sources to a data field. Each source then must be conditioned by the resulting-condition number of a different record-type. For example, all records having the resulting condition 02 or 04 can be counted in a single tally by two RCT sources to the tally: one with condition 02, the other with condition 04. A single serial number can be increased for different reasons by multiple SER sources.

If the field-source entry on a given line is RCT or SER, the entries in columns 33-38 specify the conditions to be met for increasing the record-count or the serial-count. All input records can be counted by an entry such as the second line of Figure 15. Selective record counting can be accomplished as in the third line-entry of Figure 15. In columns 34-35 of Figure 15, 02 represents the resulting-condition number of a record type defined on the input sheet. In Figure 11, condition 02 is an Invoice To card. Thus, the count in that application will be increased by 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. Figure 7 shows the pages of each customer's invoice form that are to be numbered at the top of each invoice form. With a



INTERNATIONAL BUSINESS MACHINES CORPORATION
REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS
 IBM 1401 — 1440 — 1460

Form X24-6592
 Printed in U. S. A.

Report _____
 Programmed by _____

Page 1 of 1
 Date _____

A	FIELD NAME	FIELD LENGTH UNEDITED	DECIMAL LENGTH	HALF ADJUST	FIELD STATUS			MULTIPLICAND DIVIDEND AUGEND, OR MINUEND	O P	MULTIPLIER DIVISOR ADDEND, OR SUBTRAHEND	A S	COND N	A COND N	A COND N	FIELD NAME OF REMAINDER	FIELD LENGTH OF REMAINDER	CARD NUMBER																					
					RESULTING CONDITION STATUS	RESULTING CONDITION STATUS	RESULTING CONDITION STATUS																															
1	2	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	28	29	30	35	36	37	39	40	42	43	45	46	47	52	53	54	55	75	76	80	
																																						0,1,0
																																						0,2,0
																																						0,3,0
																																						0,4,0
																																						0,5,0
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																																						1,6,0
																																						1,7,0
																																						1,8,0
																																						1,9,0
																																						2,0,0

Figure 21. Calculation Specifications Sheet

A (Arithmetic)

In Column 1 an A identifies the entry as a calculation 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 should not be used to avoid conflict with field names and instruction labels used by the RPG Processor. Field names must be left-justified.

One exception to not using a field name that includes a number is permitted in the case of control data converted to disk addresses. The field name of the converted number, if used, must be CONV1 (see Conversion-Routine Specifications under Calculation Specifications).

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.

Note: Any number of line-entries for the same field (same Field Name) is permitted. Write the line-entries in the order in which the calculations should occur.

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.

Decimal Length

Specify in Columns 11-12 the number of digits in the decimal portion of Field Name. (The maximum permitted is 09.) For example, when a field should contain three digits to the right of the decimal point, specify 03 in Columns 11-12. For further explanation of decimal length, see Decimal Alignment under Calculation Specifications.

Note: For a numeric field that contains no decimals, enter 00. For alphabetic or alphanumeric fields, leave these columns blank.

Half-Adjust

When the user wants to half-adjust (or round) the result of a calculation, he should enter an alphabetic X in Column 13. Half-adjusting the result is accomplished automatically by adding 5 to the number in the highest-order position to be dropped. Half-adjusting is done just prior to placing the result of a calculation in the Field Name specified. See

Decimal Alignment under Calculation Specifications for an example that illustrates half-adjusting. When no half-adjusting is wanted, leave Column 13 blank.

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 14-22 of the calculation specifications sheet can be used for this purpose. The allowable entries in columns 14, 17, and 20 are those given for the field status of the data specifications sheet (B, Z, N, and P), as well as the following entries that 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 sequence than factor 1.
- L Factor 2 is lower in sequence than factor 1.

Note: The H, L, and E entries are valid only if the IBM system used to execute the object program is equipped with the high-low-equal compare special feature (Standard on IBM 1440 and IBM 1460).

As mentioned under Field Status for the data specifications sheet, each status entry (Columns 14, 17, and 20) should be defined by a corresponding unique resulting-condition number (Columns 15-16, 18-19, and 21-22). These resulting-condition numbers can be used to govern other operations.

Factor 1

Columns 23-28 are used to state the field name or the literal constant that is the multiplicand (the number which is to be multiplied by another number), dividend (the number which is to be divided by another number), augend (the number to which another is added), minuend (the number from which another is subtracted), or the field with which another field is compared. A field name thus entered must have been specified by an appropriate entry in columns 2-7 of the data specifications sheet, or by a W-entry on a format specifications sheet (see Format Specifications). The alphabetic name of factor 1 is left-justified. The first letter is entered in Column 23.

Literal constants can be used as factor 1 (see Constants under Calculation Specifications). When factor 1 is a numeric literal less than seven characters long, or an alphanumeric literal less than five characters long, enter the literal constant as factor 1. If the literal requires less than six columns, right-justify it (enter the units position in Column 28), but do not use leading zeros.

Format (for a Line)

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. Other entries for column 1 are described under Format (for a Field).

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.

If a line is identified as HAA, write an H in column 2, an A in column 3, and an A in column 4. If a line is identified as TAB, write a T in column 2, an A in column 3, and a B in column 4.

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. 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.

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

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 the IBM 1440 has a single 1442 reader-punch and the input file is in cards, then punched output will be contained in cards that served as input.

If printed and punched output of the same format are both desired, enter an X in Columns 5 and 6.

Column 7 must contain a D if the line is to be written in disk storage. Enter a T in Column 7 if the line is to be written on magnetic tape. Otherwise, leave Column 7 blank.

With blocked disk or tape output, RPG will place a record-mark in the last position of each logical record.

Next Line

Columns 8-10 define the next line to be printed, punched, written in disk storage, or written on magnetic tape. This field is intended for hierarchical related lines (Numeric Level Classification). Leave these columns blank when using Alphabetic Level Classification.

Space

In Columns 11-12 enter the number of additional line spaces to be taken before printing the line. The printer spaces one line automatically after a line is printed. Thus, an entry of 01 in Columns 11-12 indicates one space between lines of print, 02 indicates two spaces between lines of print, and 03 indicates three spaces between lines of print.

In Columns 13-14, enter the number of spaces to be taken after a line is printed. The RPG processor assumes single spacing unless 02 or 03 is entered in Columns 13-14.

Note: The entries 01, 02, 03, and blank are the only permissible entries for Columns 11-12 and 13-14.

Skip

In Columns 15-16 the entries 01-12 designate skipping to carriage tape channels 1-12, respectively, before printing the line.

In Columns 17-18 entries 01-12 cause skipping to carriage tape channels 1-12, respectively, after printing the line.

In preparing reports that require heading at the top of a page, format specifications should control form-skipping upon overflow. For a simple report without headings, no specifications are necessary to cause the forms to be advanced from the last printed line on a page to the first line of the next page. Thus, if report specifications provide no forms control for overflow, whenever the object program senses a punch in carriage tape channel 12 while printing, it automatically causes skipping to channel 1. When the 12-punch in the carriage tape is sensed while printing a total line, all total lines whose output conditions are met are printed before overflow skipping occurs.

When lines are to be printed at the bottom of a page, a 12 can be entered in Columns 15-16 to cause skipping to the normal carriage-overflow channel (channel 12). Such lines should usually be specified as total lines (T in Column 1).

Stacker

1402 Card Read-Punch

In Column 19 the entry of a 4 or 8 causes the card being punched to be selected into the corresponding 1402 punch stacker. When no selection is desired, Column 19 must be left blank.

1442 Card Read-Punch or 1444 Card Punch

When the IBM 1442 Card Read-Punch is equipped with the selective stacker feature (or when the IBM 1444 Card Punch is used), a 2 can be specified in Column 19. This causes the program to select the card being punched into the number 2 stacker pocket of the 1442 (or the 1444). When no selection is desired, leave Column 19 blank.

Line Output Conditions

A line will appear in the output only if line-output conditions for the given line are specified and fulfilled.

Columns 20-28 can be used to specify a maximum of three conditions under which the line being specified is to become output. If two or three conditions are entered on one line-entry, they are considered in an and relation. The entries in these columns can be any of the resulting conditions defined on the other specifications sheets as well as OF (overflow), LC (last card), 1P (first page), F1-F6 (a change in control fields 1 through 6), SB-SD (sense switches), and negations of any of these.

Figure 30 shows that lines HAA and HBB are to be printed when condition 04 is met. If condition 04 is defined on the Input Specifications sheet to be the presence in the input specification area of a record containing an L in column 80 and the condition is met, the heading lines HAA and HBB will print.

All lines which are to be printed when condition 04 is met will be printed in the order in which they appear on the Format Specifications sheet.

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

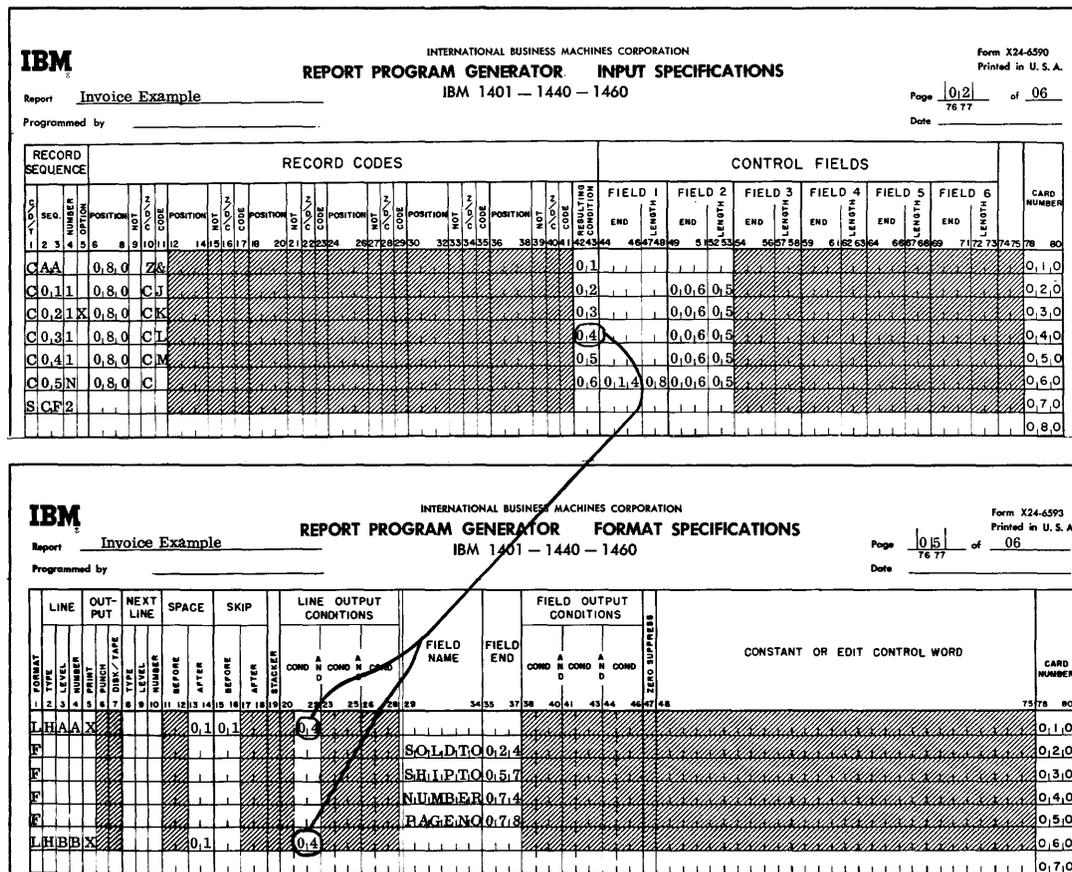


Figure 30. Conditioning a Line to Print upon Reading a Specific Kind of Data Card

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. All names must be left-justified. The entry of a K in Column 1 requires a blank field name. (A literal is not named.) 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 under Constant or Edit Control Word.

Field End

Place in Columns 35-37 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. The same conditions that can govern line output are acceptable in these columns. If several conditions in an OR relation govern the output of the field, separate entries must be made, each giving all of the information required for the field as well as each OR condition. For example, if field A is to be included in an output line when sense switch C is off or when condition 16 is met, the appropriate format specification entries are as shown in Figure 32.

FORMAT	LINE	OUT-PUT	NEXT LINE	SPACE	SKIP	LINE OUTPUT CONDITIONS				FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS				ZERO SUPPRESS
						COND	N	COND	N			COND	N	COND	N	
H										FLDA	0.75	N	S	C		
H										FLDA	0.75		1.6			

Figure 32. Output of a Field Governed by OR Conditions

Z (Zero Suppress)

A Z is entered in Column 47 to zero-suppress a field on the output line without using an edit control-word. This entry causes the object program to suppress high-order zeros and strip off the zone in the units position of the field. When an Edit Control Word is used, the Z entry in Column 47 should not be used.

Constant or Edit Control Word

A field within a line may consist of a constant. Some fields may require an edit control word. A constant, used elsewhere in another specification by its name, WORDxx, must be defined. In each of these cases,

enter the constant or the edit control word in columns 48-75, left-justified.

Literal Constants as Output Fields

Literal constants can be included as fields of output lines. They are specified: enter a K in Column 1, the proper Field End in columns 35-37, and the constant (either a numeric or an alphameric literal) in columns 48-75. Figure 33 shows how the alphameric literal, 2% DISC, is specified (line 110). Although not shown, a numeric literal can likewise be specified. The difference between the specifications for numeric and alphameric literals is only in the form of each literal. (Each is explained in Constants under Calculation Specifications.)

Edit Control Word

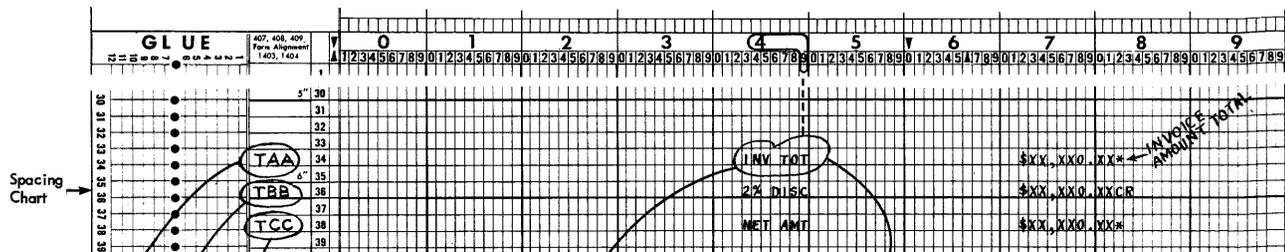
When an amount field is to be edited, the user can include the edit control word in the same format specification he writes for the field to be edited. In Figure 33, line 120, the control word \$bb,bb0.bbCR edits the field DISCNT to print \$xx,xxx.xxCR. Note that the edit control word is written, starting in column 48, in the form of an alphameric literal. If the Expanded Print Edit Special feature is available, a control word of the form \$bb,bbb.b0CR may be used.

Named Constant (WORDxx)

A constant or an edit control word that is used only once should be specified as described previously. However, when a constant or an edit control word is to be used more than once, enter WORDxx (to avoid repetitious coding) in columns 48-53 each time it is required. Then, define WORDxx by a W-entry, as explained under Naming a Constant. Figure 33 illustrates the use of one edit control word, WORD01, to edit the two amount fields TOTAMT and NETAMT (see lines 090 and 150). Note in each line-entry that the name WORD01 is not enclosed in @symbols.

Naming a Constant

As previously mentioned, both constants and edit control words can be used in calculation and format specifications by names of the form WORDxx. When so used, each constant and edit control word must be named (or defined) by a format specification. This specification must contain a W in Column 1, WORDxx in Columns 29-34, and the constant or the edit control word in Columns 48-75. A constant defined as WORDxx that is to be used in computations must be written in the form of a numeric literal. For example, if WORD04 were the constant 12345.67 to



IBM

Report *Invoice Example*

INTERNATIONAL BUSINESS MACHINES CORPORATION
REPORT PROGRAM GENERATOR FORMAT SPECIFICATIONS

Form X24-6993
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Page 10 of 06
 Date 10 16 76

LINE	OUT-PUT	NEXT LINE	SPACE	SKIP	LINE OUTPUT CONDITIONS	FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS	CONSTANT OR EDIT CONTROL WORD	CARD NUMBER
B					F2N0.8N0.7	TOTAMT	0.8.2		@INV.TOT@	0,6,0
K							0.4.9		(WORD01)	0,7,0
B					F2N0.8N0.7	TOTAMT	0.8.2		@2%DISC@	0,8,0
K							0.4.9		DISCNT	0,9,0
B					F2N0.8N0.7	DISCNT	0.8.3		@@\$.bb.bb0.bbCR@	1,0,0
K							0.4.9			1,1,0
B					F2N0.8N0.7	DISCNT	0.8.3			1,2,0
K							0.4.9		@NET.AMT@	1,3,0
B					F2N0.8N0.7	NETAMT	0.8.2		(WORD01)	1,4,0
K							0.4.9			1,5,0
B					F2N0.8N0.7	NETAMT	0.8.2		@@\$.bb.bb0.bb*@	2,4,0
K							0.4.9			2,4,0

This control word edited the data field, TOTAMT (0166461), suppressing the high-order zero and adding the symbols specified.

Printed Report

**REPRESENTATIVE COMPANY
ANY CITY — ANY STATE**

INVOICE TO E C BROWN & CO	SHIPPED TO	INVOICE NUMBER 26115	PAGE 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			\$ 1,666.61*
	2% DISC			\$ 33.29CR
	NET AMT			\$ 1,631.32*

**REPRESENTATIVE COMPANY
ANY CITY — ANY STATE**

Figure 33. Using Constant and Edit Control Word

be used as Factor 2 in a calculation specification (see Figure 26), the proper format specification would be as shown in Figure 34. Constants that are not to be used in computations, as well as all edit control words, must be written in the form of alphanumeric literals. In Figure 33, the edit control word \$bb,bb0.bb* (used twice by its name WORD01) is defined as WORD01 on line 240.

FORMAT	LINE	OUT-PUT	NEXT LINE	SPACE	SKIP	LINE OUTPUT CONDITIONS			FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS			CONST
						COND 1	COND 2	COND 3			COND 1	COND 2	COND 3	
	1													
	2													
	3													
	4													
	5													
	6													
	7													
	8													
	9													
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	100													

Figure 34. Defining a Constant Used in a Computation

Page Number

Columns 76-77 are used for page numbering in both line and field specifications. The page-number entry is in the upper right-hand corner of the format sheet. The pages 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 in columns 78-80, as explained in this corresponding paragraph under Input Specifications.

NUMERIC LEVEL CLASSIFICATION

It was suggested under Classification of Lines that the user classify each line on his printer spacing chart, and, subsequently on his Format Specifications Sheet, by assigning to each heading, total, and detail line a unique pair of letters. These letters enable the user to quickly assign an identification to each line.

However, there is another way of classifying lines which is available to the user. He may use numeric level classification. The following section describes numeric level classification. Included in this section are additional format specifications which are required when using numeric level classification. Users who are familiar with numeric level classification may continue using it. Users who are writing new RPG programs will probably prefer alphabetic level classification.

Three types of lines can appear on the user's report: heading, detail, and total lines. Heading and detail lines can contain information from the record in the input area at the time when the lines are printed; total lines cannot. An input record can effect a control field change that causes total lines to be written, but that input record cannot contribute

data to those lines. A detail line has a direct relationship to input records. Most of the data in a detail line comes from the input record. A heading line usually 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, which is important to numeric level classification, 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 can be given numeric-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 intermediate lines. The principle underlying a hierarchical relationship is that lines of higher level govern lines of lower level.

Line "Level" Relationships

Of the three types of report lines (H, D, and T), heading and total lines can be related in an established order or rank. Such lines, known as hierarchical lines, are assigned a number from 1 through 8 as the second character of the line identification code. This number represents the rank or level of a line in its relationship to other lines within the hierarchical structure. Heading and total lines in the lowest level must be assigned a level number of 1; the next higher level number assigned must be 2; then 3; and so on, through 8 for the highest level.

For both heading and total lines that are given numeric level designations (that is, hierarchical heading and total lines), there may be more than one print line that belongs to a given level. These lines should be numbered, beginning with the number 1 for the first line of that level. For example, suppose that a report requires three heading lines; two of these should print on an intermediate control-field change, and the remaining one should print on a minor control-field change. In this example, the three heading lines would be assigned these line-identification codes: H21 and H22 (the first and second heading lines of the intermediate level), and H11 (the first heading line of the minor level -- there is only one minor heading line in this example).

Suppose that, in the foregoing example, there are five total lines that should print; two on a change in the intermediate control field and three on a change in the minor control field. These five total lines should be given these line-identification codes: T11, T12, and T13 (the first, second, and third total lines

of the minor level), and T21 and T22 (the first and second lines of the intermediate level).

Heading lines in a hierarchy (identified by such numeric level designations as H21, H22, and H11) are printed in this order:

1. All the heading lines in the highest level, in line-number order.
2. All the heading lines in the next lower level, in line-number order.
3. And so on. The heading lines of the lowest level are printed last, in line-number order.

In the previous example, the order of printing the heading lines (upon a change in the intermediate control field) is H21, H22, and H11.

Total lines in a hierarchy (identified by such numeric level designations as T11, T12, T13, T21, and T22) are printed in this order:

1. All the total lines in the lowest level, in line-number order.
2. All the total lines in the next higher level, in line-number order.
3. And so on. The total lines in the highest level are printed last, in line-number order.

In the previous example, the order of printing the total lines (upon a change in the intermediate control field) is T11, T12, T13, T21, and T22.

Line-output conditions should be assigned only to the first line of each level that should print. Succeeding lines of any numbered level will follow the first line of that level. For example, condition F1 should condition heading line H11 to print, but not H12. The reason is that when H11 is printed, H12 will automatically follow, because it is the second line of level 1.

Programs generated by RPG print report lines in this order:

1. **Alphabetic-Level Heading Lines**
Printed in the order of entry on the format specifications sheet
2. **Numeric-Level Heading Lines**
Printed in high-to-low-level order according to their places in the hierarchy.
3. **Detail Lines**
Printed in the order of entry on the format specifications sheet.
4. **Numeric-Level Total Lines**
Printed in low-to-high-level order according to their places in the hierarchy.
5. **Alphabetic-Level Total Lines**
Printed in the order of entry on the format specifications sheet.

Hierarchical treatment is given only to numeric-level heading and total lines.

When the object program is running, a total line with a numeric-level designation such as T3x will force T11 and its subsequent lines, and T21 and its subsequent lines to come before it whenever the output conditions are fulfilled for T3x.

Study of Figure 35 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.

When there is a single detail-line format in a report, that line should be given an alphabetic-level designation to reflect its independent status. Such is the case in Figure 35 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.

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. It is possible that level-one heading lines might relate to a change in control-field two. In some 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 numeric levels for each type of line specified.

The line number permits scheduling lines within a level. In Figure 35 there are 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; that is, 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 numeric 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.

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. When assigning line numbers, always start with the number 1.

Numeric-Level Format Specifications

Format specifications for numeric-level classification closely follow those for alphabetic-level classification, and reference must be made to the previous section dealing with format specifications. However, three specifications are different.

Line

The entry in column 2 specifies the type of the line, as in alphabetic level classification.

Column 3 specifies the level of the line. Column 4 specifies the number of the line within a given level. When lines of a level are to be numbered, be sure to assign the number 1 to the first line.

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.

Next Line

Columns 8-10 define the next line to be printed, punched, or written on tape or disk. 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 the same type and level as the line calling for it. That is, columns 8-9 must be the same as columns 2-3.

Line Output Conditions

Columns 20-28 can be used to specify a maximum of three conditions under which the line being specified is to become output. If two or three conditions are entered on one line-entry, they are considered in an AND relation. The entries in these columns can be any of the resulting conditions defined on the other specifications sheets, as well as OF (overflow), LC (last card), 1P (first page), F1-F6 (a change in control fields 1 through 6), SB-SD (sense switches), and negations of any of these. If a line is referenced by a previous entry as a next line, columns 20-28 are left blank. This is because its line-output conditions must be the same as those for the line that referenced it.

A line will appear in the output only if:

1. Line-output conditions for the given line are specified and fulfilled, or
2. The line was specified as the next line of another line for which the output conditions are fulfilled, or
3. The line is of lower level in a hierarchy than another line of the same type for which the output conditions are fulfilled.

To illustrate the first principle, in Figure 36 the line H11 is specified to be printed when condition 04 is met.

Condition 04 (defined on the Input Specifications Sheet) is set when a record containing and L in column 80 is present. The first heading line will be printed when that record is present.

The second principle is illustrated in Figure 37. Heading line H12 will print only after line H11 prints, because the format specification of H11 contains a next line entry of H12. Note that no output conditions are specified for H12.

The third principle with regard to line-output conditions relates to the specification of hierarchies of lines. Lines related in a hierarchy must be of the same type and must have numerical-level designations that reflect their relative positions within the hierarchy. The processing principle underlying a hierarchical relationship is that lines of a higher level govern lines of lower level. Thus, when the output conditions are fulfilled for T3x lines, the object program will force T11 and its next lines, and T21 and its next lines to come before the T3x lines in the output without regard for the line-output conditions of the T1x and T2x lines. (See Figure 35.)

Furthermore, multiple lines within one level in a hierarchy must be referenced by next line designations rather than individual line-output conditions whenever there is a higher level of lines in the hierarchy. Thus, H21 must call for H22 as a next line and H22 must call for H23 as a next line to ensure that all three will be present in the output when H3x lines precede them.

SUMMARY

This section of the bulletin presents a summary of the four preceding sections. A brief explanation of the four RPG specifications sheets is presented.

Summary of Input Specifications

From knowledge of the records in the input data file, the user writes the input specifications for the Report Program Generator:

<u>COLUMNS</u>	<u>NAME</u>	<u>EXPLANATION</u>
1	C, D, or T	The medium (card, disk, or tape) used for input for every line-entry that specifies a record type. If any records must be in a fixed sequence within a control group, enter an S on the line below the entry for the last sequential record-type.
2-3	Seq.	Numeric-sequence order if a fixed record-sequence within a control group is required; two alphabetic letters if a fixed sequence within a control group is not required or if there is only one record-type per control group. Enter the letters CF on the line below the last line-entry for sequential record-control.

COLUMNS	NAME	EXPLANATION	COLUMNS	NAME	EXPLANATION
		Permissible entries; all resulting-condition numbers defined on the input, data, and prior entries of the calculation specifications sheets, as well as LC, F1-F6, SB-SD, and also negations of all of the foregoing conditions.	8-10	Next Line	Alphabetic Level Classification leave these columns blank. Numeric Level Classification contains the next line to be printed, punched, written on tape or disk. The next line must be of the same type and level as the line calling for it.
46	Tot/ Det/ Conv	T when the calculation is to be performed at total-time, D when the calculation is to be performed at detail-time, and C for a conversion-routine calculation. This column must not be left blank.	11-12	Space Before	Numbers 01, 02, or 03 for single, double, or triple line-spacing before printing this line.
47-52	Remainder Name	When using the remainder from a divide operation, enter the name assigned to it.	13-14	Space After	Same as Columns 11-12, except for spacing after printing.
53-54	Length	Enter the length of the remainder field, if used.	15-16	Skip Before	01-12 for skipping to carriage-tape channel 1-12 before printing.
55-75	(Blank)	Must not be used.	17-18	Skip After	Same as Columns 15-16, except for skipping after printing.
76-77	Page	Page number, located in the upper right-hand corner of the sheet.	19	Stacker	1402 CARD READ-PUNCH Punch 4 or 8 to select the card being punched into either the 4 or 8 punch-stacker pocket. Blank when not selecting.
78-80	Card Number	Card number.			1442 CARD READ-PUNCH 1444 CARD PUNCH Punch 2 to select the card representing this line into the number 2 punch-stacker pocket. Blank when not selecting.

Figure 40 shows the calculation specifications for the Monthly Expense Distribution Report.

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, 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	Disk/Tape	D if this line is to be written in disk storage. T if the line is to be written on magnetic tape.

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 <u>and</u> 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. Blank for a W-entry.
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.

COLUMNS	NAME	EXPLANATION	COLUMNS	NAME	EXPLANATION
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 <u>and</u> relation. If a field must be included unconditionally in an output line, Columns 38-46 are blank.	48-75	Constant or Edit Control Word	Either a constant (numeric or alpha-numeric) 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.
47	Zero Suppress	Z to zero-suppress a field without using an edit control-word.	78-80	Card Number	The first twenty lines of each sheet are prenumbered.

If the user's input file is contained in disk storage, he must specify in his control cards one of three methods (or modes) by which the input file is organized. The ways that the user can specify these modes (consecutive, random, and control-sequential) are explained in this section under those headings.

PROCESSING-ORDER RECORDS

In addition to specifying the mode by which the input file is organized, the user must also specify the order in which his input file will be processed. He provides a Processing Order Record (POR) file that defines the order in which the input file (consecutive, random, or control-sequential) will be processed. POR files can be contained in cards, tape, or disk.

Consider a card input file rather than a disk input file. The order in which records are processed is determined by the order, or the sequence, of the cards. Thus, the processing order for a card file is usually consecutive by card record.

Now consider an input file in disk storage. Assume that the first record is 100-characters and is located at address A and that the last record is located at address B. One processing order that can be easily used is consecutive by disk address, from A to B. In this case, a starting address (A) is given, the record at that address is retrieved, and the record is processed. The starting address is increased by 1, and the record at that address is retrieved and processed. This procedure continues until the record stored at the ending address (B) has been retrieved and processed. All that is required to specify the processing order in this case is two disk addresses—a lower limit (starting) and an upper limit (ending) address. Processing takes place by using these two addresses as limits for the application.

Another way to process the same disk file is by using a series (or list) of disk addresses to determine the order of processing the file records. For example, the list might be a deck of cards. Each card contains the address of a record to be processed. The order in which the addresses appear in the list determines the processing order.

In both methods of controlling the processing order of disk records just mentioned, disk addresses were used. However, in those cases where the organization of the file provides for it, control data can be used as the basis for retrieval of disk records.

Control data is a fixed field within all records of a file (for example, item number or account number)

which can be converted, by using a conversion routine supplied by the user, to the disk address of the record to which it belongs. The field can be a maximum of 30 locations. See Figure 27. The user's control data has been placed in the field labelled CONTD. The calculations shown in lines 3-5 represent the user's conversion routine.

Thus, processing order records (POR's) specify the exact way in which a disk input data file will be processed. The following section describes the formats in which card, tape, or disk POR's may be written.

CARD POR FILES

A card processing order record (POR) file may be used for consecutive, random, or control-sequential modes. Card POR files may be in three formats: one-per-record, spread, or processing limits.

One-Per-Record

This format can be used only with random processing of a disk input file. Each card contains one disk address or one control-data field, which can be located anywhere in the card. Thus, there is one card associated with each record to be processed.

If control data is used in the card, the user must provide a conversion routine.

Spread

These cards can only be used with random processing. Each card contains two or more disk addresses or control-data fields in the processing order. If control data is used in the card, the user must provide a conversion routine.

Processing-limits

A POR file of cards in this format may be used with either the consecutive or control-sequential mode of processing.

If used with consecutive processing, each card must contain either the lower and upper limits of the disk area or two fields of control data which may be converted to these limits by the user's conversion routine.

If used with control-sequential processing, each processing-limits card must contain the upper and lower limits of the disk area to be processed.

TAPE POR FILES

A tape POR file may be used only for random processing. Tape POR files may be in two formats: one-per-record or spread.

One-Per-Record

Each tape record contains one disk address or control-data field, which can be located anywhere on the tape record. A user's conversion routine must be provided if the tape record contains a control-data field.

Spread

Each tape record contains two or more disk addresses or control-data fields in the processing order. If control data is used on the tape record, the user must provide a conversion routine.

DISK POR FILES

A disk POR file may be used only for random processing. Disk POR files may be in two formats: one-per-record and spread.

One-Per-Record

Each disk POR record contains one control-data field. Thus, one disk record is associated with each input disk record to be processed. If control data is used on disk records, the user must provide a conversion routine.

Spread

Each disk POR record contains two or more disk addresses or control data fields in the processing order. If control-data is used, the user must provide a conversion routine.

POR-File Limits Card

Whenever the user puts his POR file on disk, he must provide the object program with the starting and ending disk sector addresses in a POR File Limits card. The POR File Limits Card is punched:

Columns	Contents	Explanation
1-6	XXXXXX	Starting address of the POR file.
7-12	XXXXXX	Ending address of the POR file. (If the ending address is unknown, enter the maximum expected limit. The IEOF trailer will indicate the end of the POR file.)

CONSECUTIVE MODE

If the user's disk input file is organized by a consecutive method, (as in Figure 41) his POR file must be contained in cards in the processing limits format. Each card contains two fields. Each card contains either the lower limit (the starting field) and the upper limit (the terminal field) of the disk input area, or each card contains two fields of control-data which may be converted to these limits by the user's conversion routine. If the exact upper limit is unknown, the user enters the maximum expected limit. End-of-Job will be reached when the IEOF trailer is sensed on the disk. Each limits card, then, represents a series of records which are retrieved and processed consecutively by disk addresses or by control data.

When processing consecutively by disk addresses, the program gets the first address from the starting field of the first processing limits card. To do this for 100-character records, the program increases, by 1, the number associated with the logical record within the block. The second record is then selected and processed. This operation continues until the record represented by the address contained in the terminal field of the first processing limits card has been processed or the IEOF trailer has been sensed. If there are other limits cards, processing continues in the same way, until all the records, thus represented, have been processed.

When processing consecutively by control-data, the program gets the record associated with the starting field from the processing-limits card. After the first record has been processed, the program adds 1 to the first control-data field and then gets the record associated with the new control field. Processing continues until the record associated with the control data from the last terminal field of the processing-limits cards has been processed.

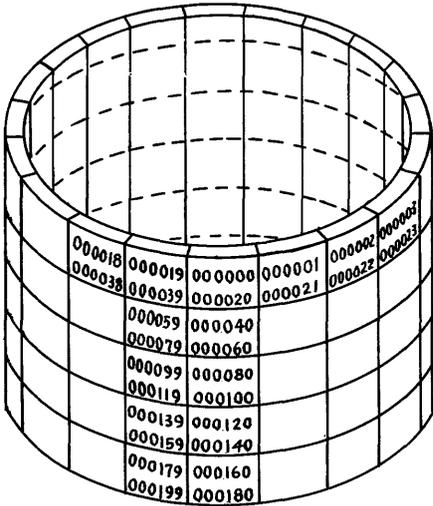
RANDOM MODE

To process a disk file in the random mode, the user supplies either the control data or the disk addresses for each disk record to be processed. When he arranges the order of control-data or disk addresses that make up his processing-order records, he defines the order for processing his disk file.

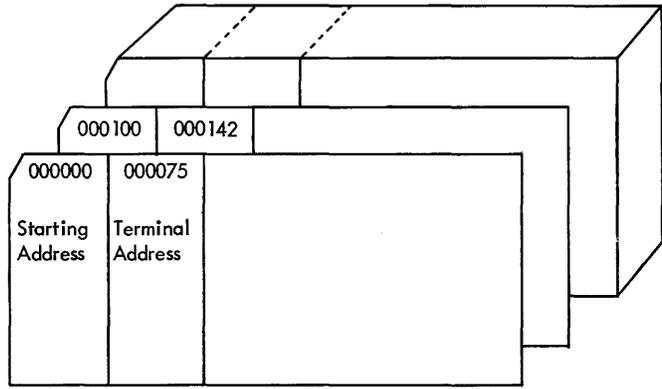
POR's can be contained in cards, tape, or disk. However, for a specific program the POR file must be contained in only one medium.

POR's in Cards

In cards, the POR's can be in two formats: one-per-record and spread. Figure 42 shows a POR file in the one-per-record format. Each card contains one



Disk Input File



Processing-Order File. Each card contains disk addresses.

Records of the disk input file are 100 characters long, unblocked.

Record Processing Order:

```

000000
000001
000002
:
:
000074
000075
Read next processing-order card
000100
000101
etc.

```

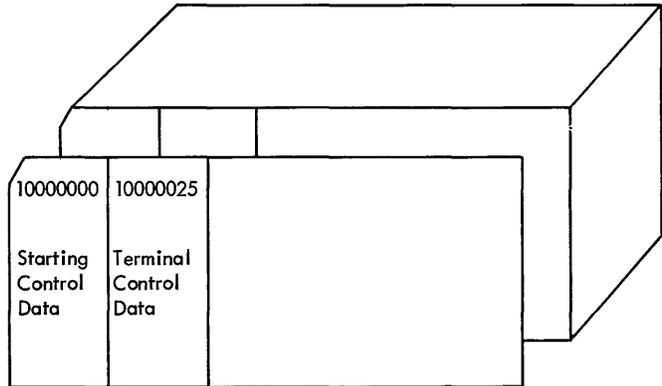
Control Data	Converted Disk Address
1000000	000000
1000001	000002
1000002	000004
:	:
1000024	000048
1000025	000050

Record Processing Order:

```

000000
000002
000004
:
:
000048
000050
Read next processing-order card
etc.

```



Processing-Order File. Each card contains control data that must be converted to disk addresses.

Records of the disk input file are 200 characters long, unblocked.

Figure 41. Consecutive Processing

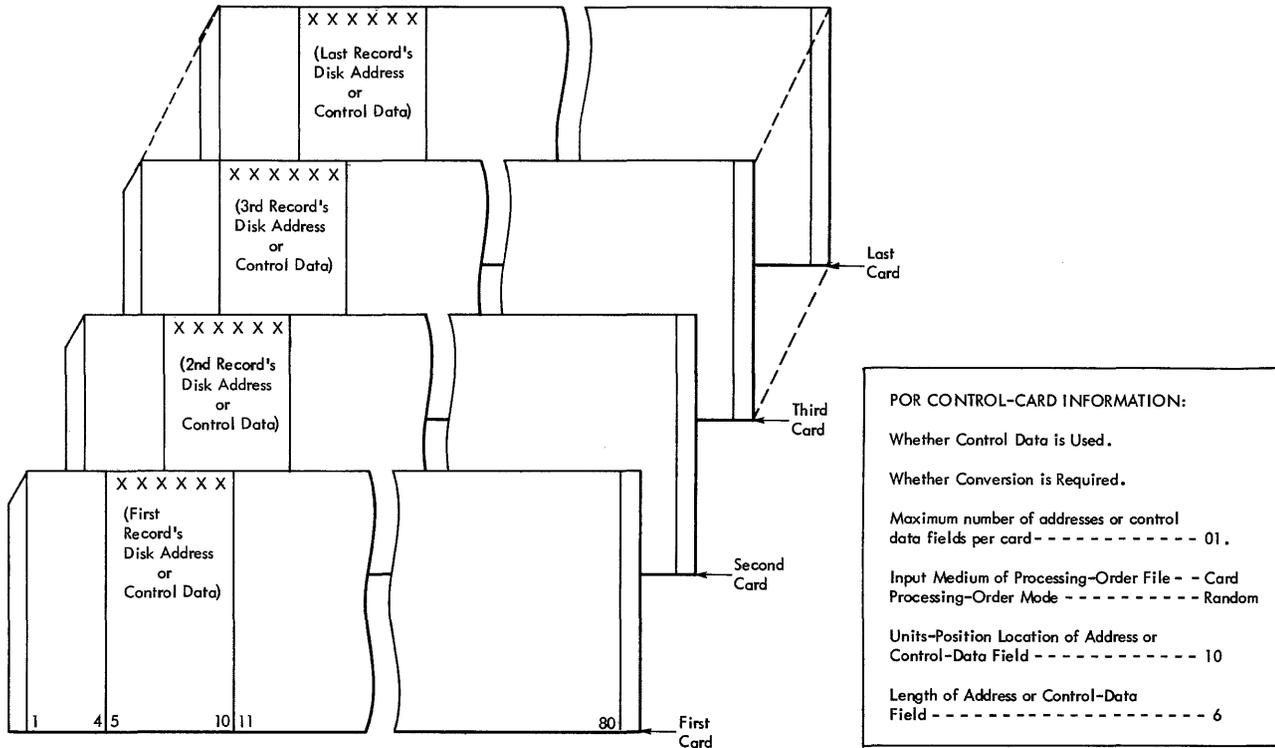


Figure 42. Processing-Order Records in One-Per-Record Format

disk address or one control-data field, which can be located anywhere in the card.

Any number of characters can precede each record's address or control-data, whichever is used. For a specific program, however, this number must remain fixed.

When disk addresses are used, the field length is 6 positions for an unblocked disk file, 7 positions for a blocked disk file (with a blocking factor between 2 and 10), and 8 positions for a blocked disk file with a blocking factor greater than 10.

Figure 43 shows a card POR file in the spread format. Each card contains two or more disk addresses or control-data fields (up to some maximum number). In Figure 43, this example shows eight columns between the first and second disk address or control-field, eight columns between the second and third, and so on, for the remainder of the card. Any number of characters can precede the first record's disk address or control-data in each card. For a specific program, this number must remain fixed.

Any spread card can contain fewer addresses or control data field than the maximum number. However, all fields to the right of the last one used must be blank (see the second card in Figure 43).

POR's on Disk

RPG can use POR's for random files that are stored in either IBM 1301 or 1311 disk storage. This is true regardless of which kind of disk storage (1301 or 1311) contains the input or output data file.

Disk POR's can be in two formats: one-per-record (Figure 44) and spread (Figure 45). Each POR in disk storage can contain either one data record's address or a control-data field (up to some maximum as shown in Figure 45).

POR's can be blocked with as many as ten records per block. Records can be up to 900 characters in length. The blocks can be of any length from 100 to 1,000 characters, in multiples of 100 characters.

A spread POR can contain less than the maximum number of addresses or control-data fields, provided that all fields to the right of the last one used are left blank. As an example, note the third processing-order record in Figure 45. Any number of characters can precede, as well as follow, each address or control data field. Any number of characters can precede the first data record's address or control-data in each spread POR record (columns 1-20 in Figure 45).

When disk addresses are used, the field length is 6 positions for an unblocked disk file, 7 positions

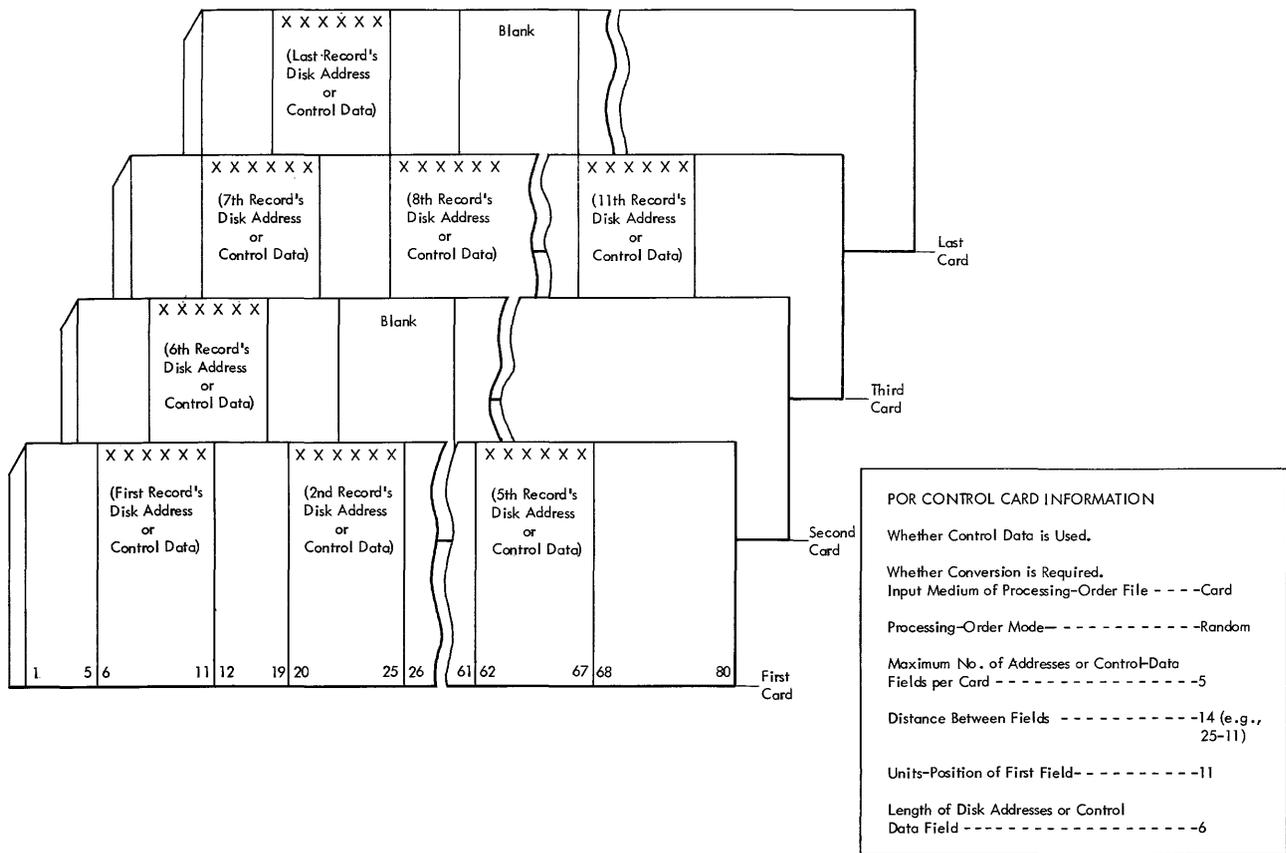


Figure 43. Processing-Order Records in Spread-Card Format

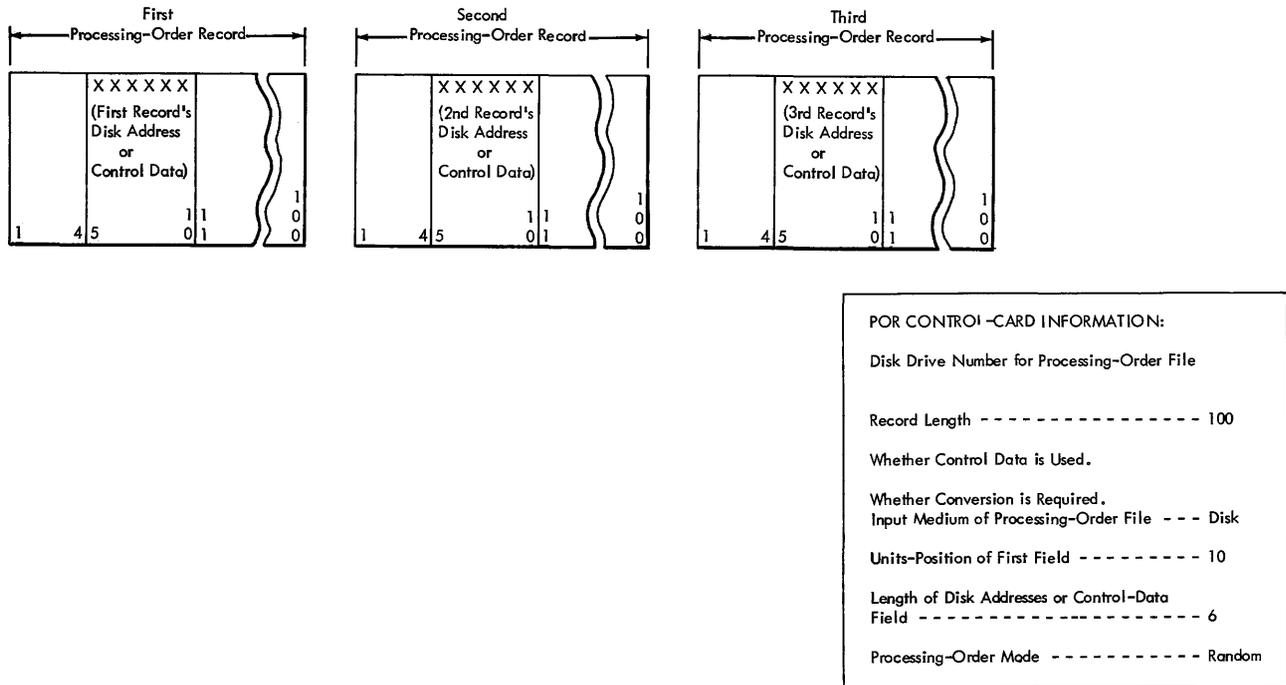


Figure 44. Fixed-Length Processing-Order Records in Disk Storage (one-per-record)

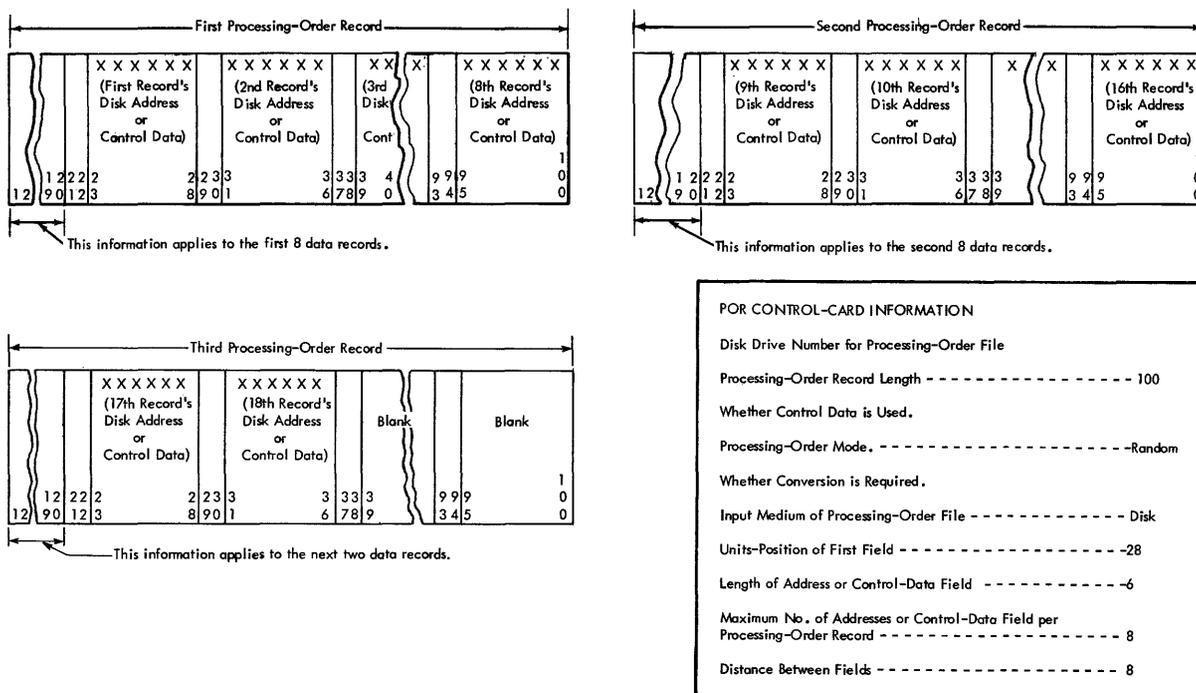


Figure 45. Fixed-Length, Spread Processing-Order Records in Disk Storage

for a blocked disk file (with a blocking factor between 2 and 10), and 8 positions for a blocked disk file with a blocking factor greater than 10 or when using the IBM Sort 5 or Sort 6 programs.

The IBM 1401 Sort 6 program or the IBM 1440 Sort 5 program produces a sorted tag table in disk storage during one of its phases of operation. This table contains the 8-digit modified disk address (SS SSSSR₁R₂) for each active file record. Such a table can well serve as the processing-order records for a disk file.

POR's on Tape

Tape POR's can be in two formats: one-per-record and spread. Each POR on magnetic tape can contain either one data-record's address or control-data field, or it can contain more than one address or control-data field (up to some maximum number). POR's must be fixed in length for any application, up to 1,000 characters. They can be either unblocked or blocked. The maximum block length is 9,999 characters. If blocked, each POR on tape must have a record mark (A82) as its last character. The maximum blocking factor is 99 POR's per block. POR's with less than the maximum number of addresses or control-data fields must contain enough

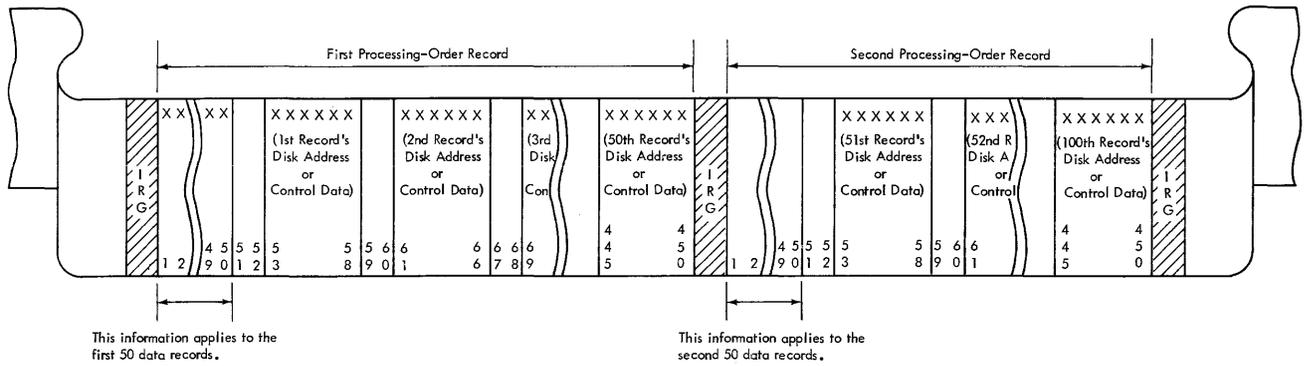
blanks to fill out the fixed record length. The same applies to a block of POR's with less than the maximum number of POR's - it must be padded with blanks (to fill out the fixed block length).

Figure 46 shows unblocked, spread POR's. Figure 47 shows blocked POR's, with a record mark as the last character in each processing-order record.

When disk addresses are used, the field length is 6 positions for an unblocked disk file, 7 positions for a blocked disk file (with a blocking factor between 2 and 10), and 8 positions for a blocked disk file with a blocking factor greater than 10.

Next-Record Field

Data records in a disk file can contain a next-record field. This field contains either the disk address or the control data of the next data record to be processed. Thus, the first disk record contains the address or the control data of the second disk record to be processed, the second disk record contains the address or the control data of the third record to be processed, and so on. The next-record field of the last record to be processed contains blanks.



POR CONTROL-CARD INFORMATION:

Record Length 450 chars.

Specify whether control data is used.

Whether conversion is required.

Processing-Order Mode Random

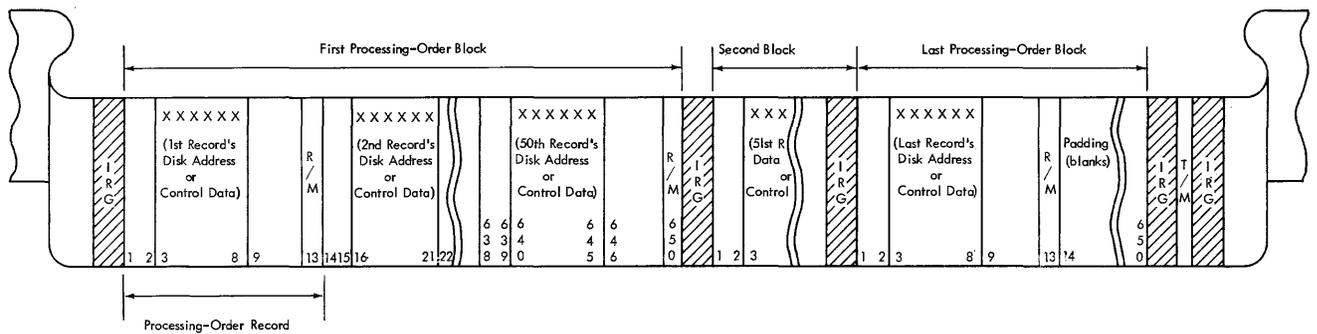
Max. No. of Addresses or Control-Data Fields per Processing-Order Record 50

Distance Between Fields 8

Units-Position of First Field 58

Length of Disk Address or Control-Data Field 6

Figure 46. Fixed-Length, Unblocked, Spread Processing-Order Records



POR CONTROL-CARD INFORMATION:

Record Length - - - - - 13

Blocking Factor - - - - - 50

Specify whether control data is used.

Whether conversion is required.

Processing-Order Mode - - - - - Random

Distance Between Fields - - - - - 13

Units-Position of First Field - - - - - 8

Length of Disk Address or Control-Data Field - - - - 6

Figure 47. Fixed-Length, Blocked Processing-Order Records

An object program generated by RPG can use the next-record field of disk-file records that are organized in the random or consecutive mode. It uses the field in conjunction with the processing-order records as follows.

- The object program gets (locates and reads out of disk storage) the first record by using the first address or control-data field in the first processing-order record. It processes the record.
- The object program gets and processes the record indicated in the next-record field of the first disk record retrieved.
- The object program gets and processes the record indicated in the next-record field of the second disk record retrieved. This same process continues, until a record is retrieved that has a blank next-record field.
- Upon retrieving and processing a disk record with a blank next-record field, the object program returns to the processing-order records to select the next disk record to be processed. This procedure continues until all the processing-order records are read and all the disk records are processed.

Random Processing of a Random Disk File

Records of a random disk file can be processed in the random mode by programs generated by RPG, provided that the user supplies his processing-order file. As mentioned previously, the processing-order file can be supplied in cards, disk-storage, or magnetic tape. Figure 48, which represents three forms of the processing-order file, is used as the basis for the following explanation of random processing of records in a random file. Note that the explanation applies for each medium of the processing-order file.

First, consider the simplest case, in which each POR contains one disk address or control data field. Assume there are no trailers. This is the order of processing the records of this disk input file:

1. The disk record represented by the first POR
2. The disk record represented by the second POR
3. The disk records represented by the third and remaining POR's, in the order read from the POR file.

Now, consider a more complex example. Suppose that the input disk file consists of masters and two associated trailers. Also, each disk record contains a next-record (NR) field, located at a fixed place in the first trailer record. This random file used the chaining technique to indirectly address file records, because there can be duplicate addresses produced by the address-conversion routine. This is the order of processing the records of this more complex file:

1. The disk record represented by field 1 of the first POR. (Trailers belonging to masters will be included in the assembled record.)

2. The disk records (masters and trailers) represented by the NR fields, until a blank NR field is encountered.
3. The disk record represented by field 2 of the first POR.
4. The disk records represented by the NR fields, until a blank NR field is encountered.
5. This same procedure is repeated for fields 3 through 10. The object program reads the next POR and continues processing the disk input records in this same order, until all input records represented by the POR file have been processed.

Note: In the foregoing procedure, the retrieval of each master disk record involves, first of all, converting the control data to a disk address. Then the control data of the disk record stored at this address is compared to the control data in the POR. If the control-data fields are identical, the record is found. Otherwise, the object program reads the overflow-address field of the master record, getting the address of the first non-home (overflow) record. This record's control data is compared to that of the POR. If the result is an equal comparison, the record is found. Otherwise, the search continues, as before, until the record has been found.

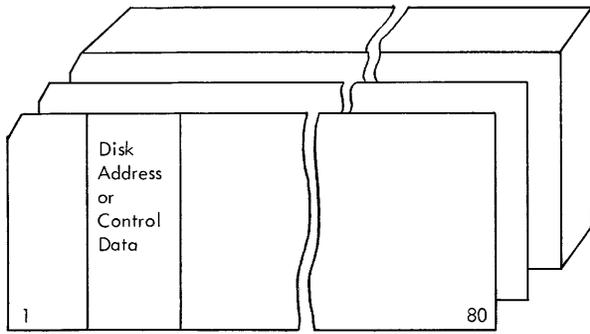
CONTROL-SEQUENTIAL MODE

If the user's disk input file is organized by a control-sequential mode, his POR file must be contained in cards in the processing-limits format. The user places a card deck, consisting of any number of processing-limits cards, directly behind the generated object program at the time he loads the program.

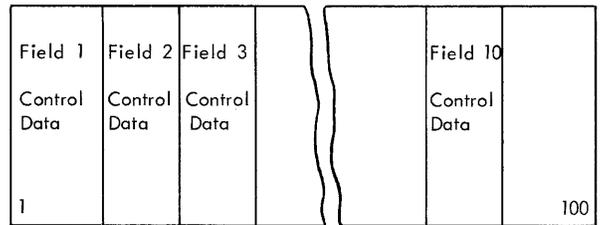
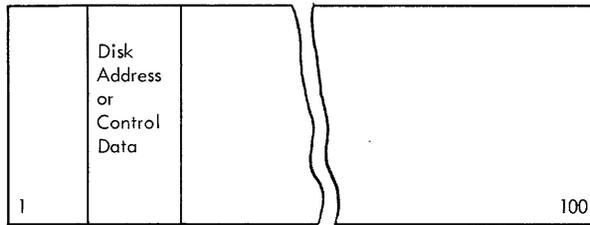
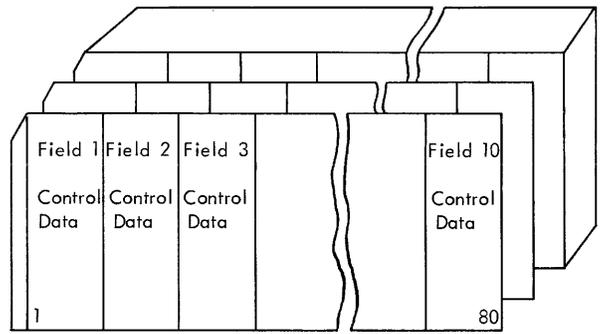
Each card contains two fields: the lower limit (the starting field) and the upper limit (the terminal field) of the disk input area. If the exact upper limit is unknown, use the maximum expected limits. End-of-Job will be reached on sensing the 1 EOF trailer on the disk. Each limits card, then, represents a series of sequential records, taken normally in ascending numerical order by control data.

The object program processes records in disk storage, using the two fields in each card as address limits for that series. The series includes any additions records that were added to the original file.

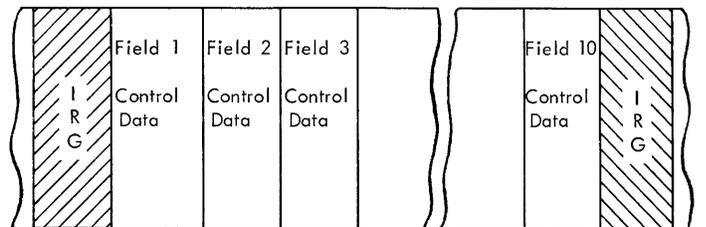
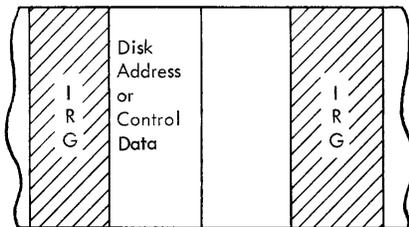
The object program reads the first processing-limits card (Figure 49). It reads out of disk storage and processes the disk records represented by the two fields in that card. It reads the next processing-limits card (if there is one) and repeats these operations until the last card is read and those disk records it represents are processed.



POR File in Cards



POR File in Disk Storage



POR File on Tape

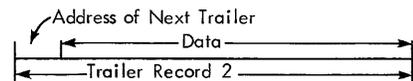
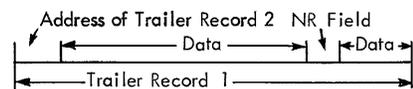
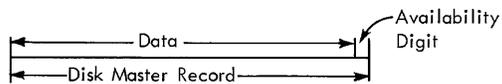
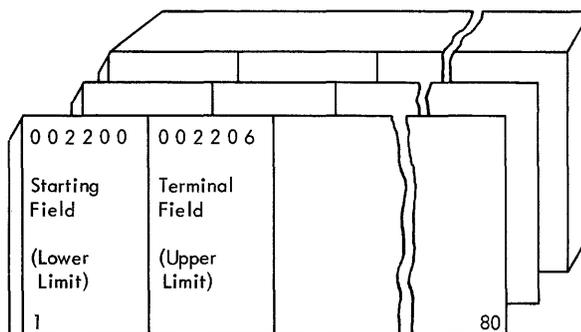
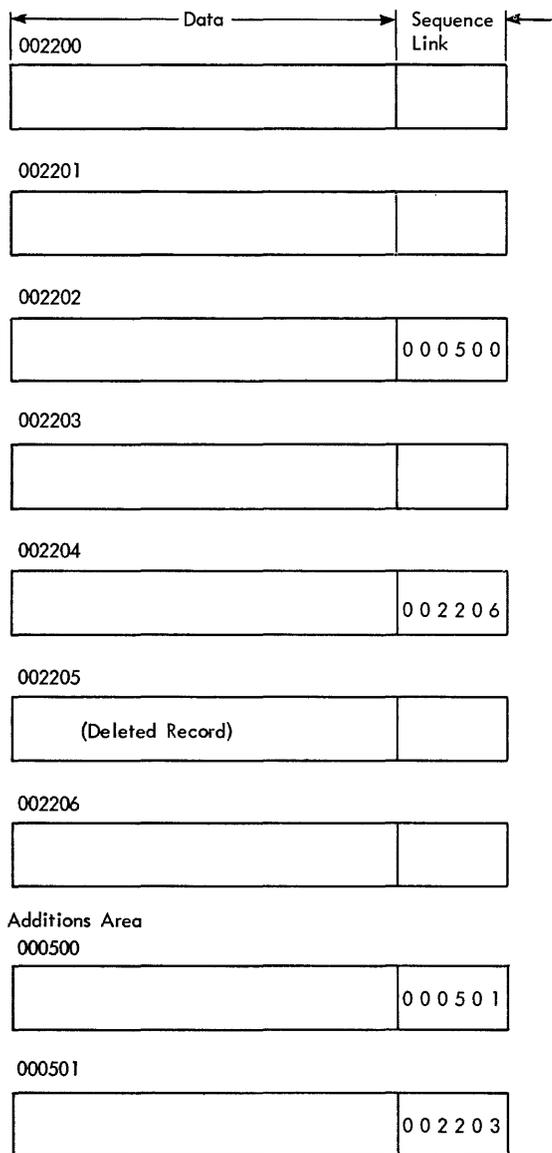


Figure 48. Random Processing of Disk Files

Main File Area



Processing-Order File

← Input file is control-sequential, consisting of 100-character unblocked records.

Order of Processing this Disk File:

- 002200
 - 002201
 - 002202
 - 000500
 - 000501
 - 002203
 - 002204
 - 002206
- Get next limits from processing-order file, and continue as above.

Figure 49. Control-Sequential Processing of Disk Files

CONTROL CARDS FOR RPG PROCESSOR

The control cards that the user prepares prior to generating his report program provide the RPG with information about the IBM 1401, 1440, or 1460 system to be used, the input and the output units to be used, general information about the input and the output files, and the user's choice of processing options. The number of control cards RPG requires depends on the medium of his input file and the output-file media he selects. Thus, to generate an object program for a card input file and a printed and/or a punched report, the user must prepare only the RPG control card. To generate an object program for a disk input file consisting of both masters and trailers, producing magnetic-tape output, for example, the user must prepare these control cards: RPG, TAPOUT, MAS, TRL, and POR.

RPG CONTROL CARD

This card is required for all applications of RPG. In it the user punches information about the IBM 1401, 1440, or 1460 system configuration, the form of RPG-generated output, the input-file medium, the output media, the general specifications for disk output (if used), and the identification for his object program. Here are the format and contents for the RPG card.

Columns	Contents	Explanation
1-3	RPG	Identification of this card.
4	1-4	Core capacity of the system to be used to generate the object program. Punch 1 for 4K, 2 for 8K, 3 for 12K, or 4 for 16K.
5	1-4	Core capacity of the object machine (that is, the system to be used to execute the object program). Punch a number, 1-4, as above.
6	1 or b	Sense switches option in source program. Punch 1 if any switches B-D are used. Otherwise leave blank.
7	1 or b	Multiply-divide special feature on object machine. Punch 1 if installed. Otherwise leave blank.
8	1 or blank	IBM 1401 Punch 1 if <u>Advanced Programming</u> special feature is installed on the object machine. Otherwise, leave blank. Blocked tape input records and blocked tape or disk output records require this special feature. IBM 1440 Punch 1 if <u>Indexing and Store Address Register</u> special feature is installed on the object machine. Otherwise, leave blank.

Columns	Contents	Explanation
		IBM 1460 Punch 1 if <u>Indexing and Store Address Register</u> special feature is installed on the object machine. Blocked tape input or blocked tape or disk output records require this special feature. Otherwise, leave blank.
9	1 or blank	<u>Modify Address</u> instruction on object machine. Punch 1 if it can be used. Otherwise, leave blank.
10	1 or blank	<u>Direct seek</u> special feature on object machine. Punch 1 if it is installed <u>and</u> used by the object program. Otherwise, leave blank.
11	1, 2, or blank	Form of RPG-generated output. Punch 1 for an Autocoder-language symbolic program deck. Punch 2 for the <u>load-and-go</u> option (the machine-language object program is stored on the systems pack.) Leave blank for a condensed, machine-language program deck.
12	3 or blank	Punch unit for RPG-generated output. Punch 3 or 1444. Leave blank for 1442 or 1402.
13	blank	Leave blank.
14-17	Card, Disk or Tape	Input-file medium when running object program.
18	1, 2, or N	IBM 1440 Printer size of object machine. If printed output was specified, punch 1 for an IBM 1443 Printer with 120 print positions; punch 2 for an IBM 1443 Printer with 144 print positions. If no printed output was specified, punch N. IBM 1401 or 1460 Printer size of object machine. If printed output was specified, punch 1 for an IBM 1403 Printer, Model 1 (100 print positions); punch 2 for an IBM 1403 Printer, Model 2 or IBM 1404 Printer (132 print positions). If no printed output was specified, punch N.
19	1, 2, 3, or N	IBM 1440 Punched-card output from object program. Punch 1 for punched output on IBM 1442 unit no. 1; punch 2 for punched output on unit no. 2; punch 3 for punched output on 1444. Otherwise punch N.
20	D or N	IBM 1440 Punched-card output from object program. Punch 1 for card output. Otherwise punch N. Disk-storage output from object program. Punch D for disk output. Otherwise punch N. Note: If the object program is to write no disk output, leave columns 21-75 blank.

Columns	Contents	Explanation
21	0, 2, 4, 6, or 8	IBM 1311 Disk drive-control number. For disk output from object program, punch the drive-control number of the IBM 1311 on which the output pack will be mounted.
	[†] 0, B, D, F or H	IBM 1301 Disk module-control number. For disk output from object program, punch module-control number of the IBM 1301 disk module to be used.
22-27	SSSSSS	Lower-limit sector address for disk-output file.
28-33	SSSSSS	Upper-limit sector address for disk-output file.
34-37	xx00	Block length in characters for disk output, in multiples of 100. To obtain this length, compute the block length and use the next higher multiple of 100. The maximum is 9900. If disk-output records are not blocked, punch record length in the next higher multiple of 100.
38-40	xxx	Record length in characters for disk output. If the records are blocked, this length must include the record-mark position. Punch 000 for 1,000-character records (the maximum).
41-42	01-99	Blocking factor for disk output. Punch 01 if disk-output records are not blocked (one record per block). The maximum is 99.
43	b	Leave blank.
44	1 or b	Label option for disk output. Punch 1 if the object program is to check the output pack's label track and write an IBM 1311 standard disk header label. Otherwise, leave blank.
45-75	blank	Leave blank.
76-80	xxxxx	User's program identification. RPG and Autocoder will include this information in the object program.

TAPOUT CONTROL CARD

RPG requires this card to generate an object program that writes magnetic-tape output. In this card the user punches these general specifications for his tape output file:

Columns	Contents	Explanation
1-6	TAPOUT	Identification of this card.
7	1-6	Tape unit number. For 1440, punch 1 or 2. For 1401 or 1460, punch 1-6.
8-11	xxxx	Block length in characters. If output tape records are to be unblocked, punch the record length here also. Maximum length is 9999.

Columns	Contents	Explanation
12-14	xxx	Record length in characters. If the records are blocked, this length must include the record-mark position. Punch 000 for 1,000-character records (the maximum).
15-16	01 to 99	Blocking factor. Punch 01 for unblocked records (one record per block). The maximum is 99.
17	x	Padding character. Any of the 64 standard BCD Interchange Code characters can be used, except these: asterisk, substitute blank, group mark, record mark, tape mark, and word separator.
		Note: If the object program is not to check and write an output-tape header label, leave columns 18-22 blank.
18	3 or blank	Label option. Punch 3 to specify that the object program is to automatically (1) read and check the old header label (to ensure that the output reel contains no unexpired data), and (2) write an IBM standard header label.
19-21	080, 084, 120, or blank	Header-label length. If the object program is to check and write an IBM standard header label, indicate the label length.
22	Y, N, or blank	Label tape mark. If a 120-character header label is to be written, punch Y. This will cause the object program to write a tape mark following the label. If an 80- or an 84-character header label is to be written, punch N. This will not cause a tape mark to be written following the label.

TAPIN CONTROL CARD

RPG requires this card to generate an object program that processes a magnetic-tape input file. In this card the user punches these general specifications for his tape input file:

Columns	Contents	Explanation
1-5	TAPIN	Identification of this card.
6	1-6	Tape unit number. For 1440, punch 1 or 2. For 1401 or 1460, punch 1-6.
7-11	xxxxx	Block length in characters. If the records are unblocked, punch the record length here also. The maximum is 09999.
12-15	xxxx	Record length in characters. If the records are blocked, this length must include the record-mark position. The maximum is 1000.
16-17	01-99	Blocking factor. Punch 01 for unblocked records (one record per block). The maximum is 99.
		Note: If the tape input file has no header label, leave columns 18-22 blank.

Columns	Contents	Explanation	Columns	Contents	Explanation
18	1, 2, 3, or blank	Header-label-check option. Punch 1 to cause the object program to skip a header label. Punch 2 to cause the object program to check the file-identification field of an IBM standard header label. Punch 3 to cause the object program to perform the same ALL label checking as the 1311 IOCS routines.	5-8	xx00	Block length in characters, the maximum length is 9900 characters. Any length specified must be a multiple of 100. To obtain this length, compute the block length and use the next higher multiple of 100. If the records are unblocked, punch the record length here in the next multiple of 100.
19-21	080, 084, 120, or blank	Header-label length. If the tape input file contains an IBM standard tape header label that is to be automatically skipped or checked, punch the label length here.	9-11	xxx	Record length in characters. If the records are blocked, this length must include the record-mark position. Punch 000 for 1,000-character master records (the maximum). Note that the maximum combined length of a master and its trailers is 1,000 characters.
22	Y, N, or blank	Label tape mark. For input files with IBM standard tape header labels that are 80 or 84 characters long, punch Y if a tape mark exists following the label. If no tape mark follows the 80 or 84 character label, punch N. Leave blank if 120-character label was specified. (RPG assumes a Y if the label length is specified as 120.)	12-13	01-99	Blocking factor. Punch 01 for unblocked master records (one master per block). The maximum is 99.
			14	b or C	Direct addressing. Leave blank if direct addressing is used for the disk input file. Punch C for a chained file.

MAS CONTROL CARD

RPG can process an input file contained in as many as five IBM 1311 disk packs or five IBM 1301 disk modules. When processing a random file, the entire file area must be on-line. When processing a consecutive or control-sequential file, successive disk packs can be placed on-line as needed. IBM 1311 disk sector addresses and their corresponding reference numbers are:

Disk Sector Addresses	Reference Number
000000-019999	0
020000-039999	2
040000-059999	4
060000-079999	6
080000-099999	8

IBM 1301 disk sector addresses and their corresponding references are:

Disk Sector Addresses	Reference Number
000,000-199,999	+
200,000-399,999	B
400,000-599,999	D
600,000-799,999	F
800,000-999,999	H

RPG always requires this card to generate an object program that processes an input file contained in disk storage. Punch in the MAS card this information:

Columns	Contents	Explanation
1-3	MAS	Identification of this card.
4	Y or N	Cylinder overflow. Punch Y if cylinder overflow can occur when the master portion of the input file or when a disk POR file is read. Punch N for no cylinder overflow.

15-17	xxx	Location of control data or first subfield. Punch the units-position location within the disk master record of the control data. Or, if the control data is split into two or three subfields, give the location of the most significant subfield. In determining this location, count the first character position in a disk master record as location 001.
18-19	01-30	Length of control data or first subfield. Punch the number of character positions for this field. The maximum length of the control data is 30 positions.
20-22	xxx	Location of second subfield. Punch the units-position location of the subfield that is second-highest in significance.
23-24	xx	Length of second subfield.
25-27	xxx	Location of third subfield. Punch the units-position location of the least-significant subfield.
28-29	xx	Length of third subfield.

Note: The number of master-record packs or modules in the input file (from 1 to 5) determines how many drive-control and address-reference numbers to punch in columns 30-39. For example, if the master records are contained in one pack, punch columns 30 and 31, leaving 32-39 blank. Numbers 0, 2, 4, 6, or 8 refer to IBM 1311 Disk Storage Drives, whereas +, B, D, F, or H refer to IBM 1301 Disk Storage Modules.

Columns	Contents	Explanation	Columns	Contents	Explanation
30	0, 2, 4, 6, 8 (for 1311) or 0, B, D, F, H (for 1301)	Drive-control number of IBM 1311 Disk Storage Drive or IBM 1301 Disk Storage Module on which the (first, if there is more than one) master-record pack is mounted or master-record module is located.	9-11	xxx	Record length in characters of each individual trailer record. If the records are blocked, this length must include the record-mark position. Note that the maximum combined length of a master and its trailers is 1,000 characters.
31	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the (first, if there is more than one) master-record pack or module.	12	0-9	Blocking factor. Punch 0 for unblocked trailer records (one trailer per block), 1 for two trailers per block, and so on. Punch 9 for ten trailers per block, which is the maximum.
32	0, 2, 4, 6, 8 or 0, B, D, F, H	Drive-control number for the second master-record pack or module.	13-14	01-99	Maximum number of trailers per master. Punch 02 for an input file having zero, one, or two trailer records per master record. There can be as many as 99.
33	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the second master-record pack or module.	15-17	xxx	Location of control data or first subfield. Punch the units-position location within the trailer record of the control data. Or, if the control data is split into two or three subfields, give the location of the most significant subfield. In determining this location, count the first character position in a trailer record as location 001.
34	0, 2, 4, 6, 8, or 0, B, D, F, H	Drive-control number for the third master-record pack or module.	18-19	01-30	Length of control data or first subfield. Punch the number of character positions for this field. The maximum length of the control data is 30 positions.
35	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the third master-record pack or module.			Note: If the control data is contained in only one field (not split into subfields), leave columns 20-29 blank.
36	0, 2, 4, 6, 8, or 0, B, D, F, H	Drive-control number for the fourth master-record pack or module.	20-22	xxx or blank	Location of second subfield. Punch the units-position location of the subfield that is second-highest in significance.
37	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the fourth master-record pack or module.	23-24	xx or blank	Length of second subfield.
38	0, 2, 4, 6, 8, or 0, B, D, F, H	Drive-control number for the fifth master-record pack or module.	25-27	xxx or blank	Location of third subfield. Punch the units-position location of the least-significant subfield.
39	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the fifth master-record pack or module.	28-29	xx or blank	Length of third subfield.
40	1, 2, 3, or b	Header-label-check option. Punch 1 for no header-label checking. Punch 2 for automatic checking of the file-identification field (field 4). Punch 3 for automatic checking of fields 1-7. This entry applies only to IBM 1311 Disk Storage. Leave blank when using IBM 1301 Disk Storage.			

TRL CONTROL CARD

RPG requires this card to generate an object program that processes trailer records of a randomly organized disk input file. Punch this information in the card:

Columns	Contents	Explanation	Columns	Contents	Explanation
1-3	TRL	Identification of this card.	30	0, 2, 4, 6, 8 (for 1311) or 0, B, D, F, H (for 1301)	Drive-control number of IBM 1311 Disk Storage Drive or IBM 1301 Disk Storage Module on which the (first, if there is more than one) master-record pack is mounted or master-record module is located.
4	Y or N	Cylinder overflow. Punch Y if cylinder overflow can occur when the trailer-record portion of the input file is read. Punch N for no cylinder overflow.	31	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the (first, if there is more than one) master-record pack or module.
5-8	xx00	Block length in characters in multiples of 100. To obtain this length, compute the block length and use the next higher multiple of 100. The maximum is 9900. If the records are unblocked, punch the record length here also in the next higher multiple of 100.	32	0, 2, 4, 6, 8 or 0, B, D, F, H	Drive-control number for the second master-record pack or module
			33	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of the second master-record pack or module.

Columns	Contents	Explanation	Columns	Contents	Explanation
34	0, 2, 4, 6, 8, or 0̣ B, D, F, H	Drive-control number for the third master-record pack or module.	11-13	xxx or blank	Record length in characters. For POR's in disk storage, specify the record length. The maximum is 900 characters for disk POR's. For tape POR's the maximum is 1000 characters (punch 000 for maximum tape).
35	0, 2, 4, 6, 8, or 0̣ B, D, F, H	Address-reference number of the third master-record pack or module.			
36	0, 2, 4, 6, 8, or 0̣ B, D, F, H	Drive-control number for the fourth master-record pack or module.	14-15	01-99 or blank	Blocking factor. Punch 01 for unblocked POR's (one POR per block) on disks or tape. When using the Sort 5 tag table or Sort 6, punch 01. The maximum factor for disk is 10, for tape 99.
37	0, 2, 4, 6, 8, or 0̣ B, D, F, H	Address-reference number of the fourth master-record pack or module.			
38	0, 2, 4, 6, 8, or 0̣ B, D, F, H	Drive-control number for the fifth master-record pack or module.	16	1, 2, or 3	Processing-order mode of the disk input file. Punch 1 for random, 2 for control-sequential, or 3 for consecutive.
39	0, 2, 4, 6, 8, or 0̣ B, D, F, H	Address-reference number of the fifth master-record pack or module.			
40	1, 2, 3, or blank	Header-label-check option. Punch 1 for no header-label checking. Punch 2 for automatic checking of the file-identification field (field 4). Punch 3 for automatic checking of fields 1-7. This applies only to IBM 1311 Disk Storage. Leave blank when using IBM 1301 Disk Storage.	17	1 or 2	Contents of POR's. Punch 1 for control data or 2 for disk addresses.
			18-19	01-30 or blank	Length of control data in characters. If POR's contain control data, specify the number of characters (30 is the maximum). Otherwise, leave blank.
			20	Y or N	Control-data conversion. If POR's contain control data, punch Y if conversion to disk addresses is required. Otherwise, punch N.
			21	6, 7, or 8	Length of disk addresses. If POR's contain disk addresses, specify the length (6, 7, or 8). Or, if POR's contain control data that requires conversion to disk addresses, specify the length (6, 7, or 8) of the resulting disk addresses. Six-digit addresses apply to POR's for an unblocked disk-input file. Seven-digit addresses apply to POR's for a blocked disk-input file where the blocking factor ranges from 2 to 10. Eight-digit addresses apply if the POR file consists of the sorted tag table produced by the IBM Sort 5 or Sort 6 program or if the blocking factor is greater than 10.

POR CONTROL CARD

RPG requires this card to generate an object program that processes a disk-storage input file. In this card the user defines his processing-order file (including processing limits cards). Punch this information in the POR card:

Columns	Contents	Explanation	Columns	Contents	Explanation
1-3	POR	Identifies the card.			
4	C, D, or T	Medium of POR file. If POR's are punched in cards, punch C; if written in disk storage, punch D; if written on magnetic tape, punch T.			
			22-24	xxx	Location of first field. Punch the units-position location within the POR of the first data record's address or control-data field. Note that, for POR's containing only one field per record, this is the location of the only field in a POR. However, for spread POR's, as well as for processing-limits cards, this is the location of the first field within a POR.
5	0, 2, 4, 6, 8 or 0, B, D, F, H	Drive-control number of the 1311 on which the POR-file pack will be mounted, or the disk module of the 1301 which contains the POR file.			
	1-6	Tape unit number. For 1440, punch 1 or 2. For 1401 or 1460, punch 1-6.	25-26	xx or 00	Distance between fields. For POR's with more than one address or control-data field per record, specify the distance between consecutive address or control-data fields. Use the arithmetic difference between the units-position locations of the fields. This applies to spread POR's used in the random mode and to processing-limits cards used in both the consecutive and the control-sequential modes. Punch 00 for a POR file that contains only one field per POR.
	blank	Leave column 5 blank if POR's are contained in cards.			
6	0, 2, 4, 6, 8, or 0, B, D, F, H	Address-reference number of 1311 POR-file pack or 1301 module.			
	blank	Leave column 5 blank if POR's are contained on cards or tape.			
7-10	xxxx or blank	Block length in characters. Any length specified must be a multiple of 100. To obtain this length, compute the block length and use the next higher multiple of 100. The maximum length for POR's on disk is 1000, for POR's on tape 9,999.	27-28	xx	Maximum number of fields per POR. Punch the maximum number of fields per POR. For processing-limits cards, 02 should be entered.

Columns	Contents	Explanation
29-31	xxx or bbb	Location of next-record field. If the disk input file contains a next-record (NR) field that will be used to identify the next record to be processed, punch the units-position location within the disk record of this NR field. Note that, if the NR field is in the first trailer record, the location to be punched is reckoned from master-record position 001. Leave blank if no NR field is to be used. Note: When using the control-sequential mode of processing, do not specify a NR field.
32-33	01-30 or bb	Length of next-record field. The maximum is 30 characters for control data. Leave blank if no NR field is to be used.
34	Y, N or blank	Convert next-record field. If the NR field contains control data that must be converted to disk addresses, punch Y. If it contains disk addresses, punch N. If no NR field is to be used, leave blank.
35	blank, 1, 2, or 3	Header-label-check option. RPG provides automatic label checking of IBM 1311 standard disk header labels and IBM standard tape header labels for POR files contained in disk storage and on magnetic tape. These are the options:
	blank	Tape POR file without a label, leave blank.
	blank	Disk POR file with or without a label, for no checking leave blank.
	1	Tape POR file with a label, to skip the label punch 1.
	2	Disk or tape POR file with a label, to check the file-identification field punch 2.
	3	Disk POR file with a label or tape POR file with a type A (120-character), or B (80-character) label, to check fields 1-7 punch 3.
	3	Tape POR file with a type C (84-character) label, to check fields 1-8 punch 3.
36-38	080, 084, 120, or blank	Header-label length. If the POR file is a labeled tape file, punch the label length (080, 084, or 120 characters). Otherwise, leave blank.
39	Y, N or blank	Label tape mark. For a tape POR file with either an 80- or an 84-character header label, punch Y if a tape mark follows the label; punch N if no tape mark follows the label. A Y is always assumed for 120-character POR tape header label. For POR's contained in punched cards or disk storage, leave blank.

RPG TRANSLATOR PROGRAM

Two previous publications, Report Program Generator for IBM 1401 Card and Tape Systems (Form J24-0215) and Report Program Generator for IBM RAMAC® 1401 Systems (Form J24-1467), present the Report Program Generator 1401 card-oriented, tape-oriented, and disk-storage (IBM 1405) oriented

systems. For a shorter reference, consider that program to be 1401 RPG.

In anticipation of the needs of present users of 1401 RPG who will have IBM 1401's or 1460's equipped with IBM 1311's, IBM provides the RPG Translator program. The function of this program is to translate programs written for 1401 RPG to corresponding programs acceptable to 1401-1311, 1460-1301, or 1460-1311. Programs that RPG Translator can thus translate are 1401 RPG programs for processing card input files and magnetic-tape input files that consist of fixed-length records.

Note: Programs for IBM 1405 disk files and variable-length-record tape files cannot be translated by RPG translator.

The RPG Translator requires one control card. In it, the user specifies whether he wants a listing. The listing usually consists of two lines for each source card. The first line contains the specification from the source card, and the second line contains the translated specification punched in the output card.

Using an IBM 1401 system, this is how the RPG translator program works:

The user loads the RPG Translator program in the 1401. He puts the 1401 RPG source deck in the 1402 read feed. (The source deck consists of the RPG specifications cards that were punched from the Input, Data, Calculation, and Format Specifications sheets.)

When the user starts executing the RPG Translator program, it reads a source card, translates the specification into the language (and the form) of RPG (on Disk), and punches the translated specification in an output card. If the user chose the option to print a listing, the program prints on the IBM 1403 or 1404 Printer the two lines of information, previously mentioned. On the listing, the second line is offset to the right 20 print positions with respect to the first line.

SPECIAL FEATURE SPECIFICATIONS

An IBM 1401 or 1460 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.

Six sample programs and the necessary control cards for each program are included in this section. Two programs use card input files (Figures 50-59 and Figures 60-67). An RPG program which uses a tape input file is shown in Figures 68-76. This example also shows part of the program listing which is produced when the object program is generated.

Three examples of RPG programs using disk input files (control-sequential, consecutive, and random) are included in this section. In the random example, a sorted tag table, produced by an intermediate phase of an IBM 1311 Sort program, is used as the POR file.

This program requires one control card, the RPG Control Card. In it the user punches:

Column	Contents	Explanation
1-3	RPG	Identifies the card.
4	2	An 8K machine is used to generate the object program.
5	2	An 8K machine is used to execute the program.
7	1	Multiply-divide special feature is installed.
9	1	Modify-address is present on object machine.
11	blank	The form of RPG-generated output is a condensed machine-language deck.
12	blank	Punch unit is 1402.
14-17	CARD	Input-file is on cards.
18	2	Printer size is 132.
19	N	No punched output.
20	N	No disk output.

CARD INPUT FILE
MONTHLY EXPENSE DISTRIBUTION REPORT

For this report, the input file is contained in a card file as shown in Figure 50. The user lays out the format of his report on the printer spacing chart (Figure 51). Figures 51-58 show the specifications sheets necessary to generate an RPG program which will produce the report. Figure 59 shows the printed report.

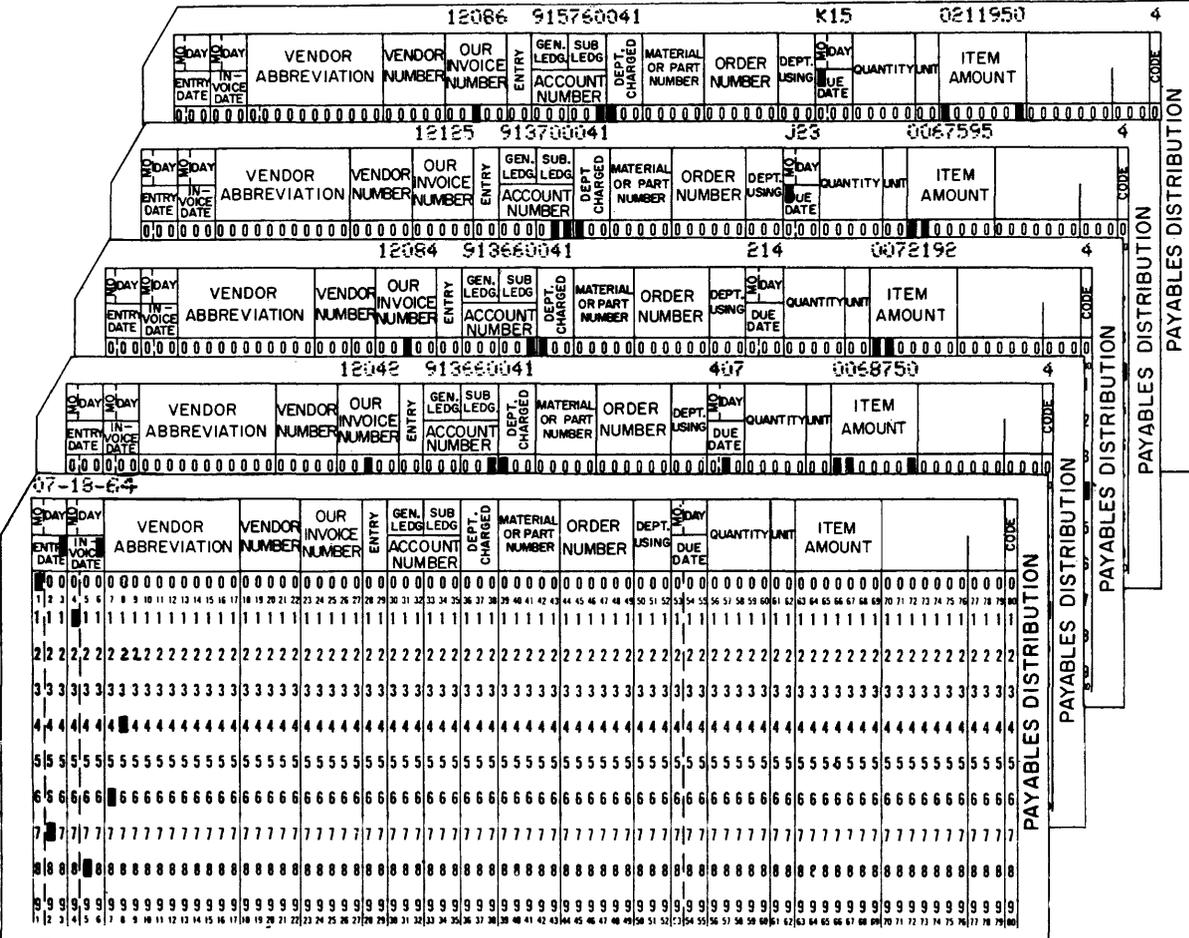


Figure 50. Cards from Input File for Monthly Expense Distribution Report



INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 407, 408, 409, 1403 AND 1404 PRINTER SPACING CHART
 6 Lines Per Inch

Form X24-6436
 Printed in U. S. A.

LINE DESCRIPTION	FIELD HEADINGS/WORD MARKS	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															
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47															
48															
49															
50															
51															

DUAL-SPEED CARTRIDGE (IBM 1403, 1404)		
Punch only one channel per line. Holes in the same channel should be punched at least 8 lines apart.		
MEASUREMENTS	FORM WIDTHS	COMMONLY USED FORM DEPTHS
Horizontal spacing 1/10"	Min. 3 1/4"	3 1/4", 3 1/2", 3 3/4", 5 1/2", 6"
Vertical spacing 1/6"	Max. 18 3/4"	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.		

Figure 51. Spacing Chart for Monthly Expense Distribution Report
 64 RPG (on Disk) Specs., 1401, 1440, and 1460

Figure 55. Format Specifications for Monthly Expense Distribution Report



INTERNATIONAL BUSINESS MACHINES CORPORATION

REPORT PROGRAM GENERATOR FORMAT SPECIFICATIONS

Report Monthly Expense Distribution Rpt.

IBM 1401 - 1440 - 1460

Form X24-6593
Printed in U. S. A.

Page 015 of 08
Date 76 77

Programmed by _____

LINE	OUT-PUT	NEXT LINE	SPACE	SKIP	LINE OUTPUT CONDITIONS						FIELD NAME	FIELD END	FIELD OUTPUT CONDITIONS						CONSTANT OR EDIT CONTROL WORD	CARD NUMBER																															
					COND	A	COND	A	COND	COND			COND	A	COND	A	COND	COND			ZERO SUPPRESS																														
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	75	78	80													
LH	AA	X											0	1	0	2																						0	1	0											
K																																								0	2	0									
K																																										0	3	0							
LH	BB	X																																								0	4	0							
F																																												0	5	0					
F																																													0	6	0				
F																																													0	7	0				
F																																													0	8	0				
F																																													0	9	0				
LH	CC	X											0	1																																1	0	0			
F																																															1	1	0		
F																																															1	2	0		
F																																																1	3	0	
F																																																1	4	0	
LH	DD	X											0	1																																		1	5	0	
F																																																1	6	0	
F																																																	1	7	0
F																																																	1	8	0
F																																																	1	9	0
LH	EE	X											0	1																																			2	0	0

MONTHLY EXPENSE DISTRIBUTION REPORT

REPORT DATE 07-18-64 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 59. Monthly Expense Distribution Report (Part 1 of 3)

MONTHLY EXPENSE DISTRIBUTION REPORT

REPORT DATE 07-18-64 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 59. Monthly Expense Distribution Report (Part 2 of 3)

		REPORT DATE 07-18-64		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 59. Monthly Expense Distribution Report (Part 3 of 3)

CARD INPUT FILE INVOICE PREPARATION

Figures 60-67 show the card input file, the printer spacing chart, the RPG specifications sheet, and the printed output for this Invoice Preparation report. One control card, the RPG control card, is required. In it, the user punches information about his data processing system.

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>	<u>Columns</u>	<u>Contents</u>	<u>Explanation</u>
7	1	Multiply-divide special feature is installed on the object machine.	7	1	Multiply-divide special feature is installed on the object machine.
9	1	Modify-address feature is installed on object machine.	9	1	Modify-address feature is installed on object machine.
11	1	The form of the RPG-generated output is an Autocoder-language symbolic deck.	11	1	The form of the RPG-generated output is an Autocoder-language symbolic deck.
12	blank	Punch unit is 1402.	12	blank	Punch unit is 1402.
14-17	CARD	Input file is in cards.	14-17	CARD	Input file is in cards.
18	2	Printer size is 132.	18	2	Printer size is 132.
19	N	No punched card output.	19	N	No punched card output.
20	N	No disk storage output.	20	N	No disk storage output.



LINE DESCRIPTION

FIELD HEADINGS/WORD MARKS

INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 407, 408, 409, 1403 AND 1404 PRINTER SPACING CHART
6 Lines Per Inch

Form X244436
Printed in U.S.A.

Printing span:

← IBM 1403, Model 1
← IBM 407, 408, 409
← IBM 1403 & 1404, Model 2

LINE	DESCRIPTION	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1															
2															
3															
4															
5															
6															
7															
8	HAA	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX
9	HBB	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX
10	HCC	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX
11															
12															
13															
14	HDD	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX
15															
16															
17															
18	HEE	XXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXX
19															
20															
21															
22															
23	TAA	XXXXXXXX	XX	XX	XX	XXXX	XXXX	XXoXXX	X,XXo.XX						
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34	TBB														
35															
36	TCC														
37															
38	TDD														
39															
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41															
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120															
121															
122															
123															
124															
125															
126															
127															
128															
129															
130															
131															

Figure 61. Spacing Chart for Invoice Preparation
76 RPG (on Disk) Specs., 1401, 1440, and 1460

**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 25,64
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.
03/15/64 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			\$ 33.29CR
	NET AMT			\$ 1,631.32*

REPRESENTATIVE COMPANY

	FIN TOT	JUL 25,64	\$	74,921.35**
--	---------	-----------	----	-------------

Figure 67. Invoice Report

TAPE INPUT FILE EXAMPLE

In this example, the user's input file is on tape. He wants a printed report as shown on the Printer Spacing chart (Figure 69). He also wants to write part of the report on tape for future use. (See line 190 of Figure 73 and line 060 of Figure 74.) Figures 68-76 show the tape input file, the Printer Spacing chart, the RPG specifications sheets, part of the program listing which is produced when the object program is generated, and the printed report. Tape output for this program is not shown.

RPG requires three control cards for this program: RPG, TAPOUT, and TAPIN.

RPG Control Card

Column	Contents	Explanation
1-3	RPG	Identifies the card.
4	2	An 8K machine is used to generate the object program.
5	2	An 8K machine is used to execute the object program.
7	1	Multiply-divide special feature is installed on the object machine.
8	1	Advanced programming special feature is installed on the object machine.
9	1	Modify address is installed on the object machine.
11	blank	Condensed deck output.

Columns	Contents	Explanation
14-17	TAPE	Input file is on tape.
18	2	Printer size is 132.
19	N	No punched card output.
20	N	No disk output.
76-80	PUBNF	Program identification.

TAPOUT Control Card

Column	Contents	Explanation
1-6	TAPOUT	Identifies the card.
7	2	Tape unit number.
8-11	0120	Block length.
12-14	120	Record length.
15-16	01	Blocking factor.
17	blank	Padding character.

TAPIN Control Card

Columns	Contents	Explanation
1-5	TAPIN	Identifies the card.
6	1	Tape unit number.
7-11	00240	Block length.
12-13	0080	Record length.
16-17	03	Blocking factor.
18	1	No label option

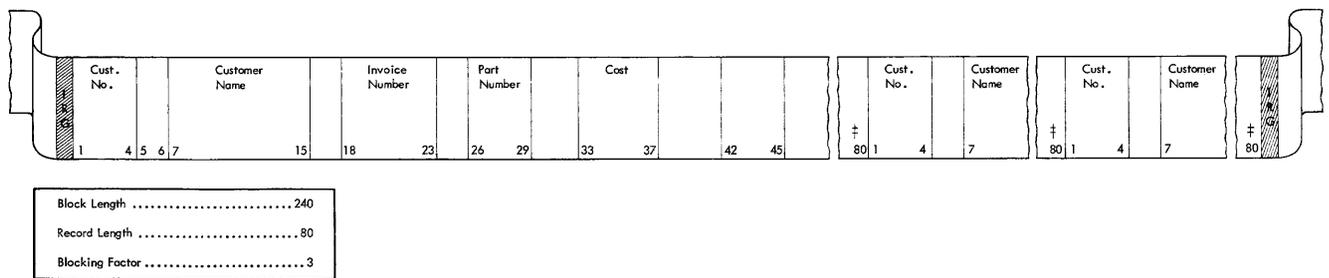
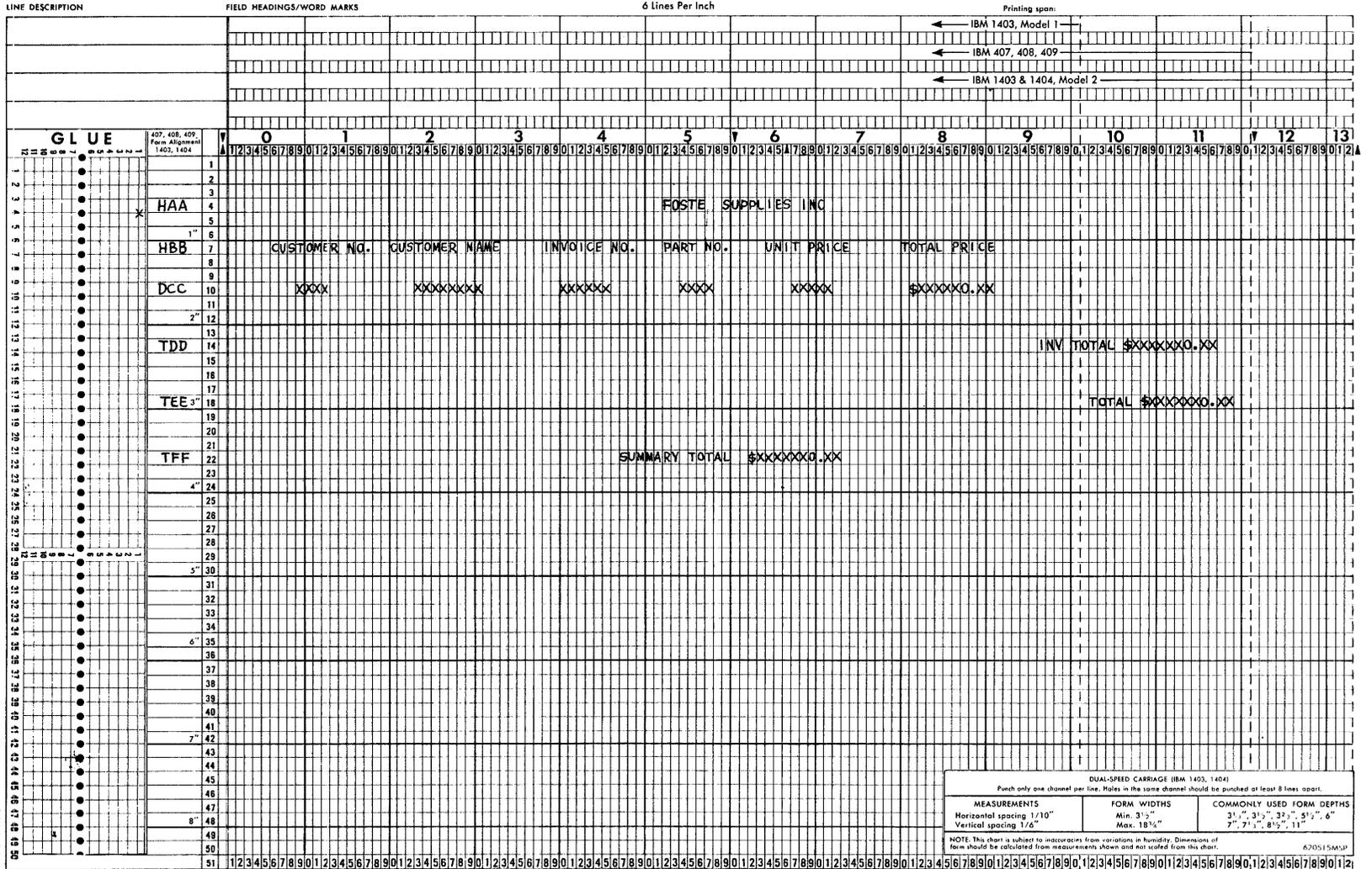


Figure 68. Tape Input File

Figure 69. Printer Spacing Chart



INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 407, 408, 409, 1403 AND 1404 PRINTER SPACING CHART
6 Lines Per Inch



1401/60 RPG EDIT LISTING

CD	PAGE	SEQ NO	LINE	CARD IMAGE	DIAGNOSTIC
		1	1010	TAAN 001NC	010230600404
				*	
		2	2010	DCUSTN000400	TAA 004
		3	2020	DCUSTNAD09 804	TAA 015
		4	2030	DINNUM00600	TAA 023
		5	2040	DPTNUM00400	TAA 029
		6	2050	DPRICE 00502	TAA 037
		7	2060	DQUANTY00300	TAA 045
				*	
		8	3010	AMULT 00802	PRICE XQUANTY& D
		9	3020	AINVTOT00902	MULT A D
		10	3030	ACUSTOT00902	MULT A D
		11	3040	AREGION00902	MULT A D
		12	4010	LHAAX 0101	IP
		13	4015	L	OF
		14	4020	K	
		15	4030	LHBBX 02	IP 070
		16	4035	L	OF
		17	4040	K	017
		18	4050	K	032
		19	4060	K	048
		20	4070	K	059
		21	4080	K	073
		22	4090	K	090
		23	4100	LDCCX 02	01
		24	4110	F	CUSTND012
		25	4120	F	CUSTNA030
		26	4130	F	INNUM045
		27	4140	F	PTNUM057
		28	4150	F	PRICE 071
		29	4155	F	MULT 090
		30	4160	LTDDX T 03	FIN04
		31	4165	L	LC
		32	4170	K	104
		33	4180	B	INVTOT116
		34	4190	LTEEX 03	F2N04
		36	4200	K	106
		37	4210	B	CUSTOT118
		38	4220	LTFFX T 03	LC
		39	4230	K	059
		40	4240	B	REGION072

RPG CONTROL CARD	COL.	INFORMATION	PUNCHED
	1-3	CTL. CARD IDENT.	RPG
	4	MACH. SIZE GEN. PROG.	2
	5	MACH. SIZE OBJ. PROG.	2
	6	SENSE SWITCHES	-NO-
	7	MULTIPLY-DIVIDE	-YES-
	8	ADVANCED PROGRAMMING	-YES-
	9	MODIFY ADD FEATURE	-YES-
	10	DIRECT SEEK	-YES-
	11	CONDENSED DECK	-YES-
	14-17	INPUT MEDIA	TAPE
	18	PRINTER OUTPUT	132
	19	PUNCH OUTPUT	-NO-
	20	DISK OUTPUT	-NO-
	76-80	IDENTIFICATION	PUBNF

TAPOUT CONTROL CARD	COL.	INFORMATION	PUNCHED
	1-6	CTL. CARD IDENT.	TAPOUT
	7	TAPE UNIT NUMBER	2
	8-11	BLOCK LENGTH	0120
	12-14	RECORD LENGTH	120
	15-16	BLOCKING FACTOR	01
	17	PADDING CHARACTER	-BLANK-
	18	LABEL OPTION	-NONE--
	76-80	PROGRAM IDENTIFICATION	

TAPIN CONTROL CARD	COL.	INFORMATION	PUNCHED
	1-5	CTL. CARD IDENT.	TAPIN
	6	TAPE UNIT NUMBER	1
	7-11	BLOCK LENGTH	00240
	12-15	RECORD LENGTH	0080
	16-17	BLOCKING FACTOR	03
	18	LABEL OPTION	-NONE-
	76-80	PROGRAM IDENTIFICATION	

ORDERED CALC SPECS

001	AMULT 00802	PRICE XQUANTY&	D
002	AINVTOT00902	MULT A	D
003	ACUSTOT00902	MULT A	D
004	AREGION00902	MULT A	D

UNDEFINED CONDITIONS

NONE

Figure 75. Part of Printout from RPG Assembly (Part 1 of 2)

```

                                RESULTING CONDITIONS
F1 S00          F2 S01          F3 S02          F4 S03          F5 S04
F6 S05          LC S06          1P S07          00 S08          0F S09
SB S10          SC S11          SD S12          04 S13          01 S15

```

```

                                LITERALS AND CONSTANTS
ADDRESS  DESCRIPTION
LABEL   LEN DEC  TYPE
S16     19      ALPHANUMERIC  FOSTER SUPPLIES INC
S17     12      ALPHANUMERIC  CUSTOMER NO.
S18     13      ALPHANUMERIC  CUSTOMER NAME
S19     11      ALPHANUMERIC  INVOICE NO.
S20     08      ALPHANUMERIC  PART NO.
S21     10      ALPHANUMERIC  UNIT PRICE
S22     11      ALPHANUMERIC  TOTAL PRICE
S23     10      ALPHANUMERIC  $ 0.
S24     09      ALPHANUMERIC  INV TOTAL
S25     11      ALPHANUMERIC  $ 0.
S26     05      ALPHANUMERIC  TOTAL
S25     11      ALPHANUMERIC  $ 0.
S28     13      ALPHANUMERIC  SUMMARY TOTAL
S25     11      ALPHANUMERIC  $ 0.
CUSTNO  S30     04 0  NUMERIC
CUSTNA  S31     09      ALPHANUMERIC
INVNUM  S32     06 0  NUMERIC
PTNUMR  S33     04 0  NUMERIC
PRICE   S34     05 2  NUMERIC
QUANTY  S35     03 0  NUMERIC
MULT    S36     08 2  NUMERIC
INVTOT  S37     09 2  NUMERIC
CUSTOT  S38     09 2  NUMERIC
REGION  S39     09 2  NUMERIC
FIELD1  S39     06      NUMERIC
FIELD2  S39     04      NUMERIC

```

END OF RPG

BEGIN AUTOCODER

Figure 75. Part of Printout from RPG Assembly (Part 2 of 2)

FOSTE SUPPLIES INC					
CUSTOMER NO.	CUSTOMER NAME	INVOICE NO.	PART NO.	UNIT PRICE	TOTAL PRICE
1111	ANDERSON	000111	1111	25050	\$ 36072.00
1111	ANDERSON	000111	2222	52050	\$ 62460.00
1111	ANDERSON	000111	3333	22022	\$ 5285.28
					INV TOTAL \$ 103817.28
1111	ANDERSON	000222	3333	22022	\$ 5285.28
1111	ANDERSON	000222	1000	45050	\$ 10812.00
1111	ANDERSON	000222	2500	10000	\$ 20000.00
					INV TOTAL \$ 36097.28
					TOTAL \$ 139914.56
2222	BRANDONS	111222	4444	25075	\$ 31031.00
2222	BRANDONS	111222	5555	85025	\$384313.00
2222	BRANDONS	111222	6666	11185	\$ 12303.50
					INV TOTAL \$ 427647.50
2222	BRANDONS	111755	6666	12285	\$ 13513.50
					INV TOTAL \$ 13513.50
2222	BRANDONS	252889	9999	22525	\$ 45050.00

FOSTE SUPPLIES INC					
CUSTOMER NO.	CUSTOMER NAME	INVOICE NO.	PART NO.	UNIT PRICE	TOTAL PRICE
					INV TOTAL \$ 45050.00
2222	BRANDONS	258456	9999	10225	\$ 20450.00
					INV TOTAL \$ 20450.00
					TOTAL \$ 506661.00
SUMMARY TOTAL \$ 646575.56					

Figure 76. Printed Report

CONTROL-SEQUENTIAL DISK INPUT FILE

Figures 77-84 are an example of a disk input file (control-sequential mode) used for input in an RPG program. The file consists of 100-character, unblocked disk records. The main file area is stored from disk locations 001200 to 011199. Additions records are stored from locations 000100 to 001099. A single processing limits card is required for the POR.

Three control cards and one processing limits card are required for this program.

RPG Control Card

<u>Columns</u>	<u>Contents</u>	<u>Explanation</u>
1-3	RPG	Identifies the card.
4	2	An 8K machine is used to generate the object program.
5	2	An 8K machine will be used to execute the object program.
7	1	Multiply-divide special feature is installed.
9	1	Modify-address feature is installed on object machine.
14-17	DISK	Input file is on disk.
18	2	Printer size is 132.
19	N	No punched output.
20	N	No disk output.

Columns 21-75 are blank. There is no disk output.

MAS Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	MAS	Identifies the card.
4	N	No cylinder overflow.
5-8	0100	Block length.
9-11	100	Record length.
12-13	01	Blocking factor.
30	0	Drive control number.
31	0	Address reference number.

POR Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	POR	Identifies the card.
4	C	POR's are punched in cards.
16	2	Processing-order mode is control-sequential.
17	2	Contents of POR's are disk addresses.
20	N	No conversion to disk addresses.
21	6	Length of disk addresses.
22-24	006	Units position of first field.
25-26	10	Distance between fields.
27-28	02	Maximum number of fields per POR.

Processing Limits Card

<u>Columns</u>	<u>Contents</u>	<u>Explanation</u>
1-6	001200	Lower limit of input file area.
11-16	011199	Upper limit of input file area.

DISK ADDRESS	6 7 9 MATL.	12 16 STOCK NO.	19 23 UNIT COST	26 DESCRIPTION	49	52 55 OLD BAL	58 61 RECPTS.	64 67 REQNS.	70 73 ON HAND	76 79 ON ORDER	82 85 MIN. INV.	88 91 AVAIL.	95 100 SEQUENCE LINK
001200	011199000055			(Dummy Record - Positions 14-94 are blank)									000101
001201	301	29648	00714	C D BRASS		0637	0000	0013	0624	0000	0081	0543	
001202	301	30623	01270	H H CLOCK BRASS		0060	0100	0066	0094	0000	0073	0021	
001203	301	35369	00324	BRASS DISC		0186	0000	0000	0186	0250	0215	0221	000103
001204	301	40732	05710	HARD SPRING BRASS		0765	0600	0207	1158	0000	0420	0738	
001205	301	41693	17500	BRASS PINION		0312	0000	0091	0221	0100	0200	0121	
001206	301	50800	00594	EXTRUDED BRASS		0854	0090	0944	0000	1000	0350	0650	
001207	301	52634	90200	BERYLLIUM COPPER		0475	0000	0283	0192	0000	0225	0033	
001208	301	60900	01565	BRONZ TUBING		0270	0500	0341	0429	0000	0274	0155	
001209	305	10005	07500	ALUMINUM CASTING		4210	0000	0060	4150	0000	0295	3955	
001210	305	20012	08400	ALUMINUM ALLOY CAST		0455	5340	0710	5085	0000	0322	4763	
001211	305	20023	09500	BRASS CASTING		0000	2000	0373	1627	0000	0032	1595	
001212	305	30023	64000	BRONZ ALLOY CASTING		0243	0081	0015	0309	0500	0400	0409	
000100	001099000000			(Dummy Record - Positions 14-94 and 96-100 are blank)									+
000101	301	10300	00153	BRASS ROD		1357	0345	0967	0735	3000	3100	0635	000102
000102	301	20400	00236	SOFT BRASS ROD		1130	0066	0786	0410	0000	0760	0350	001201
000103	301	38942	00683	BRASS TUBING		0923	0000	0500	0423	0000	0037	0386	001204

Figure 77. Disk Input Records for Stock Inventory Report

STOCK INVENTORY REPORT

JULY 2, 1964 - PAGE 1

MATL.	STOCK NO.	DESCRIPTION	UNIT COST	QUANTITY ON HAND	ON HAND COST
301	10300	BRASS ROD	1.53	735	1,124.55
301	20400	SOFT BRASS ROD	2.36	410	967.60
301	29648	C D BRASS	7.14	624	4,455.36
301	30623	H H CLOCK BRASS	12.70	94	1,193.80
301	35369	BRASS DISC	3.24	186	602.64
301	38942	BRASS TUBING	6.83	423	2,889.09
301	40732	HARD SPRING BRASS	57.10	1,158	66,121.80
301	41693	BRASS PINION	175.00	221	38,675.00
301	50800	EXTRUDED BRASS	5.94		
301	52634	BERYLLIUM COPPER	902.00	192	173,184.00
301	60900	BRONZ TUBING	15.65	429	6,713.85
305	10005	ALUMINUM CASTING	75.00	4,150	311,250.00
305	20012	ALUMINUM ALLOY CAST	84.00	5,085	427,140.00
305	20023	BRASS CASTING	95.00	1,627	154,565.00

PAGE TOTAL \$1,188,882.69

STOCK INVENTORY REPORT

JULY 2, 1964 - PAGE 2

MATL.	STOCK NO.	DESCRIPTION	UNIT COST	QUANTITY ON HAND	ON HAND COST
305	30023	BRONZ ALLOY CASTING	640.00	309	197,760.00

Final Total appears on the last page

PAGE TOTAL \$X,XXX,XXX.XX
FINAL TOTAL \$XXX,XXX,XXX.XX

Figure 84. Stock Inventory Report

CONSECUTIVE DISK INPUT FILE EXAMPLE

Figures 85-90 are an example of an RPG program using a disk input file which is organized by a consecutive method of disk file organization. Each record on disk is 100-characters in length, and each record represents a particular order to the Foste Supplies Inc. The file has been previously sorted by customer number and by sales region. The disk file is located from addresses 000401 to 000600. A single processing limits card is used for the POR.

The report desired by the company is a detailed accounting of each order, a calculation of the total cost for each order, and a total cost for each customer. Figure 90 shows part of the printed report. The printer spacing chart is not shown for this program.

Three control cards and a processing limits card are required for this program.

RPG Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	RPG	Identifies the card.
4	2	An 8K machine is used to generate the object program.
5	2	An 8K machine will be used to execute the object program.
7	1	Multiply divide special feature is installed on the object machine.
9	1	Modify address instruction is installed on the object machine.
10	1	Direct Seek special feature is installed on the object machine.
14-17	DISK	Input file is on disk.
18	2	Printer size is 132.
19	N	No punched output.
20	N	No disk output.

MAS Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	MAS	Identifies the card.
4	N	No cylinder overflow.
5-8	0100	Block length.
9-11	100	Record length.
12-13	01	Blocking factor.
30	2	Drive control number.
31	0	Address reference number.

POR Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	POR	Identifies the card.
4	C	POR's are punched in cards.
16	3	Processing-order mode is consecutive.
17	2	Contents of POR's are disk addresses.
21	6	Length of disk addresses.
22-24	006	Units position of first field.
25-26	10	Distance between fields.
27-28	02	Maximum number of fields per POR.

Processing Limits Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-6	000401	Lower limit of input file.
11-16	000600	Upper limit of input file.

Figure 90. Printed Report

FOSTE SUPPLIES INC					
CUSTOMER NO.	CUSTOMER NAME	INVOICE NO.	PART NO.	UNIT PRICE	TOTAL PRICE
000111	ANSON CO	000123	100	\$ 10.00	\$ 240.00
000111	ANSON CO	000123	101	\$ 5.97	\$ 716.40
000111	ANSON CO	000125	103	\$ 1.05	\$ 151.20
000111	ANSON CO	000130		\$101.10	\$ 1213.20
					INV. TOTAL \$ 956.40
					INV. TOTAL \$ 151.20
					INV. TOTAL \$ 1213.20
					TOTAL \$ 2320.80

RANDOM DISK FILE EXAMPLE (WITH AN IBM 1311 SORT TAG TABLE AS A POR FILE)

In this example, assume that the Foste Supplies Inc. wants the same report that was used in the previous example of a Consecutive Disk Input File (Figures 85-90). In this case, the records have been placed on disk in a random method. An IBM 1311 Sort program may be used to obtain a sorted tag table. This table may then be used as the POR file for RPG processing.

The output from the sort (the user's POR file) would be located on disk in the area assigned by the user during the sort run. For example, assume that the user assigned disk locations 000000 to 000200 as his POR file area. The sort program prints out the exact lower limit of the sorted tag table (for example, 000150). The user assigned the upper limit (000200).

The company, as in the consecutive example, wants a detailed accounting of each order, a calculation of the total cost for each order, and a total cost for each customer. The RPG specifications sheets for this program are the same as in the consecutive example (Figures 85-90). The user needs three control cards and one POR-File Limits Card for this program.

RPG Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	RPG	Identifies the card.
4	2	An 8K machine is used to generate the object program.
5	2	An 8K machine will be used to execute the object program.
7	1	Multiply-divide special feature is installed on the object machine.
9	1	Modify address instruction is installed on the object machine.
10	1	Direct Seek special feature is installed on the object machine.
14-17	DISK	Input file is on disk.
18	2	Printer size is 132.
19	N	No punched output.
20	N	No disk output.

MAS Control Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-3	MAS	Identifies the card.
4	N	No cylinder overflow.
5-8	0100	Block length.
9-11	100	Record length.
12-13	01	Blocking factor.
30	2	Drive control number.
31	0	Address reference number.

POR Control Card

<u>Columns</u>	<u>Contents</u>	<u>Explanation</u>
1-3	POR	Identifies the card.
4	D	POR file is on disk.
5	0	Drive control number of IBM 1311 on which the POR file pack will be mounted.
6	0	Address-reference number of the POR file pack.
7-10	0200	Block length.
11-13	200	Record length.
14-15	01	Blocking factor.
16	1	Indicates random method.
17	2	Contents of POR's are disk addresses.
21	8	Length of disk addresses.
22-24	008	Units position of first field.
25-26	08	Distance between fields.
27-28	25	Maximum number of fields per POR.

POR-File Limits Card

<u>Column</u>	<u>Contents</u>	<u>Explanation</u>
1-6	000150	Starting address obtained from the sort run.
7-2	000200	Terminal address.

	Page		Page
Alphabetic Level Classification	13	Machine Requirements	5
Alphameric Literals	28	MAS Control Card	59
A (Arithmetic)	25	Multiply or Divide Signs	26
Calculation Specifications	23	Named Constants	28
Calculation Specifications Sheet	9	Naming a Constant	35
Card Number	18, 22, 27, 37	Next Line	31, 40
Card Files	6	Next Record Field	52
Card POR Files	47	Numeric Level Classification	37
Classification of Lines	13	Numeric Level Format Specifications	38
Conditions	27	Numeric Literals	28
Condition 1P (First Page)	33	OP (Operation) + - X / C	26
Consecutive Mode	48	Options (RPG)	5
Constants	28	Padded Tape Records	30
Constant or Edit Control Word	35	Page Number	18, 22, 27, 37
Control Fields	17	POR Control Card	61
Control-Sequential Mode	54	POR-File Limits Card	48
Conversion of Month Field	22	Printer Spacing Chart	9, 10
Conversion Routine Specifications	29	Processing Limits	47
D (Data)	18	Processing-Order Records	47
Data Specifications	9, 18	Random Mode	48
Decimal Alignment	29	Random Processing of a Random Disk File	54
Decimal Length	19, 25	Record Codes	14
Disk Files	6	Record Sequence	13
Disk POR Files	48	RPG Control Card	57
Edit Control Word	35	RPG Translator Program	62
Factor 1	25	Sample Programs	63-104
Factor 2	26	Sequence Control	18
Field End	35	Serial, Record, and Page Numbers	22
Field Length of Remainder	27	Skip	31
Field Length Unedited	18, 25	Sources of Field	19
Field Name	18, 25, 28, 34	Space	31
Field Name of Remainder	27	Special Features Specifications	62
Field Output Conditions	35	Stacker (1402)	33
Field Status	21	Stacker (1442)	33
Format (for a Field)	34	Summary of Calculation Specifications	42
Format (for a Line)	31	Summary of Data Specifications	42
Format Specifications	30	Summary of Format Specifications	45
Format Specifications Sheet	9	Suppression of Output from Run-In Control Breaks	34
Half-Adjust	25	TAPIN Control Card	58
Initializing	23	TAPOUT Control Card	58
Input Files	6	Tape Files	8
Input Specifications	13	Tape POR Files	48
Input Specifications Sheet	9	Tot/Det/Conv	27
Line	31, 40	Translator	6
Line-Identification Code	13	TRL Control Card	60
Line "Level/Relationships"	37	Variable-Line Output Conditions	34
Line Output Conditions	40, 33	WORDxx	35
Literals	28	Z (Zero Suppress)	35
Literal Constants as Output Fields	35		

