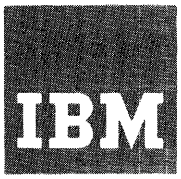
File No. S360-28
Form C24-3337-1

OS



Systems Reference Library

IBM System/360 Operating System
Report Program Generator
Specifications

This reference publication contains fundamentals of RPG programming and language specifications for the IBM System/360 Operating System, Report Program Generator.

Also included is the job setup information for executing RPG.

PREFACE

The System/360 Operating System, Report Program Generator (RPG) is a problem-oriented language designed to provide users with an efficient, easy-to-use technique for generating programs that can:

1. Obtain data records from single or multiple input files,
2. Perform calculations on data taken from input records or RPG literals,
3. Write reports,
4. Use Table Lookup,
5. Exit to a user's subroutine written in a language other than RPG,
6. Branch within the calculations,
7. Sequence check input records,
8. Maintain files.

RPG uses a set of specification sheets on which the user makes entries. The forms are simple, and the headings on the sheets are largely self-explanatory.

Although many reports use only one input file, RPG can combine data from multiple input files to create a report. The output may be a single report, or it may be several reports created simultaneously on different devices.

For information on the operating system that is beyond the purpose of this publication, refer to the following publications:

IBM System/360 Operating System, System Programmer's Guide (Form C28-6550)
IBM System/360 Operating System, Assembler (E) Programmer's Guide (Form C28-6595)
IBM System/360 Operating System, Concepts and Facilities (Form C28-6535)
IBM System/360 Operating System, Data Management (Form C28-6537)
IBM System/360 Operating System, Job Control Language (Form C28-6539)
IBM System/360 Operating System, Linkage Editor (Form C28-6538)
IBM System/360 Operating System, Control Program Services (Form C28-6541)

For titles and abstracts of associated publications, see the IBM System/360 Bibliography (Form A22-6822).

Second Edition

This edition, C24-3337-1, is a major revision of, and obsoletes, Form C24-3337-0.

Significant changes or additions to the specifications contained in this publication will be reported in subsequent revisions or Technical Newsletters.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

A form is provided at the back of this publication for reader's comments. If the form has been removed, comments may be addressed to IBM Corporation, Programming Publications, Department 452, San Jose, California 95114.

SYSTEM/360 OPERATING SYSTEM REPORT PROGRAM GENERATOR

RPG operates under control of the System/360 Operating System (referred to as the operating system). The operating system provides the RPG compiler with input and output services. Object programs generated by the RPG compiler also operate under operating system control and depend on it for similar services.

RPG supports the minimum configuration required by the operating system. The decimal arithmetic feature is required for RPG.

COMPATIBILITY OF SYSTEM/360 OPERATING SYSTEM

The RPG source language is upward compatible. The operating system Report Program Generator can compile a Model 20, a Basic Programming Support, Tape Operating System, Disk Operating System, or Basic Operating System source program that adheres to its language specifications.

The File Description Specifications Sheet of the operating system RPG may require additional information (record length and overflow indicators).

The control card of a Model 20 or Basic Programming Support program must be modified before the object program can be generated by the operating system RPG.

When a BOS, TOS, or DOS RPG program is used to retrieve records from a file with direct organization, it may be necessary to alter the method of obtaining the addresses of these records.

The operating system RPG does not use the Address Output Option of the Basic or Disk Operating System Disk Sort/Merge to retrieve records.

FUNCTION OF RPG

When RPG is used, the IBM System/360 actually performs the separate functions:

1. program-generating, and
2. data processing.

In the first function, program specifications defined by the user produce machine-language instructions. Storage areas are automatically assigned; constants or other reference factors are included; and linkages to routines for computations for input/output operations, and for other functions are produced.

In the second function, the machine-language instructions (created in the first function) are combined with the user input-data files, and both are processed through the system to produce the desired reports or output files.

USING RPG

The preparation of a report by means of RPG consists of the general operations illustrated in Figure 1 and described below:

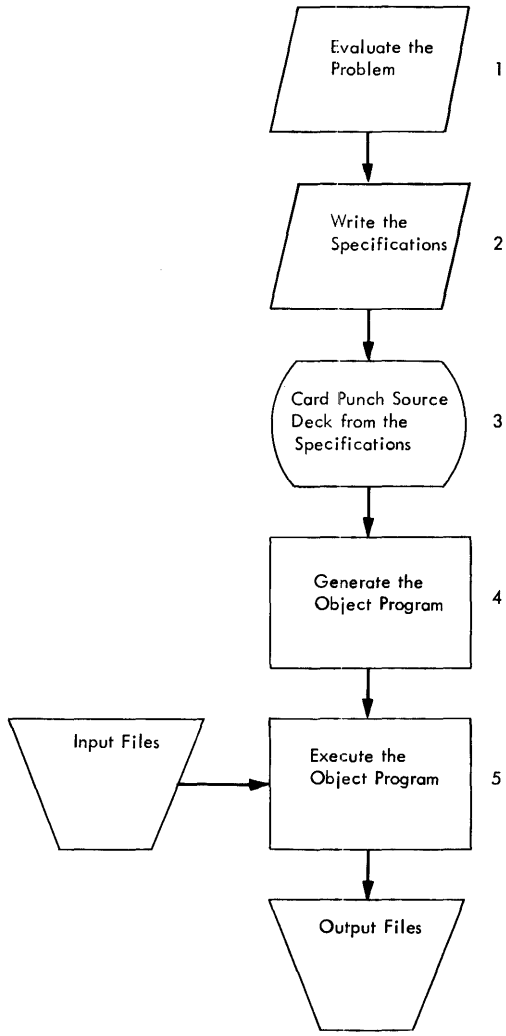


Figure 1. Producing Reports Using the RPG Program

1. The programmer must evaluate the report requirements to determine the format of the input files and the appearance of the finished report.

   For example, he must know what fields in the input files are to be used, what kind of calculations are to take place, the location of the data in the output records, and the number and the kind of totals that must be accumulated. More specific information regarding the evaluation of report requirements is described in Problem Definition.

2. After the programmer has evaluated the requirements of the report, he provides the same information to the RPG program.

   He must describe his input (record layout, fields used, etc.) by making entries on an Input Specifications sheet.

   He must state what processing is to be done (add, subtract, multiply) by entries on a Calculation Specifications sheet.

   He must state how the finished report is to look (printing position, carriage control, etc.) by making entries in the Output-Format Specifications sheet.

   He must describe all files used by the object program (input files, output files, table files, etc.) by making entries on the File Description and File Extension Specifications sheets.

3. After the specifications have been written on the appropriate forms, cards are card punched with the data from the forms.

4. These punched cards (called a source deck) are combined with the processor control card and the operating system Job Control Statements. The source deck and the control cards are supplied to an input device and are processed under control of the operating system. At the end of this step (known as a compilation step), a program capable of preparing the report specified by the programmer has been produced. This program (known as an object module) is processed by the link edit step to create a loadable program. This program (known as the load module) contains all of the computer instructions and linkages to the control system necessary to prepare the desired report.

5. The input files can then be read into the system, and processing of the program will begin. This is known as the execution step.

   At the end of the execution step, the report has been prepared and any other functions, such as file updating, are completed. Through facilities provided by the operating system, the object module can be retained for later runs without recompilation.

MACHINE FEATURES REQUIRED

Source Program Compilation

1. 32,768 main storage bytes
2. One of the following for input:
   - IBM 2540 Card Read-Punch
   - IBM 2501 Card Reader
   - IBM 2520 Card Read-Punch
   - IBM 1442 Card Read-Punch
   - IBM 2400 Series Magnetic Tape Unit
3. One of the following for output of object program:
   - IBM 2540 Card Read-Punch
   - IBM 2520 Card Read-Punch
   - IBM 1442 Card Read-Punch
   - IBM 2400 Series Magnetic Tape Unit
   - IBM 2311 Disk Storage Drive
4. One IBM 2311 Disk Storage Drive for system residence
5. One of the following for system utility files:
   - IBM 2400 Series Magnetic Tape Unit (Three)
   - Data Convert Feature (Required only if 7-track tape is used)
   - IBM 2311 Disk Storage Drive with three files
6. Standard and Decimal Instruction Sets
7. The minimum machine configuration required by the operating system

Object Module Execution

1. 32,768 main storage bytes
2. I/O units as requested by the specifications
3. Standard and Decimal Instruction Sets
4. Systems Residence only — IBM 2311 Disk Storage Drive
5. The minimum machine configuration required by the operating system

ADDITIONAL MACHINE FEATURES SUPPORTED

Source Program Compilation

1. 65,536; 131,072; 262,144; or 524,288 main storage bytes

2. One of the following for listings:
   IBM 1443 Printer
   IBM 1403 Printer
   IBM 1404 Printer (continuous forms operation only)
   One IBM 2400 Series Magnetic Tape Unit (9 track)

3. Two additional IBM 2311 Disk Storage Drives for utility files

Object Module Execution

1. 65,536; 131,072; 262,144 or 524,288 main storage bytes

This section introduces some of the basic RPG functions. These functions are considered basic because they are probably used in the most typical reports produced by RPG and because they depend on a single sequential input file only. They are also related to the functions commonly performed with conventional punched-card equipment.

Although RPG programs can process files contained on magnetic tape or direct-access storage devices, only card-input files are used for the introduction to RPG. Programmers familiar with the basic concepts of RPG may omit this section and concentrate on the detailed specification descriptions contained in the manual under RPG Specification Sheets.

Because of the numerous fields on the six specifications sheets, it may appear that writing RPG specifications is a difficult task. However, few programs use all the specifications, and some may require entries on only one or two lines of the sheets.

At the end of the description of basic RPG functions, a simple file-to-file listing application is used to illustrate how the specifications sheets are related.

Functions Described

Fifteen of the most basic RPG functions are described in this section:

1. Describing a record and its fields to the system
2. Adding and subtracting (cross-footing)
3. Detail printing
4. Establishing control fields
5. Total calculations
6. Detail and total printing
7. Group printing
8. Group indication
9. Overflow printing
10. Summary punching
11. Testing for zero, plus and minus balance
12. Using field indicators
13. Comparing
14. Multiplying and dividing
15. Sequence checking

DESCRIBING A RECORD AND ITS FIELDS TO THE SYSTEM

Entries on the Input Specifications sheet describe the data records and the fields to be read into the system.

Problem

A detail labor file contains card records, as shown in Figure 2. Three fields (A, B, and C) are to be read from each card into main storage. Field A is contained in columns 46-50; Field B is contained in columns 56-60; and Field C is contained in columns 66-70 of each record. The file that contains the records and the fields within each record are described on the Input Specifications sheet.

Each card that contains fields A, B, and C is identified by two distinct attributes.

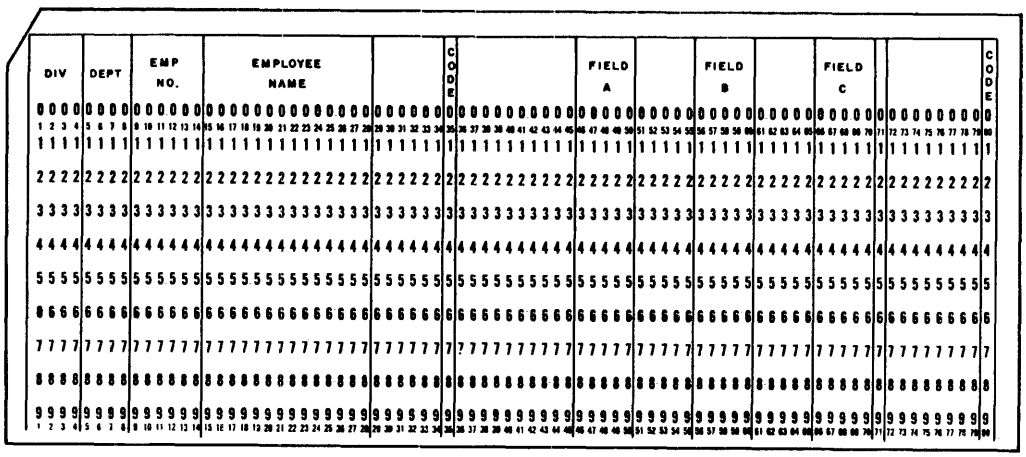


Figure 2. Input Card for Detail Labor File

They must contain a digit 5 in column 35 and no 11-zone in column 80. When these two conditions exist in the card record, the record is valid (that is, it contains fields A, B, and C).

Specifications

Figure 3 shows the input specifications required. The numbers in the following list refer to items circled in Figure 3.

1. Each file of cards must be given a name. In this example the input deck of cards represents a detail labor file. A file name can be used to describe only one file.
2. If several types of cards exist in a file, each card must be identified by its particular card code. In this example, each card read by the system must contain a 5-punch in column 35 and no 11-zone (minus) punch in column 80. These identifying codes are placed in the fields called Record Identification Codes (columns 21-41 of the form). These fields provide for three identifying codes; however, more codes can be indicated, as illustrated later in the manual.

   In this example the card codes are specified by writing a 5 in Character and a 35 in Position for the first code; and by writing an 80 in Position and a minus in Character, and an N in Not for the second code. The field on the form called C/Z/D indicates how the card column containing the card code is to be compared: D = digit portion only, Z = zone portion only, or C = all portions of the card column.

   After all the identification codes are established, the programmer assigns a two-digit number (from 01 to 99) to the card type identified. This code, known as a Resulting Indicator (columns 19-20 of the form), is used to refer to this specific card type on other specifications sheets. Using this code reduces the number of entries required on other specifications forms, as will be seen later.
3. If the input card is to be selected into a stacker (other than the one into which it would normally be selected), the stacker number is written in Stacker Select (column 42).
4. Each field of the card to be read must be defined as shown on the lines following the record-identification line. The specifications shown in this example locate the data from the input record and place it in fields A, B and C (FLDA, FLDB, and FLDC) in three separate locations in core storage.

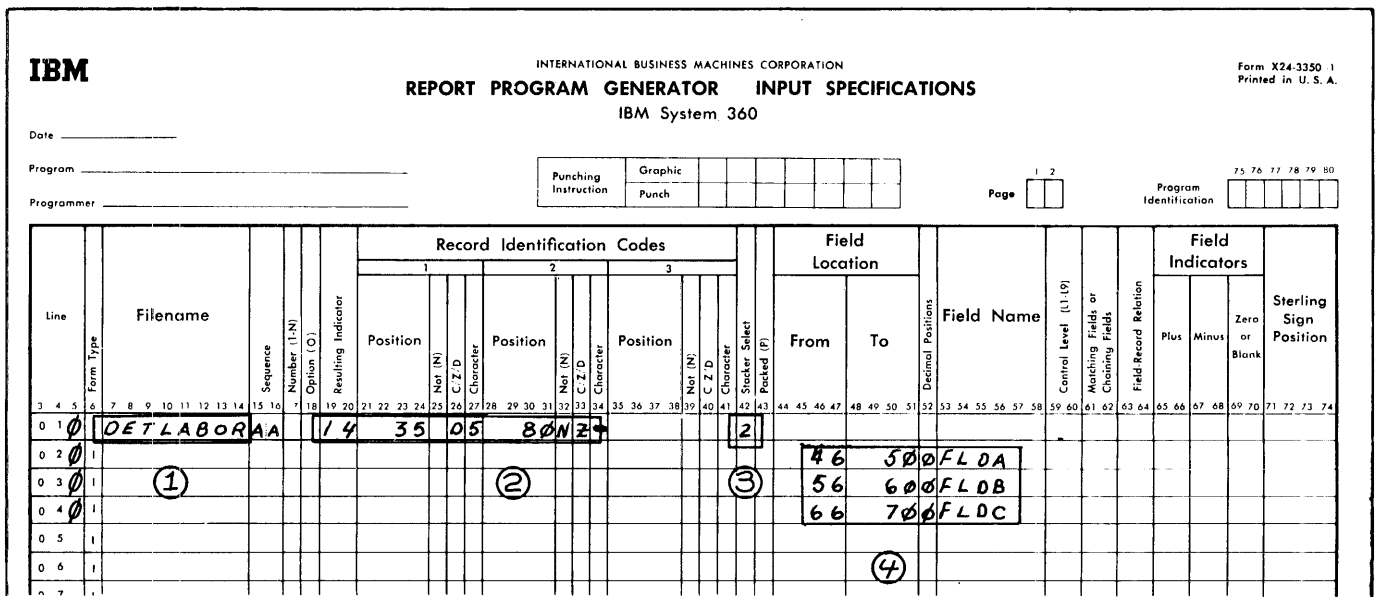


Figure 3. Input Specifications Sheet

Once the card columns of the field have been specified and the appropriate field name has been defined for the field, other references to this field are made by using its field name rather than writing down the specific card columns each time.

Although the input illustrated in Figure 3 is simplified, the entries shown will cause the contents of fields A, B, and C from the card to be read into the system during the processing of the object module. Calculations to be made from the input data are written on the Calculation Specifications sheet.

ADDITION AND SUBTRACTION

Problem

In this problem, fields A, B, and C from the previous example are used to calculate a new field (Field D). The calculation A + B - C = D is to be performed.

Specifications

Figure 4 shows the required entries, using the fields from the previous example. The form required for this problem is the Calculation Specifications sheet.

The first line of the form tells the object program to add the contents of FLDB to the contents of FLDA and place the result in FLDD.

1. The 14 in Indicators defines the card type for which the calculations are to be performed as assigned by the Input Specifications sheet.
2. The card columns for FLDA and FLDB were defined by entries on the input forms and need not be specified again.
3. The result field FLDD is defined for the program by merely writing the name FLDD in Result Field (columns 43-48) and indicating in Field Length (columns 49-51) the number of positions that must be set aside for this field in the object program. Just as in the case of FLDA and FLDB, which were defined on the input form, the name FLDD can now

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System/360

Form X24-3351-1 Printed in U. S. A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero or Blank	Compare: High 1 > 2	Low 1 < 2	Equal 1 = 2	Comments
01	C		14	FLDA	ADD	FLDB	FLDD	80									
02	C		14	FLDD	SUB	FLDC	FLDD										
03	C																
04	C																
05	C																
06	C																
07	C																
08	C																
09	C																

① ② ③

Figure 4. Calculation Specifications Sheet

be used in other calculation operations or used in defining output specifications.

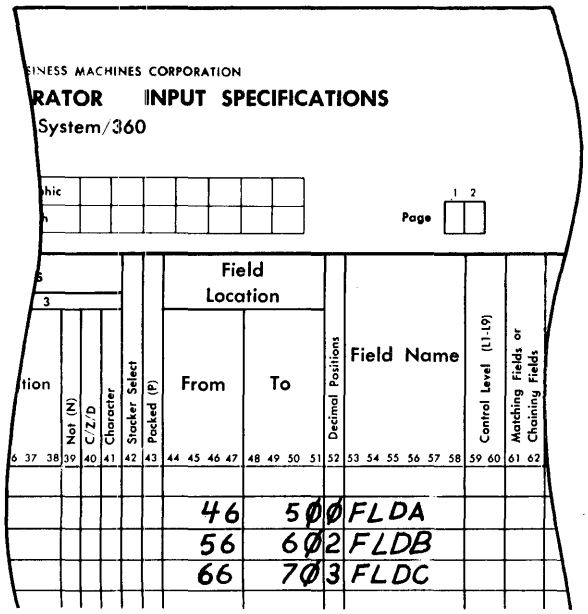
NOTE: The result of A + B is not placed back into FLDA. To do this would destroy the original contents of FLDA. In this example it is necessary to save the original value of FLDA so that it can be printed on an output report.

The second line in Figure 4 causes the object module to subtract the contents of FLDC from the result just previously obtained in FLDD and to store the new result back into FLDD.

Decimal Symbol Location

In this example there were no decimal positions in any of the three fields. In operations involving numbers containing decimal positions, the number of decimal positions in each of the fields is frequently not the same. When the number of decimal positions is not the same in both factors in an arithmetic operation, shifting the factors to align the decimal point is usually required.

RPG automatically shifts the factors. The programmer must indicate the number of decimal positions contained in each factor used in calculations, and the number of decimal positions required in the result. If a field is to have arithmetic operations performed upon it, the decimal positions must be specified. A zero is coded for no decimal positions (See Figure 4). Assume that the fields in Figure 3 have decimal positions as indicated under Decimal Positions (Column 52) in the following example:



A set of values for these fields might appear to the program as follows:

FIELD	DECIMAL POSITION	CONTAINED IN CARDS	ACTUAL VALUE
A	0	00126	126.
B	2	01123	11.23
C	3	04264	4.264

The programmer must indicate the number of decimal positions required in the result.

The calculation A + B - C = D, would result in the values being shifted like this:

```
126.000 = A
+11.230 = B
137.230
- 4.264 = C
132.966 = D
```

(Result field has three decimal positions).

The result 132.966 is stored as the value of the field called D. Entering the decimal positions on the input sheet and the calculation sheet enables the factors to be shifted automatically.

DETAIL PRINTING

Detail printing is the printing of information obtained from each record as it is read.

Problem

This problem illustrates how input fields A, B, and C, and the calculated result, field D, can be specified for listing.

Specifications

Figure 5 shows the output specifications required. The numbers in the following list refer to items circled in Figure 5.

1. The output listing must be assigned its own specific file name. In this example it has been called DAILYRPT.
   The D in Type H/D/T indicates that the line being printed is a detail line. That is, it contains information from the record just read. (The other possible entries, H and T, indicating heading lines and total lines, are described later.)
   The 2 in Space After provides a double-spaced listing. (There is one blank line after each printed line.)
2. The 14 in Output Indicators identifies the input record type present when detail printing occurs.

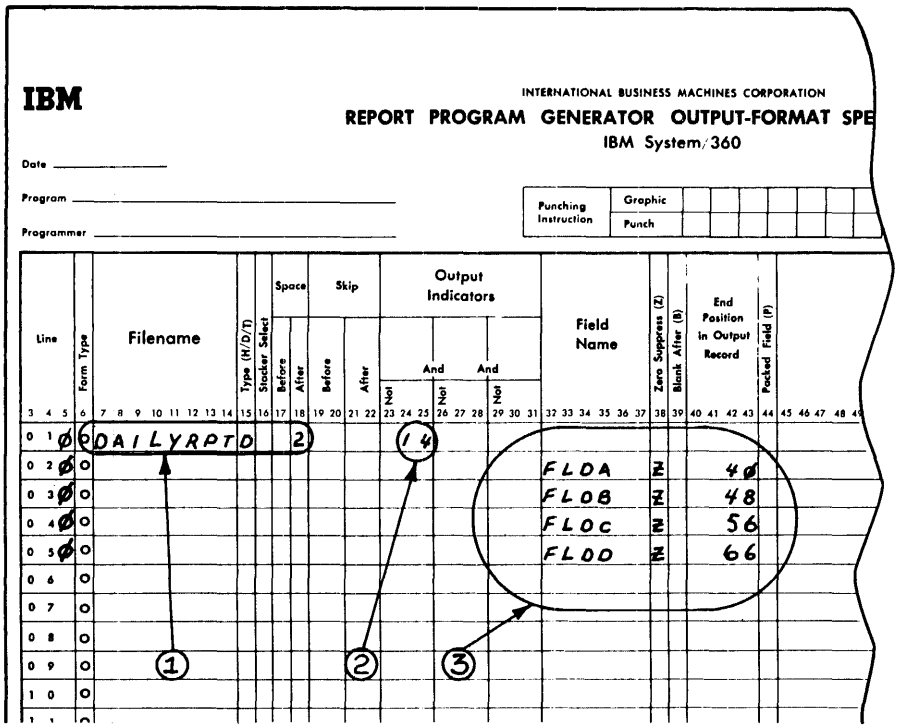


Figure 5. Output-Format Specifications Sheet

3. Each field to be printed must be specified under the heading Field Name. The Z in Zero Suppress means that zeros to the left of significant digits are not printed. (For example, the value stored in FLDA (00126) is printed as 126.)

   The printing positions for data to be printed on the output report are specified in End Position In Output Record (columns 40-43). The programmer has to indicate only the last printing position of each field (low-order or rightmost position). The length of each field has already been established for the program as part of the input specification or established in the Result Field of the calculations specifications.

When preparing a simple listing such as the one in this example, the programmer would probably select printing positions of the output unit based upon the number of positions in each field plus a number of positions as spaces between fields.

More elaborate reports are laid out on a printer form in advance of the program writing function. Usually this indicates both the location on the form where data is to be printed and the source of the data (the card columns of the input data or the names of data fields developed in the program). This is normally a function of job definition, a subject that is discussed later under Problem Definition.

Figures 3, 4 and 5 illustrate how to read data into the system, how calculations can be performed upon the data, and how the original data and the data developed in the program can be printed. The examples so far have shown the items necessary to prepare a report. A significant item not yet described is how to specify a control field.

CONTROL FIELDS

A "control field" is a field containing information to be compared from record to record. A control break occurs when the information in the control field changes. A control level establishes the relative importance of the control fields.

Problem

This example shows how to specify three levels of control.

Specifications

Figure 6 shows the input data from Figure 3 with the addition of the appropriate control data and employee name (the items inside the circle). In this example there are three levels of totals: the lowest level is employee number (EMPNO), the next is department (DEPT), and the highest level is division (DIVSON). These levels are designated L1, L2, and L3, respectively. (Because as many as nine levels of totals are possible in RPG, the common terms of minor, intermediate, and major totals are inadequate.)

To designate a control field and to establish a level of control, enter the card columns of the field in Field Location, enter an appropriate name in Field Name, and enter the correct control level (L1, L2, ... L9) in Control Level.

In the example (Figures 2 and 6) the sequence of the control fields (left to right) in the card is the same as the sequence of the control levels. The control fields, however, could have been in any location on the card, and the specifications for them could have been in any sequence on the form as illustrated in Figure 7.

The reading of the employee-name field (fifth line of the sheet in Figure 6) is also included as part of this example, but it is not related to controls. It is shown here to indicate another aspect of the decimal-positions column of the Input Specificiations sheet. When a numeric field is specified in Field Location, any digit (0 to 9) placed in Decimal Positions causes zone punches in all positions of the field (except the units position) to be removed.

Therefore, when an alphabetic field is specified, Decimal Positions should be left blank to permit the zone punches of the alphabetic field to be read into the system.

TOTAL CALCULATIONS

Total calculations are performed after a specified control break has occurred. When a control break occurs, special operations are normally performed before processing the record that caused the control break. These operations are called "total operations".

Problem

This example illustrates how totals can be accumulated at each control level.

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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System/360

Form X24-3350-1 Printed in U.S.A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15 16	17	18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43	44 45 46 47	48 49 50 51	52	53 54 55 56 57 58	59 60	61 62	63 64	65 66	67 68	69 70	71 72 73 74
01Ø	1	DETLABORAA				14	35		D5		8ØNZ-								2												
02Ø	1																				1	4		DIVSON	L3						
03Ø	1																				5	8		DEPT	L2						
04Ø	1																				9	14		EMPNO	L1						
05Ø	1																				15	28		NAME							
06Ø	1																				46	5ØØ		FLDA							
07Ø	1																				56	6ØØ		FLDB							
08Ø	1																				66	7ØØ		FLDC							
09	1																														

Figure 6. Specifying Control Levels on the Input Sheet

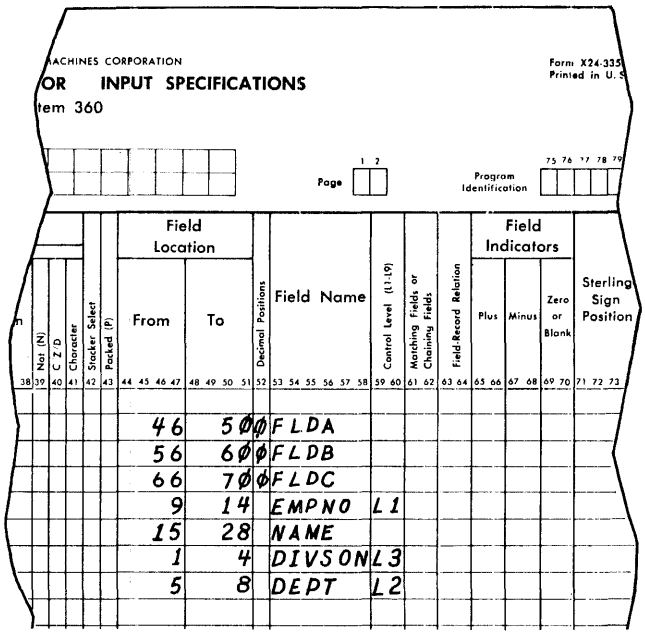


Figure 7. Example of Control Field Sequence

Specifications

Figure 8 contains the data shown in Figure 4. The additional information for this example is circled. During processing of the object module, lines 1 and 2 cause the operation A + B - C = D. The third line adds the result, contained in FLDD, from each detail card to a field called TOTE. Therefore, TOTE is the accumulated amount for each employee group. The first three specification lines are performed in the object module each time a detail card is read (see Figure 8, Indicator 14).

When the level-1 (L1) control break occurs (a card from the next employee group has been sensed), specification-line 4 adds the total of TOTE accumulated from each detail card into a field called TOTF. TOTF is used to accumulate the total for each employee group for each department.

When the level-2 control break occurs, TOTF is added into TOTG.

When the level-3 control break occurs, TOTG (which represents the accumulated amounts for each division) is added into FINTOT.

Accumulating totals at each control-break level is normally done when the corresponding totals are printed on an output report.

NOTE: In System/360 RPG—as in IBM punched card equipment—a control break at one level forces control breaks for all lower levels.

DETAIL AND TOTAL PRINTING

Problem

This example shows the specifications necessary to print the three controlling

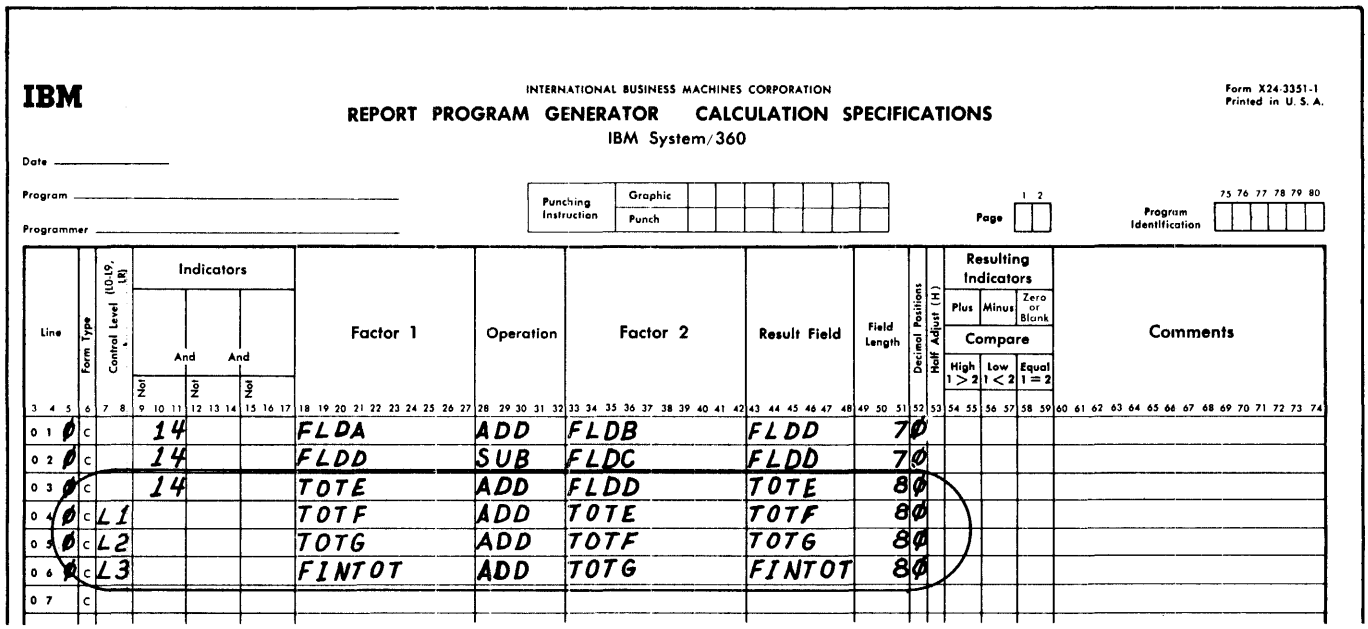


Figure 8. Specifying Control Levels on the Calculation Sheet

fields, the name, the accumulated amount in field D, the three accumulated totals, and the final total at the end of the object-module report.

Specifications

Figure 9 illustrates the specifications required for the report shown in Figure 10. The following numbers refer to the items circled in Figure 9:

1. This information is similar to the specifications in the previous example in Figure 5.
2. The data fields DIVSON, DEPT, EMPNO, NAME, and FLDD are specified for printing.
3. The specifications to print the total for the first control level shown on lines 7 and 8 are:
   a. The T in H/D/T (column 15) indicates that the line is a total line. A total line is an operation caused by a control break. The input record that causes the control break cannot contribute data to the accumulated totals or to the total line. Totals accumulated before a control break are printed.
   b. A 3 in Space After (column 18) provides two blank lines after each printed line to make the report easier to read.
   c. The L1 in Output Indicators (columns 24-25) indicates that the line is to be printed only on a level-1 control break.
   d. The field to be printed (TOTE) is indicated under Field Name (columns 32-37).
   e. The Z in Zero Suppress (column 38) indicates that zeros to the left of significant digits are not to be printed.
   f. The B in Blank After (column 39) causes the core-storage positions containing field TOTE to be set to zeros after the total is printed.

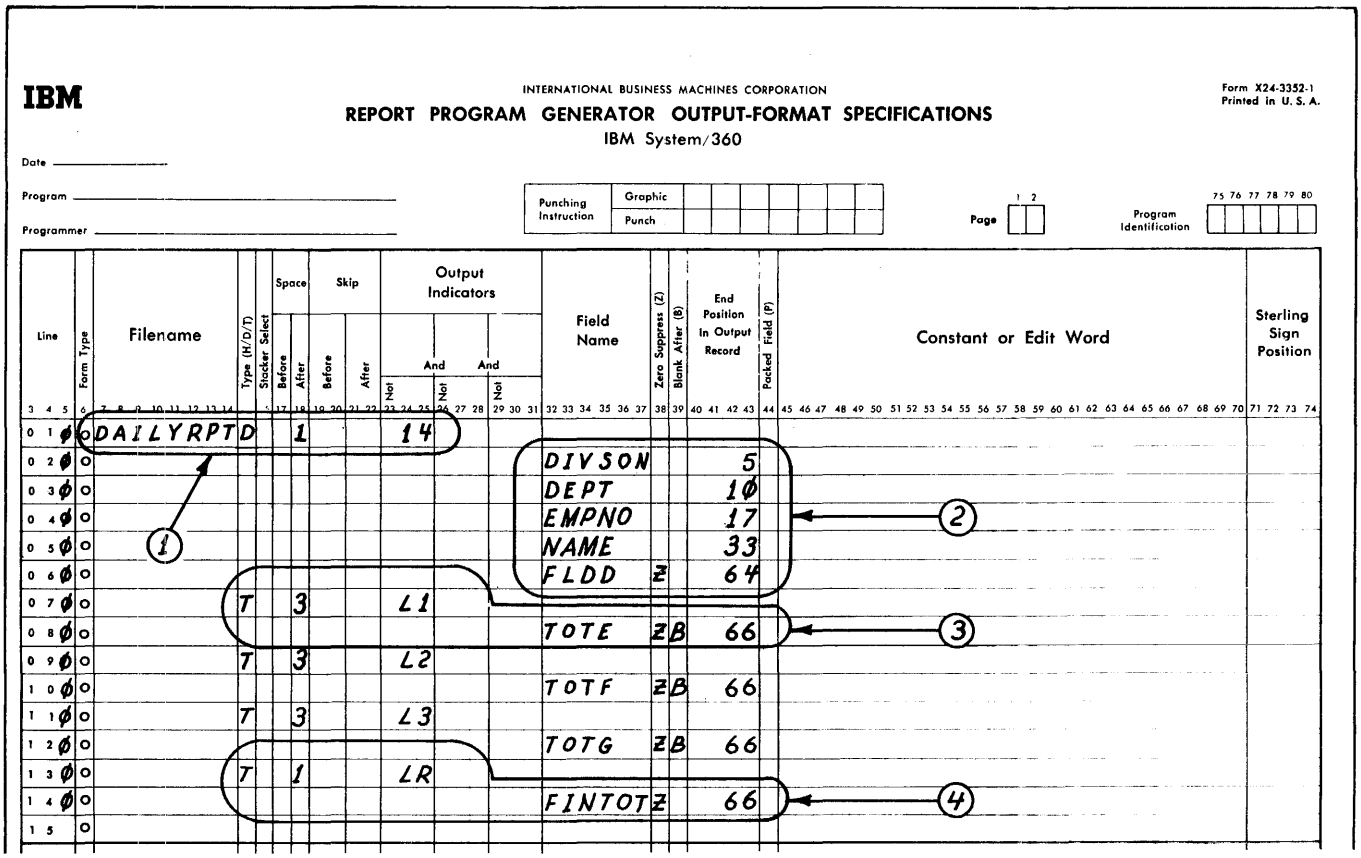


Figure 9. Specifications on the Output-Format Sheet

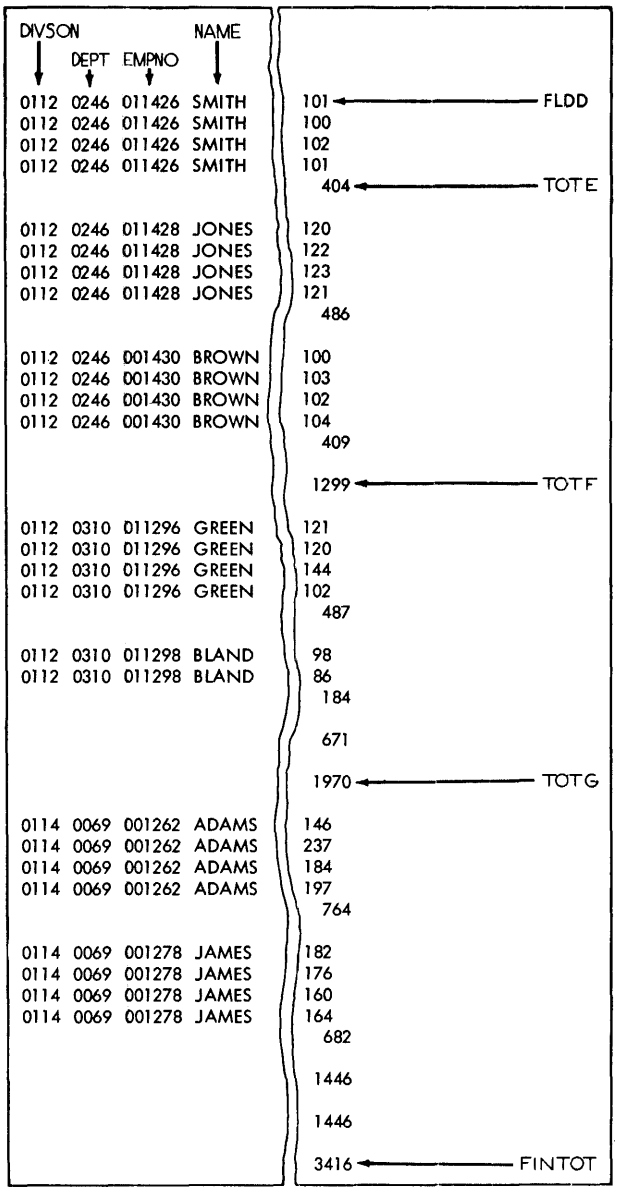


Figure 10. Detail-Printed Report

This is done so the total for one group is not added to the total of the previous group.

The specifications to print the second and third control levels are essentially the same as those for the first level.

4. The specifications for printing the final total contain the code LR (Last Record) in Output Indicators (columns 24-25). The indicator LR is turned on automatically by the program when the last card of a file has been sensed. This indicator is used to cause the final total to be printed.

GROUP PRINTING

In group-printing operations, only one line is printed for each group of detail cards. This line usually contains the control fields and the totals of the quantity fields.

An example of a group-printed report is shown in Figure 11.

The detail-printed report specifications in Figure 9 could be altered to provide a group-printed report as illustrated by the specifications in Figure 12.

The differences between Figures 9 and 12 that provide for the two types of reports are:

1. The detail line specified in Figure 9 (line 01) has been changed to a total line conditioned on an L1 break (Figure 12, line 01).
2. The total line in Figure 9 (line 07) has been combined with the first total line 01 of Figure 12.
3. The spacing on lines 09 and 11 of Figure 9 have been changed from 3 to 1 space-after in Figure 12.

GROUP INDICATION

In group-indication operations, each detail card is processed; however, only the control fields that identify the specific detail card are printed. An example of a group-indication report is illustrated in Figure 13. In this example the employee name and number are printed for each control change. The fields, division and department, are printed only when there is a control change for the division and department fields, respectively.

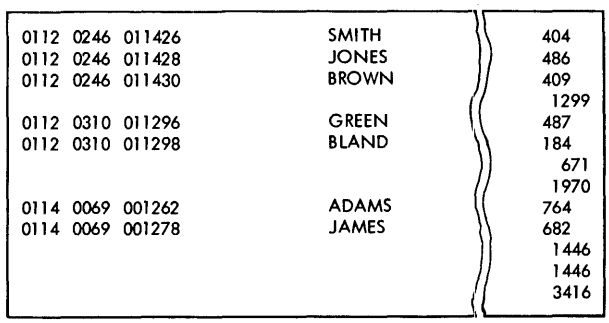
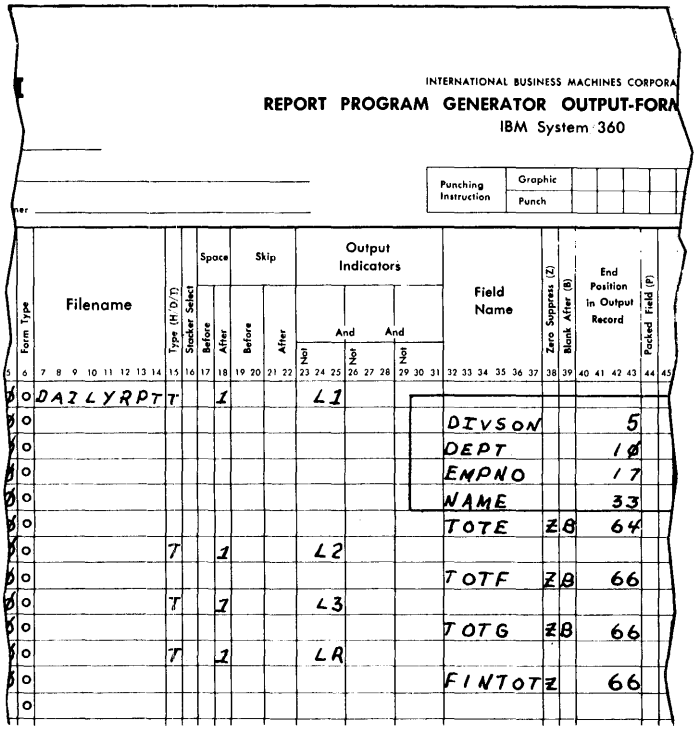


Figure 11. Group-Printed Report



INTERNATIONAL BUSINESS MACHINES CORPORA

REPORT PROGRAM GENERATOR OUTPUT-FORM

IBM System 360

Punching Instruction: Graphic Punch

Form Type	Filename	Type (H/D/T)	Stacker Select	Space Before	Space After	Skip Before	Skip After	Output Indicators And Not	Output Indicators And Not	Output Indicators And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)
O	DAILYRPT	T			1			L1							
O											DIVSON			5	
O											DEPT			10	
O											EMPNO			17	
O											NAME			33	
O											TOTE	Z	B	64	
O		T			1			L2							
O											TOTF	Z	B	66	
O		T			1			L3							
O											TOTG	Z	B	66	
O		T			2			LR							
O											FINTOTZ			66	
O															

Figure 12. Specifying a Group-Printed Report

Figure 14 illustrates how the detail-printed report specifications in Figure 9 could be altered to specify a group-indicated report.

OVERFLOW PRINTING

Overflow printing, another function used in preparing reports, can be performed in RPG. Overflow is the sensing of channel 12 in the printer carriage control tape.

Problem

This example shows the additional specifications necessary to print eight column headings at the top of each printed form. A heading-line is a line that contains constants or information from an input record, or it may be a constant defined on the Output-Format Specifications sheet.

Specifications

Figure 15 illustrates the output specifications required for this operation. The numbers in the following list refer to the circled items in Figure 15. The Filename (columns 7-14) of DAILYRPT is the same; adding overflow headings does not change it.

1. On the first line of the form, the H in H/D/T (column 15) indicates that the line to be printed is the heading line.

   The 2 in Space After (column 18) provides a blank line after each printed line.

   The 01 in Skip Before (columns 19-20) causes the form to skip to channel 01 in the carriage control tape. This positions the form for printing of the overflow heading line.

0112	0246	011426	SMITH	101
				100
				102
				101
				404
		011428	JONES	120
				122
				123
				121
				486
		001430	BROWN	100
				103
				102
				104
				409
				1299
	0310	011296	GREEN	121
				120
				144
				102
				487
		011298	BLAND	98
				86
				184
				671
				1970
0114	0069	001262	ADAMS	146
				237
				184
				197
				764
		001278	JAMES	182
				176
				160
				164
				682
				1446
				1446
				3416

Figure 13. Example of a Group-Indicated Report

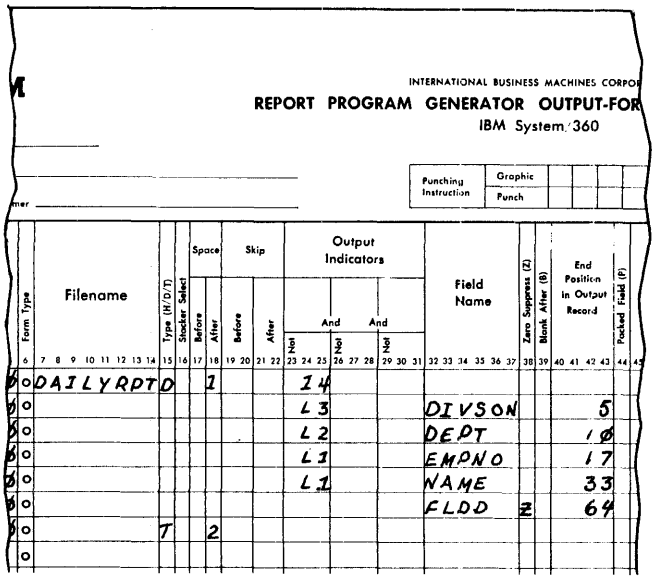


Figure 14. Specifying a Group-Indicated Report

The OF in Output Indicators (columns 24-25) causes the heading line to be printed each time there is a form overflow on the printer.

On the second line of the form, the letters OR indicate a second condition can cause the heading line to print. The second condition, indicated by 1P (first page) in Output Indicators, causes the heading line to be printed on the first page. This condition is necessary to print the heading on the first page of the report because the overflow condition does not occur until after the first page of the report has been printed.

2. The entries on lines 3-10 of Figure 15 specify the actual information or constants to be printed on the report. The actual information is contained within apostrophe symbols.

SUMMARY PUNCHING

Problem

Using an IBM 1442, punch a summary total of FLDD for each department together with the appropriate department and division numbers.

Specifications

A blank card must be merged behind each department group before the processing of

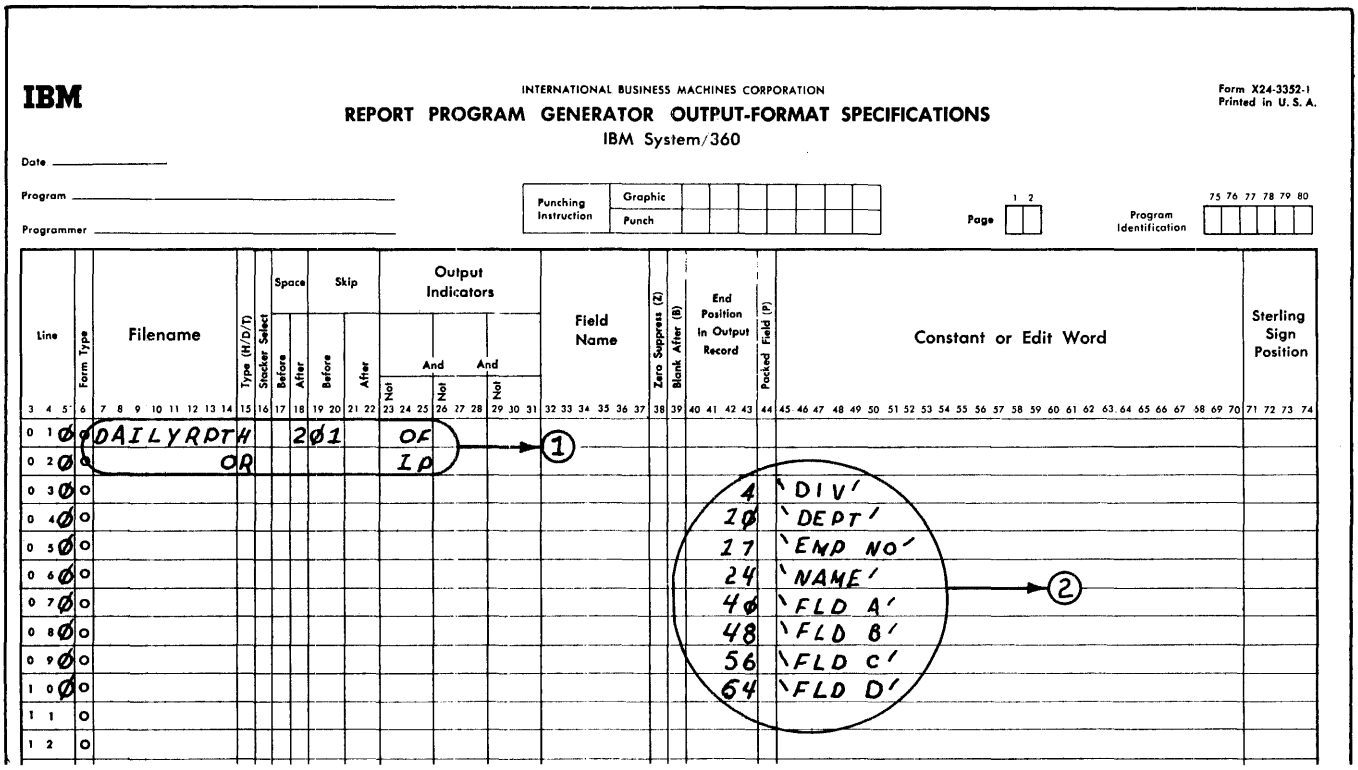


Figure 15. Printing Heading Lines

the object module is executed. Therefore the input file is a combined file; that is, a file containing cards read into the system and cards used for punching. The blank card is specified on the Input Specifications form as illustrated in Figure 16, line 09.

All other records in the file must contain punches in the card column used in the record identification specification for the blank card.

Figure 17 illustrates the Calculation Specifications for the summary punching operation.

Line 04 is processed when the blank card is read. It causes accumulation of the level-2 total for the summary card. This specification is necessary when the summary card is merged behind control groups rather than punched from a second file of blank cards. This specification is required because the level-2 control break does not occur until the first card of the next control group is read--and this does not occur until after the blank card is read.

NOTE: The control level L0 has been entered to identify a total calculation.

The summary punching of accumulated value is illustrated on the output specification sheet in Figure 18. The specifications required for this function are circled.

The cards to be punched will become a new output file which is given the name of the combined file DETLABOR. This name is specified in Filename for the specification line 12.

The T in Type (H/D/T) indicates the operation is to be performed at total time.

The 2 in Stacker Select indicates that the summary cards are to be selected into stacker number 2.

Resulting Indicator 16 in Output Indicators indicates that the operation is to occur at the time the blank card is read in.

The first field specified for punching is column 35 which will be punched with an 8 to identify the card as a summary card. The remaining three fields are punched by specifying the name of the field in Field Name and then by specifying the last column to be punched in End Position In Output Record. The format of the summary card is shown in Figure 19.

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IBM System/360

Form X24-3350 1
Printed in U. S. A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
01Ø	1	DETLABORAA				14	35		D5		8ØNZK								2												
02Ø	1																				1	4		DIVSON	L3						
03Ø	1																				5	8		DEPT	L2						
04Ø	1																				9	14		EMPNO	L1						
05Ø	1																				15	28		NAME							
06Ø	1																				46	5ØØ		FLDA							
07Ø	1																				56	6ØØ		FLDB							
08Ø	1																				66	7ØØ		FLDC							
09Ø	1		WS			16	35		C																						
10	1																														

Figure 16. Summary Punching Example, Input Specifications

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Form X24-3351-1
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Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And Not	And Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero or Blank	Compare: High 1 > 2	Low 1 < 2	Equal 1 = 2	Comments
010	C		14		FLDA	ADD	FLDB	FLDD	70									
020	C		14		FLDD	SUB	FLDC	FLDD	70									
030	C		14		FLDD	ADD	TOTEMP	TOTEMP	80									
040	C	L0	16		TOTEMP	ADD	TOTDEP	TOTPCH	80									
050	C	L1			TOTEMP	ADD	TOTDEP	TOTDEP	80									
060	C	L2			TOTDEP	ADD	TOTDIV	TOTDIV	80									
070	C	L3			TOTDIV	ADD	FINTOT	FINTOT	80									
080	C																	

Figure 17. Summary Punching Example, Calculation Specifications

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REPORT PROGRAM GENERATOR OUTPUT-FORMAT SPECIFICATIONS

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Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: And Not	And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
010	O	DAILYRPT	D			1			14								
020	O										DIVSON			5			
030	O										DEPT			10			
040	O										EMPNO			17			
050	O										NAME			33			
060	O										FLDA	Z		40			
070	O										FLDB	Z		48			
080	O										FLDC	Z		56			
090	O										FLDD	Z		64			
100	O		T			3			L1								
110	O										TOTEMP	Z	B	66			
120	O	DETLABORT	2						16								
130	O													35		'8'	
140	O										DIVSON			4			
150	O										DEPT			8			
160	O										TOTPCH			79			
	O																

Figure 18. Summary Punching Example, Output Specifications (Part 1 of 2)

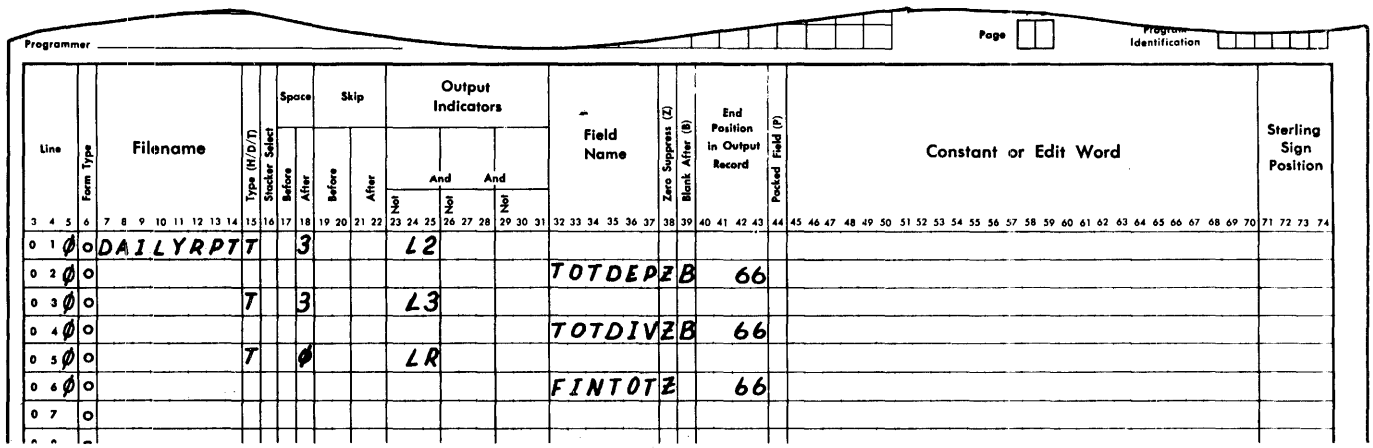

Figure 18. Summary Punching Example, Output Specifications (Part 2 of 2)

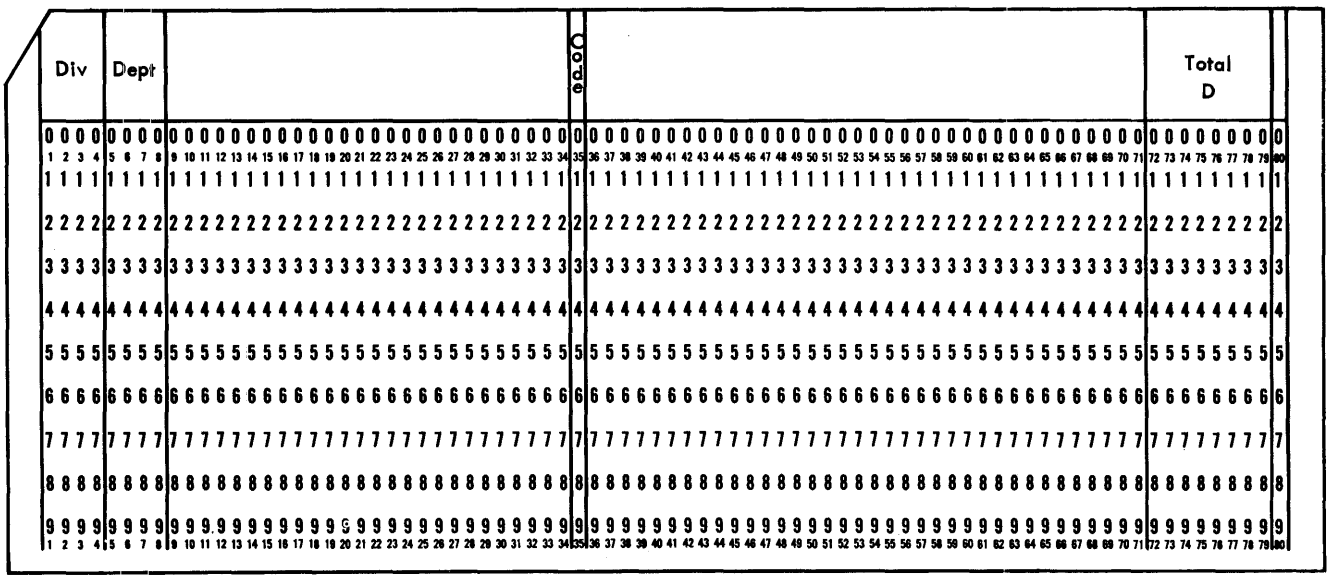

Figure 19. Summary Punching Example, Summary Card Format

TESTING FOR ZERO, PLUS, AND MINUS BALANCE

Specifications are executed in the object program in the same sequence in which they are written on the specification form unless a different sequence has been specified.

If specifications had to be followed sequentially in a fixed pattern, a program would follow a single path of operation. The program would not have the ability to choose a predefined alternative to the procedure based upon conditions encountered during progessing.

For example, assume that a program has been written containing ten specifications that cause a number of operations to be performed upon a series of quantities. If the first five specifications develop meaningless results when processed with quantities of zero, the processing time of the object program can be reduced if the first five specifications are bypassed whenever the quantity to be processed is zero.

A specification in the RPG program can be used to evaluate a quantity and, depending upon the value of that quantity, direct the program to some other specification.

Input Specifications

Three types of tests can be made on the Input Specifications sheet:

1. Testing an input field to determine if it contains a plus value
2. Testing an input field to determine if it contains a minus value
3. Testing an input field to determine if it is blank or is punched with zeros

Calculation Specifications

Three types of tests can be made on the Calculation Specifications sheet: tests to determine whether the result of a calculation is plus, minus, or zero or blank.

The program also can compare two fields and can test the result to determine if the contents of one field is greater than, smaller than, or equal to that of the other field.

Figures 20 and 21 illustrate a test for a zero balance, and Figure 22 shows the specifications for a test for a minus balance.

Figure 20 illustrates a typical test of the contents of an input field. If FLDA

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Program _____

Programmer _____

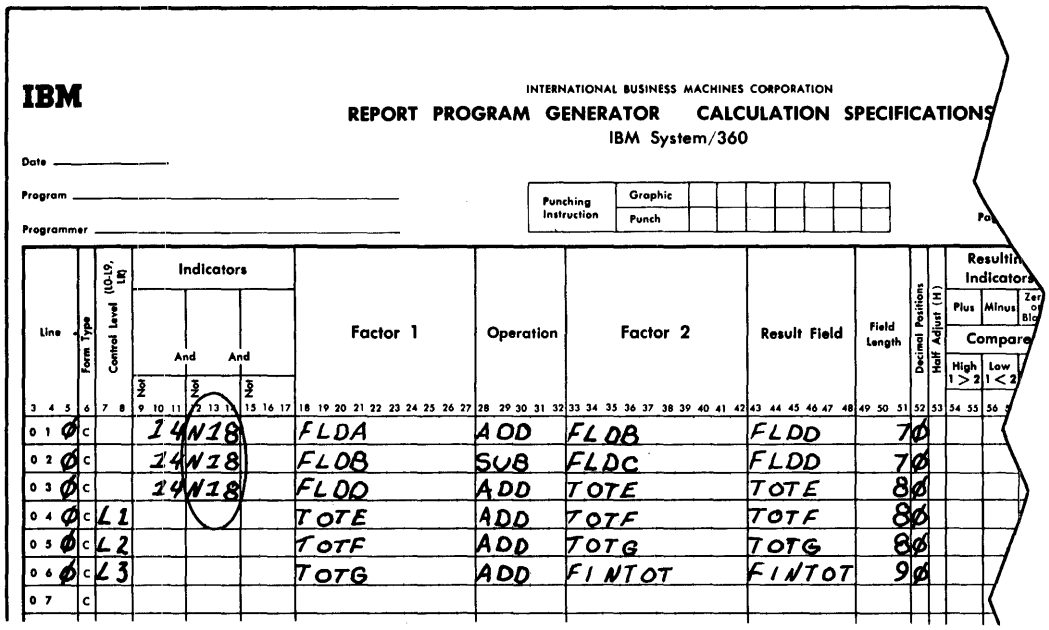
Punching Instruction: Graphic | Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence 15 16	Number (1-N) 17	Option (O) 18	Resulting Indicator 19 20	Record Identification Codes 1: Position 21 22 23	Not (N) 24	C/Z/D 25	Character 26	2: Position 27 28 29	Not (N) 30	C/Z/D 31	Character 32	3: Position 33 34 35	Not (N) 36	C/Z/D 37	Character 38	Stacker Select 39	Packed (P) 40	Field Location From 41 42 43	To 44 45 46	Decimal Positions 47	Field Name 48 49 50 51 52 53	Control Level (L1-L9) 54 55	Matching Fields or Chaining Fields 56 57	Field-Record Relation 58 59	Field Indicators Plus 60 61	Minus 62 63	Zero or Blank 64 65	Sterling Sign Position 66 67 68 69 70 71 72 73 74
01	Ø	DETLABORAA				14	35		Ø5		8ØNZ	-							2													
02	Ø																				1	4		DIVSON	L3						
03	Ø																				5	8		DEPT	L2						
04	Ø																				9	14		EMPNO	L1						
05	Ø																				15	28		NAME							
06	Ø																				46	5ØØ		FLDA						(18)	
07	Ø																				56	6ØØ		FLDB							
08	Ø																				66	7ØØ		FLDC							
09																															

Figure 20. Specifying a Test for a Zero Balance



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Punching Instruction: Graphic / Punch

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / And	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus / Minus / Zero or Blank; Compare: High 1>2 / Low 1<2
01	C		14N18	FLDA	ADD	FLDB	FLDD	70			
02	C		14N18	FLDB	SUB	FLDC	FLDD	70			
03	C		14N18	FLDD	ADD	TOTE	TOTE	80			
04	C	L1		TOTE	ADD	TOTF	TOTF	80			
05	C	L2		TOTF	ADD	TOTG	TOTG	80			
06	C	L3		TOTG	ADD	FINTOT	FINTOT	90			
07	C										

Figure 21. Test for a Zero Balance

(line 6) contains zeros, it is unnecessary to perform some of the operations entered on the Calculation Specifications sheet. To make this test, the programmer places a number from 01 to 99 in Field Indicators: Zero or Blank (columns 69-70). In this example the number is 18. If a card read into the system contains zeros in columns 46-50 (FLDA), indicator 18 is turned on.

"Turning on" an indicator means a special condition has occurred, and the program must consider this condition during the processing of calculation specifications and/or output specifications. This indicator condition is no different from having a resulting indicator turned on by a specific record identification code from an input card.

For example, the entries circled in Figure 21 are the additional specifications that bypass the calculation upon detail cards if the value in FLDA is zero or blank.

The specifications 14N18 in Indicators (columns 10-14) mean that the calculation will be performed if indicator 14 is on and indicator 18 is off. (The N in N18 stands for Not.) As now written on the Calculation Specifications sheet in Figure 21, the detail calculations are not performed if the value of FLDA from the input card is zero (Figure 20).

The same indicator specification, N18, could also be used on the Output-Format Specifications sheet to prevent the printing of detail cards when FLDA is zero (if that was a requirement of the program).

USING RESULTING INDICATORS

Problem

The calculation specifications in this example illustrate the use of a resulting indicator to test for a minus balance. The result of the test can be used to bypass some specifications and to process other specifications only when the condition tested for is present.

Specifications

The specifications for this example are shown in Figure 22. The program logic for this example is shown in Figure 23.

Line 1 specifies that FLDB is to be added to FLDA and that the result is to be placed in FLDD. Line 2 specifies that FLDC is to be subtracted from FLDD, that the result is to be placed in FLDD and that FLDD is to be tested to determine if the result is minus. In this example it is assumed that if a minus balance occurs, the calculation has no meaning. Therefore, if the result is minus, two things must be accomplished:

1. The result must <u>not</u> be added into field TOTE.
2. The contents of field FLDD must be reset to zeros. (This step might be required if FLDD were used in a subsequent step and the minus balance remaining would give incorrect results.)

This is accomplished on the specification sheet (Figure 22) by placing an indicator code (19) in <u>Resulting Indicators: Minus</u> on the specification-line 2. Indicator 19 will be turned on for a minus condition.

The function of adding TOTE to FLDD is specified on line 3. It is accomplished only if there is a no-minus condition resulting from the test on line 2. The specifications on line 4 cause FLDD to be reset to zeros only on a minus condition.

The 0 in Factor 2 on line 4 is known as a literal and is used to set FLDD to zeros. (A literal is the actual value to

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IBM System/360

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Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line 3 4 5	Form Type 6	Control Level (L0,L9, LR) 7 8	Indicators: And / And — Not 9 10 11	Not 12 13 14	Not 15 16 17	Factor 1 18 19 20 21 22 23 24 25 26 27	Operation 28 29 30 31 32	Factor 2 33 34 35 36 37 38 39 40 41 42	Result Field 43 44 45 46 47 48	Field Length 49 50 51	Decimal Positions 52	Half Adjust (H) 53	Resulting Indicators: Plus 54 55	Minus 56 57	Zero or Blank 58 59	Comments 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
01	C		14			FLDA	ADD	FLDB	FLDD	7	0					
02	C		14			FLDD	SUB	FLDC	FLDD	7	0			19		
03	C		14	N19		FLDD	ADD	TOTE	TOTE	8	0					
04	C		19	14			Z-ADD	0	FLDD	7	0					
05	C	L1				TOTE	ADD	TOTF	TOTF	8	0					
06	C	L2				TOTF	ADD	TOTG	TOTG	8	0					
07	C	L3				TOTG	ADD	FINTOT	FINTOT	8	0					
08	C															

Figure 22. Testing for a Minus Condition

be used in a calculation rather than the name of the location of the data to be used.) The remaining specifications on the form in Figure 22 are the same as those from previous examples.

By using Indicator 19, it is possible to suppress detail-card printing when the calculation D - C results in a minus balance.

COMPARISON OF TWO FIELDS

The calculation specifications in this example illustrate the ability to compare two fields and govern processing according to the result of the comparison. The comparison may be tested for a high, low, or equal condition. The result of the test can then be used to bypass some specifications or to process other specifications only when a particular condition is present.

Specifications

The calculation specifications for this example are shown in Figure 24. The program logic for the example is shown in Figure 25.

Line 1 specifies that FLDA is compared to FLDB. If the two fields are equal, Indicator 18 is turned on, and FLDA is moved to HOLD (line 2). If the two fields

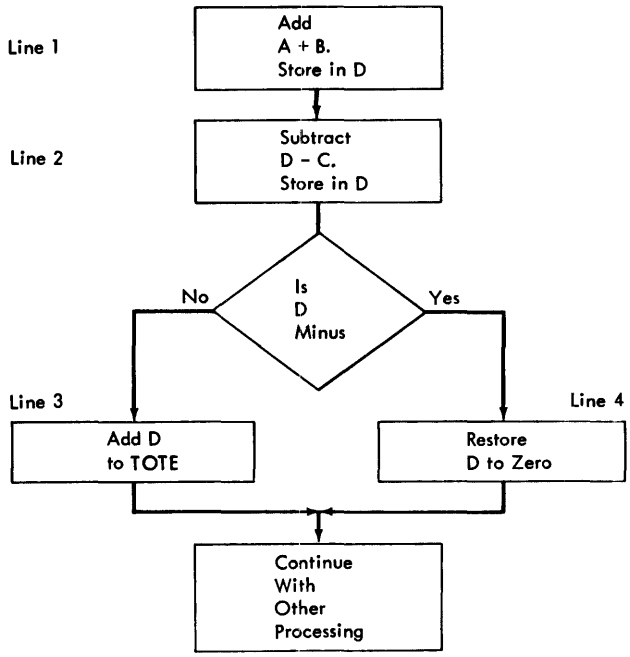

Figure 23. Testing Indicators to Govern Processing

are not equal (line 3), FLDB is subtracted from FLDA and the result is placed in SAVE.

A literal may also be used in a comparison specification. In the lower half

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Program Identification 75 76 77 78 79 80

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / And	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus / Minus / Zero or Blank	Compare: High 1>2 / Low 1<2 / Equal 1=2	Comments
01	C			FLDA	COMP	FLDB						18	
02	C		18		MOVE	FLDA	HOLD	102					
03	C		N18	FLDA	SUB	FLDB	SAVE	102					
07	C			DATE	COMP	'02-14-64'						19	

Figure 24. Specifying a Comparison

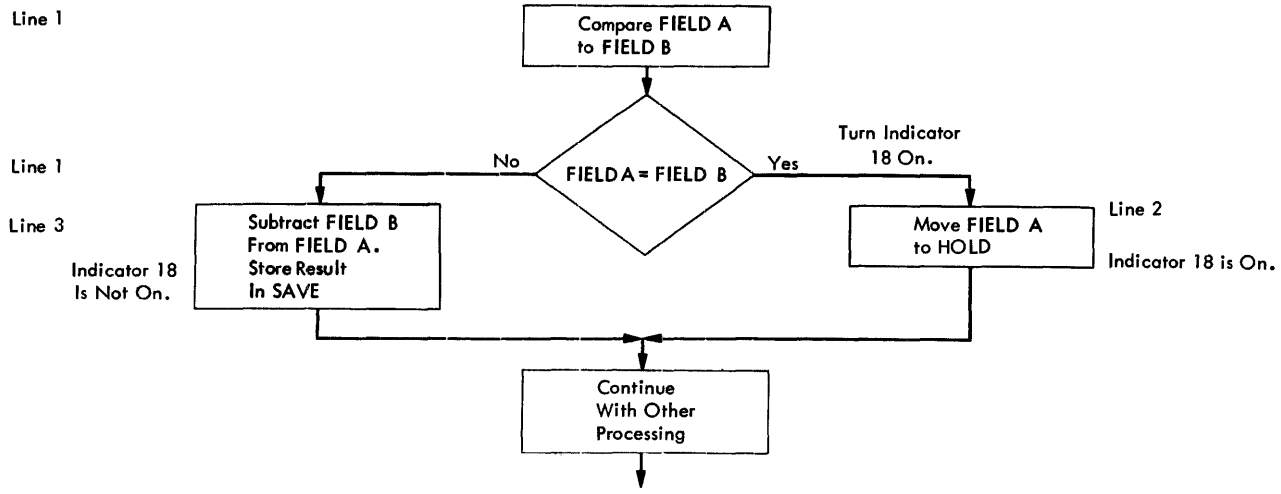

Figure 25. Testing a Comparison

of Figure 24, the contents of the input field, DATE, are compared against 02-14-64, and Indicator 19 is turned on if they are equal.

MULTIPLICATION AND DIVISION

Multiply and divide operations are easily accomplished with RPG. Moreover, two problems associated with these functions (decimal-point alignment and half-adjusting) are easily specified.

Problem

This example illustrates an inventory card (Figure 26) that must have the quantity multiplied by the price to develop a total cost on a weekly basis. The price of the part is also updated each week so that the price for the following week reflects the average fabrication costs and scrap losses on a year-to-date basis.

Specifications

The specifications to accomplish these functions are shown in Figures 27 and 28. Figure 27 shows the input specifications for all five fields. The programmer must be certain of the exact size of each field

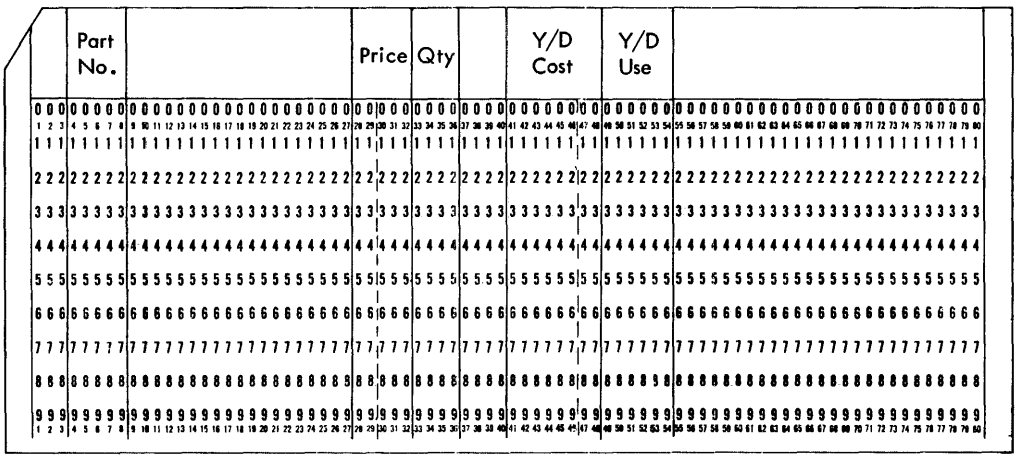

Figure 26. Inventory Card

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Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line 3 4 5	Form Type 6	Filename 7 8 9 10 11 12 13 14	Sequence 15 16	Number (1-N) 17	Option (O) 18	Resulting Indicator 19 20	Record Identification Codes 1: Position 21 22 23 24	1: Not (N) 25	1: C/Z/D 26	1: Character 27	2: Position 28 29 30 31	2: Not (N) 32	2: C/Z/D 33	2: Character 34	3: Position 35 36 37 38	3: Not (N) 39	3: C/Z/D 40	3: Character 41	Stacker Select 42	Packed (P) 43	Field Location From 44 45 46 47	Field Location To 48 49 50 51	Decimal Positions 52	Field Name 53 54 55 56 57 58	Control Level (L1-L9) 59 60	Matching Fields or Chaining Fields 61 62	Field-Record Relation 63 64	Field Indicators Plus 65 66	Field Indicators Minus 67 68	Field Indicators Zero or Blank 69 70	Sterling Sign Position 71 72 73 74
01	1	INVENTRYAA				29	80		Z	-																				
02	1																			4	8		PARTN						
03	1																			28	32	3	PRICE						
04	1																			33	36	0	QUANTY						
05	1																			41	48	2	YDCOST						
06	1																			49	54	0	YDUSE						
07	1																													

Figure 27. Input Specifications

and the number of decimal places within each field. The fields in this example are

Part Number	xxxxx	No decimal positions (alphameric)
Price	xx.xxx	3 decimal positions
Quantity	xxxx.	0 decimal positions
Y/D Cost	xxxxxx.xx	2 decimal positions
Y/D Usage	xxxxxx.	0 decimal positions

As shown in Figure 27, the decimal positions of each field are entered under Decimal Positions on the Input Specifications sheet.

The calculation specifications for this example are shown in Figure 28. Price is multiplied by quantity and the result is placed in a field called COST. The field length of COST is specified as 9. The result field is to have two decimal positions and to be half-adjusted as specified by the H in Half Adjust (column 53). The following is an example of the arithmetic of this operation, using actual values:

Price	1.213
Quantity	X 216
	7278
	1213
	2426
	262.008

The result field was specified for two decimal positions; therefore, the half-adjustment is made to the digit 8 in the units position of the field. Half-adjustment is always made to the position to the right of the last position retained as part of the result, as follows:

```
262.008
+     5  half-adjust
262.013
```

The result, 262.01, is stored as the contents of COST. The position that was half-adjusted is dropped.

The second line of the Calculation Specifications sheet provides the specifications for dividing year-to-date costs by year-to-date usage. The result is

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System/360

Form X24-3351-1
Printed in U.S.A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Control Level (L0,L9,LR)	Indicators: And / And	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus / Minus / Zero or Blank; Compare: High 1>2 / Low 1<2 / Equal 1=2	Comments
01	C		29	PRICE	MULT	QUANTY	COST	92		H		
02	C		29	YDCOST	DIV	YDUSE	PRICE	53		H		
03	C											
04	C											

Figure 28. Calculation Specifications

placed in a field called PRICE. The field length of PRICE is specified as 5, including three decimal positions. The result is to be half-adjusted, as specified by the H in Half Adjust. An example of the arithmetic of this operation, using actual values, follows. Year-to-date cost divided by usage equals price.

```
(Y/D                    1.3419          (price)
usage)   1296 | 1739.23xx              (Y/D cost)
```

The result field was specified for three decimal places. Therefore, the half-adjustment is made to the digit 9 in the units position. This is the position to the right of the last position retained as part of the result, as follows:

```
  1.3419
+    5 half-adjust
  1.3424
```

The result 1.342 is stored as the contents of PRICE. The position that was half-adjusted is dropped.

SEQUENCE-CHECKING

Two types of sequence-checking functions can be performed with RPG:

1. Checking the sequence of different record-types within a control group.
2. Checking the sequence of control groups. (See the section Using the Matching Fields Specification for Sequence-Checking.)

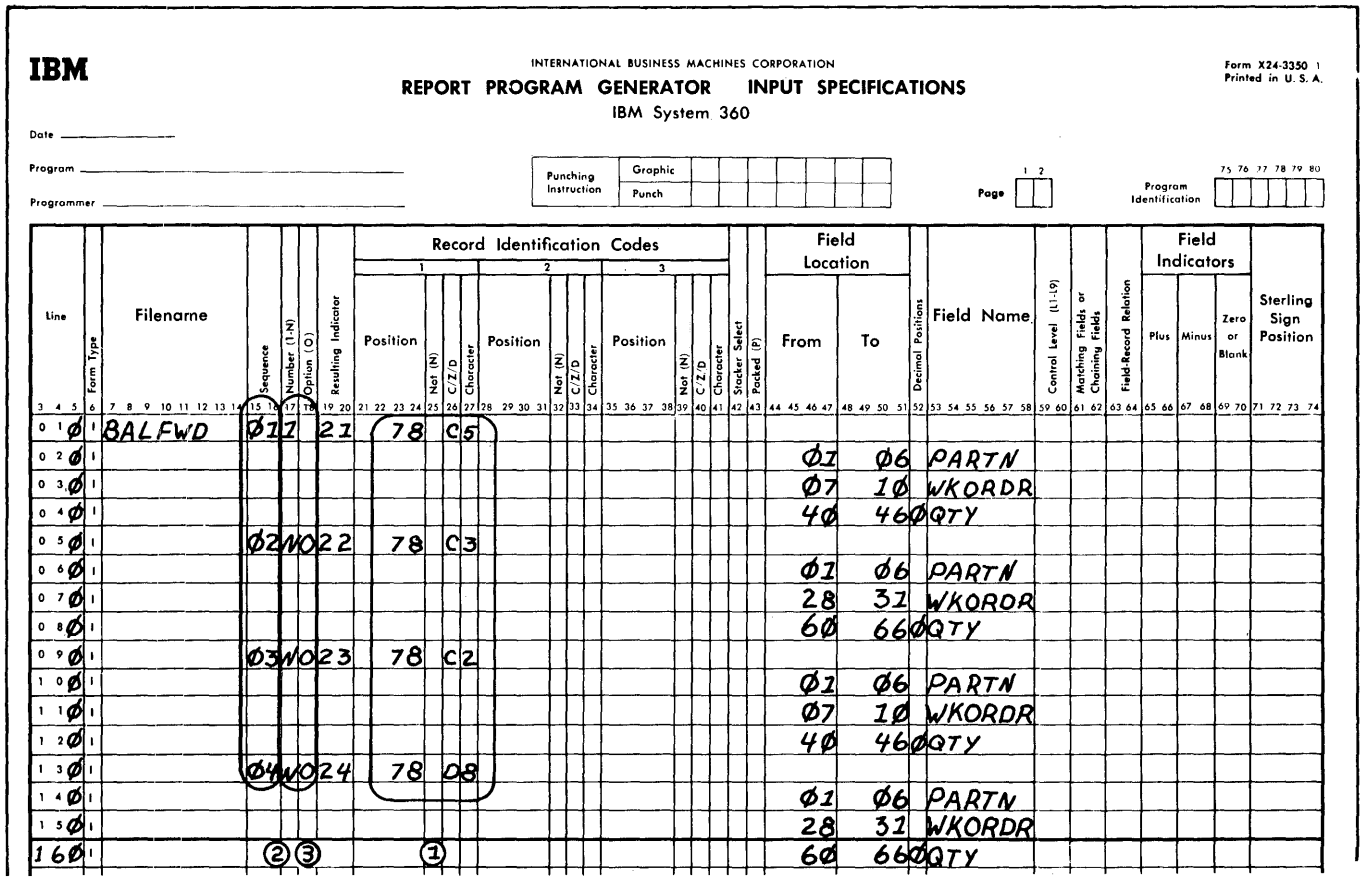
Sequence-Checking of Different Record Types within a Control Group

The application consists of updating an inventory file, which, in this case, contains from one to four of the following types for each inventory part number:

CARD	CODE
Balance-Forward	5 in col. 78
Issue	3 in col. 78
Receipt	2 in col. 78
Adjustment	8 in col. 78

Figure 29 illustrates the specifications required to check the sequence within a group of four card-types. In a complete problem the control groups (part numbers) would be designated by use of a control level indicator as explained in a previous example. The numbers on the form refer to the following numbers:

1. The record-identification codes for the four cards are specified in the same manner as in previous examples. The C in C/Z/D indicates that the entire character punched in the card is examined to establish the record-identification code.



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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System 360

Form X24-3350-1 Printed in U.S.A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
010	1	BALFWD	01	1		21	78		C	5											01	06		PARTN							
020	1																				07	10		WKORDR							
030	1																				40	460		QTY							
040	1		02	N	O	22	78		C	3																					
050	1																				01	06		PARTN							
060	1																				28	31		WKORDR							
070	1																				60	660		QTY							
080	1		03	N	O	23	78		C	2																					
090	1																				01	06		PARTN							
100	1																				07	10		WKORDR							
110	1																				40	460		QTY							
120	1		04	N	O	24	78		0	8																					
130	1																				01	06		PARTN							
140	1																				28	31		WKORDR							
150	1																				60	660		QTY							
160	1		(2)	(3)			(1)																								

Figure 29. Input Specifications

In the specifications for the last card-type (specification-line 13 on the form), a D is written in C/Z/D because there is a possibility that some of these card-types may have a zone punch. The D specifies that only the digit punches in the card are examined to identify the card-type. Thus, zone punches that could result in unequal comparisons are ignored.

2. The sequence established for the file is determined by the sequence in which the specifications for each card-type are written on the form and by the numbers placed in Sequence. In this example, the digits 01, 02, 03, and 04 are used. The numbers assigned must begin with 01 in each file and must be consecutive in ascending order.

   Alphabetic characters under Sequence in preceding examples indicate that no sequence-checking is to take place. Alphabetic specifications must always be written before numeric specifications.

These specifications are all that are required to cause the object module to perform a sequence-check of the various record-types within the part number control groups. If a sequence-check error is detected, a special indicator can be tested in the program in order to determine its status.

Two additional specifications, Number and Option, are used in these types of applications.

3. If a numeric specification is provided in Sequence, a specification must be provided in Number.

   On the first specification line, the number 1 in Number indicates that one record of that type must be present in each group. In this example only one balance-forward card for each inventory part number must be present. If there is no balance-forward card, the program recognizes an error in the input file.

   The letter N in Number of the specifications for the other record-types means that multiple card-types for each

part number may be present. In this example, multiple cards for issues, receipts, and adjustments may be present.

The letter O in Option in the specifications means that the records are optional. That is, a record may or may not be present.

If the letter O is not specified it means that the particular record must be present. This requirement applies only if Sequence has been specified as numeric.

CORRELATION OF THE RPG SPECIFICATIONS SHEETS

Figure 30 shows a file-to-file sample program. (This type of report is often called an 80/80 listing.) It illustrates the relationships of the RPG specification sheets.

Assume the contents of an input file are to be transferred to another file. In this example the input file is a card file, and the contents of the cards are to be printed. Three specifications sheets are required for this program: File Description, Input, and Output-Format Specifications.

File Description Specifications Sheet

The two files are described on this sheet. The card-input file is assigned the name INPUT, and the printed output file is named OUTPUT. Page and line sequence numbers are entered in columns 1-5. An F in column 6 indicates that each entry is a File Description Entry. The file names are entered in columns 7-14 (Filename). Column 15 contains an I or an O to indicate whether the file has an input or an output function.

Column 16 of the input file of the File Description Specifications Sheet contains a P because the file described is the primary input file for the job; the E in column 17 indicates that the end-of-file condition for this file occurs when this file is depleted.

Column 19 contains an F and a V to indicate that the file formats are fixed-length and variable-length respectively.

Block length (columns 20-23) is 80 for the input file because each card is a block of data. Record length (columns 24-27) is also 80 for the input file because each card is an unblocked record. For the output file, the block length and the record length is 132, which is the maximum length of a printer line. The program identification is entered into columns 75-80.

If the input file was read in by an IBM 1442 Card Read-Punch (as it is in this example) the code in Device (columns 40-46) would be READ42. The output printer would have a Device code of PRINTER.

Input Specifications Sheet

The Input Specifications sheet also has the program identification entered in columns 75-80 and the page and line numbers in columns 1-5. An I in column 6 of each card indicates an input specification entry.

The filename is again entered into columns 7-14. Columns 15-16 contain the sequence code AA. Indicator 01, entered into columns 19-20, will be on throughout the job to show that records from its associated file are being processed. The second line describes the field name CARDIN. The field consists of card columns 1-80.

Output-Format Specifications Sheet

On the Output-Format Specifications sheet, the filename of the output file is entered in columns 7-14. The D in column 15 indicates that each line printed in this file is a detail line. A single space after printing is specified by the entry in column 18. Indicator 01 from the Input Specifications sheet is specified in columns 24-25. When Indicator 01 is on, a record will be printed.

The second output line has the name of the field to be written in the output record entered in columns 32-37. Data from the field labeled CARDIN will be printed (end position of 80) in the output record as specified in columns 40-43.

SUMMARY

This completes the general description of some of the functions that can be performed with RPG. Some of the fields of the specifications sheets were not explained and some additional operations that can be performed with RPG remain to be described. At this point, the reader should be able to determine the scope of the RPG program.

More specific information about each specification sheet is contained under RPG Specification Sheets.

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REPORT PROGRAM GENERATOR FILE DESCRIPTION SPECIFICATIONS

IBM System/360

Form X24-3347-2
Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/T	T/D/T	Overflow Indicator	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19	20 21 22 23	24 25 26 27	28	29 30	31	32	33 34	35 36 37 38	39	40 41 42 43 44 45 46	47 48 49 50 51 52	53	54 55 56 57 58 59	60 61 62 63 64 65	66 67 68 69 70 71 72 73 74
01Ø	F	INPUT	I	P	E		F	8Ø	8Ø							READ42					
02Ø	F	OUTPUT	O				V	132	132							PRINTER					
03	F																				

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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System 360

Form X24-3350 1
Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15 16	17	18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43	44 45 46 47	48 49 50 51	52	53 54 55 56 57 58	59 60	61 62	63 64	65 66	67 68	69 70	71 72 73 74
01Ø	1	INPUT	AA			Ø1																								
02Ø	1																				1	8Ø		CARDIN						
03	1																													

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INTERNATIONAL BUSINESS MACHINES CORPORATION

REPORT PROGRAM GENERATOR OUTPUT-FORMAT SPECIFICATIONS

IBM System/360

Form X24-3352-1
Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: And	And	Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19 20	21 22	23 24 25	26 27 28	29 30 31	32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
01Ø	O	OUTPUT	D			1			Ø1									
02Ø	O											CARDIN			8Ø			
03	O																	

Figure 30. File-to-File Program

PROGRAM LOGIC

Each object program generated by RPG uses the same general logic, and for each record to be processed the program goes through the same general cycle of operations. Within that cycle, there are two different instances in time when operations specified on the Calculation and Output-Format Specifications sheets are performed. These instances are called detail and total time.

For the illustration of this concept, a generalized flowchart of an RPG object program is shown in Figure 31.

The following numbers correspond to the numbers on Figure 31. A program cycle begins with item 1 and continues through item 11. Steps 6 and 7 are referred to as total time. Steps 1 and 11 are referred to as detail time.

1. Before the first record is read, the object module prepares and prints any heading information to be printed on the first page. After the first record has been read, the program prepares and prints heading and detail information which is not conditioned on overflow.
2. The object module tests for any halt indicators. If any halt indicators are on, the program branches to item 12.
3. The object module tests for the end-of-file conditions. If the end-of-file condition has occurred, the program branches to item 13.
4. The object module then reads an input record.
5. All control level indicators and all resulting indicators (specified in columns 19-20 of the input sheet) are turned off. Then, starting with line 1 of the Input Specifications sheet, and with the record just read, the object module uses the record identification code to identify the record. When the identification code matches an entry on the input sheet, the program turns on the resulting indicator that has been specified for the record. When a control-field break occurs, appropriate control-level indicators are turned on.
6. Next, all total calculations are performed. (This step is bypassed for the initial control break which is caused by reading the first input record.)
7. Next, all total output lines which are not conditioned on overflow are prepared and printed. (This step is also bypassed for the first control break.)
8. The object module tests for the Last Record indicator (LR). If it

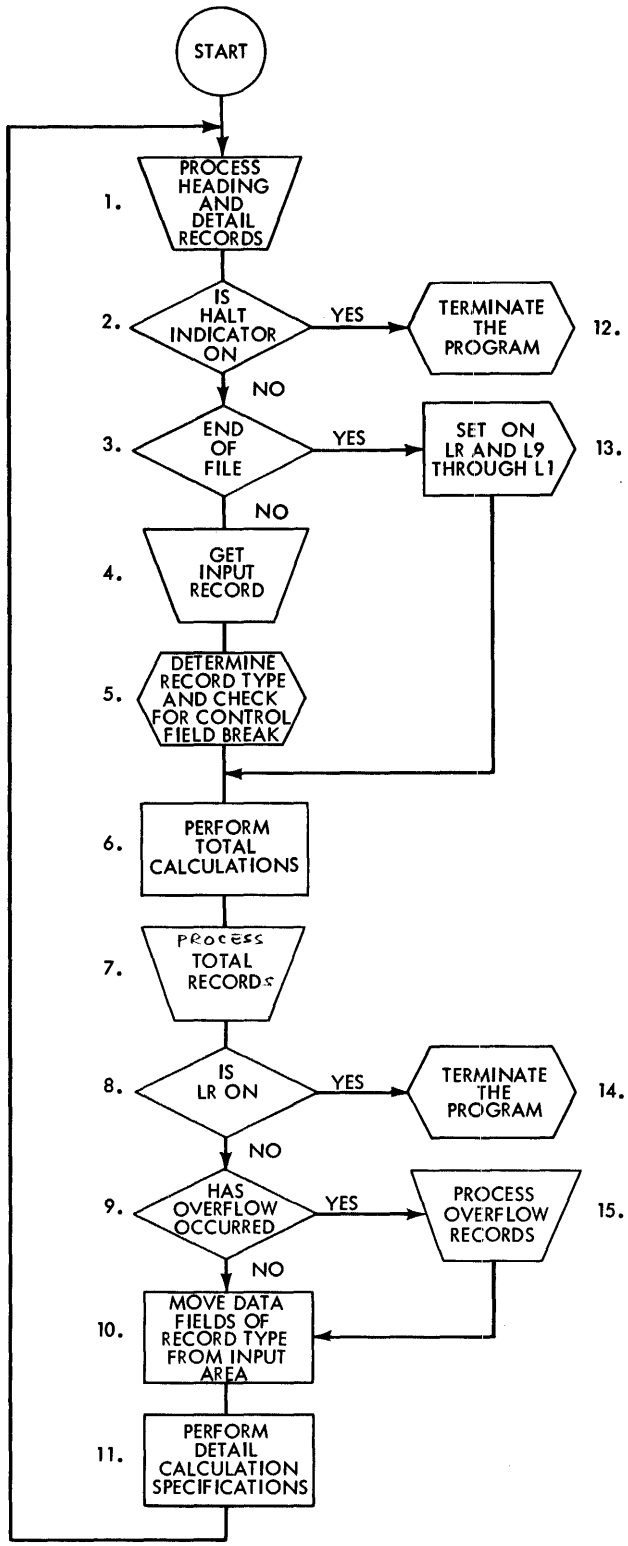


Figure 31. General Logic Flow of an RPG Object Module

is on, the program branches to item 14.

9. The object module tests for an overflow condition. If an overflow condition has occurred, the program branches to item 15. Overflow is defined as the condition existing whenever any of the indicators OA-OG, and OV are on. (This step is also bypassed for the first control break.)
10. The data fields contained in the input record just read are moved into storage. These fields are specified by field entries on the Input Specifications Sheet.
11. Any detail calculations are performed, and processing continues with item 1.
12. Program execution is terminated.
13. The Last-Record indicator (LR) is set ON and all control-level indicators L1-L9 are set ON. Then the program branches to item 6.
14. Program execution is terminated.
15. If overflow has occurred, total lines, heading lines and detail lines (in that order) conditioned by overflow are printed. The program then branches to item 10.

PROBLEM DEFINITION

The programming examples in the preceding section were intended to introduce the reader to the use of RPG and were therefore kept simple. More complex applications may require a thorough analysis of the existing or proposed system before a program can be written.

This analysis should include a description of source data and its format, and how this data should be processed to develop the report and other necessary output information.

The following types of information must be defined before coding the program:

1. The available data
2. The input and output formats to be used
3. The information required in the input and output formats
4. The codes to be used to identify the various inputs and outputs and their elements
5. The handling of the various transactions and exceptions.

After all application data has been gathered, document it for easy reference during the writing of the specification forms. One method of documenting an application is to lay out the complete format of the report on a printer spacing chart. This method also provides a pictorial representation of the final product.

PRINTER SPACING CHART

Before the report specifications are written, the programmer should have a clear picture of what he wants as the final product. If the report is to be printed, he must know the number of fields to be placed on each line of the report, the spacing between lines, and the positioning of the information within each line of the report.

Although no cards for the source deck are punched directly from the entries on this chart, the representation serves as a guide for completing the specification sheets. It plays an important role in writing report specifications. If the final product is written on magnetic tape or direct-access storage devices or if it is punched in cards, the user must know where the information is to be located. A tape layout chart or a direct-access storage-device layout chart can be used.

Layout of Lines and Fields

The two most important functions of a printer spacing chart are

1. To establish the positions of the data to be printed and to indicate the spacing between printed lines.
2. To assign each line an identification code representing the type of line. Figure 32 shows an example of the printer spacing chart (Form X24-6436).

The numbers across the top and bottom of the spacing chart represent the print positions. The numbers down the left side are the line numbers. The programmer selects the line number and print positions for a particular field and makes his notation in the selected positions.

Headings and other constant information are spelled out completely in the print positions assigned to them. Variable information is represented by Xs and, where applicable, includes credit symbols, punctuation, etc. The position in an amount field where zero suppression ends is indicated by a zero rather than an X.

Line-Identification Code

The line-identification code specifies the type of line to be printed. The identification codes are H for a heading line, D for a detail line, and T for a total line. All lines must be identified as belonging to one of these categories.

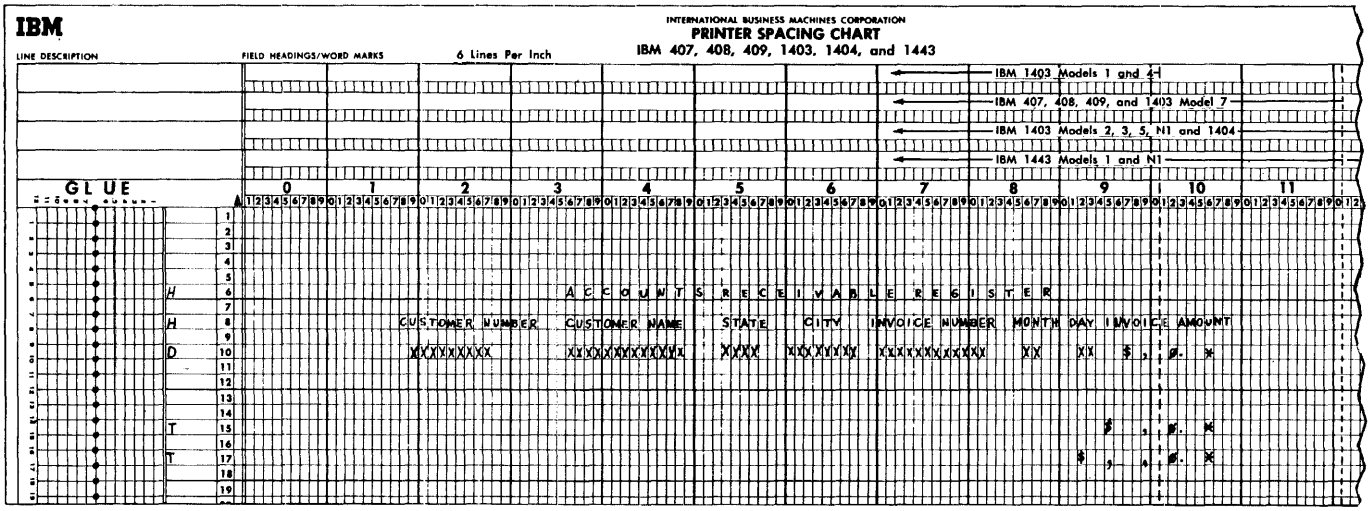


Figure 32. Printer Spacing Chart

Cross-References

To make this reference manual a more effective learning tool, numerous cross-references have been placed in the manual. They are located wherever it was thought that readers not familiar with disk storage processing and related functions would have difficulty with these unfamiliar subjects.

Disk storage, table lookup, matching field, and chaining field operations and related functions are described apart from the detailed descriptions of specifications for them.

These general introductory descriptions, contained at the back of the manual, can be used by the reader as he encounters the related specifications for them throughout the manual.

To facilitate locating them in the manual, all cross-references used are listed in the Index under Cross-References.

The section Disk Storage Concepts provides a general introduction to disk file organization and processing including terminology associated with these functions. Readers not familiar with these concepts may wish to review that section before beginning with this section.

Left- and Right-Justification

When making entries on the RPG sheets, it is important that the entry be right-justified or left-justified as required. Justifying an entry means having it begin in the first position of the specification (left-justified), or having it end in the last position of the specification (right-justified).

Alphameric entries (composed of both alphabetic and numeric entries) are always left-justified. Numeric entries are always right-justified.

Information regarding the correct justification is provided in the description of the entry, in those cases where it may not be clear to the reader as to whether the entry is alphameric or numeric.

Alphabetic Characters

In this manual, the references to alphabetic character designate the letters A through Z, the dollar sign ($), the pound sign (#), and the at sign (@).

Numeric Field Format

The System/360 packed decimal format allows two decimal digits to be represented in one core storage byte. The RPG object program automatically converts all numeric input data from unpacked to packed format. Unless otherwise specified, all numeric data is unpacked before it is output. In this manual, numeric length refers to the unpacked length although the data is actually stored in the packed format.

Sterling Routines

Sterling Routines are included in RPG to provide users with a convenient and time-saving means of handling amount fields that are punched in the format of Pound Sterling monetary units.

The presence of sterling fields is indicated to the RPG program by additional entries in the input and output specifications sheets and in the RPG Control Card. The other specifications sheets are not affected. All calculations are done in the Pence unit of measure.

RPG SPECIFICATION SHEETS

This section provides detailed explanations of each specification field contained in the six RPG forms.

The forms are listed in the sequence in which they are discussed in this publication (see Figure 33).

Input Specifications
Calculation Specifications
Output-Format Specifications
Line Counter Specifications
File Description Specifications
File Extension Specifications

Input Specifications. (Refer to Figure 34) This form is used to

1. Specify the file or files to be read into the system
2. Identify the different types of records contained in each file
3. Describe the location of the data fields in each record

Calculation Specifications. This form specifies the operations to be performed

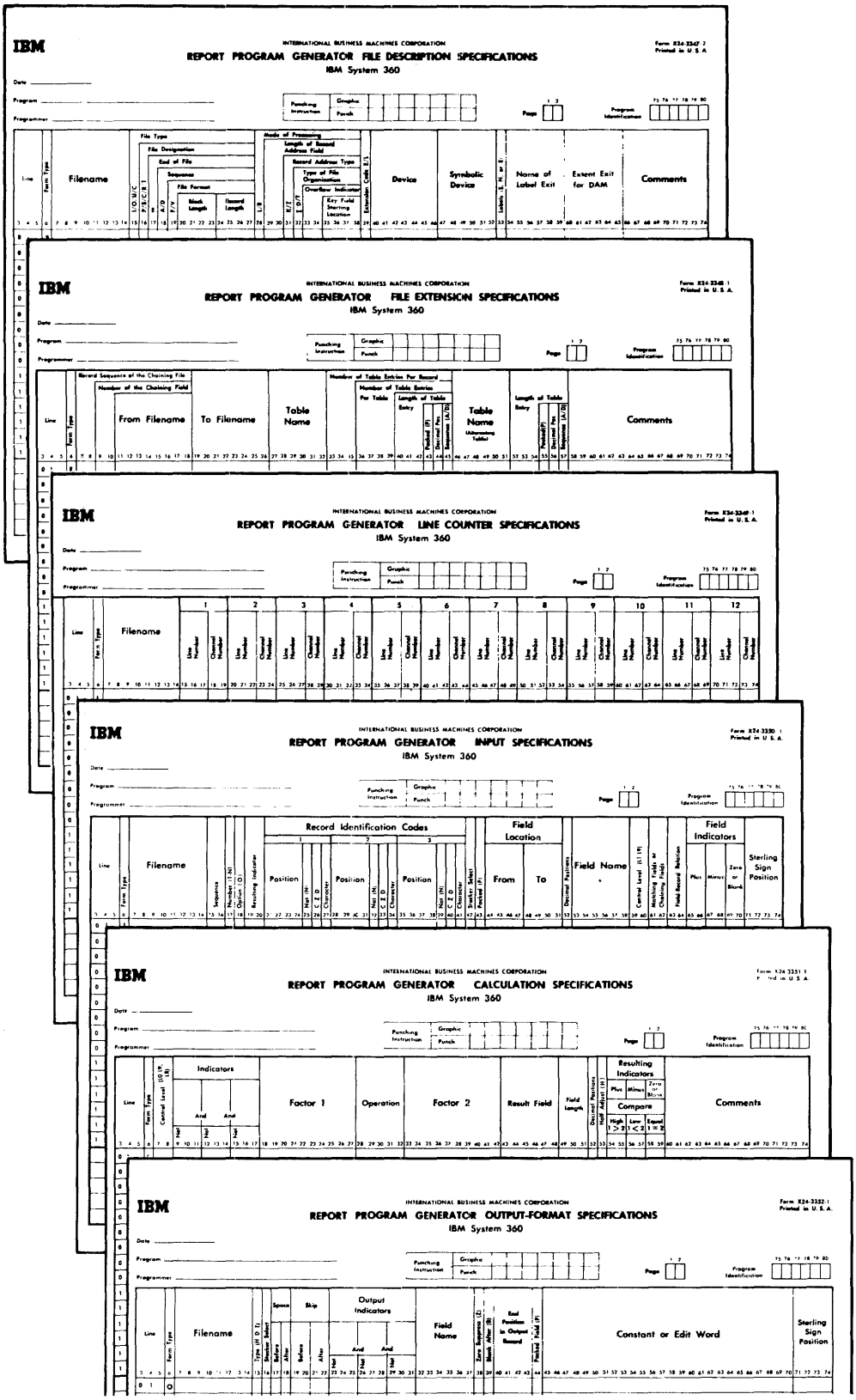
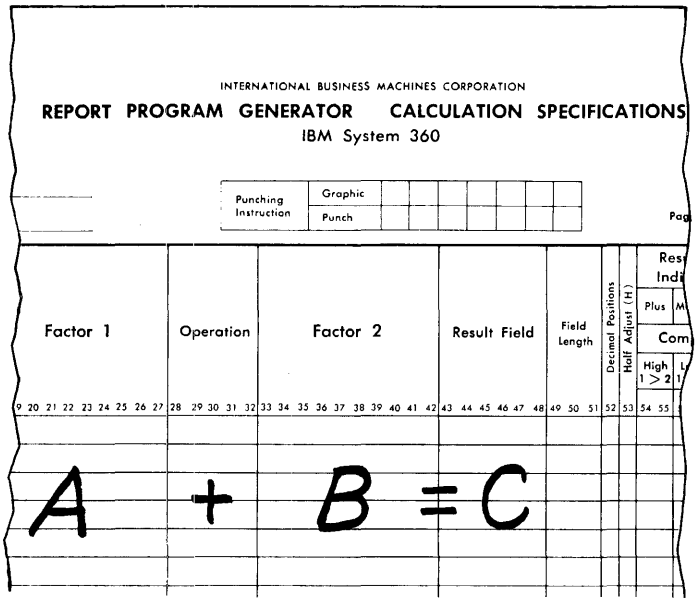


Figure 33. RPG Specification Sheets

upon the input data and upon data obtained as the result of previous calculations.

Calculation specifications are graphically illustrated below. To perform the operation A+B=C, the A field is specified in Factor 1, the kind of calculation to be performed in Operation, the B field in Factor 2 and the C field in Result Field.



Output-Format Specifications. This form specifies:

1. The kind of output files to be produced: printed reports, summary records, etc.
2. The location of the data fields in the output reports and records

These functions are illustrated in Figure 35.

Line Counter Specifications. This form must be used if a report that will ultimately be printed is to be stored on some intermediate device, and if the program uses overflow indicators (or automatic skipping).

File Description Specifications. This form provides additional information about input and output files that is not included on the input or output sheets.

File Extension Specifications. This form provides additional information about tables, chaining files, and record-address files.

COMMON FIELDS

There are five entries that have the same function in all six forms. These are described first.

NOTE: The numbers to the right of the specification name indicate the position on the specification sheet where the field is located.

Page (1-2)

This specification is located in the upper right-hand corner of the sheets. Each specification page of the source program may be numbered. The pages are numbered beginning with 01 for the File Description sheet and continuing in the following sequence:

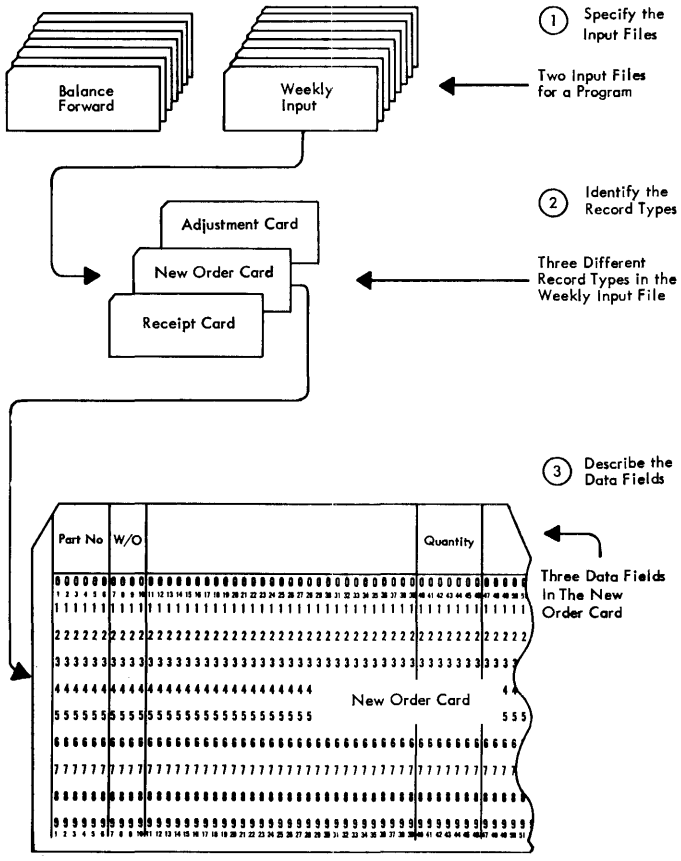


Figure 34. Function of Input Specifications

File Extension Specifications
Line Counter Specifications
Input Specifications
Calculation Specifications
Output-Format Specifications

Line (3-5)

Each specification line may be identified by a line number. The first two digits of the line number are pre-printed on the form. The third position (column 5) is used when it becomes necessary to insert an additional line between two previously written lines. The line to be inserted is written following line 15. It is given an appropriate number (and subnumber in column 5).

The page number and line number have no direct effect on the program and need not be written. These columns are for the convenience of the programmer to indicate the proper order of the RPG source program cards. For example, the specification cards for a program could be placed in numeric sequence (if, for example they were accidentally dropped or upset) by sorting or arranging them in sequence by page number and line number.

Form Type (6)

Each form has an appropriate type-code pre-printed in column 6. This code must be punched into all specifications cards. The codes are

I Input specifications
C Calculation specifications
O Output-Format specifications
L Line Counter specifications
F File Description specifications
E File Extension specifications

Comments (*Column 7)

This feature enables the programmer to insert an identifying comment in the specification sheets. This facility can be used, for example, to identify the end of one section of a program. These comments are written on the specification line, preceded by an asterisk in column 7. During the generation of the object program, the asterisk in column 7 identifies the comment so that it is not considered a specification.

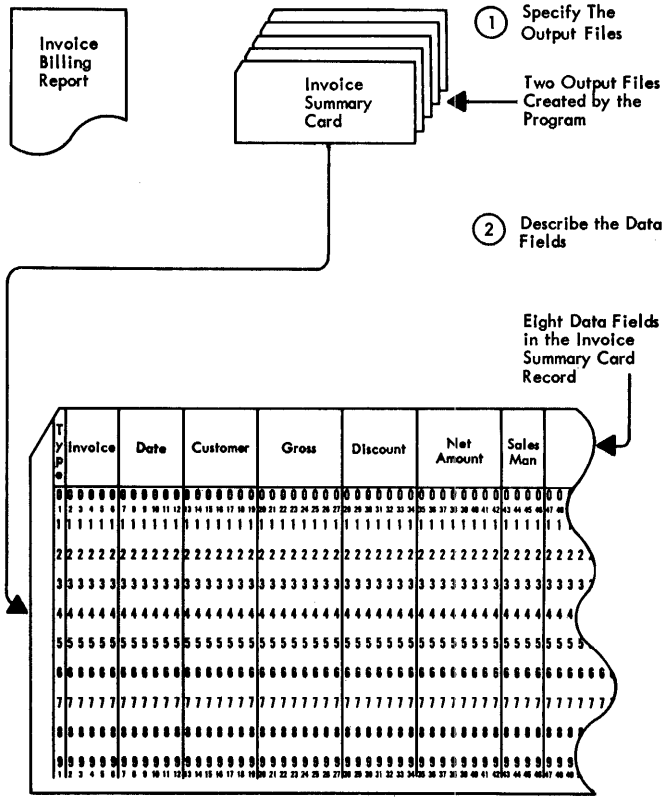


Figure 35. Functions of Output-Format Specifications

Program Identification (75-80)

This identification is located in the upper right-hand corner of the sheets. This entry identifies the specification cards for a particular program or for a specific section of a large program.

GENERAL INFORMATION

The specifications for this sheet are divided into two categories as shown in Figure 36.

1. Record Identification (columns 7-42). These entries identify the input record (by specifying the identifying record codes it contains) and specify the relationship of the record to other records in the file.

   One line of the sheet is used to describe one record type.

   When the specifications are being written it is not necessary to indicate the specific input units used in the program. The unit used for each file is specified on the file description sheet. Each file name therefore is related to a specific input unit. By merely writing the file name on the input sheet, the input unit has, in effect, been specified.
2. Field Description (columns 43-74). These entries describe the fields of the input record used in the report.

   Each field is described on a separate line and is written on the line below its corresponding record-identification entry.

Sequence of Input Records

To save processing time, input records that occur only rarely in the program should always be specified at the end, and input records that occur frequently should be specified at the beginning of each specification list. (Specification list is a term used to describe the specifications from one or more of the same type of specifications sheets.)

On each detail cycle, the specifications are examined in the same sequence in which they are written on the Input Specifications sheet.

For example, assume a card file containing 3000 cards is to be processed and that there are five different exception procedures that must be followed for some of the cards. If the program is written so that the specifications concerning the exception cards are at the beginning of the

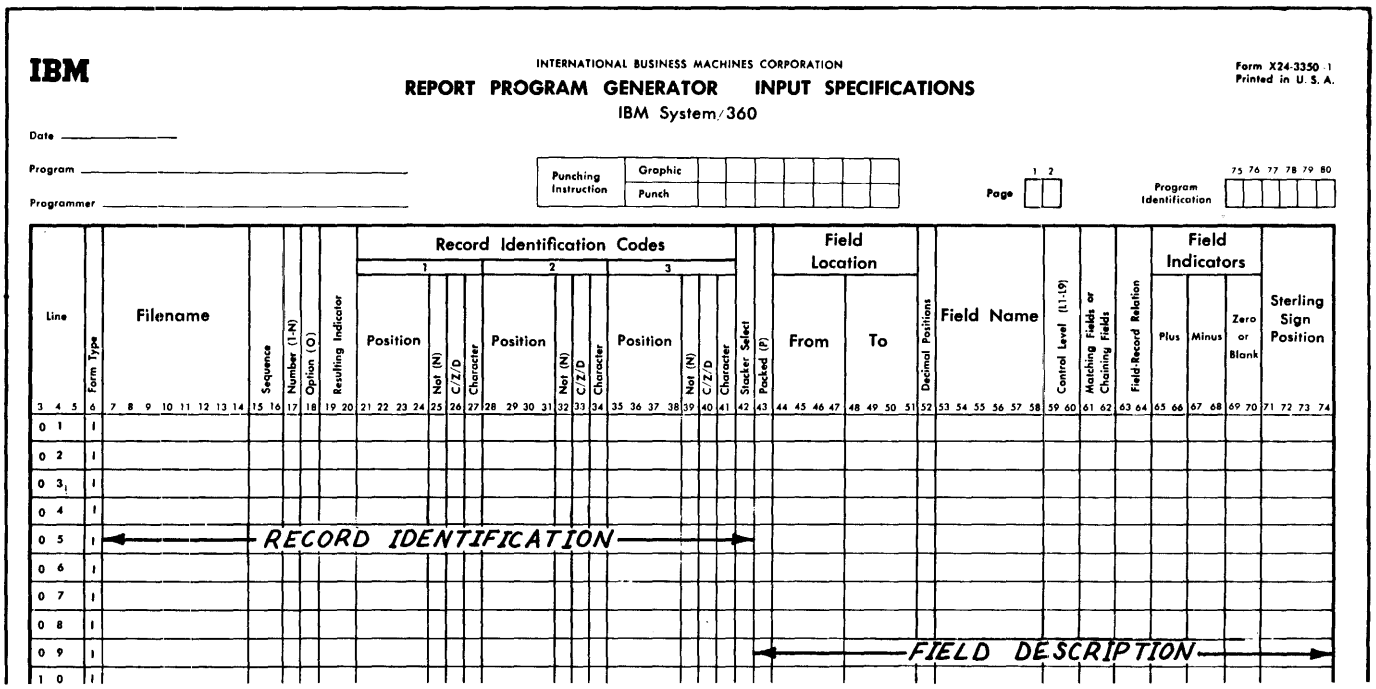


Figure 36. Input Specifications Sheet

input list, then, as each card is read, all specifications for the exceptions must be examined first before the specifications for the normal processing are found. Thus a great amount of processing time would be wasted if the card file contained only two or three exception cards but the exception specifications had to be examined for all 3000 cards.

RECORD IDENTIFICATION ENTRIES

FILENAME (7-14)

A file name must be given to each input file. The file name must be left-justified (that is, it must start in column 7) and it must begin with an alphabetic character. The remaining characters of the name may be alphameric, but must not contain special characters or embedded blanks. The file name may be eight characters or fewer. (Embedded blanks are blank positions falling between other characters of the name.)

NOTE: In this publication, alphabetic character refers to the letters A through Z, the dollar sign, pound sign, and the at sign ($, #, and @).

The file name must be entered only with the first record-identification line of the appropriate file.

SEQUENCE (15-16)

This specification is used to check the sequence of cards within a control group. Figure 37 illustrates a card file containing three types of cards for each part-number control group. In this example, to assure correct accumulation of the values, the balance-forward card must be the first card in the control group, the receipt card the second, and the new order card the last.

The specifications for checking the sequence of these cards is shown in Figure 38. (Field description specifications are not shown.)

If the file is not in sequence the halt indicator H0 is turned on. Unless this H0 indicator is turned off by a SETOF operation (See Turning Indicators On or Off) in the calculation specifications, the program will terminate before the next input record is read.

The cards are specified on the form in the same sequence in which they are to be read by the object module.

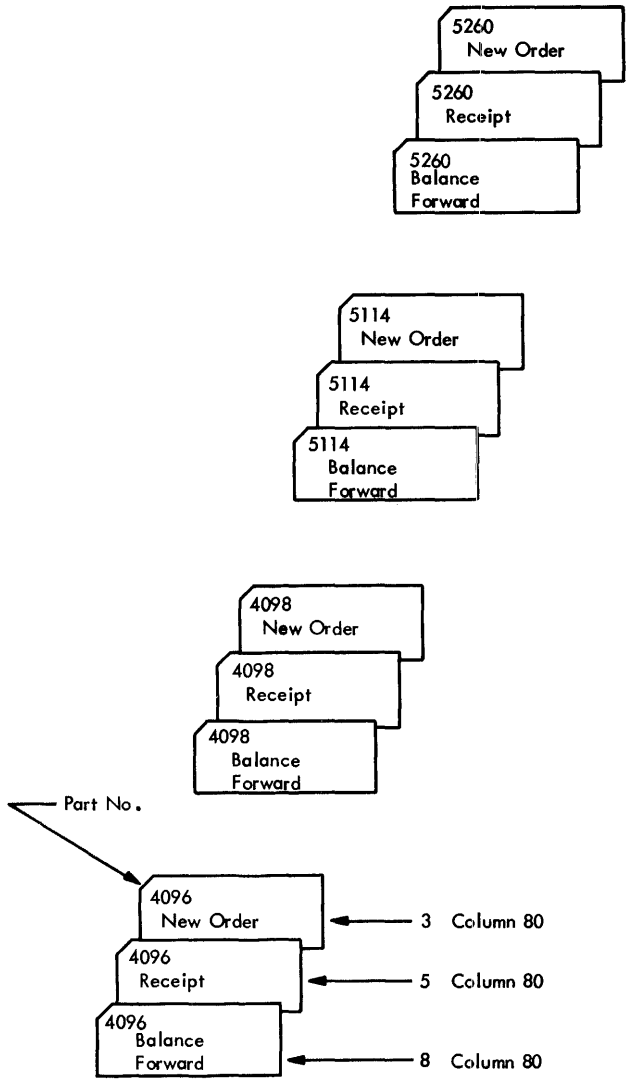


Figure 37. Card Types within Control Groups

NOTE: The entries in Sequence must begin with 01 in each file and be consecutive in ascending order.

Alphabetic codes must be placed in Sequence if the input records do not have to be in sequence within a control group or if it is not necessary to stop processing when the records are not in sequence. Any two alphabetic characters can be used.

Within a given file, header cards or other cards that are not in sequence must be specified on the form before specifications that must be sequence-checked.

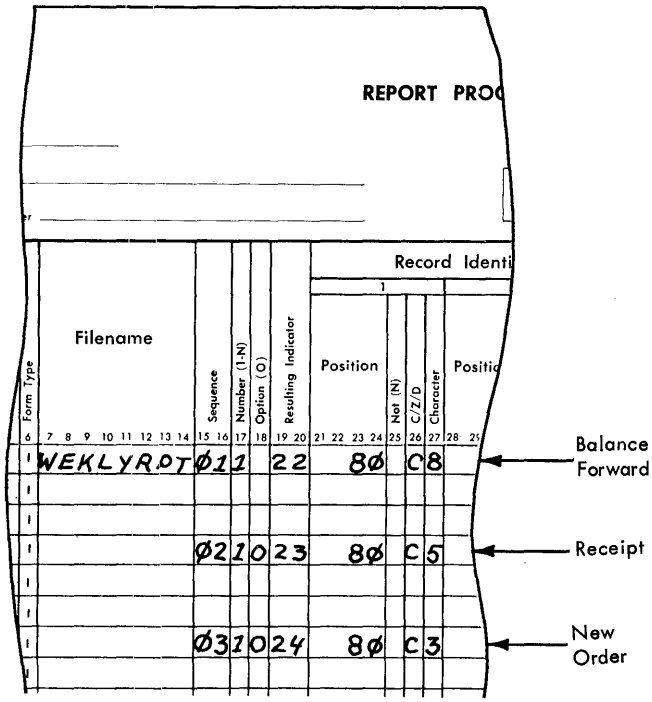


Figure 38. Example of Sequence-Checking within Control Groups

NOTE: If a numeric specification is given in Sequence then specifications must also be provided in Number and Option.

NUMBER (17)

If a numeric code is assigned under Sequence, an entry must also be made in Number (column 17). If an alphabetic code has been assigned under Sequence, this column must be blank.

This specification indicates whether only one record of a specific record-type should exist in each control group or whether one or more than one record of a specific record-type may exist in each control group. For example, Figure 39 illustrates two control groups of cards. In this example, there can only be one balance-forward record in each control group, but there may be one or more new orders or receipt records.

The entry for the specification Number is either:

1 if only one record of a type may exist in a control group, or
N if one or more records of a type may exist in a control group.

The specifications required for the example in Figure 39 are illustrated in Figure 40.

OPTION (18)

This specification is used only with numeric-sequenced record types.

If the presence of a record is optional, the letter O is entered in this column. If a specific record type must be present in order to perform an operation, or if records are non-sequential, this column must be left blank.

In both Figures 38 and 40, the specifications under Option indicate that there must be a balance-forward card for each control group, but there may or may not be a new-order or receipt card.

RESULTING INDICATOR (19-20)

This specification is used in conjunction with the next specification Record Identification Codes (21-41). It has two purposes:

1. To establish a 2-digit code for each input record type.

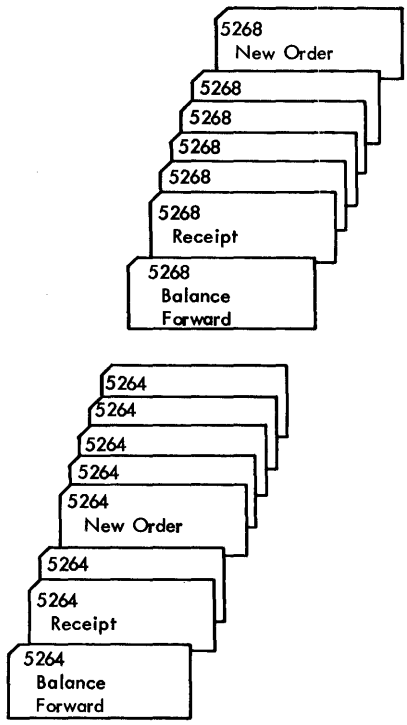


Figure 39. Number of Record Types within a Control Group

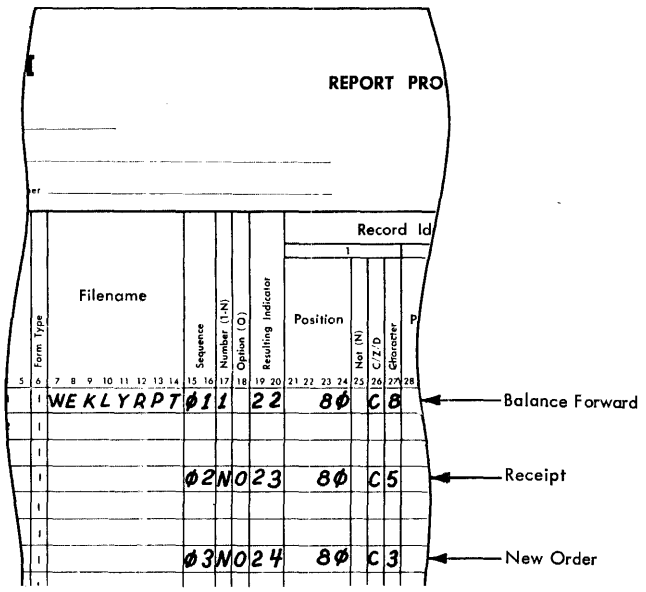


Figure 40. Example of Using Number Specification

2. To set up a special condition in the object program each time the input record is read into the system. The object program may consider this condition during the processing of the calculation and output specifications.

As an example of the first function, assume that a certain card type is identified by the following codes:

1. Digit 5 in column 40
2. 11-punch in column 79
3. No 12-punch in column 80

By assigning a two-digit resulting indicator to represent all of these codes it is much easier to refer to this card type during the writing of the calculation and output specifications.

As an example of the second (and more important) function of this specification, resulting indicators can be compared to selectors in punched-card machines, or to internal or external switches on electronic data processing machines. The use of resulting indicators (like the use of selectors and switches), is to permit certain operations to occur only on specific conditions.

Figure 41 illustrates, by symbols, how resulting indicators are used in the object program. In this example, a payroll file contains three types of cards.

Card Type	Resulting Indicator
current earnings	14
deduction	15
adjustment	16

When one of these cards is read into the system during the object run, the appropriate resulting indicator is turned on, and those specifications pertaining to the record are performed. The detail specifications for these record types are indicated on the calculation and output specifications forms and are controlled by one of these three indicators. Specifications associated with other record types are not performed.

The input specifications required to establish the three indicators shown above are illustrated in Figure 42. (Field description specifications are not shown.)

Resulting indicators—from input records—are turned ON and OFF, during the processing of the object program, as the various record types are read by the system. However, only one resulting indicator can normally be on at one time. When a resulting indicator is turned on, all other resulting indicators are turned off. (See Chaining for an exception to this rule.)

Other indicator conditions that can be established in the program are Field

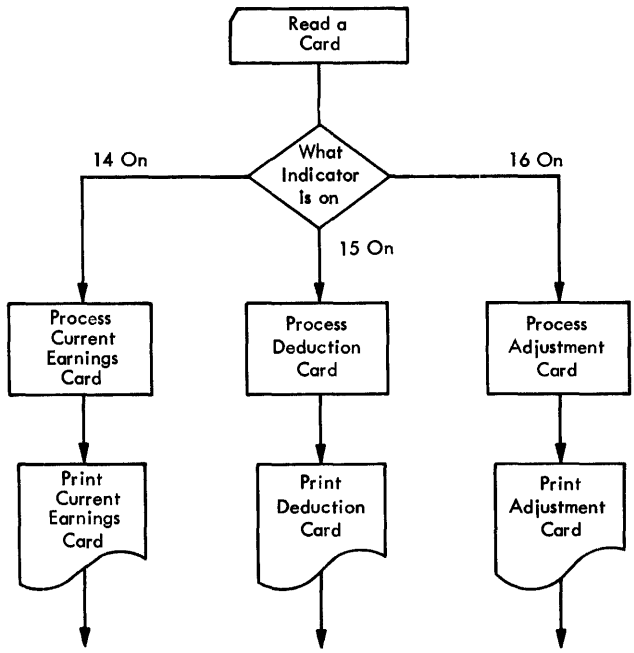


Figure 41. Sample Logic Flow Using Resulting Indicators

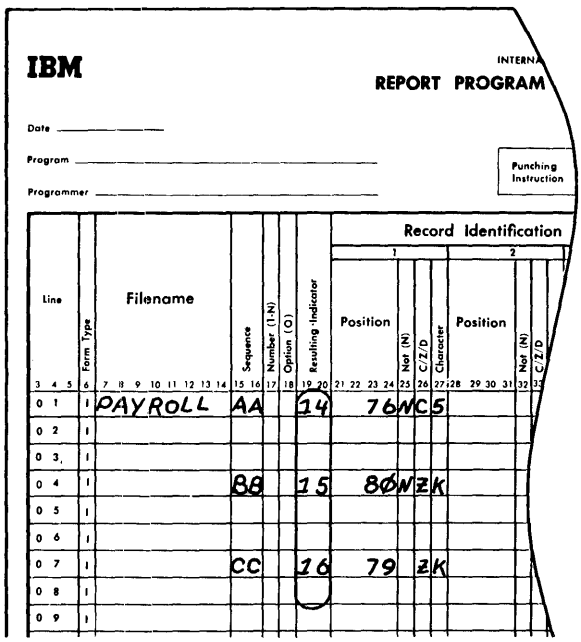


Figure 42. Specifying Resulting Indicators on Input Specifications

Indicators (columns 65-70) of the input specifications and Resulting Indicators (columns 54-59) of the calculation specifications. These functions are described later, but one aspect of their use is of interest at this time.

All three types of indicators are assigned a 2-digit number in the range of 01 through 99. Any of these 99 codes can be assigned to any one of the three types of indicators. Also the indicator codes do not have to be assigned in any sequence. For example, four different card types that are read into the system could be assigned codes 40, 62, 99, 02.

RECORD IDENTIFICATION CODES (21-41)

This specification provides a way of identifying each different record type used in the object program. As mentioned previously, once the record type has been defined on the Input Specifications sheet, references to the record are made by its resulting indicator.

These columns provide for the entry of one to three identifying codes as indicated by the number 1, 2, and 3 on the Input Specifications sheet. It is possible to specify more than three record identification codes by using more than one line. If only one record type is in the input file, the identification codes can be left blank.

Each of the three sets of entries is the same, so only the first set (columns 21-27) is described. Each set is divided into four categories:

Position	(21-24)
Not	(25)
C/Z/D	(26)
Character	(27)

Position (21-24)

Enter in these columns the position in each data record of the character that contains the identifying code. The position must be right-justified in columns 21-24, and leading zeros may be omitted.

Not (25)

Enter an N in this column if the code described must not be present in the specified record position. Otherwise leave this column blank.

C/Z/D (26)

The object module identifies the different record-types of a program by comparing the character written in Character against the codes contained in the records. The entry in Column 26 specifies whether the object program is to compare against the entire character (C), against only the zone portion (Z), or against only the digit portion (D). Enter a C, Z or D in column 26.

Zone Record Identification. Testing a zone means that the zone of the character located in the position specified in columns 21-24 of the input sheet is used to identify the record. (The word "Zone" in this case refers to the meaning of this word in punched-card data processing systems. It does not refer to bits 0-3 of the System/360 EBCDIC character coding.)

The ampersand, the minus, and the blank are exceptions. An ampersand will be identified as a 12-zone, a minus will be identified as an 11-zone, and a blank will be identified as a no-zone. The four common zones are:

1. 12-zone or plus zone ($\overset{+}{0}$, A-I, and &)
2. 11-zone or minus zone ($\bar{0}$, J-R, and minus)
3. 0-zone (S-Z)
4. No zone (0-9 and Blank).

NOTE: When a blank, ampersand, or minus is used in the character portion of a zone test, other characters which contain the same machine zone (e.g., ., $ or %, respectively) will not satisfy the zone test.

Digit Record Identification. Testing a digit means that the digit portion of the character located in the position specified in columns 21-24 of the input sheet is used to identify the record. (The word "digit" in this case refers to the meaning of this word in punched-card data processing systems. It does not refer to bits 4-7 of the System/360 EBCDIC character coding.)

Character (27)

Enter in this column the identifying character that will be compared to the character specified in the input record. The character used in this column may be any letter A through Z, any number 0 through 9, or any special character.

Examples of Record Identification Codes

Examples of record-identification specifications are shown in Figure 43. The explanation of each entry is given here.

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REPORT PROGRAM GENERATOR IN

IBM System 360

Punching Instruction: Graphic / Punch

Filename	Sequence	Number (1-N) Option (O)	Resulting Indicator	Record Identification Codes 1: Position	Not (N)	C/Z/D	Character	2: Position	Not (N)	C/Z/D	Character	3: Position	Not (N)	C/Z/D	Character	Stacker Select	Packed (P)
9 10 11 12 13 14	15 16	17 18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43
			(1)	48		Z	K										
			(2)	48	N	Z	K										
			(3)	62		D	5										
			(4)	49		C	T										
			(5)	16		C	4	40	N	C	5	80		Z	A		

Figure 43. Record Identification Codes

1. This entry specifies an 11-zone in record position 48. Any of the letters J-R could be placed in Character because they all contain an 11-zone. A Z must be placed in column 26 so that only the zone portion is checked. If a C were placed in this column, the object program would compare the letter K against the input-record code instead of an 11-zone. A minus could be placed in this field to represent an 11-zone, and an ampersand could represent a 12-zone.
2. This entry specifies that no 11-zone may be present in record-position 48.
3. This entry specifies that the digit portion of the code is checked. A character whose digit portion is 5 must be in record-position 62. For example, a 5, N, V, or E would fulfill this requirement.
4. This entry specifies that the letter T must be present in record-position 49.
5. These entries specify that all three codes must appear in the same record. A 4 must appear in column 16. Column 40 must not contain the number 5, and column 80 must contain a 12-zone.

NOTE: When more than one record type is specified for a file, the record identification codes of all record types should be mutually exclusive; that is, it should not be possible for an input record to satisfy the identification codes of more than one record type.

AND Relationship

The last example illustrates the way to specify more than one code on ~~more than~~ one line. If an input record contained five different codes, they could be specified as shown in Figure 44. This is known as an AND relationship. It implies that the card is identified by:

1. A 4 in column 16
2. No 5 in column 40
3. An 11-zone in column 80
4. A 2 in column 20
5. A 3 in column 25

Additional specification lines can be used to specify as many record-identification codes as required. Each additional line must begin with the word AND in columns 14-16 and blanks in columns 17-20.

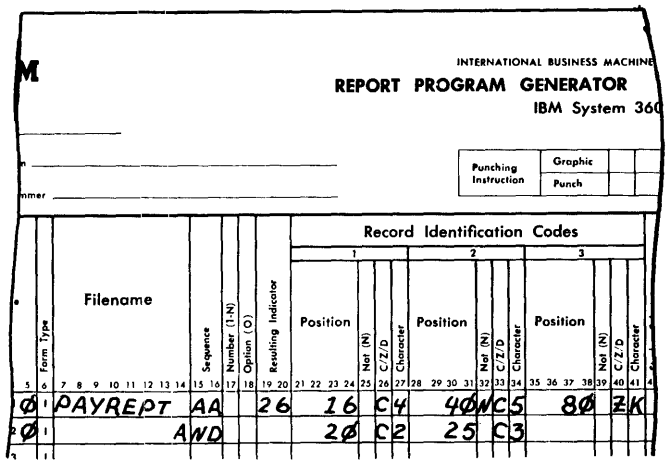

Figure 44. Specifying More Than Three Identification Codes

OR Relationship

An AND relationship is concerned with specifying more than three record identification codes, for one record type, whereas an OR relationship is used to specify two different record types with just one set of field description specifications. The fields in the two record types may be in the same positions or in different positions.

A complete description of OR relationships is presented after the description of Field Location (columns 44-51).

Omitting Record Identification

When input records are to be processed alike without regard for their identifying codes, columns 21-41 may be left blank; however, Sequence (columns 15-16) and Resulting Indicator (columns 19-20) must be specified.

When only certain record types within a group are to be read and processed, they must be listed first with their identifying record codes. The remaining record types may be bypassed or processed as a group. In either case, they are specified as the last record type, and they must have a resulting indicator specified for them. Columns 21-41 of the Input Specifications sheet can then be left blank.

If a record type that has not been identified on the Input Specifications Sheet appears in an input file during the processing of the object module, a special indicator, H0, is turned on. Unless H0 indicator is turned off by a SETOF operation (see Turning Indicators On or Off) on the Calculation Specifications sheet, the program terminates before the next input record is read.

NOTE: If the records are to be bypassed, they should not be referred to on the calculation or output sheets.

Variable-Length Input Records

If the record length of the shortest variable-length record is less than the highest position tested in Record Identification, a blank cannot be used as a means of identifying a record in those positions that exceed the length of the minimum record. This is illustrated in the following example.

Record Identification Codes	Record Length
X-14	30
X-30, X-41 NX-60 NX-49	60
X-21, NX-79	80
X-49, NX-34	50

The minimum variable-length record is 30 positions; therefore a blank cannot be used as a record identification code in any position higher than 30.

STACKER SELECT (42)

This specification causes cards to be selected into stackers of the input/output units. It is used when an input/output unit with more than one stacker is attached to the system.

If no entry is made in Stacker Select, the cards from the input file are selected to the first stacker pocket depending on the input/output unit attached to the system.

For input cards that are to be punched by the program (i.e., combined file), stacker selection must be specified on the Output-Format Specifications sheet.

The stacker pockets and their acceptable codes are shown in Figure 45.

The stacker-select entry is made on the same line with the record identification. If different records in an OR relationship are to be stacker-selected, the appropriate

Input Unit	Stacker Number	Stacker Select Code
1442 Card Read-Punch	1 2	1 or Blank 2
2501 Card Reader	-	Blank
2520 Card Read-Punch	1 2	1 or Blank 2
2540 Card Read-Punch	R1 R2 ~~RPG~~	1 2 ~~0~~

Figure 45. Summary of Stacker Select Specifications (Input)

stacker-select entry must be written on each OR-record identification line.

FIELD DESCRIPTION ENTRIES

As mentioned previously, the Input Specifications sheet consists of two categories: record identification and field description.

On the record identification portion of the Input Specifications sheet, one line represents the specifications for one record type. On the field-description portion of the sheet, one line represents the specifications for one field of a record.

The following information concerns the individual field descriptions of one record type. Field descriptions are always written on the specification line immediately below the specification line that identifies the record type.

Field description entries describe the fields of the input record to be used in the report. Each field of the record requires one line on the Input Specifications sheet. Columns 7-42 of the line must be blank.

NOTE: Unused record fields should not be described, since this would waste core storage and processing time.

PACKED (43)

Packed format in the System/360 means that two decimal digits can be represented in one core storage byte. This is the data format used for numeric fields in RPG. Because input data is usually represented in the unpacked format —one digit in one core storage byte— the RPG program automatically converts numeric input data from the unpacked format to the packed decimal format. Because the packed decimal format permits greater utilization of storage capacities (Card-Tape-Disk) the RPG program permits numeric data to be put out in the packed decimal format. (See Output-Format Specifications Sheets.)

In order to utilize this numeric output data in subsequent processing runs, RPG permits data in packed decimal format to be read into the RPG program.

Enter a P in this column if the numeric input field is in the packed decimal format. Otherwise leave this column blank. (The letter P causes the RPG program to bypass the normal conversion of unpacked format to packed decimal format.)

The implied field length for determining the length of fields in calculation specifications for input in packed decimal format is:

$2n - 1$
n = number of input record positions used

FIELD LOCATION (44-51)

Columns 44-51 of the Input Specifications sheet are used to describe the location of each field in the record. The maximum field length for a numeric field is 15 digits. The maximum field length for an alphameric field is 256 characters.

From (44-47). This specification contains the location of the first position (leftmost position) of the field.

To (48-51). This specification contains the location of the last position (rightmost position) of the field.

NOTE: The entries in columns 44-47 and 48-51 must be right-justified. Leading zeros may be omitted.

Figure 46 illustrates a card input record. The field location specifications necessary to read this card into the system are shown in Figure 47.

The fields of the record may be listed in any sequence. (In this example they are shown in the same sequence as they appear on the card to make the example easier to understand.)

The specifications in Decimal Positions and Field Name are also included in Figure 47 because all three fields are closely

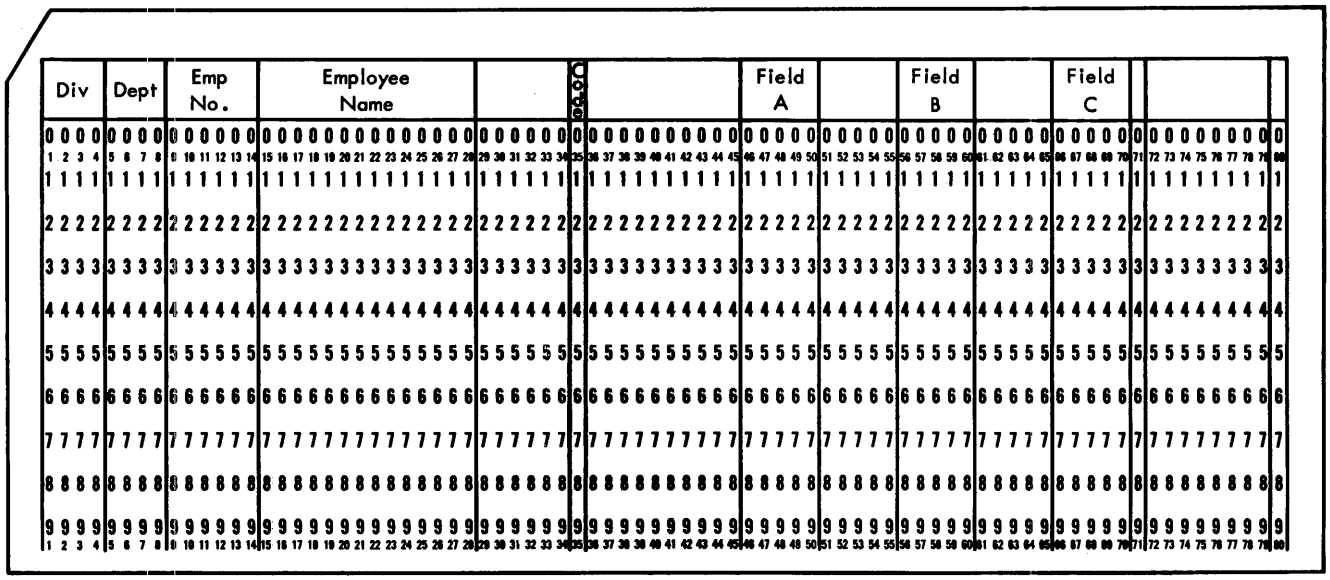

Figure 46. Sample Input Card

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IBM System/360

Form X24-3550-1
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Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
01Ø	I	DETLABORAA				14	35		D	5	8Ø	M	E	K							1	4		DIVSON							
02Ø	I																				5	8		DEPT							
03Ø	I																				9	14		EMPNO							
04Ø	I																				15	28		NAME							
05Ø	I																				46	5ØØ		FLDA							
06Ø	I																				56	6ØØ		FLDB							
07Ø	I																				66	7ØØ		FLDC							
08Ø	I																														
09	I																														
10	I																														

Figure 47. Example of Field Location Specifications

related. These specifications are explained following the description of Field Location.

Records in an OR-Relationship

It is possible to specify two different record types with just one set of specifications. This is known as an OR relationship. There are three types of OR relationships:

1. One or more record types have the same fields in the same positions of the record. (For example, all fields in one record type are in the same relative positions in another record type.)
2. One or more record types have the same fields, but the fields are in different positions of the record. (For example, unit cost is in positions 21-25 in one record type and in positions 31-35 in another record type.)
3. One or more record types have different fields in the same positions or in different positions of the record. (For example, two record types with ten fields in the same relative positions, but with three fields in different positions.)

It is of value to specify an OR relationship for the types in items 2 and 3 above only if there are more fields that are alike than fields that are unlike.

As an example of the first type of OR relationship assume that there were two detail labor cards in the preceding example; perhaps the second having been created during the previous week's reporting. If the second card had the same fields as the first, but with a different record identification code, it would not be necessary to repeat all of the field specifications for the second card.

Figure 48 shows the only additional specifications required in order to specify both detail labor cards. The specification OR is entered in columns 14 and 15, and columns 16-18 are left blank. The last OR line (if there is more than one OR relation) is followed by the field description entries.

Figures 49 and 50 illustrate how to specify two records in an OR relationship when the field locations are not the same. The input record in Figure 49 is similar to the record in Figure 46 except that FLDC is located in positions 61-65, instead of positions 66-70. By specifying an OR relationship it is possible to specify both record types with one set of specifications.

Figure 50 illustrates the specifications for this example. The numbers in the margin of the subsequent text refer to the numbers circled in Figure 50.

1. When field locations are not the same for both types, it is necessary to provide a separate resulting indicator code for the second record type.
2. Each field that is not located in the same positions in both record types must be specified twice. Each of the two specifications must be related to the appropriate record type. This is accomplished by specifying the appropriate resulting indicator code in Field-Record Relation.

For example, FLDC located in positions 66-70 is related to resulting indicator 14 (the record type identified by a 5 in column 35); and field FLDC in positions 61-65 is related to resulting indicator 16 (the record type identified by a 6 in column 35). Thus, if resulting indicator 14 is on; FLDC will be taken from positions 66-70; if resulting indicator 16 is on, FLDC will be taken from positions 61-65.

It is also possible to take advantage of an OR relationship to specify control fields that are not in the same positions in two different record types. In addition, specifying record types in an OR relationship is not limited to just two records. As many records as required can be specified as having an OR relationship.

DECIMAL POSITIONS (52)

This specification performs two functions:

1. It is used by the object program to determine the number of decimal positions contained in the field specified in Field Location.
2. It causes the field specified in Field Location to have 0-(zero), 11-, or 12-zone bits removed from all positions except the rightmost position.

If the field specified in Field Location is to have calculations or edit functions performed upon it or if it will be zero-suppressed in the output, there must be a specification in Decimal Positions. If there are no decimal positions in an arithmetic field, a zero must be specified. This specification must be left blank if the field is alphameric.

In Figure 51, the fields DIVSON, DEPT, and EMPNO contain numeric information, but

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Form X24-3350 1
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Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
010	1	DETLABORAA				14	35		D5		80			NZK																	
020	1	(OR					35		D6	)																					
030	1																				1	4		DIVSON							
040	1																				5	8		DEPT							
050	1																				9	14		EMPNO							
060	1																				15	28		NAME							
070	1																				46	50		FLDA							
080	1																				56	60		FLDB							
090	1																				66	70		FLDC							
100	1																														

Figure 48. Records in an OR-Relationship, Identical Field Locations

Div	Dept	Emp No.	Employee Name		Code		Field A		Field B	Field C		
0000	0000	000000	00000000000000	000000	0	0000000000	00000	00000	0000	00000	0000	0000000000
1111	1111	111111	11111111111111	111111	1	1111111111	11111	11111	1111	11111	1111	1111111111
2222	2222	222222	22222222222222	222222	2	2222222222	22222	22222	2222	22222	2222	2222222222
3333	3333	333333	33333333333333	333333	3	3333333333	33333	33333	3333	33333	3333	3333333333
4444	4444	444444	44444444444444	444444	4	4444444444	44444	44444	4444	44444	4444	4444444444
5555	5555	555555	55555555555555	555555	5	5555555555	55555	55555	5555	55555	5555	5555555555
6666	6666	666666	66666666666666	666666	6	6666666666	66666	66666	6666	66666	6666	6666666666
7777	7777	777777	77777777777777	777777	7	7777777777	77777	77777	7777	77777	7777	7777777777
8888	8888	888888	88888888888888	888888	8	8888888888	88888	88888	8888	88888	8888	8888888888
9999	9999	999999	99999999999999	999999	9	9999999999	99999	99999	9999	99999	9999	9999999999

Figure 49. Sample Input Record, Differing Field Locations

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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System/360

Form X24-3350-1 Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic | Punch

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Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
010	1	DETLABOR	AA			14	35		D5		80	NZ	K																		
020	1	OR				16	35		D6																						
030	1						1														1	4		DIVSON							
040	1																				5	8		DEPT							
050	1																				9	14		EMPNO							
060	1																				15	28		NAME							
070	1																				46	50	00	FLDA							
080	1																				56	60	00	FLDB							
090	1														2						66	70	00	FLDC			14				
100	1																				61	65	00	FLDC			16				
110	1																														

Figure 50. Records in an OR Relationship, Differing Field Locations

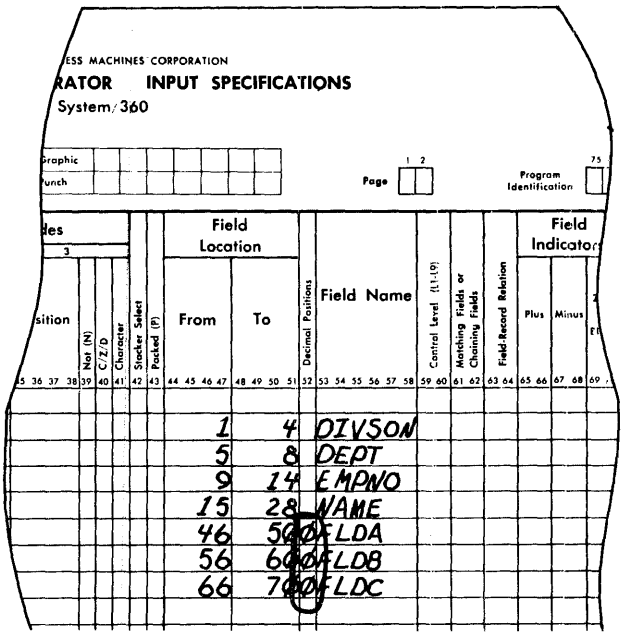


Figure 51. Specifying Decimal Positions on Input Form

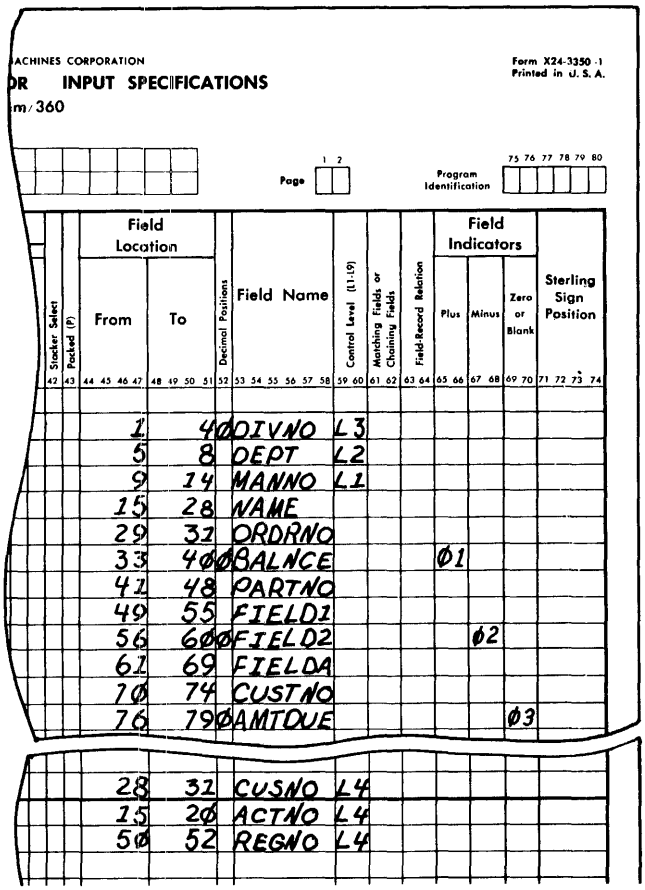
because they will not have arithmetic operations performed upon them, they are specified as "alphabetic" fields by leaving Decimal Positions blank. The NAME field is alphabetic and therefore is also blank in Decimal Positions. The fields FLDA, FLDB, and FLDC are numeric arithmetic fields with decimal specifications of zero.

FIELD NAME (53-58)

Each field defined must be given a field name. Once a name has been assigned to a field, other references to it are made by using the field name, rather than by using the specific record position each time. Thus, the record positions of the input fields are not needed when writing the calculation and output specifications.

The field name must begin with an alphabetic character, and it must start in column 53. The field name may be alphameric, but it may not contain special characters or embedded blanks.

Figure 52 illustrates field names that are easy to read and suggest the function of the fields they represent.



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Program Identification 75 76 77 78 79 80

Stacker Select 42	Packed (P) 43	Field Location From 44 45 46 47	Field Location To 48 49 50 51	Decimal Positions 52	Field Name 53 54 55 56 57 58	Control Level (L1-L9) 59 60	Matching Fields or Chaining Fields 61 62	Field-Record Relation 63 64	Field Indicators Plus 65 66	Field Indicators Minus 67 68	Field Indicators Zero or Blank 69 70	Sterling Sign Position 71 72 73 74
		1	4	Ø	DIVNO	L3						
		5	8		DEPT	L2						
		9	14		MANNO	L1						
		15	28		NAME							
		29	32		ORDRNO							
		33	4Ø	Ø	BALNCE				Ø1			
		41	48		PARTNO							
		49	55		FIELD1							
		56	6Ø	Ø	FIELD2					Ø2		
		61	69		FIELDA							
		7Ø	74		CUSTNO							
		76	79	Ø	AMTDUE						Ø3	
		28	32		CUSNO	L4						
		15	2Ø		ACTNO	L4						
		5Ø	52		REGNO	L4						

Figure 52. Field Names

Two input files may have fields with the same field names. A field name is assigned only once by RPG. The two input files will use the same storage location for fields with identical names. This procedure is permissible when using RPG, but the programmer should be aware that possible errors in calculations or output may occur when two input files have the same field names. This is especially important when chaining fields are specified on the Input Specifications sheet.

Specifying the Same Data Field as Alphameric and Numeric

If the same field from an input record is to be used as both an alphameric and a numeric field, the field must be specified twice by assigning two different field names to the same location in the record. (If no decimal positions are specified for the field, it is considered to be an alphameric field.)

Using Input Data Fields as Constants

The term constant is frequently used to describe information that is not changed with each record. It is usually not altered during the object run. Examples of constants are date cards, or other data that may be changed for each run.

The technique to get this information to the program is by defining a special record type and by assigning a field name that is not otherwise used. This technique will also permit entering of constants that are too large to be specified as literals in the source program.

When only a single input file is processed, the date or constant card(s) may be placed at the front of the file preceding the first data record.

If an additional file is required for entering the constant information, it may be designated as a primary file, and the data file as a secondary file. Using this technique, the primary file will be processed first and the constant information will be entered prior to the data records.

If multiple input files are processed, the constant card(s) may appear as the first records on any file. The constant records should be defined in the input specifications for the associated file and should not have matching fields. (See Matching Fields.) In a job with multiple files, the constant file could be designated as secondary and since its associated input specifications have no matching fields, its records will be processed first.

CONTROL LEVEL (59-60)

As the object program is processed, a change in a control field causes all processing indicated by this change to be initiated. Columns 59-60 are used to provide a convenient and simple method for specifying all control functions.

Up to nine control levels can be used by RPG. These levels are designated from low to high as L1, L2, L3,.... L9. An indicator similar to a resulting indicator is associated with each control-level designation. They are used to control functions specified on the calculation and output specification sheets. When the field specified in Field Location is a control

field, its appropriate control level must be specified in columns 59-60. The first three lines in Figure 52 shows the entries for three control fields.

The field DIVNO (first entry in the example) is the highest level of control.

The indicator L3 could be used to specify when the calculation specifications for the control field DIVNO are to take place, or when the totals for the field DIVNO are to be printed or summarized. More information regarding the use of the control level indicators is presented in the descriptions of the calculation and output specifications sheets.

NOTE: Whenever control levels are used, a control break will occur on the first record of a record type which has control levels. Total calculations, total lines and overflow lines are bypassed until after the control break occurs.

Additional Functions of Control Level Specifications

If a field specified in Field Location also has an entry in Control Level, the object program places the field into two storage areas. One area, known as a control-field holding area, is used for the controlling functions of the field, and the other is used for any other uses of the field (such as for printing or for arithmetic calculations).

For example, it may be necessary to use a field for controlling functions but without considering zone bits in the comparison of one record to the next record. If the zone bits are not to be used in a comparison, specify the field as numeric by making a decimal entry in column 52. If the zone bits are to be used in a comparison, leave column 52 blank.

In Figure 52, L3 in columns 59-60 causes the field DIVNO to be placed into storage in one area with zone-bits removed from all positions of the field (to be used for control functions) and to be placed in another area with zone bits removed from all positions of the field except the units position.

The RPG program automatically performs the operations of storing the field twice and performing the appropriate zone elimination. No additional specifications need be written by the programmer.

Split Control Fields

Several fields in an input record can be specified as one control field. In the lower half of Figure 52, three fields, which are not in adjacent record positions, are specified with the same L4 control level. The three fields are treated as one control field:

CUSNO ACTNO REGNO

The first field defined on the input sheet is placed in the high-order position, and the last field is placed in the low-order position. All fields are placed according to the sequence in which they are defined on the Input Specifications sheet.

Using Split Control Fields with Field-Record Relation

The use of the Field-Record Relation specification in conjunction with control level indicators permits the programmer to define the same control level for split or non-split control fields in various record types. This is illustrated in Figure 53 and Figure 54.

The following points must be considered when using field-record relation indicators with split-control-field specifications.

1. The overall field length for each control level must be the same in each group.
2. The sum of the split-control fields cannot be greater than 256 bytes.
3. Split control fields of any one level are arranged in storage in the same sequence as they appear in the input specifications.
4. If a field-record relation indicator is specified for a control level, the related field location is used for control purposes whenever that indicator is on. The examples that are identified by the circled numbers in Figure 53 illustrate this point.
   1 When either indicator 93 or 94 is on, L1 is composed of positions 1-5 and 6-10.
   2 When indicator 91, 93, or 94 is on, L2 is composed of positions 11-20.
   3 When indicator 92, 93, or 94 is on, L3 is composed of positions 21-40. A control level with a blank field-record relation indicator is used for control purposes when all indicators that condition any field with the same control level are off.
   4 To specify a portion of a split control field as being common to several record types, repeat that portion of the field definition with each record type indicator.

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Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes: 1 Position	1 Not (N)	1 C/Z/D	1 Character	2 Position	2 Not (N)	2 C/Z/D	2 Character	3 Position	3 Not (N)	3 C/Z/D	3 Character	Stacker Select	Packed (P)	Field Location From	Field Location To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Minus	Zero or Blank	Sterling Sign Position
010	I	SPLITCTLAA				91	80		C	1																					
020	I	OR				92	80		C	2																					
030	I	OR				93	80		C	3																					
040	I	OR				94	80		C	4																					
050	I																		1		1	5		FLDA	L1						
060	I																				6	10		FLDB	L1						
070	I																		2		11	20		FLDC	L2						
080	I																				76	77		DAY							
090	I																		3		21	30		FLDD	L3						
100	I																				31	40		FLDE	L3						
110	I																		4		41	45		FLDA1	L1		91				
120	I																				46	50		FLDB1	L1		91				
130	I																				51	70		FLDF	L3		91				
140	I																		4		41	45		FLDA1	L1		92				
150	I																				46	50		FLDB1	L1		92				
160	I																				74	75		MONTH			92				
170	I																				61	70		FLDC2	L2		92				
180	I																				78	79		YEAR							

Figure 53. Example of Multiple Split-Control-Field Specifications

MATCHING FIELDS OR CHAINING FIELDS (61-62)

This specification is used if the input consists of more than one file. It provides the program with the ability to match or to chain the records of one file with those of another file.

Matching Fields

Up to three matching fields (designated by M1, M2, and M3) are allowed. This entry may be used to match records in different sequential files. The second sample program at the back of this publication uses matching fields in a card input file and a tape input file to govern processing of records. A discussion of this use of matching fields is contained in Processing Multiple Input Files.

If a field specified in Field Location also has an entry in Matching Fields, the field is placed into another storage area known as a matching-field holding area. Comparisons of matching fields are performed in these holding areas.

Using the Matching Fields Specification for Sequence-Checking. If only one input file is specified, fields within the file may be sequence-checked by using the Matching-Fields specification. Up to three fields within the file may be checked. In Figure 55 three fields within the input file are to be sequence-checked. The data from the three fields will be moved by the RPG program to the matching-field holding area as shown in Figure 56. When the second record has been read, it will be moved as shown. The compare operation is made on all three fields at the same time. M3 is placed in the highest-order position. M1 is placed in the low-order position.

In column 18 of the File Description Specifications sheet the programmer must specify if the file is in ascending or

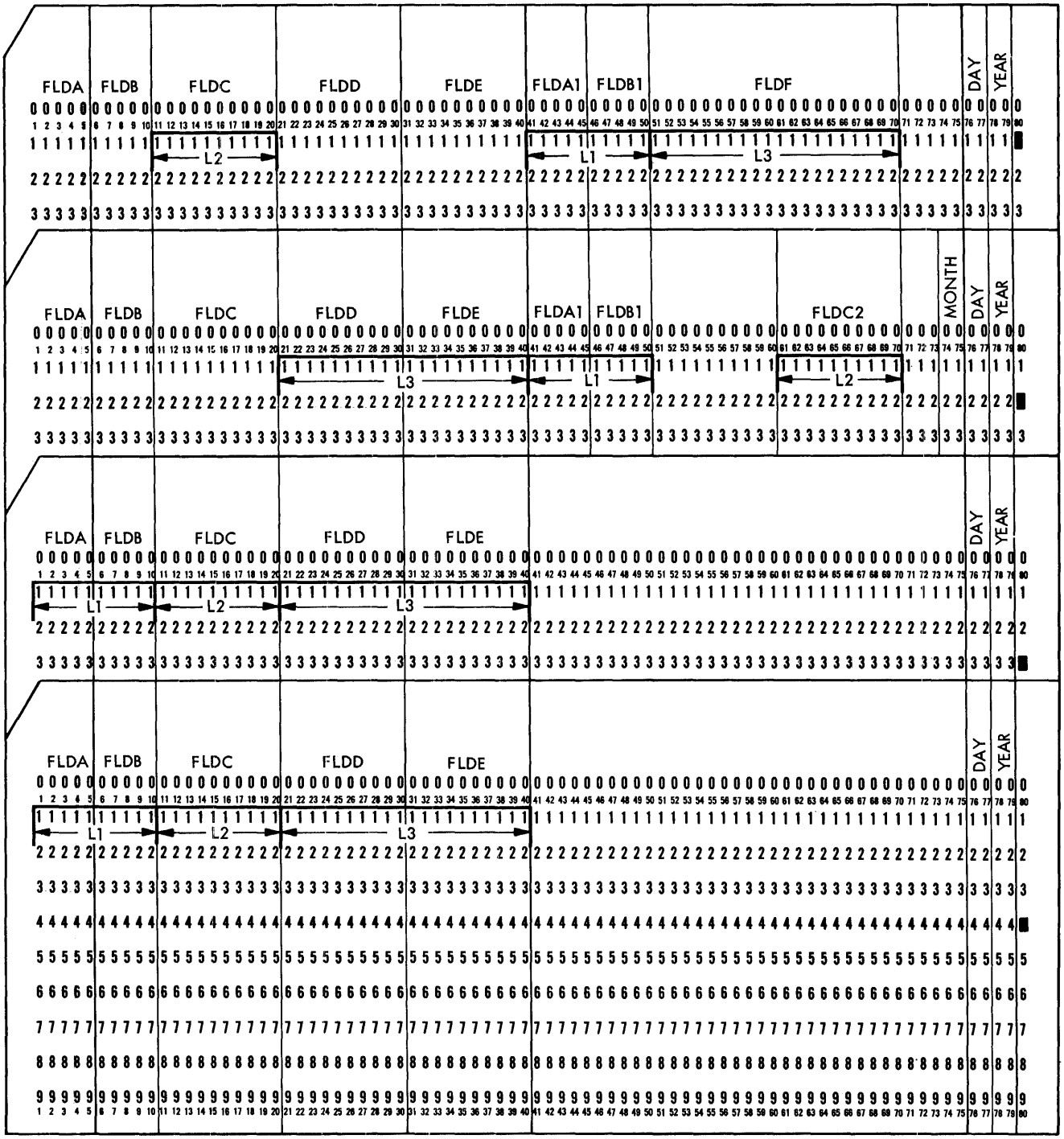


Figure 54. Input Cards with Multiple Split Control Fields

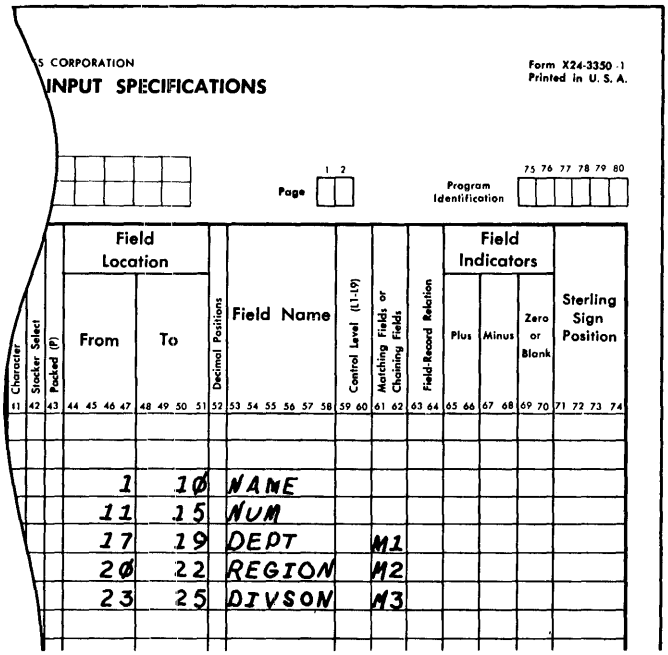


Figure 55. Using Matching Fields to Sequence Check in a Single Input File

descending sequence. In Figure 56 assume that the file has been specified in ascending sequence. The number 003051008 is lower than 005025003. Thus, the file is in ascending sequence.

NOTE: A chaining file may also be sequence checked. However, if it is the chaining field that is to be sequence checked, it must be defined twice using two different field names. The chaining indicator is entered in one field definition and the matching fields indicator in the other.

If the file is not in sequence the Halt indicator H0 is turned on. Unless this H0 indicator is turned off by a SETOF operation (See Turning Indicators On or Off) in the calculation specifications, the program terminates before the next input record is read.

Exit to External Translate Subroutine. If the sequence of the matching fields is not the same as the collating sequence of the System/360, the RPG program can provide an automatic exit to an external user subroutine that translates the sequence of the matching fields to the collating sequence of the system.

An entry in the RPG Processor Control Card is all that is required to cause the RPG program to branch to the subroutine. The automatic branch occurs after the input card is read in and before the RPG program checks the sequence of the matching field.

The subroutine to translate the matching fields must use the predefined label ALTSEQ. The register conventions for this subroutine are the same as those for the EXIT operation. (See Exit to a Subroutine.) The address of the matching-field holding area will be contained in Register 1. The subroutine must place the translated fields back into the matching-fields hold area before it returns control to RPG.

Chaining Fields

The use of chaining files is explained in the section Chaining. Up to nine chaining fields are permitted in a record. In these columns enter the code that identifies the chaining field (C1 through C9).

FIELD-RECORD RELATION (63-64)

This specification is used when there are records in an OR relationship and the fields of the records are not in the same location. Enter in columns 63-64 the appropriate resulting indicator which will

Data Contained in First Record

DEPT 008
REGION 051
DIVSON 003

Data Contained in Second Record

DEPT 003
REGION 025
DIVSON 005

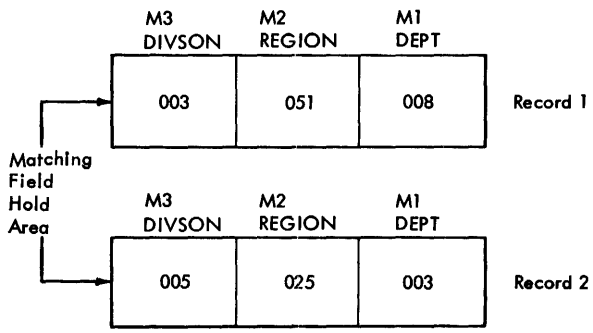


Figure 56. Comparing Matching Fields

be on when the field is used. An explanation of the use of this specification was contained in Records in an OR Relationship, and an example of this specification is provided in Figure 50.

Using Field-Record Relation with Chaining Files

An additional function of this specification is to selectively control chaining operations. (See Chaining for a general explanation of chaining. In order to understand this function, readers should be familiar with chaining operations and with the use of the Calculation Specifications sheet.)

If a chaining field is specified on a field description line and Field-Record Relation is blank, the chained record will be obtained whenever the record type (for the chaining field) is present. However, if a resulting indicator is placed in Field-Record Relation, then the chained record will be obtained only if the record-type is present and the resulting indicator (in Field-Record Relation) is on.

This feature provides the programmer with the ability to utilize chaining files on a selective basis. The function of this feature of Field-Record Relation is similar to the function of controlling calculations by the status of resulting indicators.

A variation of the use of this function of Field-Record Relation is to control two chained files with one chaining field. For example, the chaining field would be specified twice on the Input Specifications sheet. Each specification line would be conditioned by a separate resulting indicator. The particular chained record obtained would depend upon the status (on or off) of the appropriate resulting indicator.

FIELD INDICATORS (65-70)

This specification is used to test the status of a field when it is read into the system. Depending upon the status of the field — plus, minus, or zero or blank — it turns on an indicator that can be used to control calculation and output specifications, or even to stop the processing of the object program.

The entry for the specification is an indicator which will be turned on when the field specified on the line is plus, minus, or zero or blank.

Field Status Conditions

Plus. A plus condition occurs when the value of a numeric field is greater than 0.

Minus. A minus condition occurs when the value of the numeric field is less thar zero.

Zero or Blank. A zero-or-blank condition occurs if a numeric field contains all zeros or blanks, or if an alphameric field contains all blanks. It is turned on if a numeric field is either +0 or -0.

NOTE: For alphameric fields, columns 65 through 68 must be blank.

Types of Indicator Codes Used

A 2-digit field indicator code is used for this specification. These codes, ranging from 01 to 99 can be defined one or more times on the form. If they are defined more than once, the second specification of this indicator resets it from the status it may have had by the previous specification for it.

NOTE: "Defining" these indicators means specifying them on the input form in Resulting Indicators or in Field Indicators. This should not be confused with "using" these indicators. "Using" these indicators means specifying them in Indicators on the calculation form or in Output Indicators on the output form as many times as required. In the latter case, they are merely tested to determine their status and not reset by the test.

Halt Indicators

There are ten additional indicator codes, known as Halt indicators that can be used in the RPG program. These indicators, designated as H0 through H9, halt the processing of the object program when error conditions (as determined by the programmer) have been detected. These indicators can also be used in calculation and output specifications sheets to control specifications and stop processing. For example, the status of a field can be tested, and depending upon the results of the tests, a halt indicator may be set on which terminates the object program.

If one of these indicators has been turned on during the processing of a record,

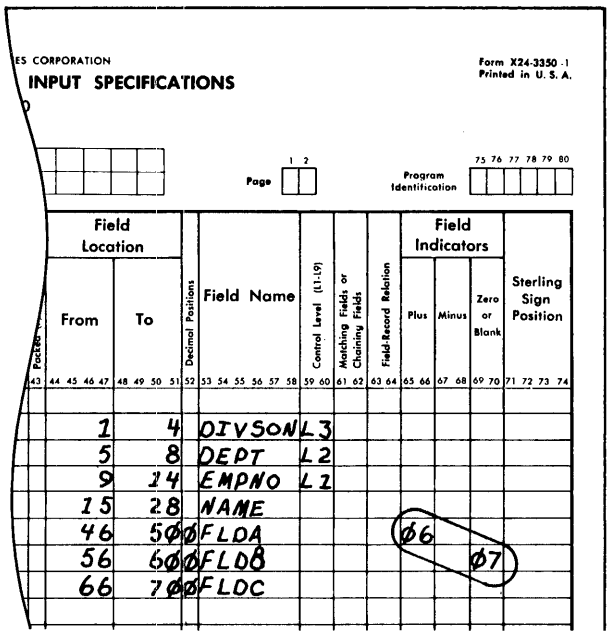
the object program terminates at the completion of the processing of that record. However, processing will not be interrupted if a halt indicator that has been turned on is turned off (in the program) before the program attempts to read the next input record.

The H0 indicator can also be turned on automatically by the RPG program. The conditions that cause H0 to be turned on automatically are listed in Appendix H. Unless H0 is turned off by a SETOF operation (see Turning Indicators On or Off) in the calculation specifications, the program terminates before the next input record is read.

Use of Field Indicators

The field indicator 07 in Figure 57 is used to determine if FLDB contains zeros or blanks, and Indicator 06 is used to determine if the value contained in FLDA is positive. Indicator 07 and 06 would both be used to control functions in the calculation and output specifications that must be altered or modified depending on the status of FLDA and FLDB.

NOTE: Use of Indicators H0-H9 as field indicators testing zero or blank (69-70) causes the program to terminate as the first record is read because any indicators used in (69-70) are initialized on.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INPUT SPECIFICATIONS
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Page
Program Identification
Field Location
From
To
Decimal Positions
Field Name
Control Level (L1-L9)
Matching Fields or Chaining Fields
Field-Record Relation
Field Indicators
Plus
Minus
Zero or Blank
Sterling Sign Position
Packed
1 4 DIVSON L3
5 8 DEPT L2
9 14 EMPNO L1
15 28 NAME
46 50 FLDA 06
56 60 FLDB 07
66 70 FLDC

Figure 57. Example of Field Indicators Specifications

How Field Indicators are Turned Off and On

Indicators used for testing for plus and minus conditions, are "set" (turned on or off) if their respective conditions occur when a record is read into the system. Each field indicator is related to only one record type. Therefore the indicators are not reset (turned on or off) until the related record type is read again or until the indicator number is defined in some other specification. One or more field indicators can be on at one time.

Indicators used for testing for zero or blank conditions are set in the same manner as those used for testing for plus and minus conditions. They can, however, be reset by one other condition. The output specification Blank After causes a field to be set to blanks or zeros (depending upon whether the field is alphabetic or numeric) after execution of the output operation specified. If the field being reset to blanks or zeros is an input field that is being tested for zero or blank, the field indicator specified for it is turned on when the field is set to blanks or zeros by the Blank After specification.

Any plus or minus indicators associated with the field are not turned off by virtue of the Blank After specification. All zero or blank indicators are initialized on at the beginning of the program to reflect the initial status of the associated fields. (All fields defined in an RPG program are initialized to zero if numeric or blank if alphameric.) The indicators remain on until the status of the associated fields change as a result of an input record being read or a calculation being performed.

STERLING (71-74)

Enter in these columns the position in the record that contains the sign of the sterling field. If the sign is in the normal position, enter an S in column 74. Leading zeros may be omitted. Leave these columns blank if the sterling specification is not used. Additional information on Sterling is in Appendix D. Sterling Routines for the Report Program Generator.

SUMMARY OF INPUT SPECIFICATIONS

This concludes the description of the input specifications. Additional information on

matching or chaining fields may be found in Processing Multiple Input Files. The input specifications listed below are used with the calculation and output forms.

Resulting Indicator
Field Name
Control Level
Matching Fields
Field Indicators

The use and function of these specifications may become more apparent to the reader after the descriptions of the calculation and output specifications have been read.

This sheet is used to specify the operations to be performed by the object program upon the input data and upon data obtained as a result of other calculations. Two general rules govern the writing of calculation specifications:

1. Each operation is specified on one line of the sheet. Operations must be listed in the order in which they are to be performed in the object program.
2. Detail calculations must precede all total calculations. Calculations within these two groups must be specified in the order in which they are to be performed on the data.

The calculation sheet is divided into three categories as shown in Figure 58:

1. When calculations are to be performed. These entries (columns 7-17) determine when the calculations are to be performed and upon what conditions they are to be performed.
2. What kind of calculations are to be performed. These entries (columns 18-53) determine the kind of calculations to be performed, such as add, subtract, multiply, etc. These entries also supply information about the result of the calculation.
3. What tests are to be made on the results of the calculations. These entries (columns 54-59) test the results of the calculations to modify subsequent calculations or output specifications.

SPECIFYING WHEN CALCULATIONS ARE TO BE PERFORMED

The two specifications in this category are Control Level and Indicators.

CONTROL LEVEL (7-8)

Calculations are performed at either detail time or total time. This specification indicates the control level of specifications performed at total time. An entry in Control Level determines when the calculation specified in positions 18-59 of the line is to be performed.

The entries for this specification are the control level indicators L1 through L9, and the indicators L0 and LR.

A test for a control change is made after each record is read into the system.

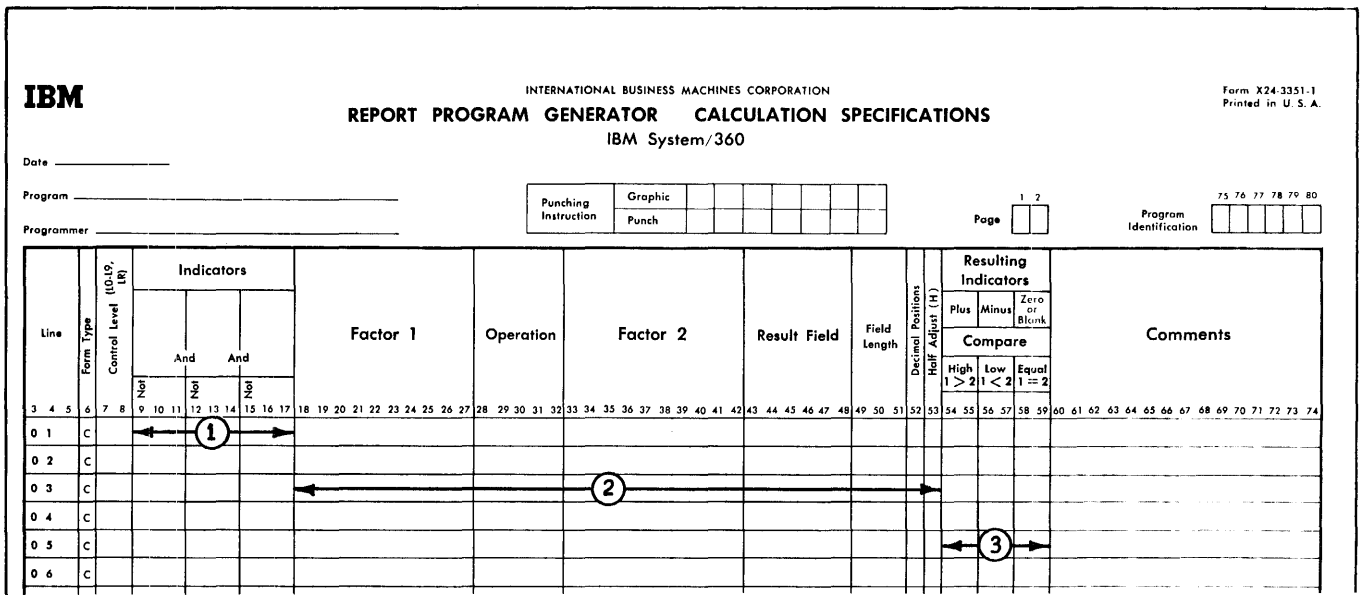

Figure 58. Calculation Specifications Sheet

Total calculations are performed after this test is made and before the record that caused the control change is processed.

Control level indicators are turned on by control breaks. Whenever a control break occurs, the indicator for the new control level and all indicators for the lower-order control levels are turned on at the same time. A change to control level 3, for instance, causes the Indicators L3, L2, and L1 to be turned on.

A control level indicator remains on during total time and during the subsequent detail time, which includes both the calculating and the printing of the detail record.

If an object module has only detail calculations, this specification is left blank. The indicators that control detail calculations are specified in Indicators (Columns 9-17). However, Columns 9-17 may also be used to control total calculations.

The next two paragraphs describe the indicators LR (Last Record) and L0 (Level Zero).

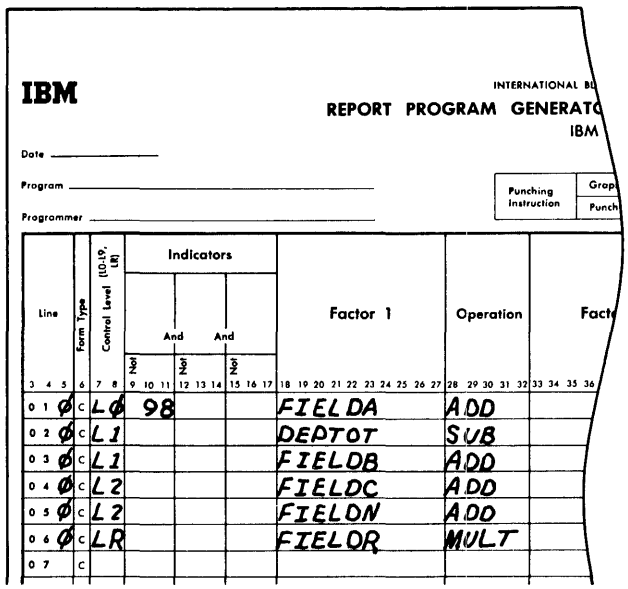

Figure 59. Using Control Level Specifications

LR (Last Record) Indicator

This indicator is turned on after the last input record has been read and calculated and after the appropriate detail lines are printed and punched. At this time the control level indicators L1 through L9 are also turned on.

If there is more than one input file, the programmer determines which files are to be checked for the last record. This is accomplished in the File Description Specifications sheet.

LR is turned on when all files with an LR specification have been completely read.

L0 (Level Zero) Indicator

The Level Zero indicator is on throughout the execution of the object module. It is used to specify total calculations to be performed at a time when no control break has occurred.

The L0 indicator can be used, for instance, to accumulate a total for each page of a report, even though there is no control break at the end of a page.

Figure 59 illustrates six Control Level specifications.

INDICATORS (9-17)

The entries in columns 9-17 indicate the conditions that control the calculations specified in columns 18-59. From one to three indicator codes considered to be in an AND relationship may be specified. The AND relationship means that if three indicator codes are specified, all three indicator conditions must be satisfied before the calculation can take place. It is not possible to have an OR condition with this specification.

Enter in columns 10-11, 13-14, and 16-17 the indicators that determine when the calculation is to be performed. If an indicator must be off, enter an N in either column 9, 12, or 15 (whichever is appropriate).

The specifications used in these columns can be arranged into the following categories:

1. If columns 9-17 and columns 7-8 are blank, the calculation specified on the line is performed each time a detail record is read.
2. A resulting-indicator code determines the particular record type on which the calculation is to be performed. This

calculation will not be performed on any other record type.

3. A field-indicator code controls the calculation according to the status of an input field.
4. A resulting-indicator code controls the calculation by conditions that occurred on previous calculations. (This feature is shown on the Calculation Specifications sheet, columns 54-59, but it has not been discussed at this time.)
5. A control-level indicator, L1-L9, used with a particular resulting indicator permits the calculation to be performed at detail time, but it is performed only on the first record of the control level specified.
6. The MR, matching-record, indicator code means that the calculation is performed only if there is a matching record in a second input file.
7. The halt indicators H0 through H9 are normally used to terminate the program or to suppress a calculation when an error has been detected on a previous calculation.
8. The overflow indicators permit the calculation to take place only if a page overflow has occurred.
9. All total calculations will be bypassed until the first control break has occurred.

In addition, this specification entry (columns 9-17) may contain a combination of some of the preceding categories. Also, a calculation may be controlled by the fact that an indicator must not be on.

Figure 60 shows entries that may be made in columns 9-17. The numbers to the right of the entries refer to the following list:

1. The first example is a blank entry. This means that the calculation is performed on every detail record.
2. In this example, Indicator 16 could be a resulting indicator for a specific record type.
3. In this example, Indicator 16 could be a resulting indicator, and Indicator 18 could be a field indicator, which is specified on the Input Specifications sheet. If Indicator 18 is used to test an input field for blanks, this entry means, in effect, that the calculation would be performed if record-type 16 is present and the contents of the field represented by Indicator 18 is not blank.

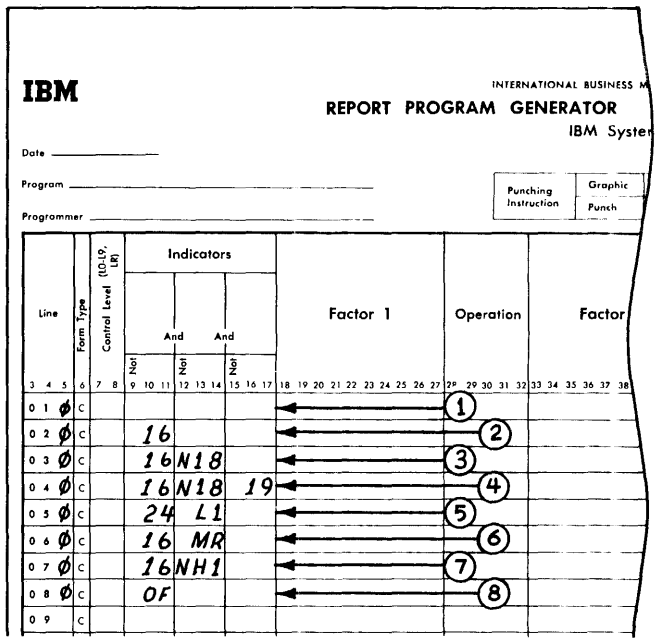

Figure 60. Using Indicators

4. This example is similar to the previous example. However, Indicator 19 could be a resulting indicator turned on by the previous calculation. The calculation specified on this line in columns 18-59 would not be performed unless Indicator 19 was also on.
5. This entry means that the calculation is performed at detail time on control-level 1, and only if Indicator 24 is on.
6. This entry means that the calculation is performed only if Indicator 16 is on and there is a matching record condition. For example, when fields from detail records are multiplied by a factor contained in a master record, the program must have a way of ensuring that the detail record has been matched with the appropriate master record.
7. The entry of NH1 prevents the object program from performing the calculation if an error condition has occurred. Note that when an error occurs, the job is not terminated until after all processing for the record has been completed. This facility is provided so that the programmer can prevent the calculation of erroneous data.
8. This entry means that the calculation is performed on the detail cycle following an overflow condition.

SPECIFYING THE KIND OF CALCULATION

In order to describe the kind of calculations to be performed, the following conditions must be considered.

1. The fields to be used
2. The arithmetic operation to be performed
3. The disposition of the results

FACTOR 1 (18-27)

This specification can be a field name or a literal. If it is a field name it must have been defined on the Input Specifications sheet, or it must be defined in the result field of a calculation. The field name must be left-justified, and the first character must be alphabetic.

Literal

A literal is the actual data to be operated on, rather than a name representing the location of data. Literals may be numeric or alphabetic. Numeric literals may be up to ten characters long. Alphameric literals may be up to eight characters long.

Numeric Literals

A numeric literal can consist of any combination of the numbers 0-9. One decimal symbol and/or one plus sign or one minus sign may also be used.

Rules for Forming Numeric Literals

1. Blanks must not appear within a numeric literal.
2. The sign, if present, must be the leftmost character. If a literal is unsigned, it is treated as a positive literal.
3. The decimal symbol can appear anywhere in the literal.
4. Numeric literals must not be enclosed in apostrophe symbols.

Alphameric Literals

Any set of consecutive characters enclosed in a set of apostrophe symbols is treated as an alphameric literal. (The apostrophe is a 5,8 punch.) Alphameric literals may not be used in arithmetic operations.

Rules for Forming Alphameric Literals

1. Any character may be used in an alphameric literal. Blanks are treated as valid characters in the body of the literal.
2. Alphameric literals must be enclosed in a set of apostrophe symbols.
3. An apostrophe symbol may be contained within a literal by entering two consecutive apostrophe symbols within the literal. For example, the literal o'clock would be coded as 'o''clock'.

Figure 61 illustrates entries for Factor 1. The numbers in circles refer to the items listed below.

1. GROSS could be a field name specified on the input sheet.
2. NETAMT could have been specified as the result field of the previous calculation.
3. This numeric literal could be used in the program to determine if specific fields in the input records were higher or lower than this number. The position of the decimal symbol must be indicated if the number is not a whole number.
4. Alphameric literals, like the one in this example, can be used to compare against a data field in the input records to perform certain types of calculations only upon records representing the month of January.

The description of Factor 1 also applies to Factor 2.

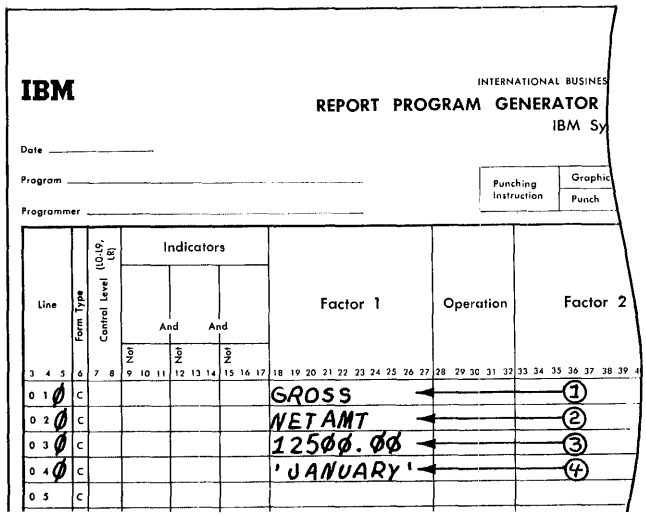

Figure 61. Factor 1

Summary of Factor 1 and Factor 2

1. Enter either the name or the literal that is Factor 1 or Factor 2 in columns 18-27 or 33-42.
2. If Factor 1 or Factor 2 contains the name of a field, the field must be defined in either:
   a. Columns 53-58 (Field Name) of the Input Specifications sheet.
   b. Columns 43-48 (Result Field) of the Calculation Specifications sheet.
3. A name cannot exceed six characters. Special characters and blanks must not be used.
4. A numeric literal cannot exceed ten characters; an alphameric literal cannot exceed eight characters.
5. Entries in Factor 1 or Factor 2 must be left-justified.

OPERATION (COLUMNS 28-32)

Entries in these columns specify the operations to be performed using Factor 1, Factor 2, and Result Field. Each operation is specified by placing the operation code in Operation (columns 28-32).

Arithmetic Operations	Code
Add	ADD
Zero and Add	Z-ADD
Subtract	SUB
Zero and Subtract	Z-SUB
Multiply	MULT
Divide	DIV
Move Remainder	MVR

Move Operations	Code
Move	MOVE
Move Left	MOVEL
Move High-to-Low Zone	MHLZO
Move Low-to-High Zone	MLHZO
Move High-to-High Zone	MHHZO
Move Low-to-Low Zone	MLLZO

Testing or Compare Operations	Code
Compare	COMP
Test Zone	TESTZ

Branching and Exit Operations	Code
Branching (or GOTO)	GOTO
Providing a Label for GOTO	TAG
Exit to a Subroutine	EXIT
RPG Label	RLABL
User Label	ULABL

Turning Indicators On or Off	Code
Set Indicators On	SETON
Set Indicators Off	SETOF

Table Operations	Code
Table Lookup	LOKUP

Conversion Routine Operations	Code
RPG Conversion Routine	RPGCV
End of RPG Conversion	ERPGC
External Conversion Routine	EXTCV
Record Key	KEYCV

Arithmetic Operations

The fields or literals involved in these operations may contain numeric characters only. All arithmetic operations are performed with automatic decimal alignment. Resulting indicators can be used with all arithmetic operations.

No arithmetic overflow will be sensed by RPG. The length of a field involved in arithmetic operations can be up to 15 digits (this includes decimal alignment when necessary). The resulting field length after decimal alignment must not be greater than 15 digits.

Add (ADD)

This operation causes the contents of the field or the literal in Factor 2 to be added, algebraically, to the contents of the field or literal in Factor 1. The result of the operation is placed in the result field specified in Result Field (columns 43-48).

Zero and Add (Z-ADD)

This operation causes the field specified in Result Field to be set to zeros and then causes the data contained in the numeric literal or the field in Factor 2 to be placed in the Result Field. Factor 1 is not used in this operation.

Subtract (SUB)

This operation causes the contents of the field or literal in Factor 2 to be subtracted, algebraically, from the contents of the field or literal in Factor 1. The result of this operation is placed in the Result Field specified.

Zero and Subtract (Z-SUB)

This operation causes the negative of the number contained in the literal or the field in Factor 2 to be placed in the result field specified. This operation is performed after the result field has been set to zeros. Factor 1 is not used in this operation.

Multiply (MULT)

This operation causes the contents of the field or literal in Factor 1 to be multiplied algebraically by the contents of the field or the literal in Factor 2. The result of this operation is placed in the result field specified.

Divide (DIV)

This operation causes the contents of the field or literal in Factor 1 to be divided by the contents of the field or literal in Factor 2. The result of this operation (quotient) is placed in the specified result field. The contents of the field or the literal in Factor 2 cannot be zero.

If factor 2 is zero, a program check and an abnormal end-of-job will result.

The following field length restrictions apply to this operation:

$$L_1 + (D_2 - D_1 + D_r) \leq 15$$

$$L_2 - (D_2 - D_1 + D_r) \leq 15$$

and if half-adjusting is specified

$$L_1 + (D_2 - D_1 + D_r) \leq 14$$

where

L_1 = length of Factor 1 (dividend)

L_2 = length of Factor 2 (divisor)

D_1 = decimal positions of Factor 1

D_2 = decimal positions of Factor 2

D_r = decimal positions of Result Field

NOTE: Invalid results are obtained if the formula is violated.

Any remainder that results from this operation is lost unless the move-remainder operation is specified as the next operation in the program.

NOTE: If a move-remainder operation follows a divide operation, the result in the divide operation cannot be half-adjusted.

Move Remainder (MVR)

This operation is used to move the remainder from a divide operation to a separate field. If MVR is used, it must immediately follow the divide operation. The divide may not be half adjusted. Figure 62 shows an example of the MVR operation. The remainder is placed in a field named STORE.

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Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / And	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus / Minus / Zero or Blank; Compare: High 1>2 / Low 1<2 / Equal 1=2	Comments
01	C		12	FIELD1	DIV	FIELD2	SAVE					
02	C				MVR		STORE					
03	C											

Figure 62. Using MVR Operation Code

The field that is to contain the remainder must be specified in Result Field.

The value of the remainder can be determined by the following formula:

R = (Dividend) - [(Divisor) x (Quotient)]

For the above equation to be valid in a divide operation involving factors containing decimal positions, the result field that is to contain the remainder must provide for the decimal positions in the remainder based on the sum of (d_2 + d_r) or d_1, whichever is greater.

Move Operations

For the MOVE and MOVEL operations, numeric fields may be changed to alphameric fields and alphameric fields may be changed to numeric fields. To change a numeric field to an alphameric field, Factor 2 is numeric, and the result field is specified as alphameric. To change an alphameric field to a numeric field, Factor 2 is alphameric, and the result field is specified as numeric. No decimal alignment is performed when a move operation is used.

Resulting indicators can be used with all move operations.

Move (MOVE)

This operation code causes data characters (starting at the rightmost position) to be moved from the field or literal contained in Factor 2 to the rightmost positions of the result field.

If Factor 2 is longer than the result field, the excess leftmost positions of Factor 2 are not moved as illustrated in Figure 63.

If the result field is longer than the field specified by Factor 2, the positions to the left of the data that is moved remain undisturbed as illustrated in Figure 64.

Factor 1 is not used in this operation.

Move Left (MOVEL)

This operation code causes data characters (starting at the leftmost position) to be moved from the field or literal contained in Factor 2 to the leftmost positions of the result field.

If Factor 2 is longer than the result field, the excess rightmost positions of Factor 2 are not moved.

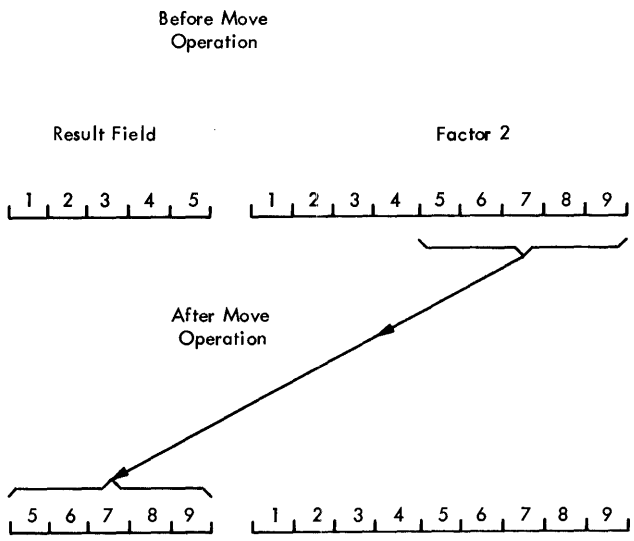

Figure 63. Move Operation -- Factor 2 Longer than Result Field

If the result field is longer than the field specified by Factor 2, the positions to the right of the data that is moved remain undisturbed. When moving data to a numeric field, the sign of the result field is retained except when Factor 2 is as long or longer than the Result Field. In this case, the sign of Factor 2 is assumed. Factor 1 is not referenced in this operation.

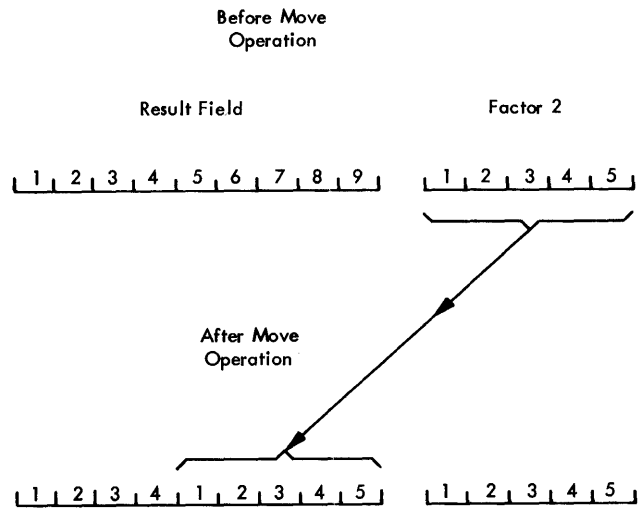

Figure 64. Move Operation -- Factor 2 Shorter than Result Field

tor 1	Operation	Factor 2	Result Field	Field Length	Decimal Position	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero	Compare: High 1 > 2	Low 1 < 2	Equal 1 = 2	Comn
23 24 25 26 27	28 29 30 31 32	33 34 35 36 37 38 39 40 41 42	43 44 45 46 47 48	49 50 51	52	53	54 55	56 57	58 59	60 61 62 63 64 65 66 67			
	MOVEL	FLDA	FLDB	40									

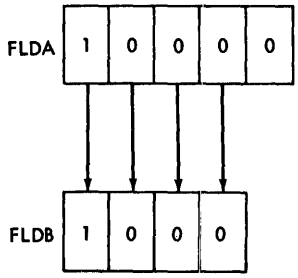

Figure 65. Using the MOVEL Operation Code

Figure 65 shows a use of this operation code. FLDA contains a five-position number (10000). FLDB is a four-position field. The result of the MOVEL is 1000 in FLDB. In this example, the MOVEL operation code performs the same function as dividing FLDA by 10. Three examples in Figure 66 provide additional examples of the operation.

Move High-To-Low Zone (MHLZO)

This operation moves the zone at the leftmost position of Factor 2 to the rightmost position of the result field.

Figure 67 illustrates the movement of zones for all four move zone operations.

Factor 2 can only be alphameric. If the zone to be moved is located over numeric data, this operation can still be performed; however, the numeric field must have been specified as an alphameric field on the Input Specifications sheet.

The result field can be numeric or alphameric. A result field specified as numeric contains an F zone for a plus sign or a D zone for a minus sign after this operation.

Figure 68 illustrates a Move High-to-Low Zone operation (alphameric to alphameric).

Move Low-To-High Zone (MLHZO)

This operation moves the zone at the rightmost position of Factor 2 to the leftmost position of the result field. Factor 2 can be numeric or alphameric, but the result field must be alphameric.

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6 27	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Result Indicat: Plus	Min	Comp: High 1 > 2	L 1
	28 29 30 31 32	33 34 35 36 37 38 39 40 41 42	43 44 45 46 47 48	49 50 51	52	53	54 55			
	MOVEL	'DATA'	FLDA	6						
	MOVEL	FLDA	FLDB	81						
	MOVEL	1357.65	FLDC	42						

Factor 2	Result Field (after move)
DATA	DATAxx
987.6$\bar{5}$	98765xx.x
1357.6$\bar{5}$	13.5$\bar{7}$

Figure 66. Additional Functions of the MOVEL Operation

MLLZO		
Factor 2 Result Field	Alphameric Alphameric	Bits 0-3 of rightmost byte of Factor 2 are moved to bits 0-3 of rightmost byte of Result Field.
Factor 2 Result Field	Alphameric Numeric	Bits 0-3 of rightmost byte of Factor 2 are moved to bits 4-7 of the rightmost byte of the Result Field.
Factor 2 Result Field	Numeric Alphameric	Bits 4-7 of rightmost byte of Factor 2 are moved to bits 0-3 of rightmost byte of the Result Field.
Factor 2 Result Field	Numeric Numeric	Bits 4-7 of rightmost byte of Factor 2 are moved to bits 4-7 of rightmost byte of the Result Field.
MHLZO		
Factor 2 Result Field	Alphameric Numeric	Bits 0-3 of leftmost byte of Factor 2 are moved to bits 4-7 of rightmost byte of Result Field.
Factor 2 Result Field	Alphameric Alphameric	Bits 0-3 of leftmost byte of Factor 2 are moved to bits 0-3 of rightmost byte of the Result Field.
MLHZO		
Factor 2 Result Field	Alphameric Alphameric	Bits 0-3 of rightmost byte of Factor 2 are moved to bits 0-3 of leftmost byte of Result Field.
Factor 2 Result Field	Numeric Alphameric	Bits 4-7 of rightmost byte of Factor 2 are moved to bits 0-3 of leftmost byte of the Result Field.
MHHZO		
Factor 2 Result Field	Alphameric Alphameric	Bits 0-3 of leftmost byte of Factor 2 are moved to bits 0-3 of leftmost byte of Result Field.

Figure 67. Move Zone Operations

Move High-To-High Zone (MHHZO)

This operation moves the zone at the leftmost position of Factor 2 to the leftmost position of the result field. Factor 2 and the result field must be alphameric.

Move Low-To-Low Zone (MLLZO)

This operation moves the zone at the rightmost position of Factor 2 to the rightmost position of the result field. Factor 2 and the result field are alphameric or numeric. A result field specified as numeric contains an F zone for a plus sign or a D zone for a minus sign after this operation.

Testing or Compare Operations

Compare (COMP)

This operation causes the contents of the field or the literal in Factor 1 to be compared against the contents of the field

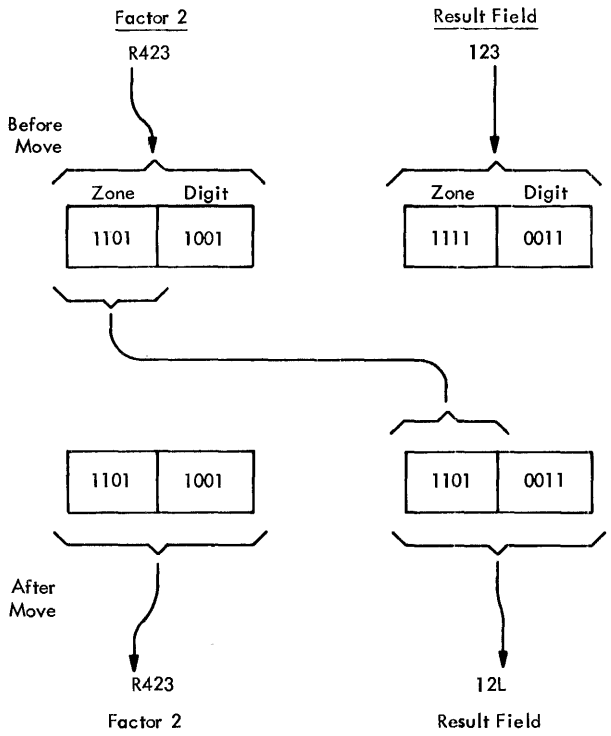


Figure 68. Move High-to-Low Zone Operation

or literal in Factor 2. The outcome of this operation can be used to turn on an indicator that has been specified in columns 54-59 (Resulting Indicators High, Low, or Equal). These indicators are turned on as follows:

High: Factor 1 is greater than Factor 2.
Low: Factor 1 is less than Factor 2.
Equal: Factor 1 is equal to Factor 2.

This operation is used to make comparisons to alter or modify subsequent calculations. No result field is specified.

- The Factor-1 and Factor-2 fields are aligned according to whether they are numeric or alphameric. If numeric fields are compared, fields of unequal length are aligned to the implied decimal point.
- Missing digits in numeric fields are assumed to be zeros.
- If alphameric fields are compared, fields of unequal length are aligned to their leftmost characters and the unused positions are filled with blanks.
- The alphameric compare operation is based upon the internal collating sequence of the system.
- For equal alphameric fields, the maximum field length is 256 characters.
- For unequal alphameric fields, the maximum field length is 200 characters.
- An alphameric field and a numeric field should not be compared because the results of such a comparison are unpredictable.

All numeric comparisons are algebraic. An absolute comparison can be performed by means of a short routine programmed to meet the user's requirements. Figure 69 shows an example of comparing the absolute value of a sum to a literal.

Test Zone (TESTZ)

This operation is used to test the zone of the leftmost position of the alphameric field that is entered in the result field. The format of a Test Zone operation is shown in Figure 70.

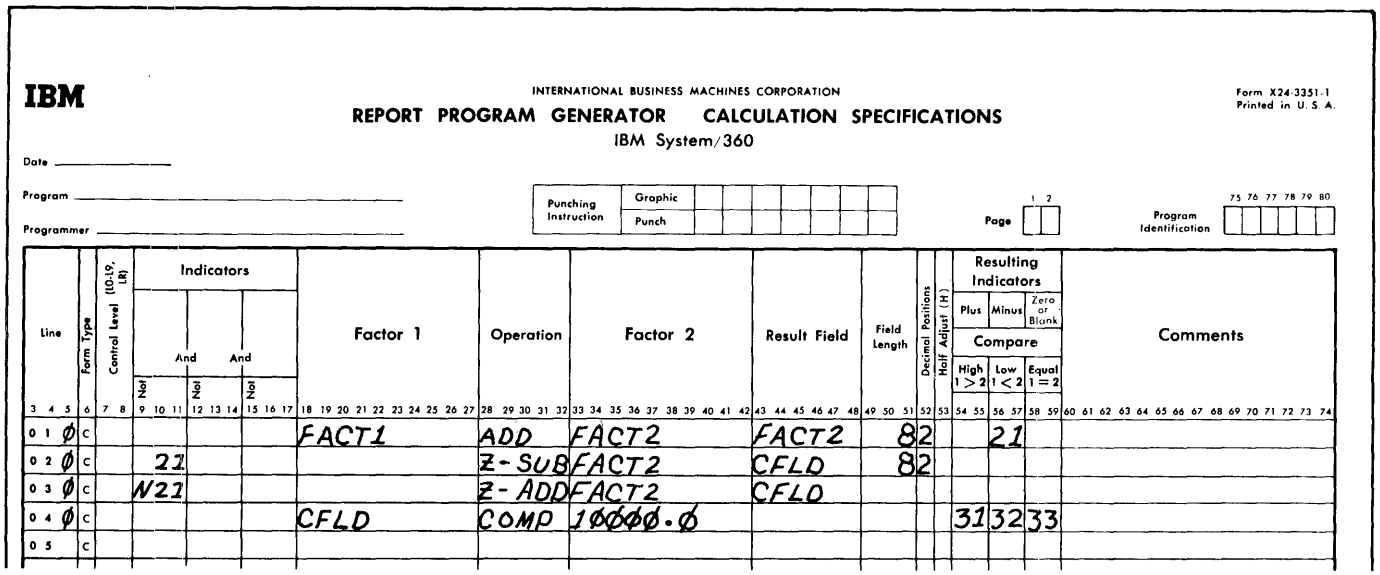
If the result of the test is a 12-zone (&, A through I, 0), the indicator specified in columns 54-55 will be turned on. If the result of the test is an 11-zone (-, J through R, 0), the indicator specified in columns 56-57 is turned on. Any other zone turns on the indicator specified in columns 58-59.

Figure 71 shows an example of this operation. When Indicator 25 is on, the field DATA is tested. If the leftmost position has a 12-zone, Indicator 01 is turned on. If the position has an 11-zone, Indicator 02 is turned on.

Branching and Exit Operations

Exit to a Subroutine (EXIT)

This operation code enables the programmer to transfer control from the RPG program to a user subroutine. Factor 2 contains the name of the subroutine. The name of the subroutine cannot be greater than six alphameric characters; the first character must be alphabetic. Factor 1 and the Result Field are not used. See EXIT to a User's Routine for a complete discussion of this operation.



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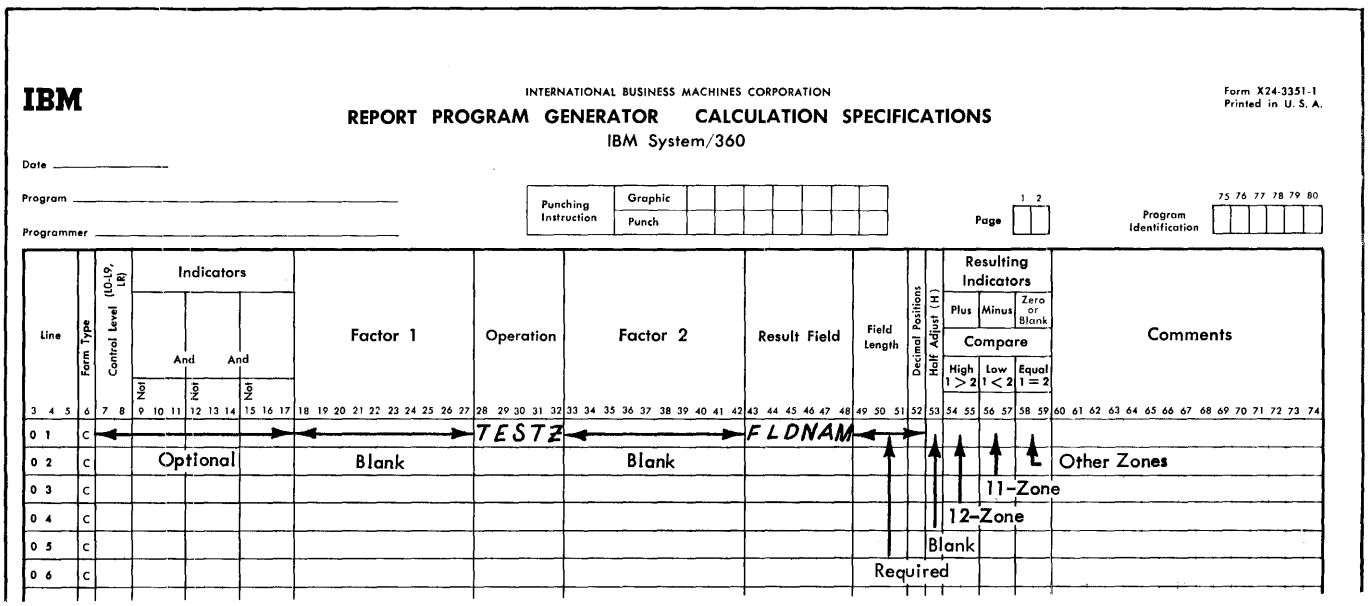
Line 3 4 5	Form Type 6	Control Level (10-19, LR) 7 8	Indicators: And / And — Not 9 10 11	Not 12 13 14	Not 15 16 17	Factor 1 18 19 20 21 22 23 24 25 26 27	Operation 28 29 30 31 32	Factor 2 33 34 35 36 37 38 39 40 41 42	Result Field 43 44 45 46 47 48	Field Length 49 50 51	Decimal Positions 52	Half Adjust (H) 53	Resulting Indicators: Plus / Minus / Zero or Blank — Compare: High 1>2 / Low 1<2 / Equal 1=2 54 55 56 57 58 59	Comments 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
01 Ø	C					FACT1	ADD	FACT2	FACT2	82			21	
02 Ø	C		21				Z-SUB	FACT2	CFLD	82				
03 Ø	C		N21				Z-ADD	FACT2	CFLD					
04 Ø	C					CFLD	COMP	10000.Ø					313233	
05	C													

Figure 69. Example of an Absolute Compare Routine



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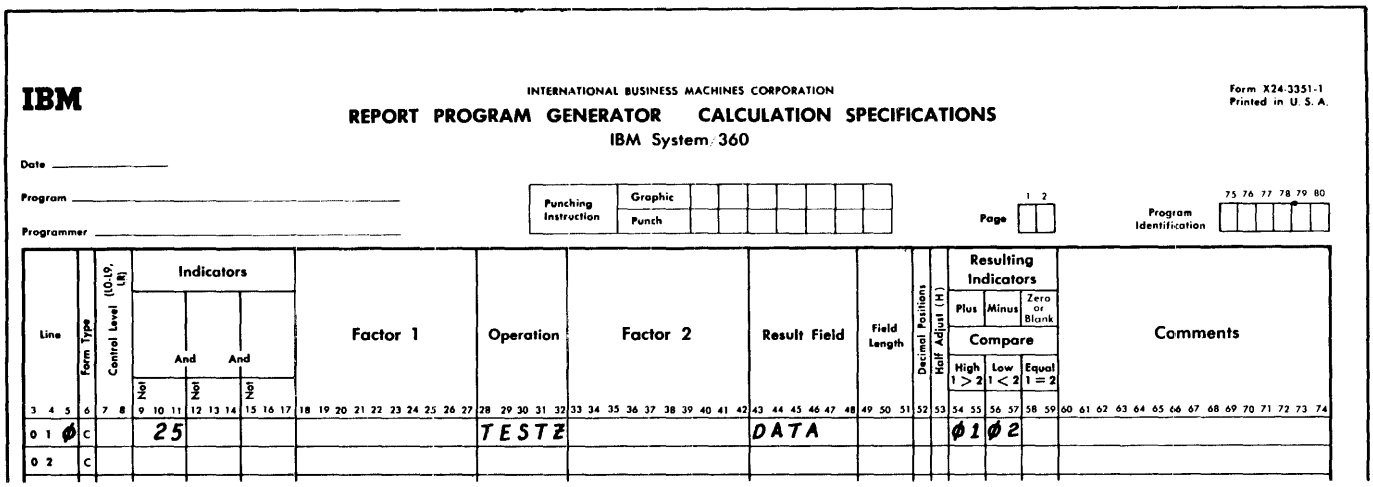
Line 3 4 5	Form Type 6	Control Level (10-19, LR) 7 8	Indicators: And / And — Not 9 10 11	Not 12 13 14	Not 15 16 17	Factor 1 18 19 20 21 22 23 24 25 26 27	Operation 28 29 30 31 32	Factor 2 33 34 35 36 37 38 39 40 41 42	Result Field 43 44 45 46 47 48	Field Length 49 50 51	Decimal Positions 52	Half Adjust (H) 53	Resulting Indicators: Plus / Minus / Zero or Blank — Compare: High 1>2 / Low 1<2 / Equal 1=2 54 55 56 57 58 59	Comments 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
01	C						TESTZ		FLDNAM					
02	C		Optional			Blank		Blank						Other Zones
03	C												11-Zone	
04	C												12-Zone	
05	C											Blank		
06	C									Required				

Figure 70. Format of the TESTZ Operation



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Program Identification

Line	Form Type	Control Level (LO,L9,LR)	Indicators: And / Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus / Minus / Zero or Blank; Compare: High 1>2 / Low 1<2 / Equal 1=2	Comments
01	C		25		TESTZ		DATA				Ø1 Ø2	
02	C											

Figure 71. Using a Test Zone Operation

RPG Label (RLABL)

This operation provides the facility for a subroutine, external to the RPG program, to reference a field in the RPG program. The name of the field to be referenced is entered in Result Field.

The field must be a valid numeric or alphameric field, an indicator, or a table. The use of an indicator or table as an RLABL is explained in the section Using Tables and Exit Routines in the Object Module.

Field length and decimal position must be defined in (unless defined by a preceding entry in either the input or calculation specifications) the Result Field of a RLABL entry. The field name may be from one to six alphameric characters. The first character must be alphabetic. Indicators, Factor 1, and Factor 2 are not used.

User's Label (ULABL)

This operation enables the RPG program to reference a field contained in a user subroutine. The name of the field to be referenced is entered in Result Field. This name may be from one to six alphameric characters; the first character must be alphabetic. Indicators, Factor 1, and Factor 2 are not used. The field length must be defined.

Branching or Go To (GOTO)

The operation code GOTO enables branching to occur in the object module. This means leaving one point in the program to begin operations at some other location in the program. The location of the other routine is identified by a name. This name is entered in Factor 2 and the code GOTO is entered in Operation (columns 28-32). For example, a routine (a group of specifications) to calculate the employee contribution to the Federal Insurance Contribution Act might be labeled FICA. Branching to this routine would require that Factor 2 of the GOTO operation contains the name FICA and that the first operation in the routine be a TAG operation, that is, an operation that defines the name of the routine being branched to (refer to description of next operation code).

Branching can be performed within detail calculations or within total calculations, but not between detail and total calculations. Branching can be forward or backward, skipping over specifications or going back over specifications previously skipped or processed.

If GOTO occurs at total time, Control Level (Columns 7 and 8) of the specification must have a control level specification (L1 through L9, L0, or LR). If it occurs at detail time, a control specification is not required. Factor 1 and the Result Field are not used in this operation.

For additional information see Using the Calculations Sheet.

Providing a Label for GOTO (TAG)

The operation TAG provides a name to which the program can branch. Enter this name in Factor 1 and the code TAG in Operation

(columns 28-32). The name will be used as Factor 2 of the operation code GOTO.

If the TAG operation occurs at total time, Control Level (columns 7 and 8) of the specification must have a control level specification (L1 through L9, L0, or LR). If it occurs at detail time, a control specification is not required. Factor 2 and the Result Field are not used.

Turning Indicators On or Off

Set Indicators On (SETON)

This operation code causes the indicators specified in columns 54-55, 56-57, or 58-59 to be turned on.

NOTE: The column headings of Plus, Minus, or Zero and High, Low, or Equal have no meaning during this operation and should be ignored. Columns 54 through 59 are used -- for this operation code -- merely to record three sets of indicator codes.

Specify the first indicator in columns 54-55, the second indicator in columns 56-57, and the third indicator in columns 58-59. One use of this specification is to turn on a halt indicator when input records are out of sequence. Any RPG indicator, except L0 and 00, can be turned on. Figure 72 shows an example of this facility. The 01 is an indicator that is set on for the first record of a sequence. The L3 is a control level that occurs with the first record of the sequence. If such a situation (L3 and 01) does not occur, the Halt Indicator H1 is turned on.

Set Indicators Off (SETOF)

This operation code causes the indicators specified in columns 54-55, 56-57, or 58-59 to be turned off. Any RPG indicators, except L0 and 00, can be turned off.

For example, when an L3 break occurs, L1-L3 are turned on. If the user did not want L1 on, he could have turned it off by using the SETOF operation code.

Table Operations

Table Lookup (LOKUP)

Table lookup allows the RPG program to look up a table contained in core storage and procure from it specific data needed in the calculations. A table may consist of a set of arguments or a set of functions. Tables may be arranged in either ascending or descending sequence, or they may be out of sequence.

All tables used in an RPG program are loaded into core storage at program object time. They are loaded into the program in the same sequence that they appear on the File Extension sheet.

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Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero or Blank	Compare: High 1>2	Low 1<2	Equal 1=2	Comments
01	C		L3 N01		SETON						H1						
02	C																

Figure 72. Using SETON for a Record Out of Sequence

The LOKUP operation code causes the contents of the field or literal contained in Factor 1 to be used as the search argument. Factor 2 contains the name of the argument table to be searched, and the Result Field contains the table name from which the associated function will be obtained. Decimal alignment is not performed for this operation. (The Result Field may be left blank if the associated function is to be located but not retrieved from the table.)

The use of two Resulting Indicators causes the RPG program to look up that table entry that is high or equal, or low or equal in relation to the search argument.

After the lookup operation is completed, the function that is retrieved is placed in a special holding area for the function table. The name of this area is the same as the name of the function table.

To utilize the function in another operation (for example in an arithmetic operation), the name of the function table is specified in Factor 1 or Factor 2. In this case, the function table name (in Factor 1 or Factor 2) refers to the special holding area in the function table.

To update the function table (for example, a move operation to replace the old function with the new updated function) the name of the function table is specified in the Result Field. The new function is then placed in its proper place in the function table and in the special holding area.

After each table lookup operation, the retrieved function should be used (or moved from the special holding area to another location) before the next table lookup operation is performed. Each subsequent lookup operation overlays the function obtained from the previous lookup operation.

See Using Tables in the Object Program for additional information and examples of table lookup operations.

Conversion Routine Operations

RPG Conversion (RPGCV)

This operation code is used to indicate that the track-address conversion routine is coded on the RPG Calculation Specifications sheet. Factor 1 contains the name (label) of the conversion routine. This name must also be specified on the File Extension sheet in columns 27-32. The Result Field contains the name of the field that contains the relative track address. This field must be alphameric and must have a length of 3. Indicators and Factor 2 are not used.

End of RPG Conversion (ERPGC)

This entry terminates the conversion-step entries that have been coded on the Calculation Specifications sheet. No other entries are necessary.

Indicators, Factor 1, Factor 2, and Result Field are not used.

External Conversion Routine (EXTCV)

This entry is used to indicate that the track-address conversion routine is external to the RPG language.

Factor 1 contains the label specified on the File Extension sheet in columns 27-32.

The Result Field contains the name of the field that will contain the track address. This name is defined in the RPG program by this operation and must not be defined in the external routine. The field must be alphameric and must have a length of 3.

Factor 2 must contain the name of the external conversion subroutine that the RPG program branches to. The specification Indicators is not used.

Record Key (KEYCV)

This operation code establishes the name of the field that is to contain the key of the disk record. (It is used only when records are retrieved using record key data.) The code KEYCV is placed in Operation (columns 28-32) and the name of the field is placed in Result Field (columns 43-48). The field length and decimal positions must be specified if the field has not been defined previously. Indicators, Factor 1, and Factor 2 are not used.

The operation must follow the RPGCV or EXTCV operation. The name of the field that will contain the record key is defined in the RPG program by this operation and must not be defined in the external conversion routine.

Table 1 is a summary of the specification entries required for some of the operation codes just described. The only operation codes listed are those for which the

Table 1. Summary of Operation Specifications

O = Optional R = Required b = blank

Operation	Control Level	Indicators	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust	Resulting Indicators
Add	O	O	R	ADD	R	R	O	O	O	O
Zero and Add	O	O	b	Z-ADD	R	R	O	O	O	O
Subtract	O	O	R	SUB	R	R	O	O	O	O
Zero and Subtract	O	O	b	Z-SUB	R	R	O	O	O	O
Multiply	O	O	R	MULT	R	R	O	O	O	O
Divide	O	O	R	DIV	R	R	O	O	O	O
Move Remainder	O	O	b	MVR	b	R	O	O	b	O
Move	O	O	b	MOVE	R	R	O	b	b	b
Move Left	O	O	b	MOVEL	R	R	O	b	b	b
Move High-to-Low Zone	O	O	b	MHLZO	R	R	O	b	b	b
Move Low-to-High Zone	O	O	b	MLHZO	R	R	O	b	b	b
Move High-to-High Zone	O	O	b	MHHZO	R	R	O	b	b	b
Move Low-to-Low Zone	O	O	b	MLLZO	R	R	O	b	b	b
Compare	O	O	R	COMP	R	b	b	b	b	R
Test Zone	O	O	b	TESTZ	b	R	R	R	b	R
Exit to a Subroutine	O	O	b	EXIT	R	b	b	b	b	b
RPG Label	O	b	b	RLABL	b	R	O	O	b	b
User's Label	O	b	b	ULABL	b	R	R	R	b	b
Branching or GOTO	O	O	b	GOTO	R	b	b	b	b	b
Providing a Label for GOTO	O	b	R	TAG	b	b	b	b	b	b
Set Indicators ON	O	O	b	SETON	b	b	b	b	b	R
Set Indicators OFF	O	O	b	SETOF	b	b	b	b	b	R
Table Lookup	O	O	R	LOKUP	R	O	O	O	b	R
RPG Conversion	O	b	R	RPGCV	b	R	R	R	b	b
End of RPG Conversion	O	b	b	ERPGC	b	b	b	b	b	b
External Conversion Routine	O	b	R	EXTCV	R	R	R	R	b	b
Record Key	O	b	b	KEYCV	b	R	O	O	b	b

format and required entries may be the most difficult to remember.

RESULT FIELD (43-48)

This specification sets up a location in storage to contain the result of a calculation. The name of the result field can be alphameric and must be left-justified.

It must not contain blanks, or special characters and the first character must be alphabetic. The sign for arithmetic fields is always stored in the units position of the result field.

The same name can be used several times in different calculations if the length of the field and the number of decimal positions are the same for all calculations.

Figure 73 illustrates Result Field specifications. On the first line GROSS is multiplied by DRATE and the result field is established as DISCNT. This result field is then used as Factor 2 on the next specification to calculate a net amount. This same result field is then used as Factor 1 on the next specification line to calculate total discount.

FIELD LENGTH (49-51)

This entry specifies the length of the result field. The entry must specify the number of positions to be reserved for the result field. In Figure 73, DISCNT is eight positions long. The unpacked length must be specified. The maximum numeric field length is 15 digits, and the maximum alphameric field length is 256 characters.

If the same field name is used for more than one calculation and the field length and number of decimal positions are the same, the field-length specification and the decimal-position specification need be specified only for the first specification it is used with.

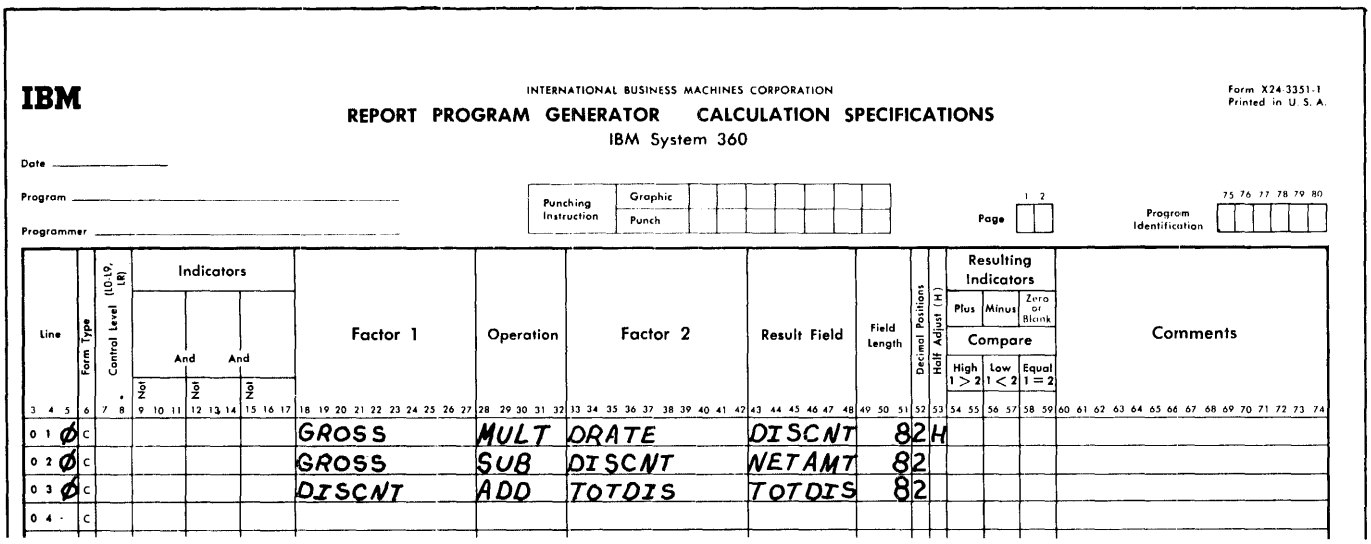
If the result field is longer than the number of positions specified for it, the excess leftmost positions are lost.

NOTE: If half-adjustment is specified, the field length entry refers to the length of the result field after half-adjustment.

DECIMAL POSITIONS (52)

An entry in this column indicates the number of positions to the right of the decimal symbol in the result field. An entry must be made in this column for all arithmetic operations if the field has not been defined previously. If the result field does not have any decimal positions, the entry must be a 0. A maximum of nine decimal positions can be specified.

This specification is the only entry required to determine the number of decimal places in a calculated result. (The decimal point of input fields is specified on the input specifications.) The object



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Program Identification 75 76 77 78 79 80

Line 3 4 5	Form Type 6	Control Level (LO-L9, LR) 7 8	Indicators: And Not 9 10 11	And Not 12 13 14	And Not 15 16 17	Factor 1 18-27	Operation 28-32	Factor 2 33-42	Result Field 43-48	Field Length 49-51	Decimal Positions 52	Half Adjust (H) 53	Resulting Indicators: Plus 54 55	Minus 56 57	Zero or Blank 58 59	Compare: High 1>2 60 61	Low 1<2 62 63	Equal 1=2 64 65	Comments 66-74
01	C					GROSS	MULT	DRATE	DISCNT	8	2	H							
02	C					GROSS	SUB	DISCNT	NETAMT	8	2								
03	C					DISCNT	ADD	TOTDIS	TOTDIS	8	2								
04	C																		

Figure 73. Result Field Entry

module considers the number of decimal positions in both factors of an arithmetic operation and automatically "shifts" the factors or the results to provide the correct number of decimal positions.

In Figure 73 each result field has two decimal positions.

If the result field is alphameric, this column must be left blank.

HALF ADJUST (53)

This specification is used to half-adjust, or round, the result field. Enter an H in this column if the data in the result field is to be half-adjusted.

Half-adjusting is accomplished in the object program by adding an absolute value of 5 to the right of the last position retained in the result field.

In Figure 73, DISCNT is half-adjusted.

If the result field is an alphameric field, this specification must be left blank.

If the number of decimal positions in the arithmetic result is less than or equal to the decimal positions specified for the pertinent result field, the half-adjustment specification has no effect.

This completes the description of the specifications required for determining the kind of calculations to be performed.

TESTING THE RESULTS OF CALCULATIONS

The last category of specifications for the calculation form is Resulting Indicators.

RESULTING INDICATORS (54-59)

This specification may be used to test the value of a result field after the completion of an operation. As the result of this test, an indicator is turned on which can be used to control subsequent calculation operations or to control output operations. The specification is used in five ways:

1. To determine whether the result of an arithmetic operation is plus, minus, or zero. (In the case of half-adjustment, the resulting indicator refers to the result after half-adjustment.)
2. To test the result of a compare operation to determine if:

   Factor 1 > Factor 2 -- High
   Factor 1 < Factor 2 -- Low
   Factor 1 = Factor 2 -- Equal

3. To define the type of LOKUP operation to determine:
   a. If the argument next-higher than the search argument is found.
   b. If the argument next-lower than the search argument is found.
   c. If the argument equal to the search argument is found.

   NOTE: If an equal-search resulting indicator is specified, it takes precedence over either high or low indicators if an equal-table value exists.

4. To define a TESTZ operation as to what type of zone is to be tested.
5. To define SETOF and SETON operations as to what indicators are to be turned off or on.

The entries for this specification can be any of the indicator codes 01 through 99 and the halt indicators H0 through H9. They can be defined one or more times on the form. If these indicators are defined more than once, a subsequent specification of the indicator resets it from the status it may have had by the previous specification for it.

NOTE: "Defining" these indicators means specifying them as resulting indicators or field indicators in the input specifications, or as resulting indicators in the calculation specifications. This should not be confused with "using" these indicators. "Using" these indicators means specifying them in Indicators on the calculation form or in Output Indicators on the output form as many times as required. In the latter case they are merely tested to determine their status and are not reset by the test.

NOTE: Resulting indicators are not reset (turned on or off) until the next time a calculation is performed for which the program specifies the indicator as a resulting indicator. This means that one or more resulting indicators can be on at one time.

NOTE: An indicator specified in columns 58-59 (Zero or Blank) for ADD, Z-ADD, SUB, Z-SUB, MULT, DIV, MVR, MOVE, and MOVEL is initialized on.

A resulting indicator used to test for a zero balance can be reset by one other condition. The output specification Blank After causes a numeric field to be set to zeros after execution of the output operation specified. If this field is also a Result Field being tested for zero, the resulting field indicator specified is turned on when the field is set to zeros by the Blank After specification. If the field is also a result field being tested for plus or minus, the resulting field indicators specified are not turned off when the field is set to zeros by the Blank After specification.

Table 2 illustrates the various conditions that cause resulting indicators to be turned on.

On the first line in Figure 74, DISCNT is subtracted from GROSS and the result is stored in NETAMT. If the answer is a minus number, Indicator 10 is set on. If the answer is zero, Indicator 15 is set on.

On the second line in Figure 74, the literal JANUARY is compared against the contents of DATE. If the result is equal, Indicator 24 is turned on.

COMMENTS (60-74)

Positions 60 through 74 of the form are not required by the program. Data placed in these positions will be printed as a separate field during the compilation of the object program. An asterisk in column 7 is not required if this type of comment is in a line containing specifications.

USING THE CALCULATION SPECIFICATIONS SHEET

Figure 75 illustrates entries on the Calculation Specifications sheet that are used in part of a payroll application. The entries on the sheet are discussed by line number.

NOTE: The blank spaces signify that additional calculations have been specified, but in this example they have been omitted.

Line Number	Explanation
01	The program branches to GRSPAY from some other detail calculation (not shown in this example).
02	The number of hours the employee worked is compared with the literal 40. If the employee worked more than 40 hours, Indicator 20 is turned on. If the employee worked less than 40 hours, Indicator 22 is turned on.
03-05	If Indicator 20 is on, three calculations are performed. The literal 40 is subtracted from the

Table 2. How Resulting Indicators are Turned On

		Columns 54-55		Columns 56-57		Columns 58-59	
		PLUS	HIGH	MINUS	LOW	ZERO OR BLANK	EQUAL
Arithmetic Operation →	If the Result Field has a :	Plus Value (Except $\pm$ 0)	-	Minus Value (Except 0)	-	Zero Value ($\pm$ 0 And 0)	
Table Lookup →	If the table argument is :	-	Next higher than the search argument	-	Next lower than the search argument	-	Equal to the search argument
Compare Operation →	If factor 1 is :	-	Greater than factor 2	-	Less than factor 2	-	Equal to factor 2

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Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / And — Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero or Blank	Compare: High 1>2	Low 1<2	Equal 1=2	Comments
01 Ø	C			GROSS	SUB	DISCNT	NETAMT	82		H					1Ø1	5	
02 Ø	C			'JANUARY'	COMP	DATE										24	
03	C																

Figure 74. Result Field Indicators

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Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / And — Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero or Blank	Compare: High 1>2	Low 1<2	Equal 1=2	Comments
01 Ø	C			GRSPAY	TAG												
02 Ø	C			HOURS	COMP	4Ø								2Ø	22		
03 Ø	C		2Ø	HOURS	SUB	4Ø	OVERHR	31									
04 Ø	C		2Ø	RATE	MULT	OVERHR	SAVE	62	H								
05 Ø	C		2Ø	SAVE	MULT	1.5	SAVE		H								
06 Ø	C		N22	RATE	MULT	4Ø	GROSS	62	H								
07 Ø	C		N22	SAVE	ADD	GROSS	GROSS										
08 Ø	C		N22		GOTO	FICA											
09 Ø	C				(ADDITIONAL CALCULATIONS)												
10 Ø	C			FICA	TAG												
11 Ø	C			GROSS	MULT	.Ø3	DFICA	62	H								
12 Ø	C			YDFICA	ADD	DFICA	HOLD	62	H								
13 Ø	C			HOLD	COMP	144.ØØ									21	21	
14 Ø	C		21		GOTO	ADFICA											
15 Ø	C			144.ØØ	SUB	YDFICA	DFICA										
16 Ø	C			ADFICA	TAG												
17 Ø	C			YDFICA	ADD	DFICA	YDFICA										
18 Ø	C				(ADDITIONAL CALCULATIONS)												
19 Ø	C			WHTAX	TAG												
	C				(ADDITIONAL CALCULATIONS)												

Figure 75. Using the Calculation Specifications Sheet

Line Number	Explanation
	number of hours worked, and the overtime hours are placed in the field OVERHR, which is a three-position field with one decimal position. RATE is multiplied by OVERHR and the result is placed in the field SAVE, which is a six-position field with two decimal positions. SAVE is multiplied by the literal 1.5 (which is the overtime premium rate). The result is placed back in SAVE, and it is half-adjusted.
06	RATE is multiplied by 40, and the result is stored in GROSS. This operation is performed whether or not the employee worked any overtime. It is not performed if the employee has worked less than 40 hours.
07	GROSS is added to SAVE if Indicator 22 is off.
08	The program branches to the label FICA if Indicator 22 is off.
09	Additional calculations.
10	The operation code TAG provides the label FICA. The RPG program branches to this label.
11	GROSS is multiplied by the literal .03 and the result is placed in the field DFICA, which is a six-position field with two decimal positions. The result is half-adjusted.
12	DFICA is added to YDFICA and the result is placed in the field HOLD.
13	The contents of HOLD are compared with the literal 144.00, and if HOLD is less than, or equal to, 144.00, Indicator 21 is turned on.
14	If Indicator 21 is on, the program branches to the label ADFICA.
15	YDFICA is subtracted from the literal 144.00 and, the result is placed in DFICA.
16	The operation TAG provides the label ADFICA to which the program can branch (either from the specification on line 14 or sequentially from the specification on line 15).
17	DFICA is added to YDFICA and the result is stored in YDFICA.
18	Additional calculations.
19	The operation code TAG provides the label WHTAX to which the RPG program can branch.

This form specifies the kind of output files to be produced and the location of the specific data fields in the output reports and records.

GENERAL INFORMATION

The specifications for this form can be divided into two categories as illustrated in Figure 76: file identification and control (columns 7-31), and field description (columns 23-74).

File Identification and Control. These specifications identify the output records that make up the files. They direct cards to the appropriate stackers and provide the correct spacing on printed reports. They determine under what conditions the records are to be produced.

Field Description. These specifications indicate where and when the individual fields are to be placed in the output record. All field description entries are written on the lines following their corresponding file identification specification. Each field is described on a separate line.

The reader should note that the specication Output Indicators is used for both file identification and field description. The facility of controlling the printing and punching of each specific field of the record provides a great amount of program flexibility in RPG.

Specifying Output Units

When writing the Output-Format specifications, it is not necessary to indicate the specific output units used in the program. The I/O unit used for each file is specified in the File Description sheet. Each file name therefore is related to a specific output unit. By merely writing the file name on the output form, the output unit has in effect been specified.

FILE IDENTIFICATION AND CONTROL

FILENAME (7-14)

A file name is assigned to each output file. The file name must be left-justified, and it must begin with an alphabetic character.

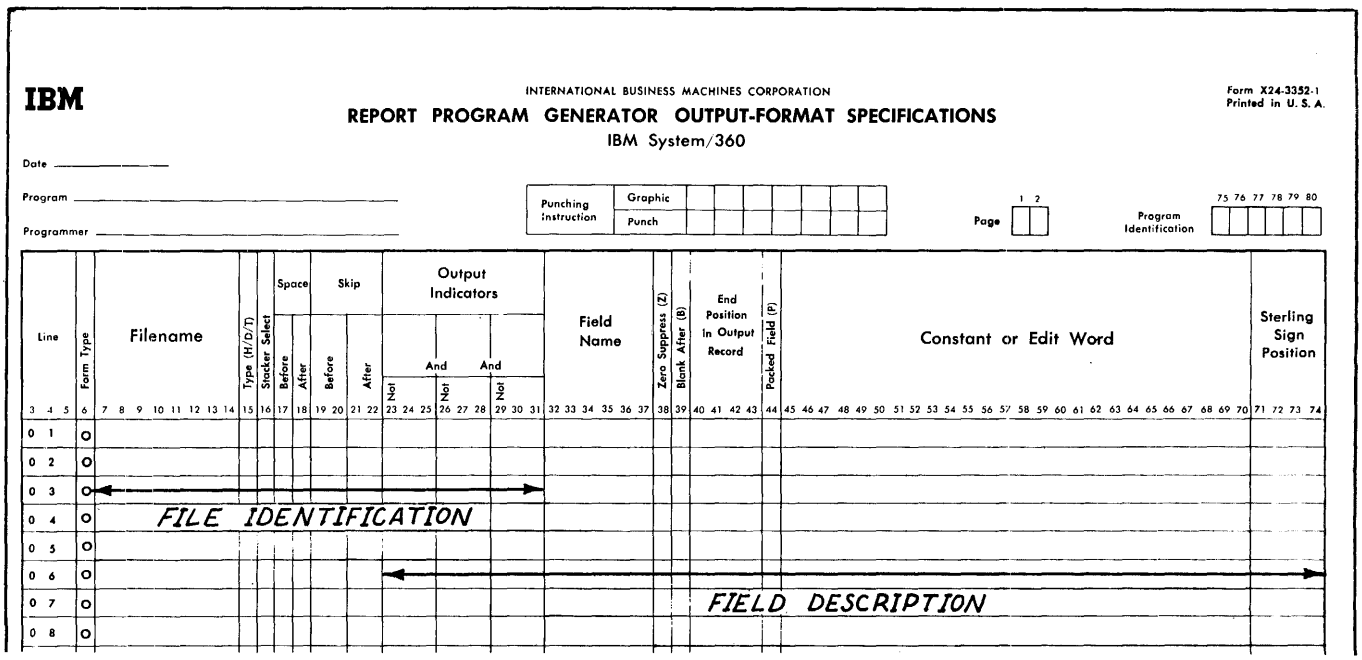


Figure 76. Output-Format Specifications Sheet

The file name may be alphameric, but it must not contain special characters or blanks.

When writing the output specifications, the file name need only be entered once. Enter it on the first line to define the file as shown in Figure 77.

TYPE H/D/T (15)

The entry in this column identifies the type of record being specified. The following three entries are used for this specification:

H -- Heading Record
D -- Detail Record
T -- Total Record

NOTE: All heading records for a file must be entered first, followed by all detail records, and then by all total records for the same file (Figure 77).

Heading Records. These records usually contain constant information. However, they may also contain information from input records, including the record present at the time the output record is produced.

Detail Records. These records have a direct relationship to the input record. Most data in a detail record comes from the input record or from calculations performed at detail time.

Total Records. Operations upon fields from the input record are preceded by the test for control-field changes, the performance of total-time calculations, and the formation of total records. Thus, data from an input record that causes a control-field change cannot contribute data to total records that result from that control change. But heading and detail records can contain data from the input record.

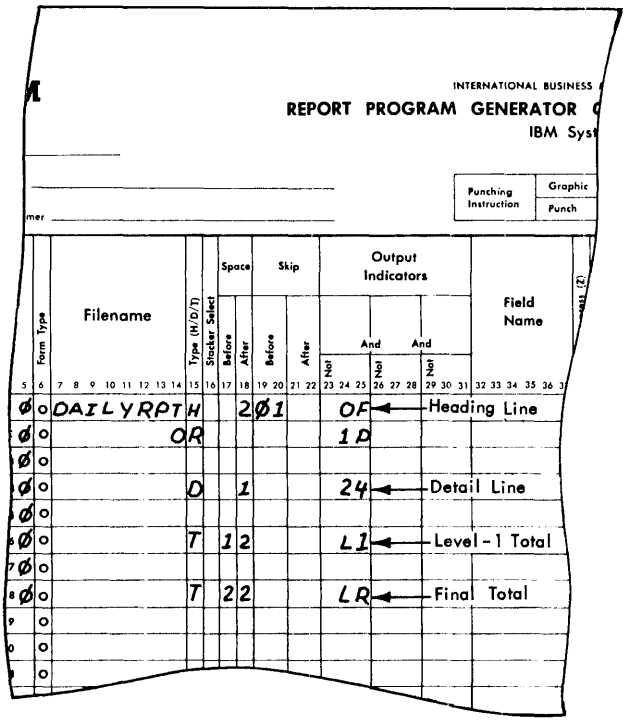


Figure 77. Specifying Heading, Detail, and Total Lines

STACKER SELECT (16)

If punched output occurs in the object program, a stacker number is entered in this column. The cards fall in the stacker that is indicated by this column. The stacker pockets and their acceptable codes are listed in Figure 78.

SPACE (17-18)

This specification (and the next specification Skip, columns 19-22) is used to provide the proper spacing of printed reports.

NOTE: If the record is to be printed, at least one entry is required in columns 17-22.

Output Unit	Stacker Number	Stacker Select Code
1442 Card Read-Punch	1 2	1 or Blank 2
2520 Card Read-Punch	1 2	1 or Blank 2
2540 Card Read-Punch	P1 P2 RP3	1 2 3

Figure 78. Summary of Stacker Select Specifications (Output)

Space Before (Column 17)

Enter in this column the number of lines to be spaced before the line is printed. Specify zero, one, two, or three spaces before printing by placing the entry 0, 1, 2, or 3 in column 17. If this column is left blank, no spacing before printing will be provided.

Space After (Column 18)

Specify zero, one, two, or three spaces after printing by placing the entry 0, 1, 2, or 3 in column 18. A blank in this column will provide single spacing after printing a line.

SKIP (19-22)

This specification provides for the proper spacing of reports. It is directly related to the function of the printer carriage-control tape.

Skip Before (Columns 19-20)

The entries 01-12 cause the printer carriage to skip to channels 1 through 12 of the carriage tape before the line is printed. In Figure 77, before the heading line is written, the form skips to channel 1.

Skip After (Columns 21-22)

The entries 01-12 cause the printer carriage to skip to channels 1 through 12 of the carriage tape after the line is printed.

NOTE: The order in which spacing and skipping is performed is as follows:

Skip Before
Space Before
Skip After
Space After

Overflow Indicator

Carriage overflow or the line number associated with channel 12 in the Line Counter Specifications sheet cause the setting of the indicator as specified by the user in the File Description Specifications (columns 33-34).

Channel 12 is sensed as the corresponding line is printed. The overflow indicator is turned on after the next line is printed. Thus, one extra line is always printed after the overflow is detected and before the overflow functions can occur. In planning a printer operation, the carriage tape overflow punch must coincide with the next-to-last line to be printed on the form.

Using the Line Counter specifications causes the overflow indicator to be turned on when the line counter reaches the specified line number.

The overflow indicator remains on for one complete processing cycle and is off after the heading and detail lines of the next record are printed. The overflow indicator can be used to control calculation specifications because it is on during calculations.

A test for the overflow status is made by the object module immediately before each line of the report is printed (but after any Space Before specifications are executed). Two conditions can occur at this time:

1. If the overflow indicator is on before a detail line is printed, the detail line, and any other detail lines whose output indicators are on, are printed.
   Any Space After specifications are executed, the next record is read, and a test is made to determine if a control break has occurred. If one has occurred, all total lines (caused by the control break) are printed, and then any overflow printing specified is performed.
2. If the overflow indicator is on before a total line is printed, all total lines, whose output indicators are on, are printed. This is followed by any specified overflow printing.

Automatic Skipping

If an overflow indicator is not specified as one of the first three indicators (columns 23-31 of output specifications) for any line of a print file, then the RPG compiler provides the object module with automatic skipping from channel 12 to channel 01 on that file.

Printing Lines Conditioned by Overflow

If an output heading line is coded as in the upper half of Figure 79, the heading line will print whenever the OF or L1 indicator is on. If L1 and OF occur at the same time during processing, the line

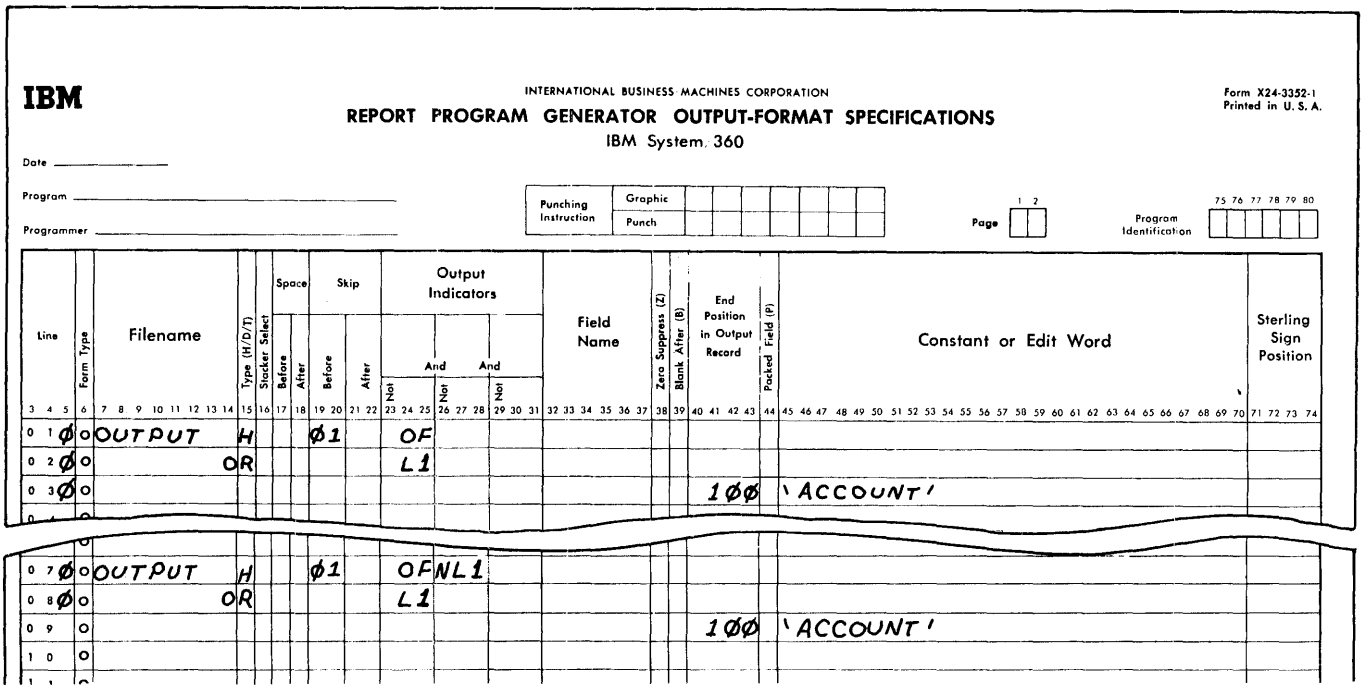


Figure 79. Specifying Output Indicators for Overflow

prints twice, thus possibly providing an error in the printed report. To prevent this situation the line is coded as shown in the lower half of Figure 79. By making the condition mutually exclusive (both conditions can cause the skip, but not at the same time), the line is not printed twice.

The order in which the object module prints lines conditioned by overflow follows:

1. When overflow occurs during the printing of a heading or detail line, the object module does not print lines conditioned by overflow. The program does, however, take note that the overflow condition has occurred.
2. Total lines not conditioned by overflow are printed.
3. The object module then tests to see if overflow has occurred.
4. Total lines conditioned by overflow are then printed.
5. Heading and detail lines conditioned by overflow are then printed.

NOTE: If an overflow condition has been specified, automatic skipping is not performed.

Multiple Printers

With this program it is possible to use a maximum of eight output printer files for each RPG object module. When producing records for more than one printer, the user must specify the printer on which the overflow condition occurs by assigning a unique overflow indicator for each printer.

In columns 33-34 of the File Description sheet, one of eight available overflow indicators is entered. The following eight indicator codes are used:

OA, OB, OC, OD, OE, OF, OG, and OV.

OUTPUT INDICATORS (23-31)

This specification may be used for either file identification or field description. Entries in this column may specify a maximum of three indicators. These indicators control:

1. When the line is to become output, or
2. When a particular field is to be written.

The following information applies only to its use in the file identification line.

If more than one indicator is specified on one line, all indicators are considered in an AND relationship. That is, all indicator conditions specified must be satisfied before the output condition can be executed.

If the object module requires that more than three indicators be in an AND relationship, the letters AND are entered in columns 14-16 of the following line, and the additional indicators are specified on that line.

If the output condition is executed in an OR relationship (one or the other of two sets of conditions) the letters OR are entered in columns 14-15 of the following specification line, and the OR indicators are specified on that line.

Additional specification lines can specify as many output indicators in either an AND or OR relationship as required by the object module. Each additional line must begin with AND or OR in column 14.

When an OR line is specified on a print file, the printer control functions (columns 17-22) may all be left blank, in which case those of the preceding line will be implemented. They may, however, differ from the preceding line if required. This implementation does not occur for Stacker Select entry since a blank is a valid stacker select code.

If a line is to be conditioned as an overflow line, the overflow indicator must not appear in a specification line having the letters AND in columns 14 through 16.

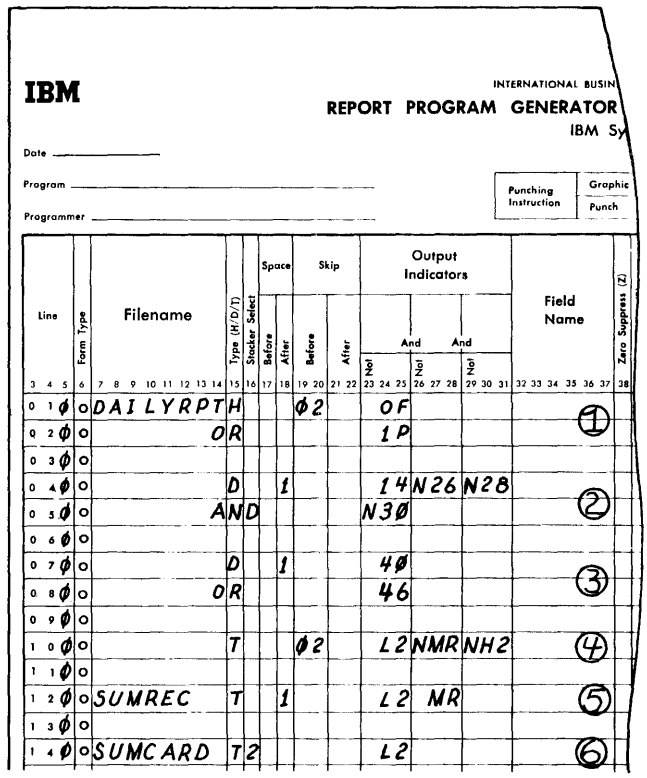
Examples of Output Indicators

The entries for this specification can be arranged into the categories listed below.

1. A resulting indicator code specifies the particular record-type on which the output operation is to be performed. The operation cannot be performed on other record types.
2. A field indicator code controls the output operation by the status of an input field.
3. A resulting indicator code controls the output operation by conditions that have occurred during calculations.
4. A control level indicator (L1 through L9 and LR) causes the output operation to be performed only at the control level specified.
5. The MR indicator code causes the output operation to be performed only if there is a matching record in a second input file.
6. The halt indicators H0 through H9 are normally used to suppress an output operation when an error has been detected in the input data or during a calculation.
7. Overflow indicators cause the output operation to take place only if a page overflow has occurred. (Overflow line.)
8. The 1P (first page) indicator enables overflow headings to be printed on the first page of a report. (This indicator is turned on at the beginning of processing before any input records have been read.)

In addition, this specification may contain a combination of some of the eight categories listed. Also, the operation may be controlled by the fact that an indicator must not be on. This is accomplished by placing an N in columns 23, 26, and 29.

Figure 80 shows six examples of output indicators when they are used as part of the file identification specifications. The numbers to the right refer to the following discussion:



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Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space Before	Space After	Skip Before	Skip After	Output Indicators And	Output Indicators And Not	Output Indicators And	Output Indicators And Not	Field Name	Zero Suppress (Z)	
01Ø	O	DAILYRPT	H				Ø2		0F						①
02Ø	O		OR						1P						
03Ø	O														
04Ø	O		D		1				14	N26	N28				
05Ø	O		AND						N3Ø						②
06Ø	O														
07Ø	O		D		1				4Ø						
08Ø	O		OR						46						③
09Ø	O														
10Ø	O		T				Ø2		L2	NMR	NH2				④
11Ø	O														
12Ø	O	SUMREC	T		1				L2	MR					⑤
13Ø	O														
14Ø	O	SUMCARD	T	2					L2						⑥

Figure 80. Specifying Output Indicators

1. The control carriage is skipped to channel 02 before printing, and the heading line is printed only when an overflow condition occurs or when the 1P (first page) indicator is on.
2. The detail line is printed only if Indicator 14 is on, and Indicators 26, 28, and 30 are off. Indicators 26, 28, and 30 could be field indicators from the input specifications, or they could be resulting indicators from the calculation specifications.
3. The detail line is printed if Indicator 40 or 46 is on.
4. The total line is printed and the control carriage is skipped to channel 2 before printing only if the Level-2 indicator is on, the MR indicator is off, and H2 is off. The specification NH2 prevents the object module from printing a line if an error condition has occurred.

   The program does not stop until after all processing for the record has been completed. This feature enables the programmer to prevent the printing of erroneous data.
5. The summary record is printed at the Level-2 control time, but the MR (matching record) indicator must also be on.
6. A summary card punched at the Level-2 control time is selected into stacker 2 of an IBM 1442 Card-Read Punch.

This concludes the description of the file identification specifications. The remaining descriptions of the output form are concerned with the field-description section of the output specifications.

FIELD DESCRIPTION

These entries include specifications about:

1. The control of the individual fields of a record, and
2. The output format of individual fields of a record. The fields of the record are written on the lines below their corresponding file entries. Each field is described on a separate line, and no entries are permitted in columns 7-22 of a field-description line.

OUTPUT INDICATORS (23-31)

The same types of indicators used for file identification can be used for field description. The maximum number of indicators that can be considered in an AND relationship is three; all must be specified on one field-description line.

Figure 81 shows four sets of indicators used as output indicators for field-description lines. The numbers to the right of the figure correspond to the following list:

1. Four fields are printed from a detail record identified by Indicator 44: invoice, amount, customer, and salesman. The entry L1 causes the field, SALESM, to be printed only for the first detail record of each control group. (Remember that a control level indicator remains on during the following detail calculation and print cycle.) The salesman field is "group indicated".
2. The second example illustrates how to prevent the printing of just one field of a record. The field AMOUNT is printed only if Indicator 16 is off. This indicator is used to determine if the calculated field AMOUNT is zero.
3. This example selectively prints the field headings for an invoice form. This specification prints all the heading information on the first form, but if the information for one customer order continues on two or more forms, only the customer and invoice fields on succeeding forms are printed.

   Printing of the entire line is controlled by Indicators 04 or OF. In the field description specifications, the OF indicator is also used to prevent printing of fields order number, date, and salesman when an overflow condition occurs.
4. The last example illustrates how a field can be controlled for printing by an AND relationship and an OR relationship.

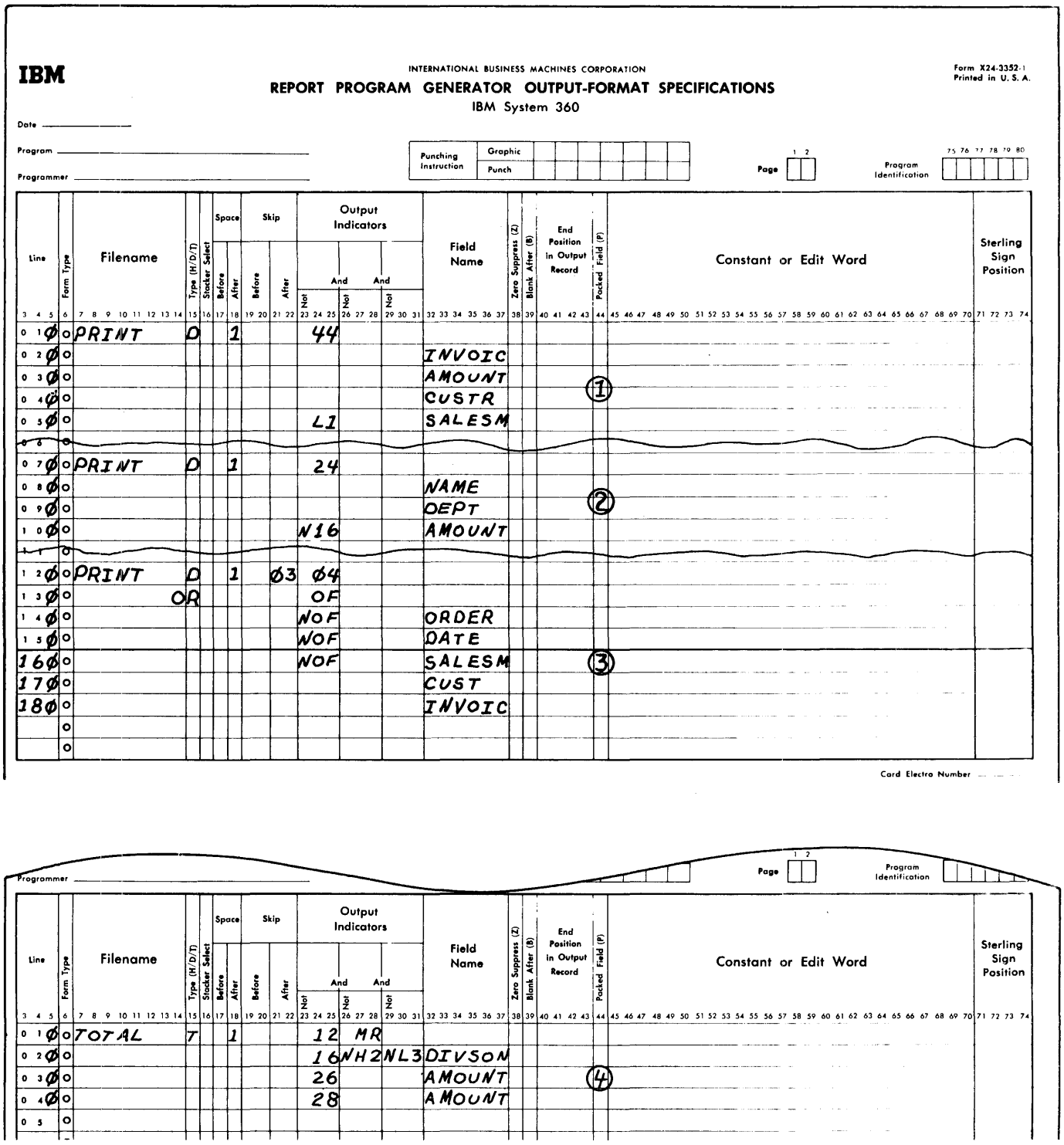
   The field DIVSON is controlled by three AND indicators: 16, NH2, and NL3.

   The field AMOUNT is controlled by two OR conditions. In the field description line, the OR relationship is used by writing the field name twice and specifying each appropriate OR indicator.

   The letters OR cannot be specified in columns 14-15 of a field description.

FIELD NAME (COLUMNS 32-37)

This specification identifies each field of the record to be written. The fields may



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REPORT PROGRAM GENERATOR OUTPUT-FORMAT SPECIFICATIONS

IBM System 360

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Printed in U. S. A.

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Program

Programmer

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line 3 4 5	Form Type 6	Filename 7–14	Type (H/D/T) 15	Space: Stacker Select 16	Space: Before 17	Space: After 18	Skip: Before 19 20	Skip: After 21 22	Output Indicators: Not 23 24	Output Indicators: And 25	Output Indicators: And Not 26 27	Output Indicators: And Not 28	Output Indicators: And Not 29 30	Output Indicators: And Not 31	Field Name 32–37	Zero Suppress (Z) 38	Blank After (B) 39	End Position in Output Record 40–43	Packed Field (P) 44	Constant or Edit Word 45–70	Sterling Sign Position 71–74
010	O	PRINT	D		1				44												
020	O														INVOIC						
030	O														AMOUNT						
040	O														CUSTR				(1)		
050	O								L1						SALESM						
060	O																				
070	O	PRINT	D		1				24												
080	O														NAME						
090	O														DEPT				(2)		
100	O								N16						AMOUNT						
110	O																				
120	O	PRINT	D		1		03		04												
130	O		OR						OF												
140	O								NOF						ORDER						
150	O								NOF						DATE						
160	O								NOF						SALESM				(3)		
170	O														CUST						
180	O														INVOIC						
	O																				
	O																				

Card Electro Number

Programmer

Page 1 2

Program Identification

Line 3 4 5	Form Type 6	Filename 7–14	Type (H/D/T) 15	Space: Stacker Select 16	Space: Before 17	Space: After 18	Skip: Before 19 20	Skip: After 21 22	Output Indicators: Not 23 24	Output Indicators: And 25	Output Indicators: And Not 26 27	Output Indicators: And Not 28	Output Indicators: And Not 29 30	Output Indicators: And Not 31	Field Name 32–37	Zero Suppress (Z) 38	Blank After (B) 39	End Position in Output Record 40–43	Packed Field (P) 44	Constant or Edit Word 45–70	Sterling Sign Position 71–74
010	O	TOTAL	T		1				12		MR										
020	O								16	NH2	NL3				DIVSON						
030	O								26						AMOUNT				(4)		
040	O								28						AMOUNT						
05	O																				

Figure 81. Specifying Field Names

be listed on the form in any sequence. The order in which they appear in the output record is determined by the entry in columns 40-43.

Enter in columns 32-37 the name of the field that is defined on the line. The field name must have been previously defined on either the input or calculation sheet. (For an exception to this, see Page Numbering.) If a constant is to be written, it is specified in Constant or Edit Word (columns 45-70), and Field Name is left blank.

Examples of field names are given in Figure 81.

ZERO SUPPRESS (38)

An entry of Z in this specification causes zero-suppression of the field in the output record, which must be a numeric field. Zero suppression means that zeros to the left of the first (high-order) significant digit in the field are replaced by blanks in the output record.

This specification performs an additional function: zone bits in the unit position of a field are removed during zero suppression. This provides a means of "zone elimination" for amount fields. Normally, this specification is used for printing numeric fields, but not for punching them, because it is usually necessary to punch the sign codes and leading zeros.

If an edit control word is specified for the field, this specification must be blank.

BLANK AFTER (39)

An entry of B in this specification causes the output field to be reset to blanks or zeros after the field is placed in the output record. Alphameric fields are set to blanks; numeric fields are set to zeros.

This specification has an additional feature: if the output field being reset by the Blank After specification is also being tested for zero or blank on the input specifications or being tested for zero on the calculation specifications, the corresponding indicator is turned on after the output field is reset. However, associated plus or minus indicators are not turned off.

If a given field is specified for output at more than one position in the same record, the blank-after entry is made only on the last specification where the field is used.

NOTE: A Blank After specification also affects any constant in storage. Since each constant is stored only once for every RPG program — no matter how often it is used — a constant affected by a Blank After specification is not available for use in subsequent operations.

END POSITION IN OUTPUT RECORD (40-43)

This specification indicates the location of the field in the output record. In columns 40-43, enter only the position in the output record where the rightmost (low-order) character of the field is to be located.

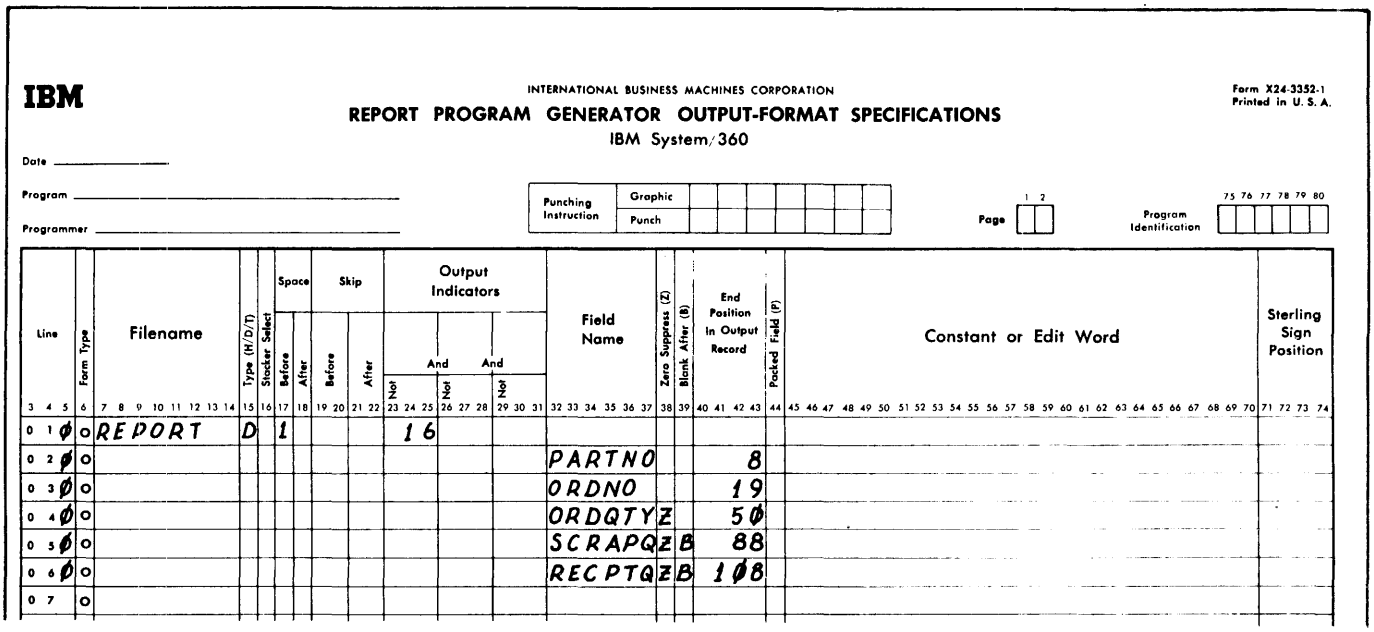
Assume that a ten-position amount field is to be printed in print positions 21 through 30. The entry in columns 42 and 43 would be 30. Columns 40 through 41 are left blank, because the leading zeros may be omitted.

If an amount field is being edited, the program considers the entire edit word as the "field" to be placed in the output record. For example, in the previous example assume the letters CR are to be printed at the end of minus amount fields. The R would be printed in position 30, the C in position 29, and the 10-position amount field would then be printed in positions 19 through 28. Thus the amount field is always printed in positions 19-28, and the credit symbol (if applicable) is printed in positions 29 and 30.

Figure 82 illustrates various field description specifications. It shows the specifications for printing a detail line. The three quantity fields ORDQTY, SCRAPQ, and RECPTQ are zero-suppressed. The quantity fields SCRAPQ and RECPTQ are also reset to zeros by the Blank After specification.

Figure 83 illustrates an example of field selection specification. These entries punch a summary card at control level-1. In this example, a new balance (NEWBAL) and an old balance (OLDBAL) are used in the weekly reports; at the end of the month only the new balance is to be summarized for the following month's report.

Both fields are specified for the same punching positions in the output record. The actual field that is punched, however, is controlled by the setting of Indicator 26. The number of fields that can be specified for field selection is not limited.



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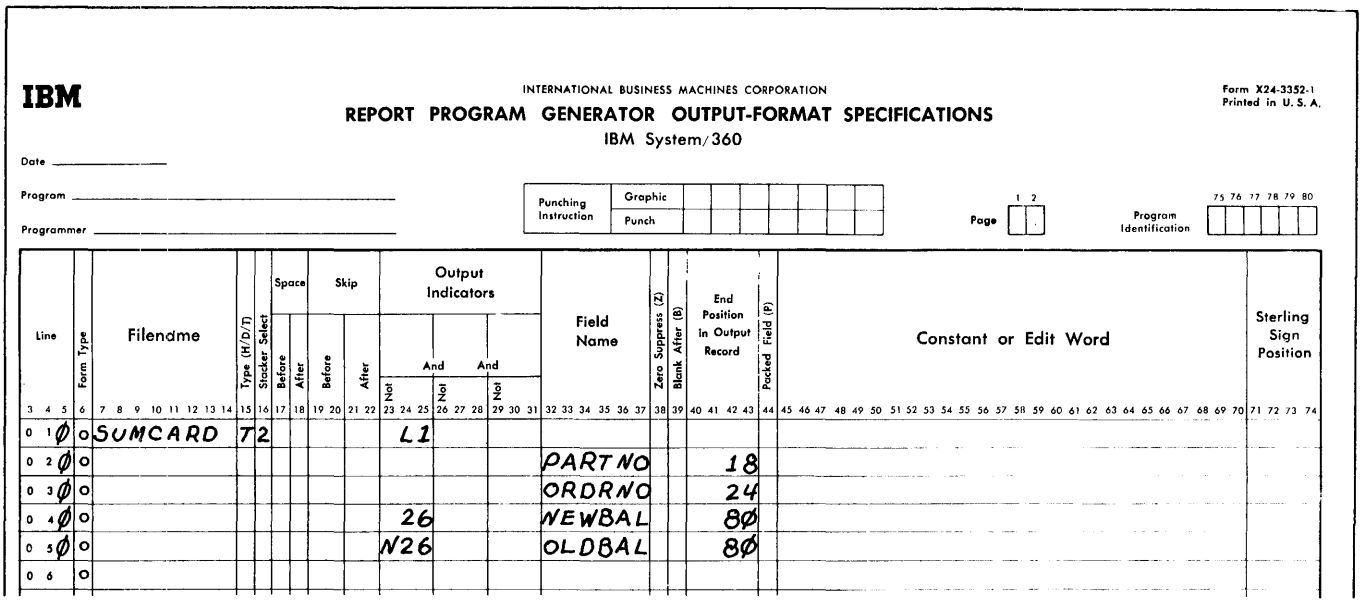
Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Space: Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: Not	Output Indicators: And Not	Output Indicators: And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19 20	21 22	23 24 25	26 27 28	29 30 31	32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
01Ø	O	REPORT	D	1					16									
02Ø	O											PARTNO			8			
03Ø	O											ORDNO			19			
04Ø	O											ORDQTY	Z		5Ø			
05Ø	O											SCRAPQ	Z	B	88			
06Ø	O											RECPTQ	Z	B	1Ø8			
07	O																	

Figure 82. Field Description Specifications



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Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Space: Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: Not	Output Indicators: And Not	Output Indicators: And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19 20	21 22	23 24 25	26 27 28	29 30 31	32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
01Ø	O	SUMCARD	T	2					L1									
02Ø	O											PARTNO			18			
03Ø	O											ORDRNO			24			
04Ø	O								26			NEWBAL			8Ø			
05Ø	O								N26			OLDBAL			8Ø			
06	O																	

Figure 83. Example of Field Selection Specifications

PACKED FIELD (44)

Packed format in the System/360 means that two decimal digits can be represented in one core storage byte. This is the data format used for numeric fields in RPG. Because input data is usually represented in the unpacked format — one digit in one core storage byte — the RPG program automatically converts numeric input data from the unpacked format to the packed decimal format.

Because the packed decimal format permits greater utilization of storage capacities (Card-Tape-Disk) the RPG program permits numeric data to be put out in the packed decimal format.

Enter a P in this column if the numeric output field is to be in the packed decimal format. Otherwise, leave this column blank. The letter P causes the RPG program to bypass the normal conversion of packed decimal format to unpacked format.

The number of bytes occupied in the output record by a numeric field in packed format can be determined in the following manner:

1. Divide the length of the field by 2
2. Eliminate the rightmost decimal fractions
3. Increase the result by one.

If an edit control word or sterling entry are specified for the field, this column must be blank.

PAGE NUMBERING

Page numbering, another automatic feature of RPG, is specified in the field description portion of the output specifications. The last entry in Field Name in Figure 84 causes each page of the output form to be consecutively numbered in print positions 65 to 68 (the number is always defined as four positions long unless defined by a header card on the input specifications). The page number is increased by one before it is printed.

Page numbering normally begins with number 1, but the programmer may start page numbering with any number by preparing a header card containing the starting page

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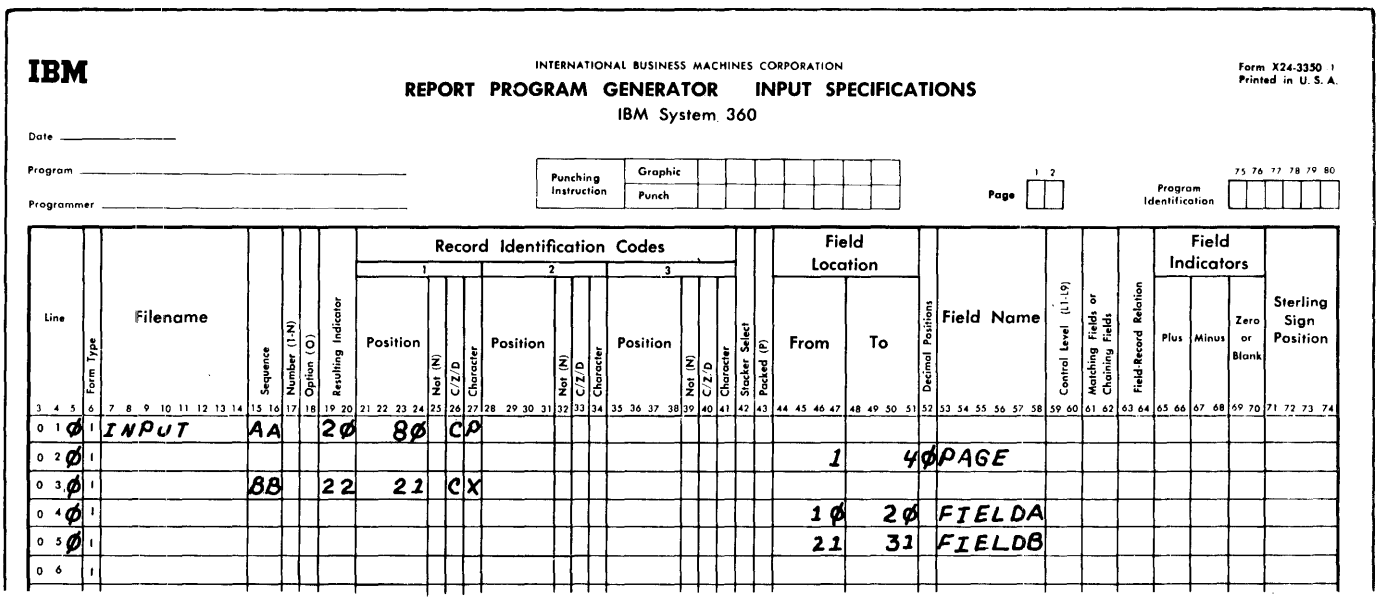
Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space Before	Space After	Skip Before	Skip After	Output Indicators And/Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
01	O	DAILYRPT	H					03	OF							
02	O		R						04							
03	O								NOF	ORDRNO			12			
04	O								NOF	DATE			19			
05	O								NOF	SALESM			28			
06	O									CUST			35			
07	O									INVOICE	Z		46			
08	O									PAGE			68			
09	O															

Figure 84. Example of Page Numbering Specifications



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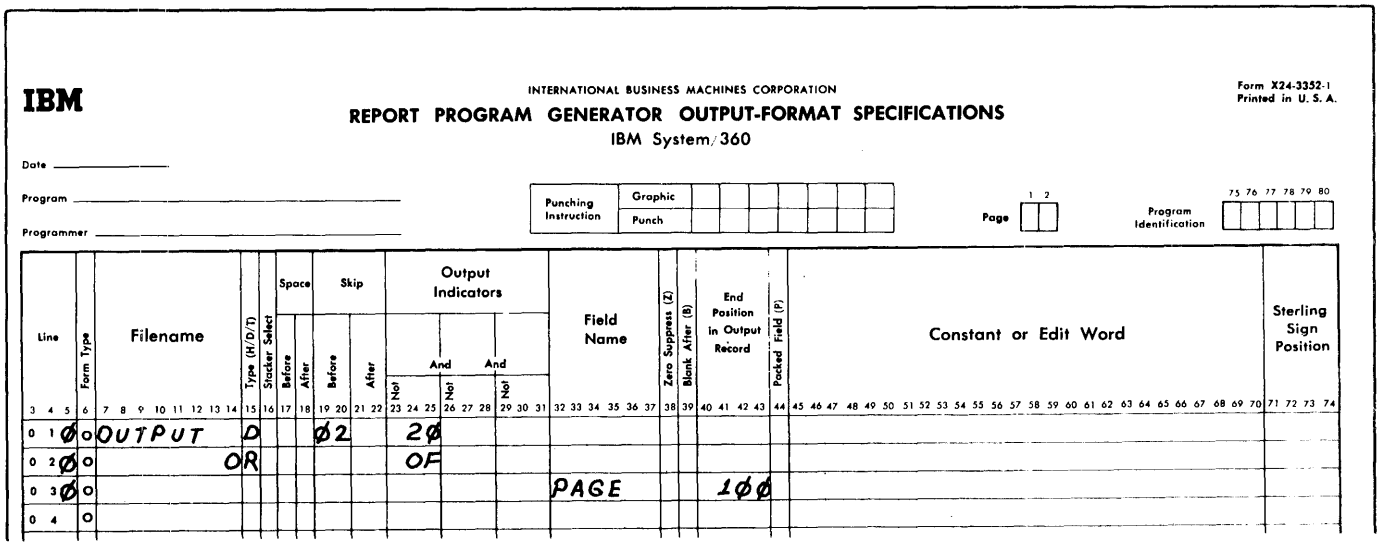
Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
01Ø	1	INPUT	AA			2Ø	8Ø		C	P																					
02Ø	1																				1	4Ø		PAGE							
03Ø	1		BB			22	21		C	X																					
04Ø	1																				1Ø	2Ø		FIELDA							
05Ø	1																				21	31		FIELDB							
06	1																														



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Program Identification

Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: And Not	Output Indicators: And Not	Output Indicators: And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
01Ø	O	OUTPUT	D				Ø2		2Ø									
02Ø	O		OR						OF									
03Ø	O											PAGE			1ØØ			
04	O																	

Figure 85. Page Numbering

number, less 1. The header card must be defined on the input specifications with a field named PAGE. The field must be defined as numeric (Ø in column 52) and can be 1 to 15 positions long. In Figure 85 the page number is initialized from sequence AA on the Input Specifications sheet (line 01Ø). If page numbering were to begin with the number 500, 499 would be punched in columns 1-4 of the input record that contains the character P in column 80. PAGE is defined on the Output-Format Specifications sheet as a separate field that prints in position 100.

It is possible to reset the page number to zero and start a new series of page numbers during the processing of the program. For example, rather than number each page of a report, it may be required to start page numbering with 01 for each major control break. In this case the major control level indicator must be placed in Output Indicators on the same line as the Field Name specification PAGE.

Any output indicators specified in a PAGE line are checked before printing. If all conditions are met, the page counter is reset to 0 before being incremented by 1.

Page Numbering for Multiple Printers

The individual printer files can initialize page numbering. Eight special PAGE entries (PAGE, PAGE1, PAGE2, PAGE3, PAGE4, PAGE5, PAGE6, and PAGE7) can be initialized to any count in the same manner as described for PAGE.

CONSTANT OR EDIT WORD (45-70)

This specification provides constants in the output records or permits editing of numeric fields. Constants and edit words must be left-justified.

Constants

This entry provides a convenient method of placing into the object module alphameric data (literals) that does not change from one processing of the program to the next. A literal is the actual data to be used in the output record rather than a name representing the location of data.

A literal of up to twenty-four alphameric characters may be placed in columns 45-70. The literal must begin in column 45, and it must be enclosed by a set of apostrophe symbols even if it contains only numeric characters. The literal beginning in column 45 will be placed on the output record as defined in End Position in Output Record, (columns 40-43).

Rules for Forming Alphameric Literals in an Output Record

1. Any character in the character set may be used in an alphameric literal. Blanks are treated as valid characters.
2. Alphameric literals must be enclosed in a set of apostrophe symbols. An apostrophe symbol may be contained within a literal be entering two consecutive apostrophe symbols within the literal. For example, the literal o'clock would be entered as 'o''clock' in columns 45-54 of the Output-Format Specifications sheet.
3. Field Name (columns 32-37) must be left blank when an alphameric literal is defined on the line.

Edit Words

An edit word provides for the punctuation of amount fields, including the printing of dollar signs, commas, periods, and sign status. Column 38 (Zero Suppression) and column 44 (Packed) must be left blank. An edit operation is shown in Figure 86.

When an amount field is to be edited, its edit word is placed in columns 45-70 of the line which specifies the field. An edit word consists of two parts (the body and the status) as shown in Figure 87.

The body of the edit word is the portion beginning with the leftmost character, and continuing to the right of the character that governs the transfer of the rightmost position of the data field.

The status of the edit word is the portion continuing to the right from the body including all characters preceding the closing apostrophe symbol. The CR (credit) or - (minus), if present, may appear anywhere within the status.

A character in the edit word that is replaced by a numeric character from the data field is referred to as a digit position. A blank in the edit word is a digit position as are the characters 0, *, and $ under certain conditions.

Rules for Forming an Edit Word

1. An edit word must be enclosed in a set of apostrophe symbols.

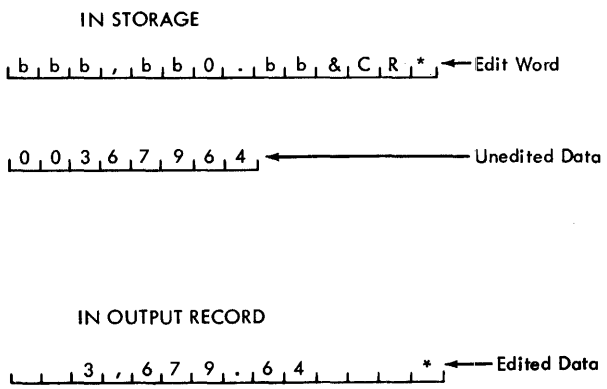


Figure 86. Edit Operation

2. A blank in the edit word is replaced with the digit from the corresponding position of the data field specified in Field Name.
3. An ampersand causes a space in the edited field. There is no way to obtain an ampersand in an edited field.
4. A zero is used to stop zero-suppression. It is put in the rightmost position where zero suppression is to take place. It is replaced with the character from the corresponding position of the data field, unless that character is a zero. At least one leading zero is suppressed.
5. An asterisk in the body of the control word is used for asterisk protection and zero suppression. It is put in the rightmost position where zero suppression is to take place. It is replaced with the character from the corresponding position of the data field unless that character is a zero and there is no significant digit to its left. Each zero that is suppressed is replaced by an asterisk.
6. A dollar sign in the body of the edit word written immediately to the left of the zero-suppression code (0) causes the insertion of a dollar sign in the position to the left of the first significant digit. This is called the floating dollar sign. If it is necessary for the dollar sign to appear when all digits in the data are significant, the edit word must start with an ampersand to allow a space in which it can print.

   A dollar sign that is entered immediately after the initial apostrophe symbol will be fixed. That is, it will be printed in the same location each time. This is called the fixed dollar sign.

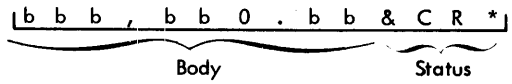


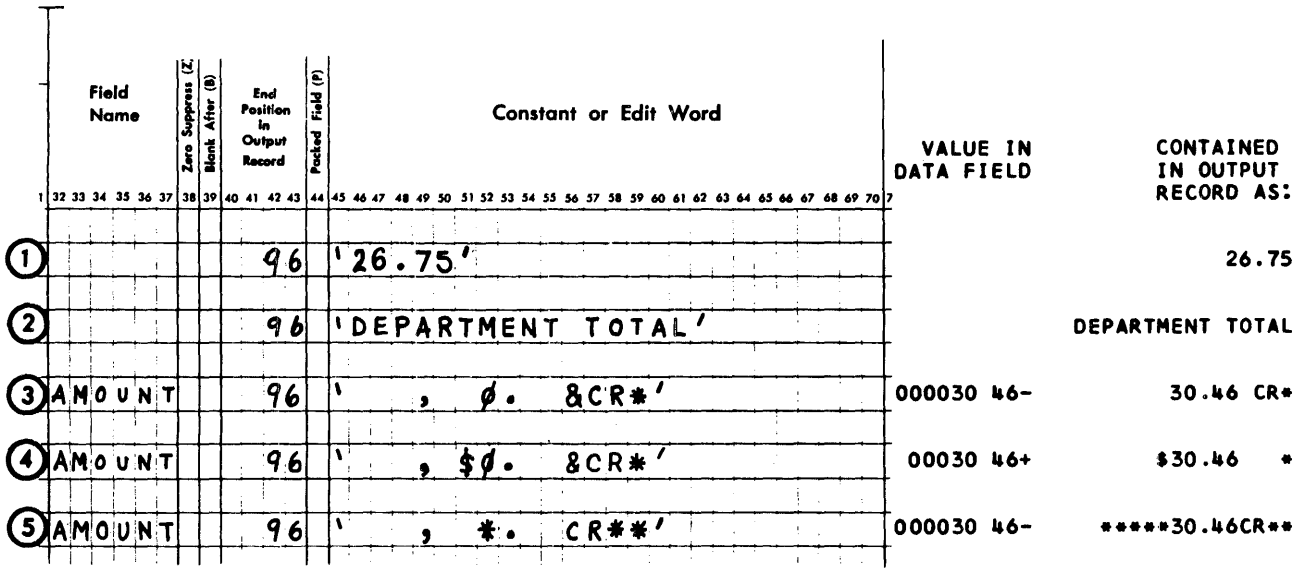
Figure 87. Two Parts of an Edit Word: Body and Status

   NOTE: In the edit word '$0bb' the dollar sign is considered to be fixed and not floating.

7. The decimal and commas are printed in the edited output field in the same relative positions in which they were written in the edit word unless they are to the left of significant digits. In that case, they are blanked out or replaced by an asterisk. Any characters other than the fixed dollar sign which precede the first digit position will always be suppressed.
8. All other characters used in the body of the edit word are printed if they are to the right of significant digits in the data field. If they are to the left of high-order significant digits in the data word, they are blanked out, or if asterisk protection is used, they are replaced by an asterisk.
9. The letters CR or the minus symbol in the status portion of the edit word are undisturbed if the sign in the data field is minus. If the sign is plus, they are blanked out.
10. Asterisks to the right of the CR or minus symbol are undisturbed. They are normally used to indicate a specific class of total.
11. If there are more digit positions in the edit word than there are digits in the field to be edited, leading zeros will be added to the field before editing.
12. An edit word can contain a maximum of 15 digit positions. An exception occurs for a sterling field where the maximum is 16 digit positions.

Figure 88 illustrates the use of constants and edit words. The numbers to the left correspond to the following list:

1. The constant 26.75 is in the output record ending in position 96. The Field Name specification must be blank.
2. The constant DEPARTMENT TOTAL is contained in the output record ending in position 96. The Field Name specification must be blank.



	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	VALUE IN DATA FIELD	CONTAINED IN OUTPUT RECORD AS:
	1 32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 7		
1				96		'26.75'		26.75
2				96		'DEPARTMENT TOTAL'		DEPARTMENT TOTAL
3	AMOUNT			96		' , Ø. &CR*'	000030 46-	30.46 CR*
4	AMOUNT			96		' , $Ø. &CR*'	00030 46+	$30.46 *
5	AMOUNT			96		' , *. CR**'	000030 46-	*****30.46CR**

Figure 88. Using Constants and Edit Words

3. This example illustrates zero-suppression to the left of significant digits. The letters CR are written because the amount field might be minus.
4. In this example, the floating dollar-sign protection enters the $ to the left of the first significant digit.
5. Asterisk protection enters as many asterisks to the left of the first significant digit as required to fill out the number of positions specified in the edit word.

STERLING SIGN POSITION (COLUMNS 71-74)

Enter in these columns the position in the record that will contain the sign of the sterling field. Leading zeros may be omitted. Enter an S in column 74 if the sign is in the normal position. For Print files the normal position must be used. If the Sterling specification is not required, leave this column blank. Additional information on Sterling is in Appendix D. Sterling Routines for the Report Program Generator.

The Line Counter Specifications sheet provides the important facility to store reports, which will ultimately be printed, on any intermediate device such as tape or disk. It also provides the convenience of an "internal" carriage control tape when using an actual printing device.

This sheet is necessary because any output lines for the printed report that depend upon the sensing of a channel-12 punch in the carriage control tape will not be produced for tape or a direct access storage device. Thus, the Line Counter Specifications sheet is used to relate the line of the printed page of the report to its corresponding punch in the carriage control tape.

A standard IBM System/360 independent carriage control character is added as the first byte of each record that is put out on the intermediate device. For example, a 132 character record becomes 133 characters long. An auxiliary program must be used to retrieve these records for printing. This program can be written in RPG or another programming language.

NOTE: When automatic skipping is desired (overflow indicators are not specified) and the report is to be stored on some intermediate device, the Line Counter Specifications sheet must be used.

HOW TO USE LINE COUNTER SPECIFICATIONS

In Figure 89, three lines of the report are conditioned by the carriage control tape. Channel 1 is used to control printing of Monthly Sales Report.

Tape channel 6 is used to control amount, and channel 12 is used to condition total sales. On the Line Counter Specifications sheet (Figure 90) the name of the file is entered in columns 7-14. The entries, in this example, in columns 15-29 relate directly to the printer spacing chart. The numbers in the following list correspond to this discussion:

1. The first line controlled by the carriage control tape is line 6. In columns 15-17 of the Line Counter sheet, 006 is entered. The corresponding channel punch is channel 1. In columns 18-19, 01 is entered.
2. Line 13 of the report (amount) is controlled by a punch in channel 6. Columns 20-22 contain 013, and Columns 23-24 contain 06.
3. Line 17 (total sales) is controlled by the punch in channel 12 of the carriage control tape. Columns 25-27 of the Line Counter Specifications sheet contain 017, and columns 28-29 contain 12.

Entries on the Output-Format Specifications are not changed. On the File Description sheet, the line that is used to define the output file must contain an L in the Extension Code Field (column 39). The L indicates that a line counter specification is required for the output file.

If the Line Counter Specifications sheet is used, an entry must be made for channel 1 and channel 12.

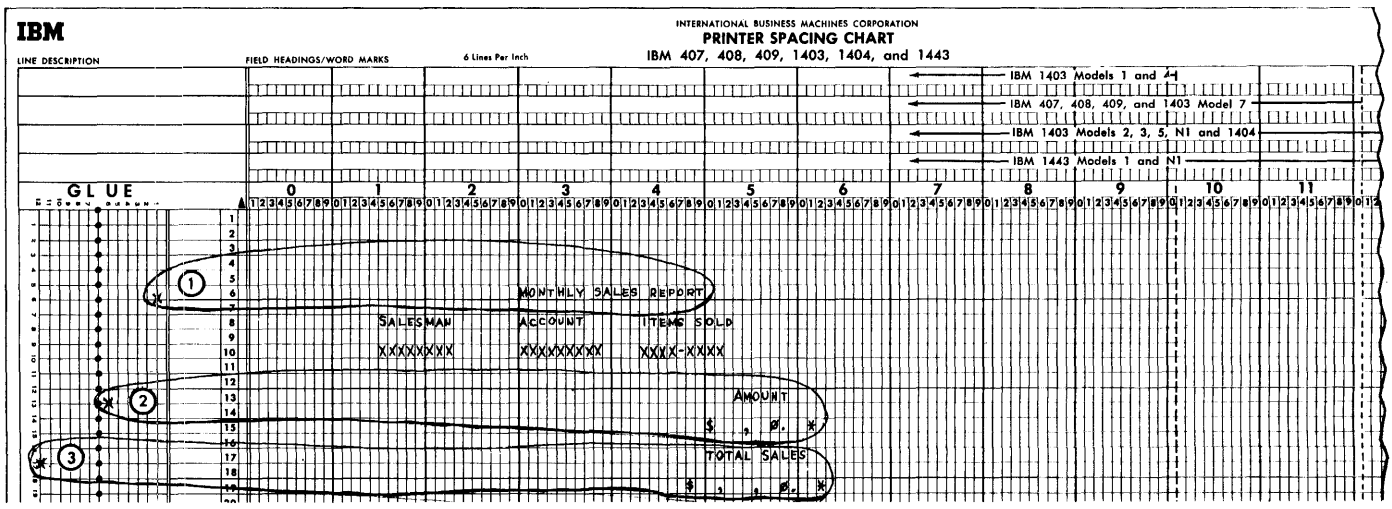


Figure 89. Using the Carriage Control Tape

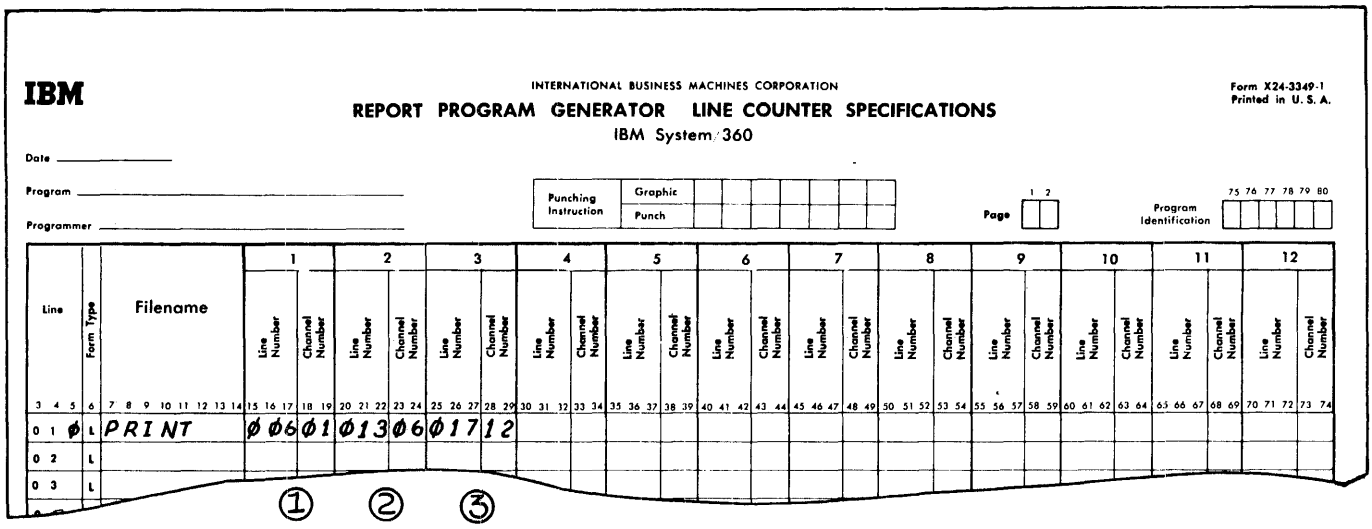


Figure 90. Using the Line Counter Specifications

This sheet is used to provide information to RPG about:

1. The input files, defined on the Input Specifications sheet, from which the object module will obtain data records.
2. The input files used by the object program, such as record-address files, table files, and chaining files.
3. The output files, defined on the Output-Format Specifications sheet on which the object module will write data records. Each file used by the object program must be defined. Each line of the File Description sheet is used to define one file.

This form also identifies each file used in the program with the input or output unit with which it is associated. Each line of the form is used to specify one file.

Maximum Number of Files Available

The maximum number of files that can be used in the program is 10. The list below defines the maximum number of files for the various types of files that can be used. Any combination of these, up to 10, is permitted.

Type of File	Maximum Number
Input	-
Primary	1*
Secondary	8
RAF	1
Chained	9
Table	8
Output	9**
Update	-
Primary	1
Secondary	8
Chained	9
Combined	-
Primary	1
Secondary	1

*Each program must have one (and only one) primary file.
**Up to a maximum of eight printers can be used in a program.

FILENAME (7-14)

Each file used in the program is identified by writing the name of the file in columns 7-14. The file name must be left-justified (that is, it must start in column 7) and it must begin with an alphabetic character. The remaining characters of the name may be alphameric, but must not contain special characters or embedded blanks. The file name may be eight characters or fewer. (Embedded blanks are blank positions falling between other characters of the name.) The file name entered in these columns must also have been entered on the Input Specifications sheet (for input data files), on the Output-Format Specifications sheet (for output data files) or on the File Extension Sheet (for Table, RAF, or chaining files).

FILE TYPE (15)

An entry in this column specifies the type of file defined on the line of the sheet. The following four entries are allowed in this column:

I Input File

Identifies the file as an input file (it may be a record-address file, table file, or a file containing input data records).

O Output File

Identifies the file as an output file (it may be an updated table file to be written out).

U Update File

Identifies the file as an update file (Direct Access Storage Device only). An update file is both an input and an output file.

The file is an update file if the object program alters the data in one or more fields of each record contained in the file. The overall length of the record cannot be changed even in a variable length file.

A chained file may be updated at detail time or at total time. All other DASD files can be updated at detail time only.

C Combined File

Identifies the file as a combined file (card file only). A combined file is a file containing cards read into the system

and cards used for punching. It must reside on an IBM 1442 Card Read-Punch.

Reading and then punching into the same file is accomplished in two different ways.

1. Punching into the same card that is read.
2. Punching into a blank trailer card in the same file.

Figure 91 illustrates two examples of File Name and File Type specifications.

1. Detail cards are read into the system in one file, summary cards are punched into a separate file (which, in this example, might be the punch feed of an IBM 2540 and might contain blank cards only), and the printed report is in a third file.
2. There are two input files in this example. The second file (INPUTSEC) also contains cards that will be used for punching output data; therefore it is specified with file-type C.

FILE DESIGNATION (16)

This specification is used to designate the type of input file being defined on this line of the File Description sheet. The five entries permitted in this column are listed here. Detailed explanations of chained files, table files, record-address files, primary files, and secondary files may be found in the sections Using Tables in the Object Program and Processing Multiple Input Files at the back of this publication.

If the file is an output file, leave this column blank. An entry must be made if the file is an Input, Update or Combined file. Enter in column 16 the following codes:

Entry	Explanation
P	The file defined is a primary file. Only one primary file may be defined.
S	The file defined is a secondary file.
R	The file defined is a record-address file which relates to a direct access storage file. Only one RAF may be defined.
C	The file defined is a chained file.
T	The file defined is a table file.

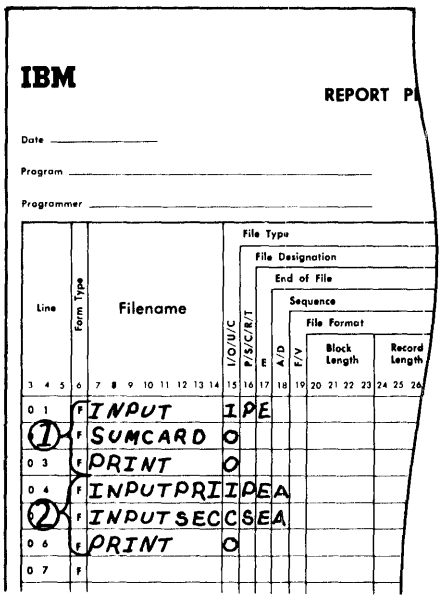


Figure 91. Specifying File Name and File Type

END OF FILE (17)

Enter an E in column 17 if the input file is a sequential file and it is to be checked for an end-of-file condition.

For one input file, the E entry will cause the LR (Last Record) indicator to turn on when the last record of the file has been processed. For multiple input files, the end-of-job condition (LR) will occur when all the input files (defined on this sheet with an E in column 17) have reached the end-of-file.

If this column is left blank for all input files, the end-of-job condition occurs when all input files have been processed.

NOTE: An E should not be entered in Column 17 if the file is processed randomly or if the file is either an output or table file.

SEQUENCE (COLUMN 18)

This entry is normally made if there is more than one input file and the matching-fields specification (columns 61-62 of the Input Specifications Sheet) is used. An entry in this column indicates whether the matching fields are in ascending or descending sequence.

Enter an A in column 18 if the matching fields are in ascending order, or a D if the matching fields are in descending order.

NOTE: If this column is left blank when matching fields are used, ascending order is assumed.

Sequence-Checking of Input Files

If there is only one input file or a chaining file in the program, this specification may be used to sequence-check fields of the file to ensure that the file is in sequence. By entering the codes M1, M2, or M3 in columns 61-62 of the Input Specifications sheet, sequence-checking with respect to these fields occurs. In this specification (column 18), either A or D must be entered to specify whether the file is ascending or descending.

The Halt Indicator, H0, is turned on when a record of an input file is found to be out of sequence. Unless the H0 indicator is turned off by a SETOF operation in the calculation specifications, the program will terminate before the next input record is read.

FILE FORMAT (19)

This column is used to indicate the format of the input or the output records. Enter an F in this column if the records are fixed-length. Enter a V in this column if the records are variable in length.

NOTE: Enter a V in this column if the output file is used in conjunction with the Line Counter Specifications Sheet.

BLOCK LENGTH (COLUMNS 20-23)

This specification is used to indicate the block length of the input or output records. It is used in conjunction with the next specification, Record Length.

The RPG program provides four techniques for handling records:

1. Fixed-length. All records have the same number of bytes of data.
2. Variable-length. Each record can have a different number of bytes of data.
3. Unblocked. Only one logical record in each physical record.
4. Blocked. Two or more logical records in one physical record. Blocked records are not supported by the Direct Access Method (DAM).

Fixed-length, Unblocked (Figure 92). Each logical record is the same length as the physical record.

Fixed-length, Blocked (Figure 93). Blocked records are usually considered to be two or more logical records within one physical record.

Variable-length, Unblocked (Figure 94). Each logical record is the same as a physical record, and the logical records can vary in length. Each record contains both a block-length field (BL) and a record-length field (RL). These two fields are used by and created by the RPG program. The block-length and record-length fields are illustrated here only to show how the program utilizes and controls the records. Those fields are ignored by the user when he establishes his data records and when he specifies record-length and block-length specifications.

Variable-length, Blocked (Figure 95). One or more logical records (of variable-length) are contained within each physical record.

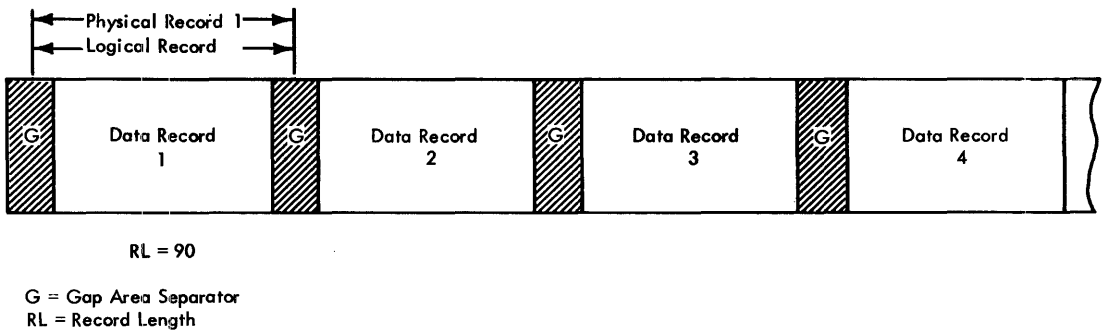


Figure 92. Fixed-Length, Unblocked Record Format

Specifications for Block Length

Unblocked

If the records are unblocked, the entry for this specification is the length of a record. If variable-length records are used, it is the length of the longest record. This means that the entry for this specification for unblocked records is always the same as the entry for the Record Length specification.

Blocked

If the records are blocked, the entry for the specification is the length of the largest block. For example, if three fixed-length 90-character records are contained in each block, the specification for Block Length is 270.

If there are variable-length records used in the file — for example Figure 95— the Block Length specification depends upon not only the number of variable-length records in each block, but also upon the maximum size of each variable-length record.

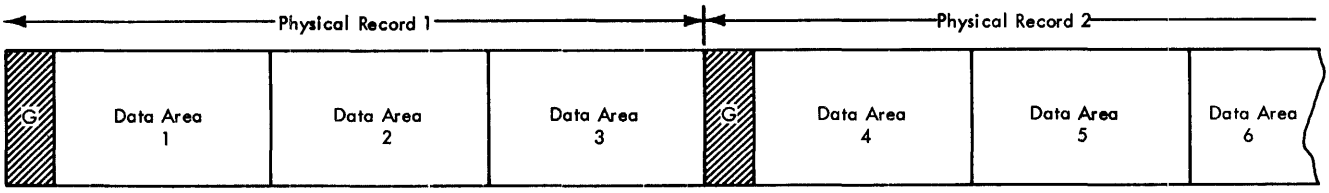


Figure 93. Fixed-Length, Blocked Record Format

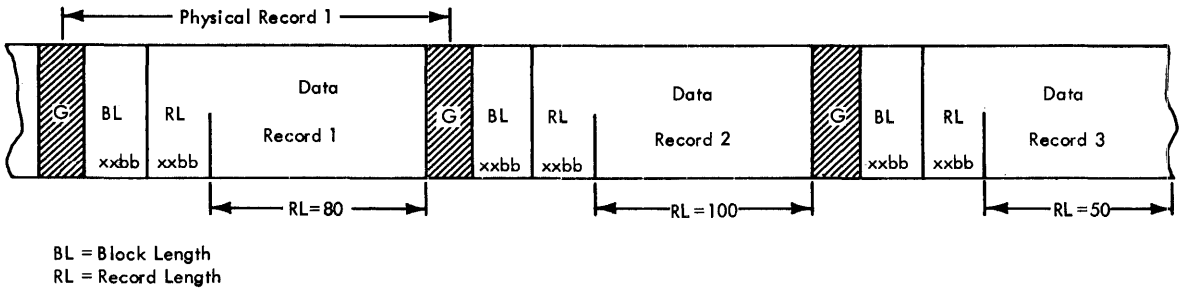


Figure 94. Variable-Length, Unblocked Record Format

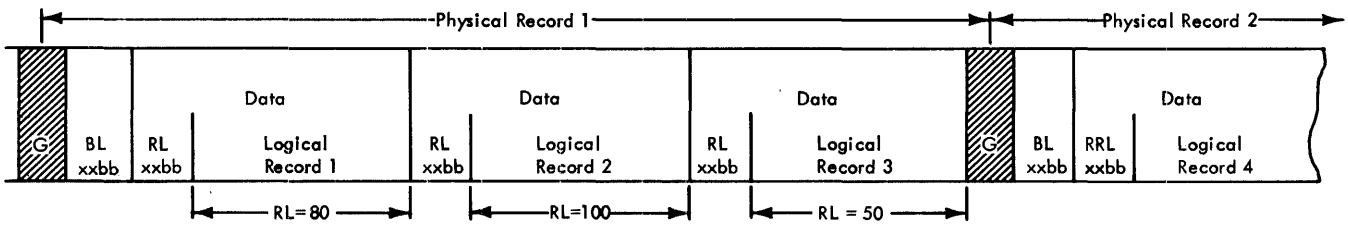


Figure 95. Variable-Length, Blocked, Record Format

If, in Figure 95, the three variable-length records (in physical record 1) will never exceed 80, 100, and 50 positions respectively, then the block length would be 230.

The entry must be right-justified, leading zeros may be omitted.

For blocked variable-length records, RPG allows buffer space for n record length fields (Figure 95); where n is given by the formula:

$$\left\lceil \frac{\text{block length}}{\text{record length}} \right\rceil + 5$$

RECORD LENGTH (24-27)

This specification is used to enter the length of the logical records contained in the file. If the file contains records that are variable in length, enter the length of the largest record. (The entry must be right-justified.)

NOTE 1: If the block length equals the record length, RPG considers the file to have unblocked records for both fixed-length and variable-length records.

NOTE 2: If the block length is greater than the record length, RPG considers the file to have blocked records for both fixed-length and variable-length records.

MODE OF PROCESSING (28)
(Non-sequential DASD Only)

This specification is used to indicate the method or mode by which the file is processed. Acceptable entries are listed here.

Entry

L Enter an L in this column if a segment of the file is to be processed. The upper and lower limits of the file will be supplied, in this case, by a Record Address File (RAF). The RAF will be supplied by the user. This entry applies to indexed-sequential files only.

R Enter an R in this column if the user's records are to be processed randomly. In this case, the records to be processed will be obtained by a record-address file, or a chaining file. This entry applies to files with direct or indexed-sequential organization.

Blank If no entry is made in this column for the file, the entire file will be processed sequentially. This entry applies to indexed-sequential files only.

LENGTH OF RECORD ADDRESS FIELD (29-30)
(Record Address File Only)

If the file being defined is a record-address file, enter the number of positions that each entry in the RAF occupies.

For example, if a six-position part number field is used in the RAF, the entry would be a 6.

RECORD ADDRESS TYPE (31)
(Non-sequential DASD Only)

If the records from the file are to be retrieved by using record keys, enter a K in this column. The K indicates that the file defined on this line will be processed, using a record key.

If the records are to be retrieved by the record identification, enter an I in this column.

TYPE OF FILE ORGANIZATION (32)
(Non-sequential DASD Only)

Enter an I if the file has indexed-sequential organization. Enter a D in this column if the file has direct organization.

RULES FOR DASD SPECIFICATIONS
(Columns 28, 31, and 32)

The four rules listed below summarize the entries for the specifications Mode of Processing, Record Address Type, and Type of File Organization.

1. If a direct access storage device is not used in the system, columns 28, 31, and 32 are left blank.
2. If the type of file organization is Sequential, then columns 28, 31, and 32 are again left blank.
3. If the type of file organization is indexed-sequential (I in column 32), then column 31 must contain a K and column 28 can be either L, R, or blank.
4. If the type of file organization is direct (D in column 32), then column 31 can contain either a K or I, and column 28 can only contain an R.

Table 3 illustrates the code combinations possible for these three specifications.

OVERFLOW INDICATOR (33-34)

If the file defined on the line is a printer file or an output file with an associated Line Counter Specifications sheet and overflow indicators are used, enter the overflow indicator associated with the file. A maximum of eight overflow indicators is allowed. The following are permissible overflow indicators:

OA	OE
OB	OF
OC	OG
OD	OV

KEY FIELD STARTING LOCATION (35-38) (DASD Only)

This specification indicates the location of the key field within the data record. This specification is provided so that the key field may be located anywhere within the data record.

The entry for this specification is the starting position of the key field. For example, if the key field is in positions 112 through 116, the entry would be 112.

The entry must be right-justified, leading zeros may be omitted.

This entry is required for indexed-sequential files only and is blank for directly organized files.

EXTENSION CODE (39)

This specification is used to indicate to the RPG processor that additional information about the file is coded on the File Extension Specifications sheet or Line Counter Specifications sheet.

Enter an E in this column if the file defined on the line is a:

Chaining file
Table file
Record Address file (RAF)

These files always have additional specifications on the File Extension Specifications sheet.

Enter an L if the Line Counter Specifications sheet is used for the output file described on this line.

DEVICE (40-46)

This specification relates a file to a specific type of input or output unit during program compilation time.

If the output file is a printer, enter PRINTER in columns 40-46.

If the file is an input or output file and it is associated with a card reader or

Table 3. Processing Direct Access Storage Files

Type of File Organization (Column 32)	Record Address Type (Column 31)	Mode of Processing (Column 28)
Sequential (blank)	Not applicable (blank)	The entire file (between limits) will be processed (blank)
Indexed-Sequential (I)	Record Key (K)	The entire file will be processed (blank)
		A segment of the file will be processed The limits to be processed are supplied by a Record Address File (RAF) (L)
		The records will be processed randomly The addresses are supplied : (a) by an RAF, or (b) by the data contained in the chaining field of an input record. (R)
Direct (D)	Track address with Record Key (K) or, Track Address with Record Identification (I)	The records will be processed randomly. The addresses to be converted are supplied by an RAF, or by a chaining file. Conversion is required for RAF or chaining file. (R)

card punch unit, enter one of the following:

READ01	IBM 2501 Card Reader
READ20	IBM 2520 Card Read-Punch
READ40	IBM 2540 Card Read-Punch
READ42	IBM 1442 Card Read-Punch

If the file is an input or output file and it is associated with a tape unit enter TAPE in these columns.

If the file is associated with an IBM 2311 Disk Storage Drive enter DISK11.

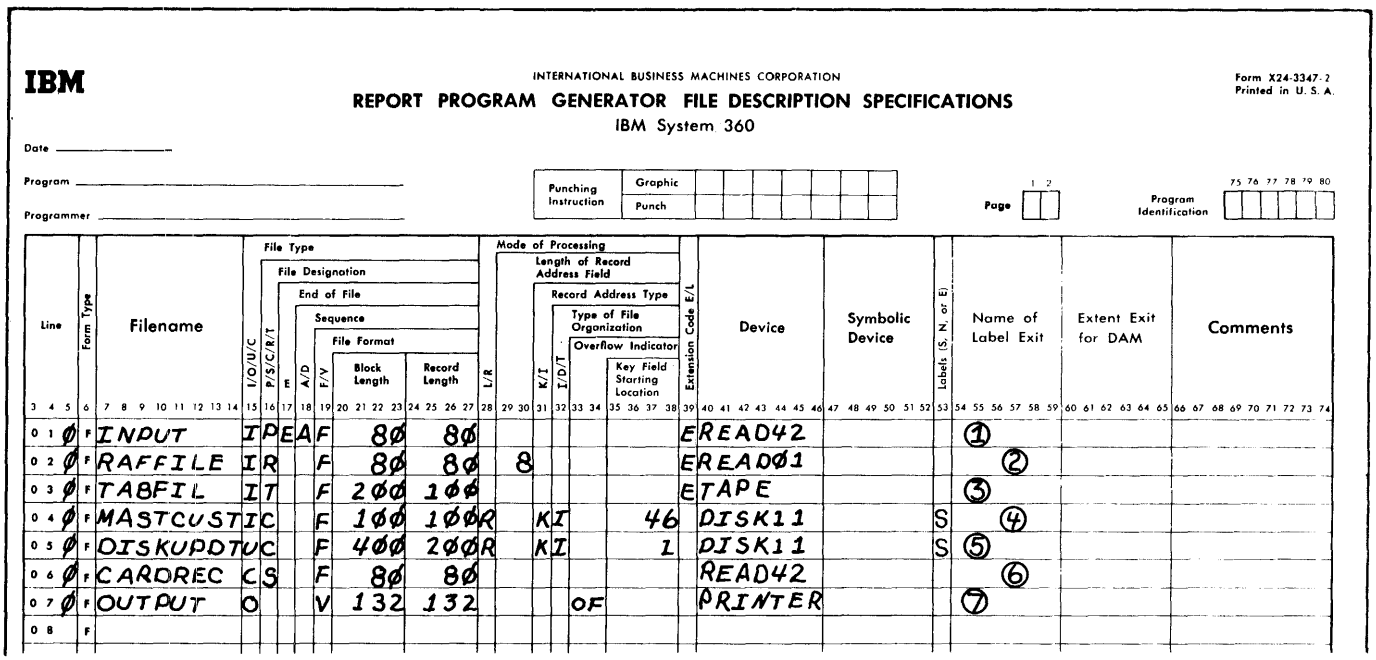
SYMBOLIC DEVICE (47-52)

Not used.

ENTRIES FOR FILE DESCRIPTION SHEET

Figure 96 shows several examples of entries on the File Description Specifications sheet. The numbers to the right correspond to the numbered explanations that follow.

1. The P in column 16 indicates the input file INPUT is the primary file. The E in column 17 indicates that the end-of-job condition will occur when this file is depleted. The file is ascending (A in column 18). The block length is 80, and each record is 80 characters long. The E in column 39 indicates that the file will be referenced on the File Extension sheet. This file is read in on an IBM 1442 Card Read-Punch. The Device code is READ42.
2. The record-address file defined on this line has a fixed format (column 19). It has a block length of 80. Each record is 80 characters long and the length of each record-address field is 8. The E in column 39 indicates that the File Extension sheet will be used. The record-address file is read into the program by an IBM 2501 Card Reader. The Device code is READ01.
3. The third file defined on this sheet is a table file. The T in column 16 indicates that it is a table file. It has a fixed format, a block length of 200, and a record length of 100. Column 39 (E) indicates that it will be further defined on the File Extension sheet. The file is read in on magnetic tape, therefore the Device code is TAPE.
4. MASTCUST is an input file that will be processed under the control of another



IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

REPORT PROGRAM GENERATOR FILE DESCRIPTION SPECIFICATIONS

IBM System 360

Form X24-3347-2 Printed in U. S. A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/T	I/D/T	Overflow Indicator	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
01	F	INPUT	I	P	E	A	F	80	80						E	READ42			(1)		
02	F	RAFFILE	I	R			F	80	80		8				E	READ01			(2)		
03	F	TABFIL	I	T			F	200	100						E	TAPE			(3)		
04	F	MASTCUST	I	C			F	100	100	R		K	I	46		DISK11		S	(4)		
05	F	DISKUPDT	U	C			F	400	200	R		K	I	1		DISK11		S	(5)		
06	F	CARDREC	C	S			F	80	80							READ42			(6)		
07	F	OUTPUT	O				V	132	132				OF			PRINTER			(7)		
08	F																				

Figure 96. Entries for File Description Sheet

file. It is a chained file (C in column 16). It will be processed randomly (R in column 28). The record addresses that will be referenced by the chaining file are record keys (K in column 31), and the file is organized indexed-sequentially (I in column 32). The key field begins in position 46 of the record. This file is located on a direct access storage device and is given the Device code of DISK11.

5. The update file DISKUPDT (U in column 15) will be used for input, and it will be updated after processing of each record has been completed. It is an indexed-sequential file, and it will be processed randomly. The C in column 16 indicates that the file is a chained file. In this example, the record length is 200 with a block length of 400. The key field begins in position 1 of the record.

   This file is located on a direct access storage device and is given the Device code of DISK11.

6. The file CARDREC is a combined file (C in column 15). Assume that the file will be used as input, and additional information will be punched in the input cards during processing. It is a secondary file (S in column 16). This combined file is read in and punched out on an IBM 1442 Card Read-Punch. The Device code is specified as READ42.

7. The file OUTPUT is a printed report in this example. It is variable in length, and the longest record is 132 characters. The overflow indicator for this file is OF (columns 33-34). This printed report has a Device code of PRINTER.

LABELS (53)

When label processing is used for a tape or disk, the program checks the labels on the input file to see if the correct file is on-line. The output files are checked, and if the label has expired, a new label is written.

If nonstandard labels are used for magnetic tape files, nonstandard label processing routines must be provided by the user and incorporated in the operating system at system generation time. (For details refer to IBM System/360, Operating System, System Programmer's Guide.) The appropriate nonstandard label processing routine is selected and executed by the operating system.

Label Options in RPG

The specification Label (column 53) provides three options for label processing in the RPG program.

1. S Standard Labels. Label processing is provided by the RPG program. No additional programming is required by the programmer.
2. E Standard Labels Followed by User-Standard Lables. RPG provides processing for the standard labels and then provides an automatic exit to a user subroutine for the processing of the user-standard labels. (See next specification Name of Label Exit.) This option is not available for indexed-sequential files.
3. b No Labels. An entry of blank indicates no label processing is to be performed by the RPG program. This option is not available for DASD files.

NAME OF LABEL EXIT (54-59)

This specification must contain the name of the routine written by the user to process user standard labels (E in column 53). The name can be either alphabetic or numeric, but the first character must be alphabetic. If the entry is shorter than six characters, it must be left-justified.

Refer to Control Program Services (see Preface) for label exit register conventions.

EXTENT EXIT FOR DAM (60-65)

Not used.

COMMENTS (66-74)

Leave these columns blank unless comments are entered.

This concludes the description of the File Description Specifications sheet.

Entries made on the File Extension sheet provide information to RPG about such functions as chaining files and tables used in the object module, and information about record-address files. These functions are illustrated in Figure 97.

In the sections Using Tables in the Object Module and Processing Multiple Input Files detailed information and examples show how to use these functions.

The entries allowed on the File Extension sheet are discussed in the following section.

RECORD SEQUENCE OF THE CHAINING FILE (7-8)

This specification is used only for chaining files. The entry for this specification is the same entry that is made for the chaining file in Sequence (columns 15-16) on the Input Specifications sheet.

NUMBER OF THE CHAINING FIELD (9-10)

This specification is used only for chaining files. The entry for this specification is the identifying number of the chaining field (C1 through C9). This number

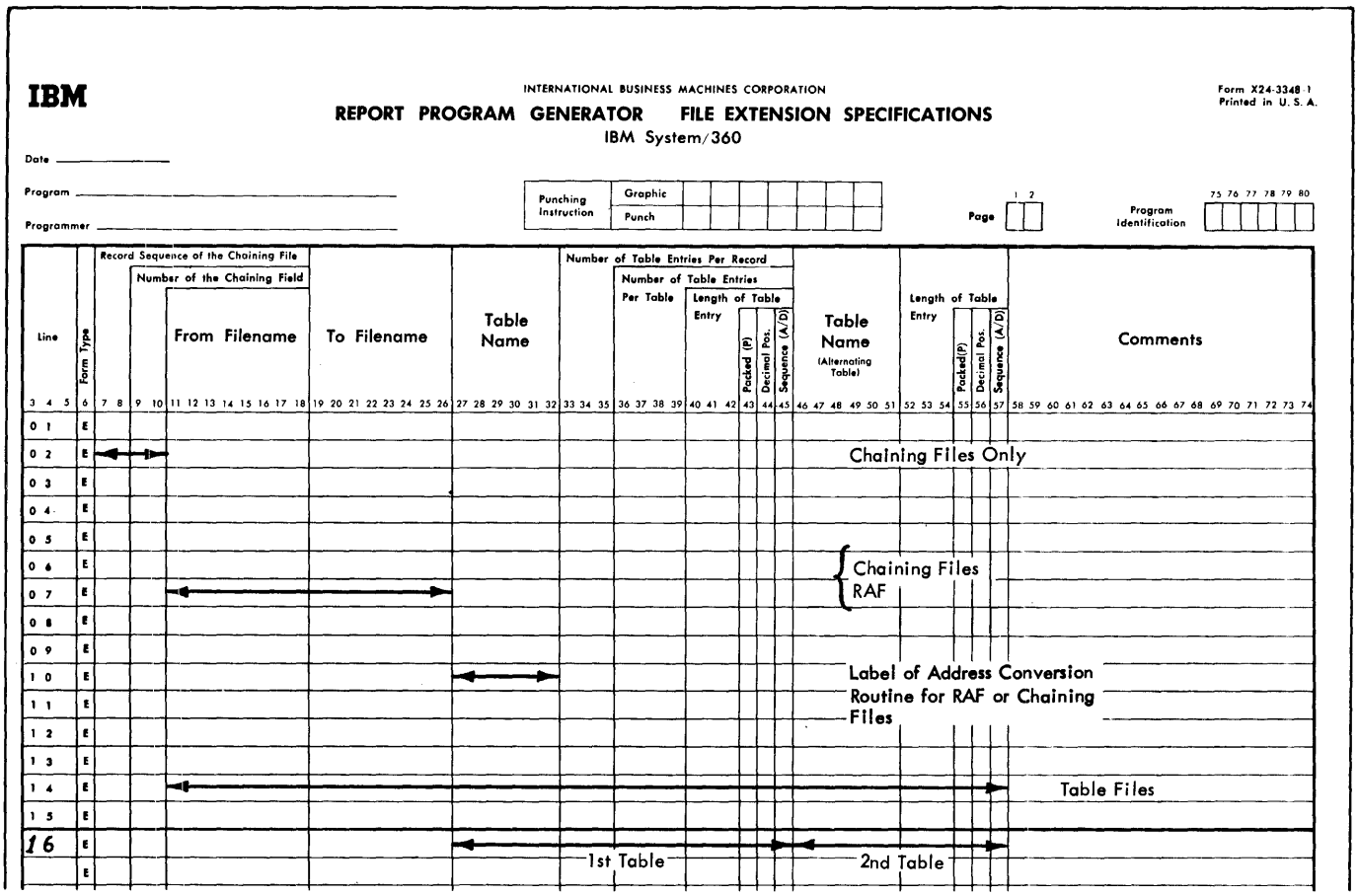


Figure 97. Use of File Extension Specifications

was entered in Chaining Field (column 61-62) of the Input Specifications sheet.

FROM FILENAME (11-18)

This specification is used in conjunction with the next specification To Filename (19-26). The purpose of these two specifications is to identify—for the RPG program—the relationship between two files. For example, they provide the name of a chaining file and the name of the file that is chained to it. Both the From Filename and To Filename are taken from Filename (columns 7-14) of the related entry from the file description sheet.

Figure 98 illustrates the entries for those two specifications.

TO FILENAME (19-26)

The entries for this specification are described above and in Figure 98.

TABLE NAME (27-32)

This specification and the remaining specifications on the form (columns 33-57) are used to describe table files. Table files are processed in the same order in which they appear on the File Extension Specifications sheet. This specification is also used to specify the name of the address conversion routine for an RAF or chaining file.

A table file is composed of a table of arguments and a table of functions. If both the arguments and functions are entered on one input unit, the table file is known as an "alternating" table file. That is, the input record contains an argument field followed by a function field, followed by the next argument field, etc. In this case, the argument table is described in columns 27 through 45, and the function table is described in columns 46 through 57 on the same specification line.

If only an argument table is used, it is still described in columns 27-45, and columns 46-57 are left blank.

It is possible to have the arguments contained in one input file and the functions in another input file. In this case, each file is described on a separate specification line in columns 27 through 45, and columns 46-57 are left blank.

NOTE: It is not a requirement of the program that the arguments must be specified first. The function entries may be listed first, however for the following specification descriptions the manual assumes the argument entries are specified first.

Specifications for Table Name

This specification contains the name of the argument table. The name must be in the form TABnnn. The entries nnn may be any alphameric characters.

When a file that has direct organization is processed under control of a record-address file or a chaining file, the entry for these columns is the label of the user's conversion routine.

Type of File	* From Filename (11-18)	* To Filename (19-26)
Chaining Files	Chaining Filename. This is the file that has the data record containing the chaining field. The name of the file is taken from columns 7-14 of the File Description Sheet.	Chained Filename. This is the file from which the data record is obtained. The name of the file is taken from columns 7-14 of the File Description specification for the Chained File.
Record Address File	The name of the record-address file is entered in this specification.	The name of the file that contains the data record to be processed is entered in this specification.
Table Files	If a Table file is being defined (columns 27 through 57) enter the name of the file that contains the table.	If the table file being defined, will be put out after it is updated, enter the name that was assigned to it on the Output-Format sheet. If it is not being put out, leave blank.

* All entries must be left-justified

Figure 98. From and To Filenames

Figure 99 illustrates the File Extension specifications for a Record Address file (RAF) and the master customer file it is used with.

The concepts of chaining and record-address files have not been discussed at this point in the publication. For a complete discussion of chaining, address conversion, and record-address files, see Processing Multiple Input Files.

NUMBER OF TABLE ENTRIES PER RECORD (33-35)

Enter in columns 33-35 the maximum number of table entries (that is, arguments or functions) that are contained in each input record. The entry must be right-justified.

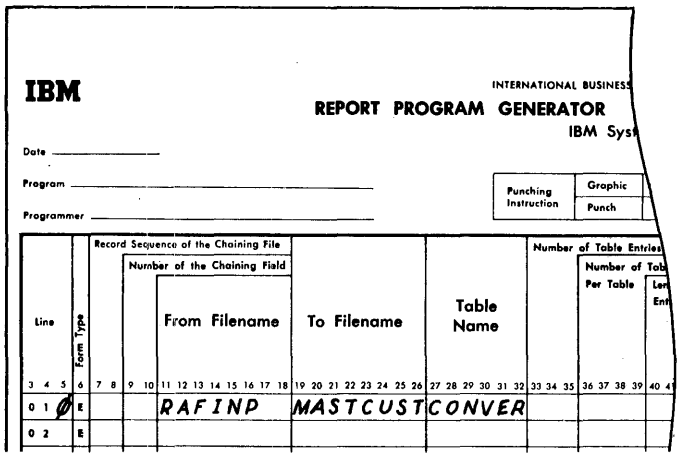
NUMBER OF TABLE ENTRIES PER TABLE (36-39)

In these columns, enter the exact number of table entries (arguments or functions) contained in the table. The entry must be right-justified.

NOTE: The above two entries refer to tables, not to files. Thus, in alternating table files the entries are the total number of arguments or functions, not the sum of the two.

LENGTH OF TABLE ENTRY (40-42)

Enter in columns 40-42 the length of each table entry. The maximum size of a numeric entry is 15 characters, of an alphameric entry 256 characters. The entry must be right-justified.


IBM

INTERNATIONAL BUSINESS

REPORT PROGRAM GENERATOR

IBM Sys

Date

Program

Programmer

Punching Instruction | Graphic | Punch

Line	Form Type	Record Sequence of the Chaining File: Number of the Chaining Field	From Filename	To Filename	Table Name	Number of Table Entries: Number of Tab Per Table	Len Ent
3 4 5	6	7 8 9 10	11 12 13 14 15 16 17 18	19 20 21 22 23 24 25 26	27 28 29 30 31 32	33 34 35	36 37 38 39 40 41
0 1 Ø	E		RAFINP	MASTCUST	CONVER		
0 2	E						

Figure 99. File Extension Specifications, Conversion Routine Label

PACKED (43)

If the data for the table is in the packed-decimal format, enter P in this column. Otherwise, leave this column blank.

DECIMAL POSITIONS (44)

If the data contained in the table is numeric, enter the number of decimal positions (1-9). Enter a zero if there are no decimal positions. If the data is alphameric, leave this column blank.

SEQUENCE (45)

If the data contained in the table is in ascending sequence, enter an A in this column. If the data contained in the table is in descending sequence, enter a D in this column. Leave this column blank if the data contained in the table is not in ascending or descending sequence or if this specification is not required.

NOTE: The next four specifications (columns 46-57) are used only if alternating arguments and functions are read in on one input unit. The entries for these specifications are written on the same specification line as the entries in columns 33-45.

TABLE NAME (46-51)

If alternating arguments and function tables are used, enter the second table name in these columns. It must be of the form TABnnn. The entry must be left-justified.

LENGTH OF TABLE ENTRY (52-54)

Enter in these columns the length of each table entry. The maximum size of a numeric entry is 15 characters; of an alphameric entry 256 characters. The entry must be right-justified.

PACKED (55)

Enter a P if the data for the table is in the packed decimal format. Otherwise leave this column blank.

DECIMAL POSITIONS (56)

If the data contained in the table is numeric, enter the number of decimal positions

(1-9). Enter a zero if there are no decimal positions. If the data is alphameric, leave this column blank.

SEQUENCE (57)

If the data contained in the table is in ascending sequence, enter an A in this column. If the data contained in the table is in descending sequence, enter a D in this column. Leave this column blank if the data contained in the table is not in ascending or descending sequence or if this specification is not required.

COMMENTS (58-74)

Leave columns 58-74 blank, unless comments are entered in these columns.

ENTRIES ON THE FILE EXTENSION SHEET

Figure 100 shows several examples of entries that can be made on the File Extension sheet. The numbers to the right of the entries correspond to these explanations:

1. In this example, INPUT is a card file containing the record key that will be used to process records in the DASD file MASTCUST. The file INPUT is the chaining file. That is, it is the file that links or chains to another file (in this case MASTCUST). The field contained in INPUT, which is used to link the two files, is the chaining field.

   The record sequence of the input file is taken from the Input Specifications sheet. C1 is the number of the chaining field. Thus, INPUT is chained to MASTCUST by using a field defined on the input specifications that contains C1 in columns 61-62. A complete discussion of chaining may be found in Chaining at the back of this publication.

2. In this example, RAFFILE is a record-address file that supplied the addresses of the records to be processed in the file DISKUPDT.

3. TABFIL is the name of a table file that contains both a table of arguments and a table of functions.

   The arguments in the file are identified by the table name of TABARG. The argument table is described in columns 33-45. There are 10 arguments in each record. The number of arguments in the table is 150 and each argument is 10 characters long. The arguments are numeric and there are no decimal positions, thus the entry is 0 (column 44).

   The functions in the file are identified by the table name TABFUN. The function table is described in columns 52-57. Each function is 10 characters long and each function is organized in

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REPORT PROGRAM GENERATOR FILE EXTENSION SPECIFICATIONS

IBM System 360

Form X24-3348-1 Printed in U.S.A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Record Sequence of the Chaining File: Number of the Chaining Field	Record Sequence of the Chaining File: From Filename	Record Sequence of the Chaining File: To Filename	Table Name	Number of Table Entries Per Record: Number of Table Entries Per Table	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Table Name (Alternating Table)	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Comments
01	E	AAC1	INPUT	MASTCUST												← (1)
02	E		RAFFILE	DISKUPDT												← (2)
03	E		TABFIL		TABARG	10	150	10	0		TABFUN	10	0			← (3)
04	E		TABFIL	NEWTAB	TABREC	10	150	10	0							← (4)
05	E															

Figure 100. Entries for the File Extension Sheet

the form: argument-function. Therefore, TABARG was specified first.

4. This example shows the specifications for a table file that contains only arguments. After the table of arguments is updated the table is to be written on an output unit.

TABFIL is the name of the table file.

NEWTAB is the name given to the table file when it is being written on the output unit (output operations).

The arguments in the file are identified by the table name of TABREC. The argument table is described in columns 33-45. Ten table entries are in each record. The number of table entries in the table is 150, and each table entry is 10 characters long. The data is numeric, but there are no decimal positions, thus the entry is 0. Columns 46 through 57 are left blank.

This section of the publication contains information on:

1. How to create and use tables, and
2. How to transfer control from the RPG program to a subroutine coded by the user, and how to return to the RPG program.

USING TABLES IN THE OBJECT MODULE

RPG enables the programmer to use tables in the object module. A table is nothing more than a systematic arrangement of data which is used by the object program in much the same manner that a shipping clerk would use a rate table for obtaining freight rates. The clerk might scan the table for the desired city and then select the corresponding rate.

A table may consist of two parts: an argument and a function. In Figure 101 the table consists of part numbers (arguments) and prices (functions). If the price of part number 10 is wanted, the table is searched until part number 10 is found. The corresponding function of 10 in the table is 155. (The 155 represents $1.55, in this example.) The number used to search the table is called the search argument. The card file in Figure 101 contains part numbers that have been placed in the table in a predefined sequence. The cards do not contain the prices of the parts. The part number is selected from the card by the RPG program, the table is searched, and the price is retrieved and made available for additional processing. Tables are loaded into storage by the RPG object module before any files are processed.

All entries in a table will be:

1. Arguments,
2. Functions,
3. Alternating arguments and functions, or
4. Alternating functions and arguments.

Figure 102 shows these four possibilities.

Rules for Forming Tables

1. Each unit of table data is called a table entry. That is, each argument is a table entry, and each function is a table entry.
2. The collection of all argument entries is assigned a name. The collection of all function entries is assigned a name.

   These table names must be unique, and must contain the letters TABnnn (nnn may be any alphameric entry). In

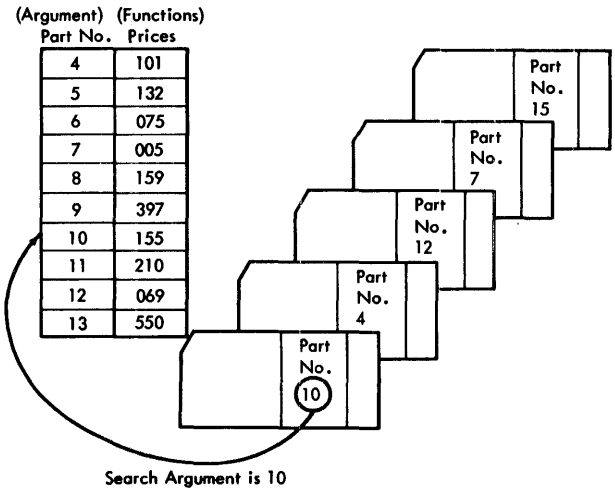

Figure 101. Using a Table

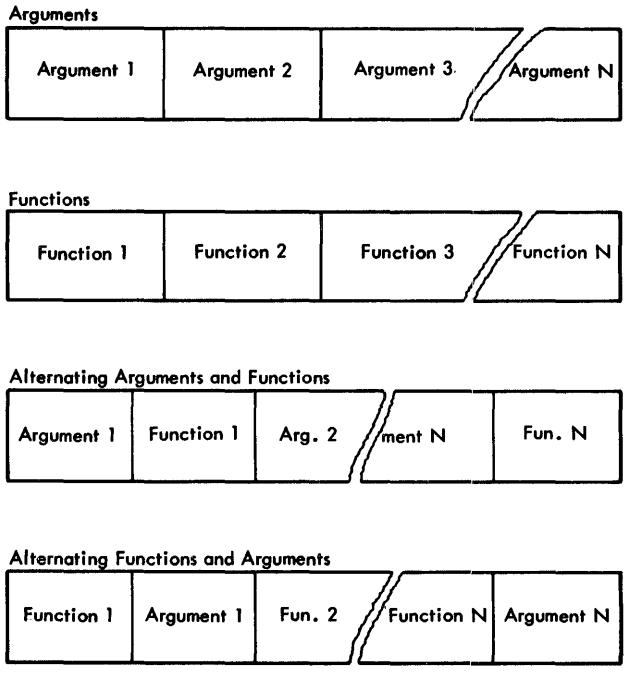

Figure 102. Four Types of Tables

Figure 106 the alternating table file called RATETABL is split into the collection of arguments (TABNUM) and the functions (TABRAT). RATETABL is the name of the file containing these two tables.

3. All tables may be loaded from the same device in the order they are specified on the File Extension sheet. The tables will be loaded into storage before the object module is processed, and each line entry on the File Extension sheet must have:
   a. A file name (columns 11-18). Multiple file extension specifications for any table file are allowable.
   b. Entries in columns 27-45 if the table is only arguments or functions.
   c. Entries in columns 27-45 and columns 46-57 if the table consists of alternating arguments and functions.

Rules for Creating Records Containing Table Data

1. Each record must begin with the first table entry of that record in position 1.
2. All records must have the same number of table entries, except the last. In Figure 104, the first card in the table file has seven table entries. All subsequent card records must have seven table entries. For example, the second card could not contain six; the third could not contain eight.
3. All entries must be adjacent in every record. In Figure 103, the first entry begins in Position 1 and the second entry begins in position 4. No blanks can be contained between the table entries.
4. All entries belonging to a table must have the same length. In Figure 103, each argument is three positions long, and each function is six positions long.

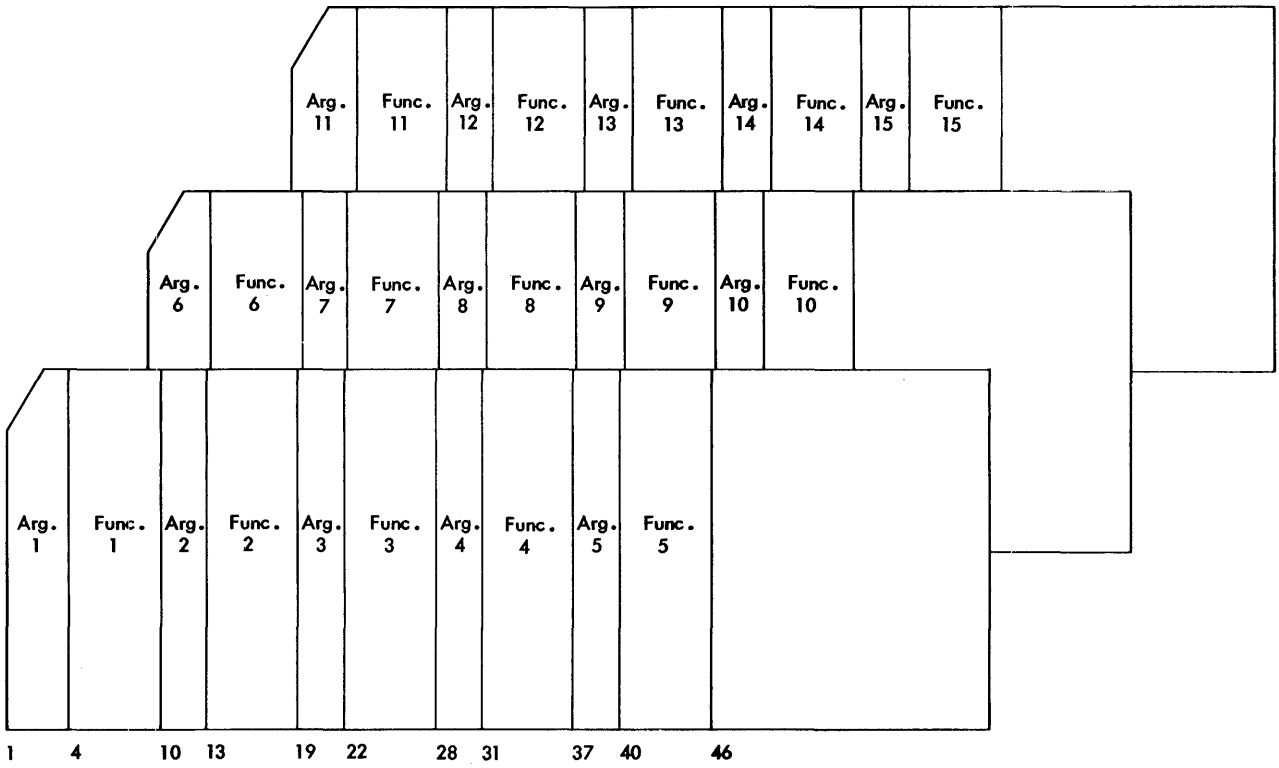

Figure 103. Table File Containing Arguments and Functions

5. When alternating tables are used, each record must begin with an entry of the same type. Each record must always begin with an argument, or each record must always begin with a function as shown in Figure 103.
6. When alternating tables are used, the table entries in each record must not be split. Function 3, for example, must be in the same record as argument 3. It is not permissible for a function to appear in a different record from its corresponding argument.
7. If a table consists of all arguments or all functions, an argument or a function must not be split. Assume that argument one, argument two, argument three, and argument four are contained in the first record. No part of argument four could overflow into the second record. Figure 104 illustrates the correct way to specify records containing arguments or functions.
8. The tables may be ascending, descending, or in no sequence. If the tables are not in sequence, only an equal search can be performed.
9. The records of a table must be on a sequentially organized file.
10. The table file to be loaded must contain the exact number of table entries as specified on the File Extension Specifications sheet.

RETRIEVING UPDATED TABLES

After a table has been updated, the table may be written out for later use.

On the File Description sheet, the programmer enters the specifications for the output file that will contain the updated table. The file must be defined as an output file.

On the File Extension sheet, the programmer enters the name of this output file in To Filename. This entry is made on the same specification line that defines the table file.

The updated table file will be put onto the output file after the program has reached the end-of-job condition (LR condition).

The name of the file need not be entered on the Output-Format Specifications sheet.

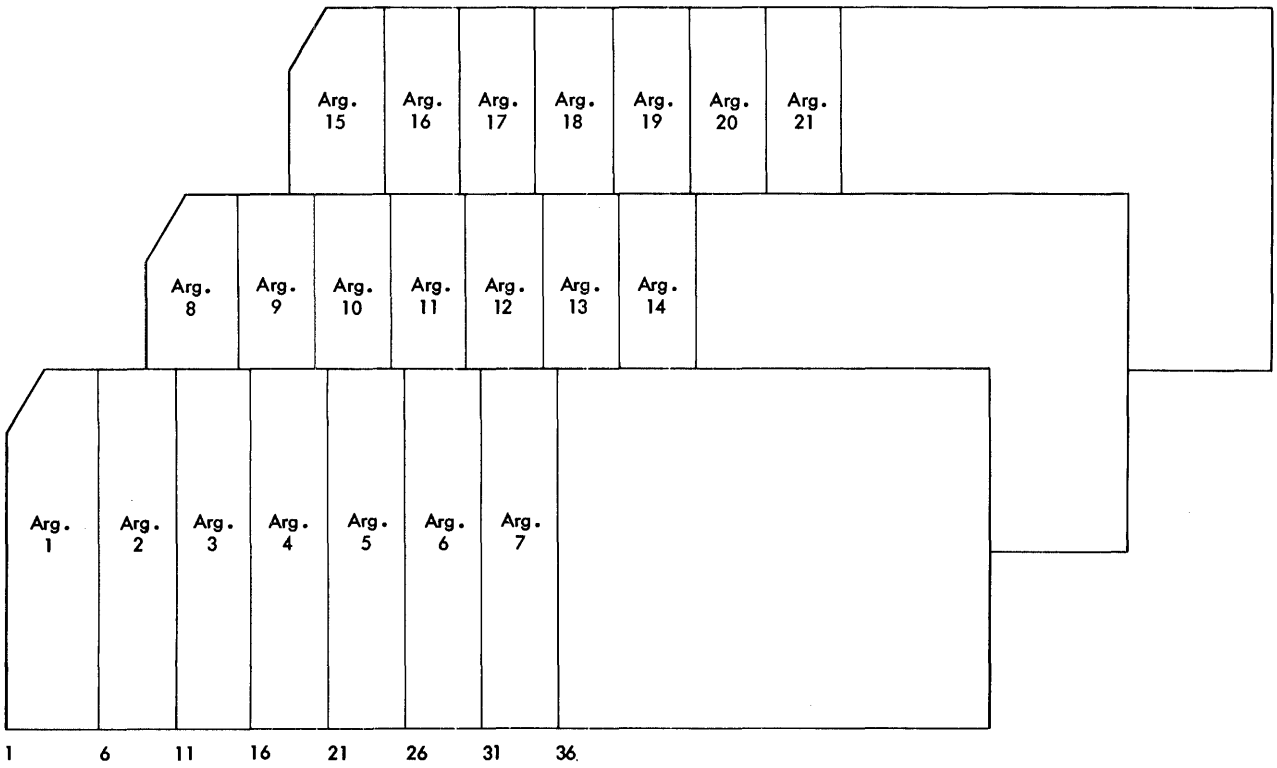

Figure 104. Table File Containing All Arguments

If the updated table is to be put out on a printer, no automatic skip to a new page will be initiated by the RPG program.

The output table must have the same format as the input table.

METHODS OF PROCESSING TABLES

The operation code LOKUP entered on the Calculation Specifications sheet causes a table lookup operation to be performed.

Factor 1 contains the search argument. The search argument may be a literal or a field name.

NOTE: The length of the data in the argument table (table argument) must be equal to the length of the search argument. The length includes the decimal positions.

Factor 2 contains the name of the table which contains the arguments.

The Result Field contains the name of the table from which an associated function is to be located.

The Result Field may be left blank if the user wants to determine if an argument is present in the table, but does not require the corresponding function.

Resulting Indicators (columns 54-59) must always have an entry when the table lookup operation is performed. The presence of indicators in this specification indicates the type of lookup to be performed. The indicators are turned on whenever the condition is satisfied.

The program may search for the table argument next-higher than the search argument, or it may search for the table argument next-lower than the search argument, or it may search for the table argument equal to the search argument. An entry must be made in columns 54-59. Combinations of high-equal or low-equal searches may be specified by placing indicators in the appropriate two of the three fields (columns 54-59).

Performance of LOKUP

The lookup operation is performed in this way:

1. The object module takes the field name or literal in Factor 1 and searches the table indicated by Factor 2. The kind of lookup is determined by the entries in Resulting Indicators.
2. After the proper entry from the argument table has been found, the corresponding function from the function table indicated by the entry in Result Field is located and placed in the special holding area of the function table. If the proper table argument is not found, the indicators in columns 54-59 are not turned on.

Using LOKUP Data Obtained

Other operations may be performed using the data just found by the table lookup operation. This data is stored in the special holding area within the function table and can be retrieved by merely using the name of the function table in either Factor 1 or Factor 2 of an operation.

Figure 105 illustrates several ways the data found by the operation may be used. The numbers on the figure correspond to this discussion.

1. Factor 1 contains the name of a field. The field PERCNT contains the search argument. The name of the table that contains the argument is TABCST. The name of the table that contains the corresponding function is TABAMT. The program will search for the value in the argument table that is equal to the search argument (columns 58-59).
2. The data found in TABAMT from the previous operation is used as the search argument in this example. (TABAMT is the name of the table; however, this name now refers to the special holding area of the table TABAMT.) The program searches for the value in the table TABARG that is equal to the search argument (columns 58-59).
3. In this example, the data obtained from the function table TABFUN from the previous lookup operation is moved to a field called WITHTX. It will be used for additional calculations.
4. In this example, the data found in the function and argument tables is updated. The literal +25 is the search argument. The table TABFIL is searched for +25 (indicated by the entry in columns 58-59). A new entry for the corresponding function of +25 is entered in TABLIT and in the special holding area. The new function is +500; the new argument is +30.
5. In example 5, a lookup with only one argument table turns on Indicator 30 if SEARCH is equal to an argument in TABNUM. If 30 is not on (N30), H1 is turned on by the SETON instruction.
6. This example illustrates the facility for adding to the table. In this example, the LOKUP operation is conditioned on the Indicator 01. (Indicator 01 is turned on when the input file contains records with additional table information. Each record contains the two fields, NEWARG and NEWFUN.) To determine the first vacant argument, a field of zeros is used as the search argument. Zeros are used because the argument field is numeric. Blanks would be used if the argument field had been alphabetic. In loading the table, the vacant table entries must be filled with zeros or blanks for numeric or alphameric fields respectively.

If there is an equal compare, Indicator 35 is turned on. Since the argument field of the table is vacant, the corresponding function field is also vacant. The new argument (NEWARG) is inserted in the TABARG field, and the corresponding new function (NEWFUN) is inserted in the TABFUN field.

NOTE: Whenever a field TABnnn appears in columns 32-37 in the output-format specification and blank-after is specified (B in column 39), the table value and hold area are updated to blanks or zero for alpha or numeric, respectively.

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System 360

Form X24-3351-1 Printed in U.S.A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And Not	Indicators: And Not	Indicators: Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Resulting Indicators: Minus	Resulting Indicators: Zero or Blank	Compare: High 1>2	Compare: Low 1<2	Compare: Equal 1=2	Comments
01		(1)				PERCNT	LOKUP	TABCST	TABAMT	42								15	
02	(2)		15			TABAMT	LOKUP	TABARG	TABFUN	42								10	
03		(3)	10	15			MOVE	TABFUN	WITHTX	52									
04	(4)					+25	LOKUP	TABFIL	TABLIT	30								20	
05	C		20				MOVE	+500	TABLIT										
06	C		20				MOVE	+30	TABFIL	30									
07	C	(5)				SEARCH	LOKUP	TABNUM										30	
08			N30				SETON						H1						
09	(6)		01			000	LOKUP	TABARG	TABFUN	42								35	
10	C		35	01			Z-ADD	NEWARG	TABARG	30									
11	C		35	01			MOVE	NEWFUN	TABFUN										
12	C																		

Figure 105. Using Table Files

EXAMPLE OF USING TABLES

Figures 106 and 107 illustrate an input data file, the way a table might appear, and the entries necessary on the RPG specification sheets.

In this example, a card-input file contains the number of hours worked by each employee (columns 42-44) and the employee's number (columns 1-5). The RPG program takes the employee number and uses it as the search argument to find the salary rate for the employee. After the salary rate has been found, it is multiplied by the hours worked by the employee. The result of this operation is the amount earned for each employee.

In this example, the table consists of alternating arguments and functions. The way the table data might appear is shown in Figure 106. The name of the file that contains the arguments and functions is RATETABL. The collection of arguments is called TABNUM (table number), and the collection of functions is called TABRAT (table rate).

Entries on the specification sheets follow.

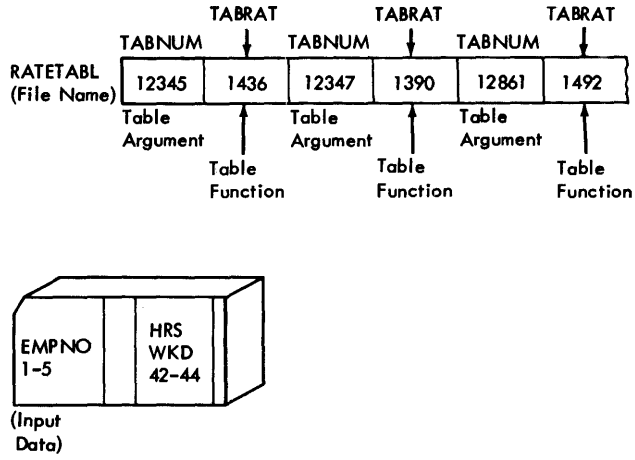

Figure 106. Using Alternating Arguments and Functions

File Description Specifications Sheet

The two files are defined on the File Description sheet. The file containing the input card records is called TIMECARD. It is an input file (I in column 15); it is the primary file (P in column 16); and when the file is depleted, processing is terminated (E in column 17). The records in the file are in ascending order (A in column 18); they are fixed-length records (F in column 19). Each record has a block length of 80 (80 in columns 22-23), and each record is 80 characters long (80 in columns 26-27). This file is read in on the IBM 2501 Card Reader, so the device code is READ01.

The table file is defined on the line below the card-input file. The name of the file (RATETABL) is entered in Filename (columns 7-14). It is an input file (I in column 15), and the records in the file are fixed-length (F in column 19). The file has a block length of 80, and each record is 80 characters long. The E in column 39 indicates that additional information about the file is coded on the File Extension sheet. This file is read in on the IBM 1442 Card Read-punch, and therefore it is assigned the Device code of READ42.

File Extension Specifications Sheet

On the File Extension sheet, the table file is further defined. The name of the file is entered in From Filename (columns 11-18). The collection of arguments (TABNUM) is entered in the first Table Name (columns 27-32). There are 8 arguments per record (columns 34-35), and there are 1500 arguments in the table (columns 36-39). Each table entry is five positions long (5 in column 42), and there are no decimal positions (0 in column 44). The table is ascending (A in column 45).

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REPORT PROGRAM GENERATOR FILE DESCRIPTION SPECIFICATIONS

IBM System/360

Form X24-3347-2 Printed in U.S.A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	File Type	File Designation	End of File	Sequence	File Format	Block Length	Record Length	L/R	Mode of Processing	Length of Record Address Field	Record Address Type	Type of File Organization	Overflow Indicator	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
			I/O/U/C	P/S/C/R/T	E	A/D	F/V				K/T	I/O/T											
01	F	TIMECARD	I	P	E	A	F	80	80									READ01					
02	F	RATETABL	I	T			F	80	80								E	READ42					

Figure 107. Coding Sheets for Table Example (Part 1 of 2)

The collection of functions is described in columns 46-57. The name of the functions (TABRAT) is entered in the second Table Name (columns 46-51). Each entry in the table is four positions long (4 in column 54), and there are three decimal positions specified (3 in column 56).

Input Specifications Sheet

The input file (TIMECARD) is described on the Input Specifications sheet. The name of the file is entered in columns 7-14. The file is assigned a sequence of AA (columns 15-16), and resulting indicator 01 is turned on whenever an input record is present for processing. No record identification codes are specified because every record will be processed in the same way.

Lines 020 and 030 are used to describe the locations of the two input fields used by the program. The employee number is located in columns 1-5 of the input record, as specified by the entries in Field Location (columns 47 and 51), and the employee number is given the field name EMPNUM. The number of hours worked by the employee is found in columns 42-44 of the input record, as specified by the entries in Field Location. The name HRSWKD is assigned to the number of hours worked by each employee.

Calculation Specifications Sheet

Three calculation specifications are shown. On line 010, EMPNUM (employee number) is used as Factor 1. The employee number is the search argument. The operation code LOKUP which is coded in Operation (columns 28-32) causes the lookup operation to be performed. Factor 2 contains the name of the collection of arguments (TABNUM) which is searched. The Result Field contains the name of the collection of functions (TABRAT). Thus, this operation causes the employee

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REPORT PROGRAM GENERATOR FILE EXTENSION SPECIFICATIONS

IBM System/360

Form X24-3348-1 Printed in U.S.A.

Line	Form Type	From Filename	To Filename	Table Name	Table Name (Alternating Table)	Comments
010	E	RATETABL		TABNUM	ATABRAT	

Line	Form Type	Filename	Sequence	Option (O)	Resulting Indicator	Position	Character	Position	Character	Position	Character	From	To	Field Name	Plus	Minus	Zero or Blank	Sterling Sign Position
010	I	TIMECARD	AA		01													
020	I											1	5	EMPNUM				
030	I											42	44	HRSWKD				

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System 360

Form X24-3351-1 Printed in U.S.A.

Line	Form Type	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Comments
010	C	EMPNUM	LOKUP	TABNUM	TABRAT	43			
020	C	TABRAT	MULT	HRSWKD	EARNS	52	H		
030	C		MOVE	+000.00	EARNS				

Figure 107. Coding Sheets for Table Example (Part 2 of 2)

number (EMPNUM) to be used as the search argument for the data contained in TABNUM. The result field is four positions long with three decimal positions. The 03 entered in columns 58-59 indicates that indicator 03 will be turned on when the search argument finds an entry in the argument table that is equal to the search argument.

The specifications on line 020 are performed when indicator 03 is on. The rate for the employee (TABRAT) which has just been located is multiplied by the number of hours worked (HRSWKD), and the result is stored in EARNS which is five positions long and has two decimal positions. The answer is half-adjusted.

If the search argument does not find an equal entry in the argument table (indicator 03 is not on), the specifications on line 030 are performed. Columns 9-11 contain the specification N03.

The literal +000.00 is then moved to the field EARNS, specifying that the employee does not have an entry in the table.

EXIT TO A USER'S SUBROUTINE

GENERAL INFORMATION

By use of the EXIT operation code on the Calculation Specifications sheet, RPG provides the facility to transfer control from the RPG object program to some subroutine that has been coded independently. A subroutine might be a standard routine such as a state withholding tax.

The subroutine, written in the assembler language, is coded by the user, and entries made on the calculation sheet enable the programmer to:

1. Exit from the RPG program to the subroutine,
2. Execute the subroutine,
3. Reference fields and indicators defined in the RPG program (RLABL usage),
4. Reference fields defined in the user's subroutine (ULABL usage), and
5. Return to the main program after the subroutine has been performed.

HOW TO CODE EXIT

On the Calculation Specifications sheet, the EXIT operation can be a conditional operation. When entries are placed in columns 7-8, 9-11, 12-14, or 15-17, the EXIT will occur when the designated conditions are satisfied. If no indicators are used, the EXIT will occur everytime the detail calculations are performed. Columns 28-31 must contain the operation code EXIT and Factor 2 must contain the label of the user's subroutine. The subroutine name may be from 1-6 alphameric characters with the first character being alphabetic. Factor 1 is not used.

POSITION OF EXIT IN THE CALCULATION SPECIFICATIONS

The following results will be obtained depending on the location of the EXIT code on the Calculation Specifications sheet.

Calculation Entry	When the Exit Will Occur
1. First Detail	At the end of the data routine (after the data is extracted from the input record).
2. Last Detail	Immediately before heading records are written.
3. First Total	At the end of the input routine (after the record-type has been determined and the control-field break has been tested).
4. Last Total	Immediately before the total records are written.

GENERAL RULES FOR USING EXIT

RPG provides the facility for the subroutine to test indicators and use tables and fields that have been defined in the RPG program. RPG also provides the facility for the RPG program to use fields that have been defined in the subroutine. These two facilities are provided by using the two operation codes RLABL and ULABL.

RLABL

If the user has defined a field or table in the RPG program and it is to be used in the subroutine to which the EXIT will occur, he must code:

1. RLABL in operation.
2. The name of the field or table in Result Field.
3. The length of the field in Field Length.
4. The decimal indication in Decimal Positions.

The user may need to reference, in the subroutine, indicators that are used in the RPG portion of this program. To do this, the user must code:

1. RLABL in Operation.
2. INnn in Result Field. The nn represents the specific indicator that the user wants to test in the subroutine. Therefore, if MR was to be tested in the subroutine, he would code INMR in Result Field.

ULABL

If the user has defined a field in the subroutine, and this field is to be used in this RPG program he must code:

1. ULABL in Operation.
2. The name of the field in Result Field.
3. The length of the field in Field Length.
4. The decimal indication in Decimal Positions.

When executing the subroutine, the user may have to use an indicator in the subroutine, and later reference that indicator in the RPG program. This can only be accomplished by first defining the indicator in the RPG program and then defining it in a RLABL operation.

USE OF REGISTERS

The way in which registers are used by the programmer is strictly defined. These rules must be followed:

1. The using register that contains the entry address of the called subroutine is Register 15.
2. When control of the program passes from the RPG program to the subroutine, the address of the RPG instruction to which the subroutine must return is stored in Register 14.
3. The RPG instruction to which the subroutine returns is the instruction that follows the EXIT operation.
4. If registers are used within the subroutine the contents of the registers the programmer intends to use must be stored before the subroutine is executed.
5. Before the subroutine transfers back to the RPG program, the registers must be restored to their original contents.

USING INDICATORS, FIELDS, AND TABLES IN THE EXIT ROUTINE

Indicators

If, in the exit subroutine, the user sets on, sets off, or tests indicators, he must observe the following rules:

1. To set on an indicator, set the data located at INnn to hexadecimal F0.
2. To set off an indicator, set the data located at INnn to hexadecimal 00. (Indicator L0 and 00 must never be set off.)
3. To test indicators:
   a. If on, the data at INnn will be hexadecimal F0.
   b. If off, the data at INnn will be the hexadecimal 00.

Fields

If numeric data from the RPG object program is used in the subroutine, it will be in the packed-decimal format. If numeric data from the subroutine is supplied to the RPG object module, it must be in the packed-decimal format.

Tables

The subroutine may refer to a table which is defined in the RPG program. As each table is created in the program, a "Table Linkage Field" is created for it. This field is a control field utilized by table operations. The format of this field is illustrated in Figure 108. Significant subfields are described below.

1. This subfield (1 byte) contains switches used by RPG.
2. This subfield (1 byte) contains the length minus 1 of each table entry. For numeric fields this subfield contains a number one less than the unpacked length although the actual table entry is in packed format.
3. This subfield (2 bytes) contains the number of entries in the table.
4. This subfield (4 bytes) contains the address of the beginning of the table.
5. This subfield (4 bytes) contains the address of the byte following the end of the table.
6. This subfield (4 bytes) is used by the RPG object program as a pointer to the selected table entry. For example, as

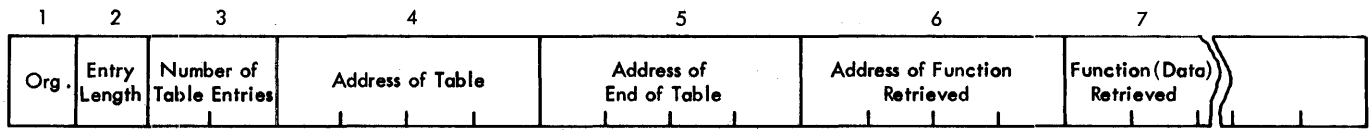

Figure 108. Format of Table Linkage Field

the result of a LOKUP operation, this subfield contains the address of the corresponding function retrieved from the table when an equal is found in the argument table.

7. This subfield is used by the object module as a transient work area. For example, as the result of a LOKUP operation this subfield contains the data from the function retrieved from the table when an equal is found in the argument table. (This subfield is word-aligned and its length is equal to the length of a table entry.) This area is also called the "special holding area".

The subroutine can use the data retrieved from a preceding LOKUP operation by simply referring to TABnnn. (Assuming that TABnnn has been defined by an RLABL operation.) The effective address of any reference to TABnnn is the first byte of subfield 7. To access the table itself, the address contained in subfield 4 of the Table Linkage Field for TABnnn must be used.

EXAMPLE OF EXIT TO A SUBROUTINE

Figure 109 shows the coding steps necessary to implement the EXIT routine.

1. An input file of the name INPUT turns on resulting indicator 01 if an X is in position 80.
2. If the field AMOUNT is zero or blank, field indicator 02 is turned on.
3. The operation SETOF defines (and sets off) indicator 14 for the RPG program so that it can be subsequently defined for use in the subroutine. (This is performed only if indicator 01 is on.)
4. Whenever indicator 01 is on, the calculation specifications entry EXIT causes the program to exit to the user's subroutine called TAXRTE.
5. Within the subroutine, the user wants three things: the AMOUNT field, and the indicators 02 and 14. The RLABL operations enable the subroutine to reference the AMOUNT field, to test indicator 02, and to utilize indicator 14 in the subroutine.
6. In the subroutine, assume there is a field (TAXAMT) that the user wants to use on the output-format specifications. If the field TAXAMT in the subroutine is blank, the subroutine turns on indicator 14. TAXAMT is referenced in the output specifications, but it will not be printed if indicator 14 is on. If the user chooses, he can use it later in the calculation specifications. The entry ULABL enables the field TAXAMT to be referenced by the RPG program.
7. On the output sheet, TAXAMT is treated as a field.

This concludes the description of tables and EXIT subroutines.

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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System 360

Form X24-3350-1
Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C Z D	1: Character	2: Position	2: Not (N)	2: C Z D	2: Character	3: Position	3: Not (N)	3: C Z D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15 16	17	18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43	44 45 46 47	48 49 50 51	52	53 54 55 56 57 58	59 60	61 62	63 64	65 66	67 68	69 70	71 72 73 74
0 1 Ø	1	INPUT	AA			Ø1	8Ø		C	X																					
0 2 Ø	1																				1	1ØØ		AMOUNT						Ø2	

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System 360

Form X24-3351-1
Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And Not	And Not	And Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Minus	Zero or Blank	Compare: High 1 > 2	Low 1 < 2	Equal 1 = 2	Comments
3 4 5	6	7 8	9 10 11	12 13 14	15 16 17	18 19 20 21 22 23 24 25 26 27	28 29 30 31 32	33 34 35 36 37 38 39 40 41 42	43 44 45 46 47 48	49 50 51	52	53	54 55	56 57	58 59	60 61 62 63 64 65 66 67 68 69 70 71 72 73 74				
0 1 Ø	C		Ø1				SETOF							14					
0 2 Ø	C		Ø1				EXIT	TAXRTE											
0 3 Ø	C						RLABL		AMOUNT	1ØØ									
0 4 Ø	C						RLABL		INØ2										
0 5 Ø	C						RLABL		IN14										
0 6	C						ULABL		TAXAMT	1Ø2									

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REPORT PROGRAM GENERATOR OUTPUT-FORMAT SPECIFICATIONS

IBM System 360

Form X24-3352-1
Printed in U. S. A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: And Not	And Not	And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19 20	21 22	23 24 25	26 27 28	29 30 31	32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
0 1 Ø	O	OUTPUT	D			1			Ø1									
0 2 Ø	O								N14			TAXAMT			5Ø		' $bb,bbb,bbØ.6b'	
0 3 Ø	O											AMOUNT			1ØØ			

Figure 109. Exit to a Subroutine

This section of the manual is for readers not familiar with disk storage operations. It contains a general description of data organization and retrieval, and defines some of the terms you may encounter in related literature.

INTRODUCTION AND TERMINOLOGY

The distinction between two concepts is important: file organization and file processing.

File Organization is the method of arranging data records on a direct access storage device. A file is organized during the development stages of the application.

File Processing is the method of retrieving data records from the file.

To achieve the most efficient use of the System/360 components, carefully consider the relationship between how a file is organized and how to retrieve records from it. This is particularly important when designing data files for storage in a direct access storage device, such as the IBM 2311.

The method of organization best suited to a particular file of disk records depends upon many factors. These factors must be analyzed for each file in each particular application. Frequently, you can use more than one method of processing on the same file. For example, records within a file might be processed at random during an updating run, and sequentially during a billing run.

LOGICAL FILE VS PHYSICAL UNIT

It is important to distinguish between a logical file and the physical unit used to store the file. A logical file is a group of related data records, such as a payroll file.

A physical unit for storage of data records could be an IBM 2400-series Magnetic Tape Unit, an IBM 2311 Disk Storage Drive, or an IBM 2501 Card Reader.

A logical file may occupy part of a disk storage drive, an entire disk storage drive, or more than one disk storage drive. The location of the logical file in disk storage is defined by its lowest and highest addresses. This area is the extent area. One logical file can occupy more than one extent area. The extent areas do not have to be adjoining.

DATA FILES

Data files are recorded on such media as: paper, cards, tape, or disk packs. Data files consist of a number of individual records that range from a few records up to thousands or millions of records.

RECORD

A record can be defined as a collection of information consisting of alphameric and/or nonalphameric characters related to a common identifier. The common identifier is known as a record's control field, or key. Usually, one of the fields within a record identifies the record. For example, man number could be the key or identifier for a payroll record.

The size or length of records varies from file to file, and can be from eighteen characters to 4,000 characters.

A single record usually includes one or more logical data fields. A data field is a sequence of one or more characters which is treated as a processing unit of information. An individual data field is normally identified by its location within a record.

The logical structure of records and of fields within records is important in high-speed recording media such as magnetic tape and disk. This logical structure is strongly affected by whether a record is of fixed- or variable-length.

FIXED-LENGTH RECORDS

In fixed-length record files, all records are allocated the same number of character storage positions. Identical data fields are present in every record, whether they are used or not. The control field (key) is usually the first field present in a record.

In many applications, fixed-length records would make inefficient use of file storage space. For example, a fixed record-length of 850 positions would waste storage and processing time, if the average record

length is 230 positions and the minimum length is only 100 positions.

Situations such as this require the development of space-saving techniques based on varying the number of storage positions allocated to data records.

VARIABLE-LENGTH RECORDS

Completely variable-length records are sometimes developed for more efficient use of storage. In this approach, the data portion of the record may be of any length, but the key (control field) size is constant. A record-length character-count field in each record shows the length of a variable-length record.

BLOCKING RECORDS

The length of individual data records varies with type of data and the application that requires such data. The format of a data record is significant to the efficient use of the various storage media available on the System/360. One important element in the design of data records involves blocking and deblocking. Input/output units (storage media) are relatively inefficient when used to record short blocks of information. To increase the efficiency of input/output units, data records are assembled into blocks of records whose sizes are convenient and efficient for processing.

Each physical record on either tape or disk requires inter-record gaps. These gaps are blank areas used to distinguish beginning and ending points of a record. If records are blocked before loading onto a tape or disk, many of these gaps can be eliminated. Variable-length blocks are permitted in System/360, Operating System RPG. The length of a variable-length block is indicated by a block-length character-counter field present in each block. (See Variable-Length Records.)

The operating system handles the blocking and deblocking of records so the user need only determine the most efficient blocking factor for his particular data file and equipment specifications. The system also creates and maintains the block-length and record-length count fields; no programming for these facilities is required by the RPG programmer.

In the operating system, only the input records for indexed-sequentially or sequentially organized files can be blocked.

FILE ORGANIZATION

Data records should be organized and stored to facilitate subsequent processing. The three types of file organization are: sequential, indexed-sequential, direct.

SEQUENTIAL ORGANIZATION

The logical sequence of records in this file depends upon a significant key (control field) appearing in the records. To establish a sequentially organized file, sort and then store the records in key sequence. This allows for records with successively higher or lower keys (control numbers) to have successively higher physical address numbers. Cards and tape files are always organized in this serial manner and usually are considered as one continuous "string" of records.

INDEXED-SEQUENTIAL ORGANIZATION

In this type of file organization also, the sequence of records depends upon a key (control) field. The records are stored sequentially in the file. This variation of file organization differs from sequential organization in two ways:

1. The records may be retrieved from the file sequentially or in a random sequence.
2. Only records with transaction activity need be retrieved.

These differences occur because indexed-sequential organization uses "index tables" which indicate to the program the general location of the records. Thus, the program does not have to "step through" the file, record after record, to locate a specific record.

The index tables (prepared and maintained by the operating system) are analogous to the index card file in a library.

For example, if the library user knows the name of the book or the author he can look in the index card file and find the location of the book in the book files. This might be an address (catalog number) of 426.25. He would then go to the book shelves, and (if it was his first time in the library) start at the first row of the book files and proceed through the rows until he found the shelf that contained 426.25. Usually, each row contains a sign

to indicate the beginning and ending numbers of all books in that particular row. Thus, as he proceeded through the rows, he would compare 426.25 with the numbers posted on each row. Assume that one row was labeled 300.88-550.00. He would then search that row for the shelf that contained the book. The shelves (like the rows) might also contain number ranges to indicate their contents. In this case, he would scan the shelf numbers until he found something like 342.00-440.96. Then he would look at individual book numbers on that shelf until he found 426.25.

The RPG program uses index tables in much the same way to locate records organized in an indexed-sequential file.

DIRECT ORGANIZATION

In direct file organization, the records are generally not stored in the sequence of their keys (control numbers). A randomizing formula coverts the record key to a numerical address (physical address) of the storage device. The record is stored at the physical address developed by the randomizing formula. In effect, a file of records will be scattered throughout an entire disk file.

RPG does not provide for creating a file with direct organization. Creation of a file with direct organization must be accomplished by the programmer using the input/output macro facilities of the assembler programming system. During the processing of the object program the user has the ability to exit to a subroutine to perform a randomizing routine upon the input data records. RPG cannot process duplicate records. (Duplicate records occur when two different control fields convert to the same physical address.)

FILE PROCESSING

For the three methods of file organization (sequential, indexed-sequential, and direct) there are three methods of file processing:

1. Sequential processing of sequentially organized files.
2. Sequential processing of indexed-sequentially organized files.
3. Random processing of indexed-sequentially organized files and directly organized files.

SEQUENTIAL PROCESSING (Sequential files)

In sequential processing of a sequentially organized file, every record in a file is examined, and each successive record in the physical file is processed in order. For example, in a card file, the card records are processed in the order that the cards are fed into the system. The 14th card in the file could not be processed until after the 13th card had been processed.

SEQUENTIAL PROCESSING (Indexed-Sequential files)

Sequential processing of an indexed-sequentially organized file has two variations.

1. An entire logical file is processed. For example, the physical unit consists of payroll records in cylinders 0 to 42 and inventory records in cylinders 43 to 99. Only the logical (payroll) file might be processed.
2. Only a segment of a file is processed. For example, a payroll file is to be updated with new pay increases. The payroll file is in sequence by department, and each week the pay raises for various departments become effective. Therefore, on each week's processing, only segments of the payroll file are updated. The updating is accomplished by reading in a card file that contains the limits of the file to be processed. One such card record might indicate that the records for departments 26-41, are to be updated, another the records for departments 76-80, etc.

RANDOM PROCESSING

In random processing, the sequence of processing has no relationship to the sequence in which the data is stored in the file. The data file could be organized in either a direct or an indexed-sequential order. This processing is sometimes called direct.

Indexed-Sequential Files

To find a random record in an Indexed-Sequential file, an index or series of indexes is first scanned to localize the area of search by determining the track that

contains the record. The index is a sequential list of the key records (of the data) with corresponding track addresses. The entire track is then scanned to find the individual record to be processed. This kind of processing is referred to as processing in a random sequence with record keys.

This type of processing is analogous to directing someone to a house location. "The Martin family lives on Harrison Street" (a track address) "and their house number is 4216" (a key).

Direct Files

To find a random record in a direct file, compute the track address by the same randomizing formula used to load the file of records. You can make direct access to the record. Index tables are not required. This kind of processing is called processing in a random sequence and it can be done using keys or record identification (ID). The record identification indicates only the location of the record on the track. For example, the 2nd, 12th, 18th, etc. record on the track. The program makes no comparison of key (control field) data when a record number is provided.

This type of processing can also be compared to directing someone to a house location. "The Martin family lives on Harrison Street", (a track address),"and their house is the 5th house from the beginning of the street." (The 5th is the record identification.)

If random processing is performed with key field only, the user supplies track address and record key field. Starting with this address the program searches the track for the record with the corresponding record key.

FILE PROCESSING IN RPG

The preceding information in this section provided a general introduction to disk storage concepts for the System/360, Operating System. The material that follows is a summary of file processing methods for the RPG program.

RPG object programs process the following input file organizations:

1. Sequential
2. Indexed-Sequential
3. Direct

~~This applies to update files as well.~~ RPG will only create sequential output files.

SEQUENTIAL ORGANIZATION

The records on the file will be made available for processing in the same order in which they are located on the medium. The file might be contained in cards, on magnetic tape, or on a DASD. The entire file is processed, beginning with the first record and continuing until the file is depleted.

The end-of-file condition is determined as the last card of the file is read. In the case of DASD, the extent of the file is obtained from the operating system.

The records may be fixed-or variable-length and blocked or unblocked.

INDEXED-SEQUENTIAL ORGANIZATION

An indexed-sequential file can only be on a direct-access-storage device (such as disk).

RPG processes indexed-sequential files in three ways:

1. Sequentially, by processing the entire file.
2. Sequentially, by processing a segment of the file between the given limits.
3. Randomly, by processing records on the file in a random order.

The records may be fixed-length and blocked or unblocked.

Processing the Entire File Sequentially

The object program obtains the limits of the file from the operating system, and the entire file is processed sequentially by record key in ascending or descending record-key sequence.

Processing Part of the File Sequentially

If only a part of the entire file is to be processed, the object program must be supplied with both the low and high keys that describe which part of the file will be processed.

An auxiliary file is used to supply these limits. This file is called a Record

Address File (RAF). The RAF does not contain data to be processed. It contains the record keys (in this case the limits) of the data records which will be processed.

The object module obtains the limits to be processed from a record contained in a RAF and then processes all the data between those limits. The object module then reads another record in the RAF, and the procedure is continued until the RAF is depleted.

Processing the File Randomly

An indexed-sequential file may be processed randomly by supplying an RAF or a chaining file. Instead of supplying the limits (as in the case of sequential processing), the RAF or chaining file contains the record key of each record of the file to be processed.

DIRECT ORGANIZATION (RANDOM)

A file with direct organization must reside on a direct access storage device. A direct file is always processed randomly. Records are retrieved from this file by using a relative track address and either a record key or record identification. The records must be fixed-length and unblocked.

A direct file is processed randomly by supplying a record-address file or a chaining file.

The RPG program or an external subroutine must provide the necessary steps to convert the data fields contained in the RAF or chaining file to the relative track address and record key or record ID to be retrieved.

The format of the relative track address created by the subroutine must be in the form TTR. (Refer to IBM System/360, Operating System, Control Program Services.

The next two major sections of the manual are Processing Single Input Files and Processing Multiple Input Files. These sections describe disk storage processing in the RPG program. In these sections, processing methods are described in detail including specific examples of methods and of coding specifications.

PROCESSING SINGLE INPUT FILES

In this section, the methods of retrieving records from one input file are discussed. Three types of file organization can be processed: Sequential, Indexed-Sequential, and Direct.

If there is only one input file, it must be designated as the primary file by entering a P in column 16 of the File Description sheet.

SEQUENTIAL FILE

Figure 110 shows the coding on the File Description sheet necessary to process a sequential file. The name of the file is MASTERIN. The records are fixed-length, and the block length is 200. Each record is 200 characters long. A blank in column 32 indicates that the file is a sequential file.

PROCESSING AN INDEXED-SEQUENTIAL FILE BETWEEN LIMITS

If only a part of an indexed-sequential file is to be processed, the object program must be supplied with both the low and high keys that describe which part of the file will be processed. Mode of Processing (column 28) of the File Description sheet must contain L.

The object program obtains the limits to be processed from a record contained in an RAF and then processes all data between those limits. The object program then reads another record in the RAF, and the procedure is continued until the RAF is depleted.

In Figure 111, the first card of the record-address file shows that the object module is to process from Bell to Dennis. The second card shows that the program is to process from Dixon to Howard. The third card shows that the third part of the file to be processed ranges from Keith to Paige. Thus, the data records that the program processes are contained with these limits. In this example, the record keys are customer names.

The record-address file in this example is nothing more than a file which supplies limits of the file to be processed. Rules for forming record-address files are contained in Creating Record Address Files at the end of this section of the manual.

Figure 112 illustrates the coding required on the File Description and File Extension sheets when limits of an indexed-sequential file are to be processed. In Figure 112, on the File Description sheet DISKIN is the name of the input file. The records are fixed-length, and the block length is 150. Each record is 150 characters long. Limits of the file are to be processed as indicated by the L in column 28. The K in column 31 indicates that the record key will be used to obtain the records from the file.

The record-address file (RAFLIMIT) is also an input file. The R in column 16 indicates that it is an RAF. It is

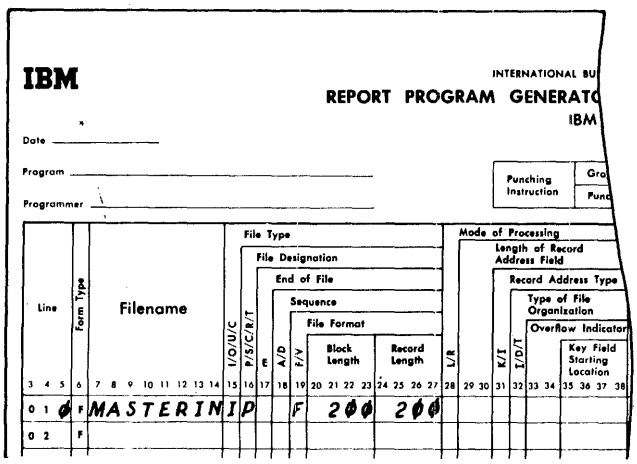

Figure 110. Coding a Sequential File

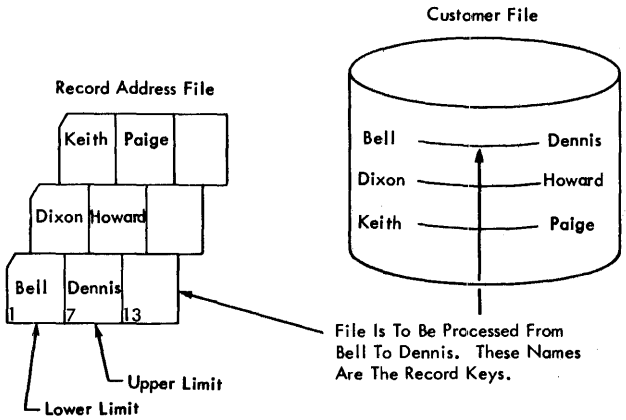

Figure 111. Contents of the Record Address File

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Program Identification

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/T	I/D/T	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels S, N, or Ei	Name of Label Exit	Extent Exit for DAM	Comments
01Ø	F	DISKIN	I	P			F	15Ø	15Ø	L	K	I	1		DISK11		S			
02Ø	F	RAFLIMIT	I	R			F	8Ø	8Ø	Ø6				E	READ4Ø					
03	F																			

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Program Identification

Line	Form Type	Record Sequence of the Chaining File: Number of the Chaining Field: From Filename	To Filename	Table Name	Number of Table Entries Per Record: Number of Table Entries Per Table	Length of Table Entry: Packed (P)	Decimal Pos.	Sequence (A/D)	Table Name (Alternating Table)	Length of Table Entry: Packed(P)	Decimal Pos.	Sequence (A/D)	Comments
01Ø	E	RAFLIMIT	DISKIN										
02	E												

Figure 112. Processing a Part of the Indexed-Sequential File

fixed-length; it has a block length of 80, and each record is 80 characters in length. The length of each record-address field is 6 characters.

Because the File Extension sheet is required to relate the RAF to the DASD file, an E is entered in Extension Code (column 39). On the File Extension sheet the coding illustrates that RAFLIMIT is to provide the addresses for DISKIN.

RANDOM PROCESSING OF AN INDEXED-SEQUENTIAL FILE

An indexed-sequential file may be processed randomly by supplying an RAF. Instead of supplying the limits (as in the case of sequential processing), the RAF contains the record key of each record of the file to be processed.

Figures 113 and 114 illustrate the specifications for this type of organization. In this example, the first record from the record-address file is read. The first RAF entry ADAMS is used to obtain the data record whose record key is ADAMS. The record is retrieved and is processed. The next entry, CABOT, is then used to find the next data record.

PROCESSING FILES WITH DIRECT ORGANIZATION

A file with direct organization must reside on a direct access storage device. Records are retrieved from this file by using relative track address and record key or record identification.

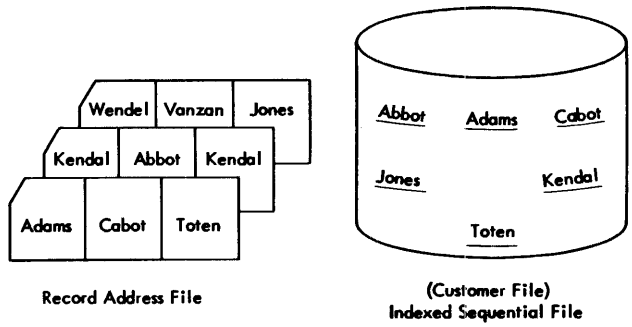

Figure 113. Randomly Processing an Indexed-Sequential File

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Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/I	I/D/T	Overflow Indicator	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
01	F	DISKIN	I	P		F	F	150	150	R		K	I	1		DISK11		S			
02	F	RAFRANDM	I	R		F	F	80	80		06				E	READ40					
03	F																				

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Line	Form Type	Record Sequence of the Chaining File: Number of the Chaining Field: From Filename	To Filename	Table Name	Number of Table Entries Per Record: Number of Table Entries: Per Table	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Table Name (Alternating Table)	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Comments
01	E	RAFRANDM	DISKIN												
02	E														

Figure 114. Processing an Indexed-Sequential File Randomly, Using an RAF

Direct organization is specified by a D in column 32 of the File Description sheet. The mode of processing is random, and an R in column 28 indicates random processing. If the record key is used to obtain the records, enter a K in column 31. If a record ID is used, enter an I in column 31.

When an RPG program processes an input file of this organization, an RAF must be supplied. The necessary steps must be supplied which convert the data fields contained in the RAF to the relative track address and the record key or record ID to be retrieved. The conversion routine depends, of course, on the way a particular data field can be converted to the track address of the record.

The conversion routine is unique, according to the needs of a particular installation. It may be nothing more than supplying the information without any calculations. To retrieve records from the file, some data fields must be converted to produce the relative track address of the record.

Supplying Data to be Converted

One entry in the RAF is supplied for each record to be retrieved. The data supplied by the RAF should be such that the relative track address and the record key or record identification can be derived. Because the RAF is not described on the input specifications, the entries in the RAF will be made available consecutively in a field called CONTD. This field is always alphameric, and it has the record length as specified in columns 29-30 of the File Description Specifications sheet.

NOTE: The field CONTD is always predefined by RPG as an RPG Label (RLABL)

Associating a Particular Conversion Routine with RAF

The File Extension specifications describing the RAF contain a field name in columns 27-32. This name is used as Factor 1 on the calculation specifications with the first specification of the conversion routine.

Methods for Specifying a Conversion Routine

Two methods of specifying a conversion routine to RPG are available:

1. The conversion routine is written on the Calculation Specifications sheet, or
2. The conversion routine can be written as an independent routine that must be combined with the generated object program.

The first specification of the conversion routine defines the type of conversion by means of the operation codes RPGCV or EXTCV. If the conversion routine is coded on the Calculation Specifications sheet, RPGCV is specified. If the conversion routine is external to the RPG language, EXTCV is specified.

External Conversion Routine

If the conversion routine is external to the RPG language, Factor 2 must contain the name (or label) of the user-supplied routine. This external conversion routine must follow the same conventions which are specified for the EXIT routine. See Use of Registers in this publication.

The Result Field must contain the name (or label) of the field, in the subroutine, which will contain the track address of the record to be retrieved. This is the result of the conversion.

Defining the Key or ID Field

Regardless of whether an RPG or an external conversion routine is specified, if record key retrieval is used (rather than record ID) the next calculation specification entry must define the field that will contain the record key.

The operation code is KEYCV, (a K in column 31 of the File Description sheet). The Result Field must contain the name (or label) of the field which will contain the actual record key used to locate the record.

If record ID retrieval is used, an operation code entry is not required. However, the File Description Sheet must contain an I in column 31.

In either key or ID retrieval, the result field of EXTCV or RPGCV must be a relative track address in the form TTR.

Conversion Operation Codes

The operation codes which follow are used in conjunction with conversion routines. If there are several conversion routines in the program, these codes are repeated.

RPGCV. This operation code indicates that the conversion routine is coded on the RPG calculation sheet.

ERPGC. This entry terminates the RPG conversion step entries that have been coded on the calculation sheet.

EXTCV. This entry indicates that the conversion routine is supplied by the user in a separate subroutine which is external to the RPG language.

KEYCV. This entry declares that the field specified in Result Field will contain the record key to be used with the relative track address. This entry must follow the RPGCV or EXTCV entry.

In the example shown in Figures 115 and 116 the data supplied in the RAF is both the record key and the data to be converted. The conversion routine shows how this field is then separated into two elements.

The field CONTD contains the 14-character field from the RAF. The first 9 characters contain the customer name which is used as the key. The remaining 5 characters contain a code for calculating the track address of the customer's record. Line 04 of the Calculation Specifications sheet (Figure 116) moves the first part of CONTD to the key field (KEYFLD) and line 05 moves the remaining part to the work field (WORKFD). The alternating table on TABFIL is used to convert this 5-character code to the 3-character relative track address that is moved to the field TRKADR.

Figure 117 shows how the calculation specifications would be coded if the conversion routine were external to the RPG language.

CREATING RECORD ADDRESS FILES (RAF)

General Information

A record-address file is one of the ways by which the necessary information to retrieve records from nonsequential files is supplied to the RPG program. Two types of record-address files may be used:

1. For random processing of a file with indexed-sequential organization or of a file with direct organization.
2. For sequential processing between limits, of a file with indexed-sequential organization.

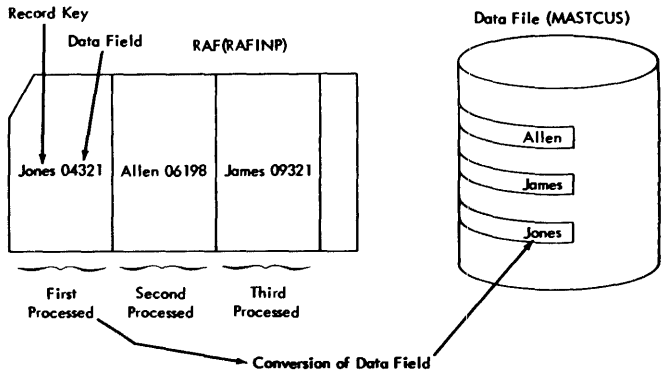


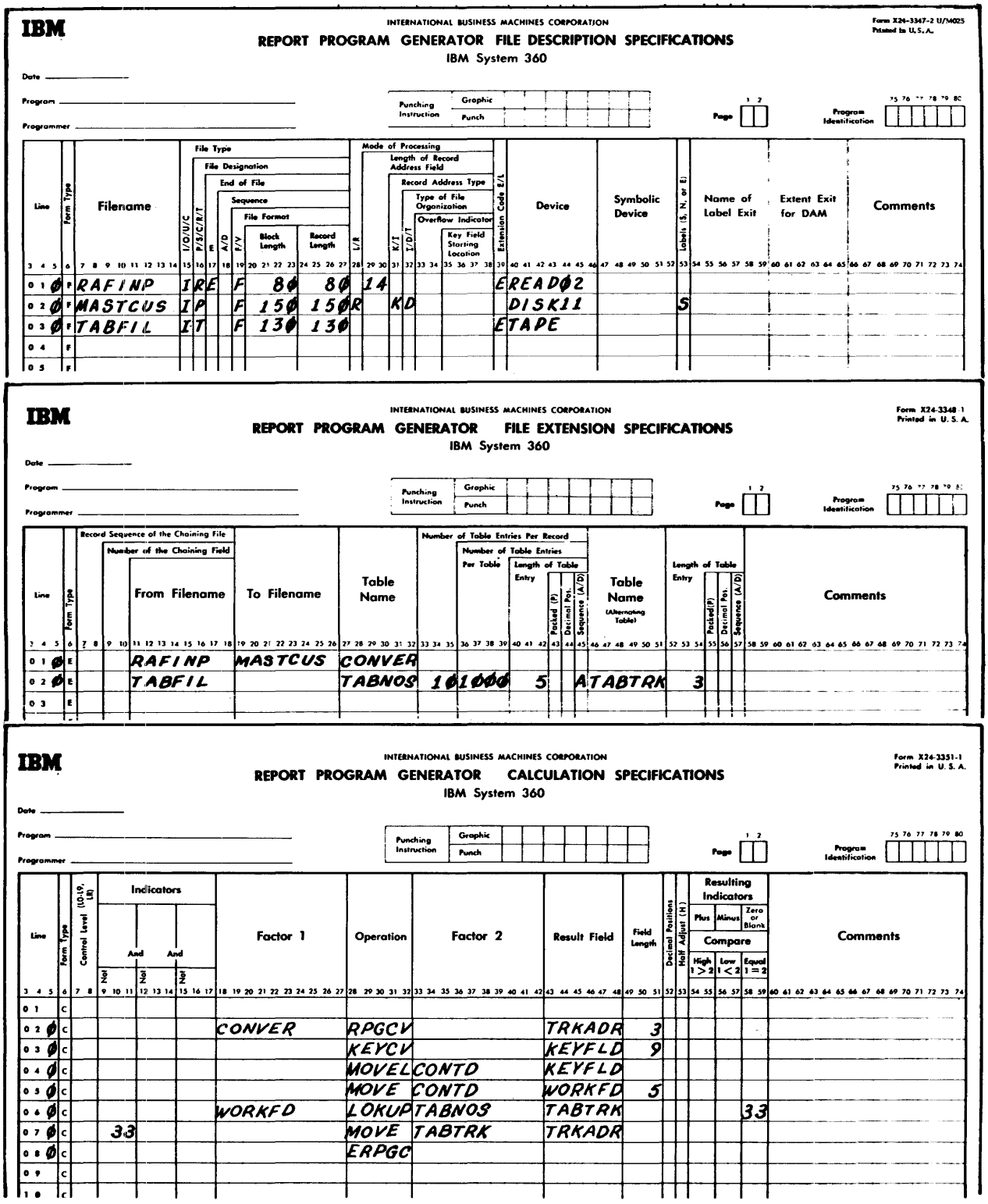
Figure 115. Conversion of a Record Address File

Only one RAF may be specified for an RPG program. An RAF is processed sequentially, and it must be on a file with sequential organization. An RAF is described on the File Description sheet and the File Extension sheet, but it is not described on the Input Specifications sheet.

Random Processing of Indexed-Sequential or Direct Organization

These rules must be followed when creating an RAF for random processing:

1. For indexed-sequential organization, the record-address field contains the record key.
   For a direct organization, each entry in the RAF must consist of a field to be converted to the track address and to either the record key or the record ID.
2. The record addresses must begin in position 1 of the record and continue without blank spaces between the record-address fields.
3. The length of the field must be the same for all records. The numeric fields must always be unpacked.
4. The number of field entries in a record may vary. A blank field, which is equal in length to the record-address field, will cause the RPG program to read the next record in the RAF.



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Program Identification

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/T	Y/D/T	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
010	F	RAFINP	I	R	E		F	80	80		14			E	READ02					
020	F	MASTCUS	I	P			F	150	150	R		KD			DISK11		S			
030	F	TABFIL	I	T			F	130	130					E	TAPE					
040	F																			
050	F																			

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Line	Form Type	Record Sequence of the Chaining File	Number of the Chaining Field	From Filename	To Filename	Table Name	Number of Table Entries Per Record	Number of Table Entries Per Table	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Table Name (Alternating Table)	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Comments
010	E			RAFINP	MASTCUS	CONVER												
020	E			TABFIL		TABNOS	10	1000	5			A	TABTRK	3				
030	E																	

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Program

Programmer

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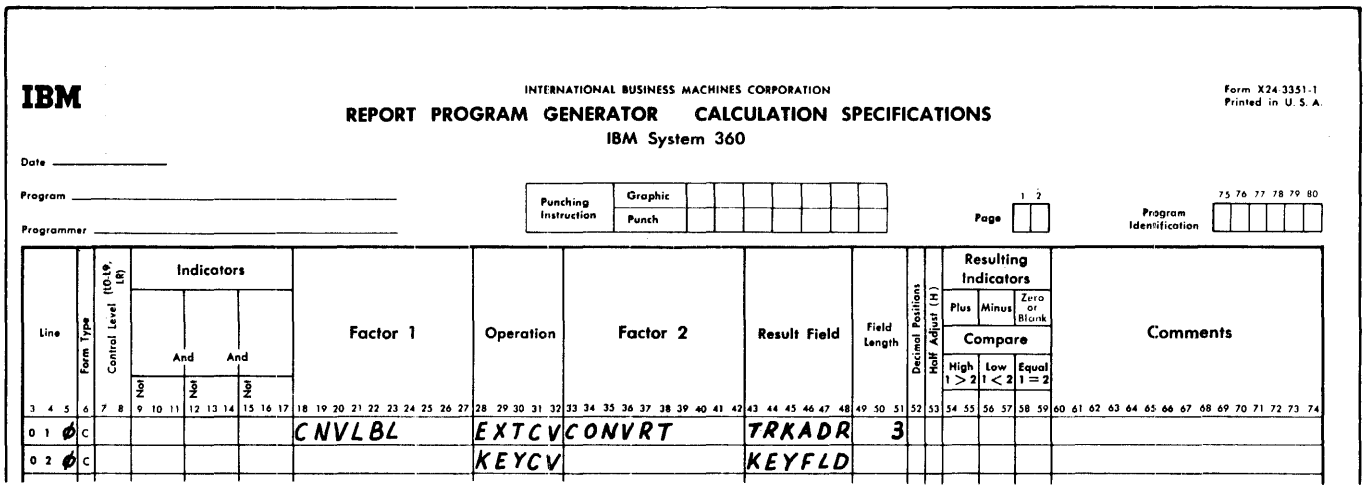
Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And Not	Indicators: And Not	Indicators: Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Resulting Indicators: Minus	Resulting Indicators: Zero or Blank	Compare: High 1>2	Compare: Low 1<2	Compare: Equal 1=2	Comments
010	C																		
020	C					CONVER	RPGCV		TRKADR	3									
030	C						KEYCV		KEYFLD	9									
040	C						MOVEL	CONTD	KEYFLD										
050	C						MOVE	CONTD	WORKFD	5									
060	C					WORKFD	LOKUP	TABNOS	TABTRK									33	
070	C		33				MOVE	TABTRK	TRKADR										
080	C						ERPGC												
090	C																		
100	C																		

Figure 116. Specifying Conversion on the Calculation Sheet



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Line 3 4 5	Form Type 6	Control Level (10-19, LR) 7 8	Indicators: And / Not 9 10 11	And / Not 12 13 14	And / Not 15 16 17	Factor 1 18 19 20 21 22 23 24 25 26 27	Operation 28 29 30 31 32	Factor 2 33 34 35 36 37 38 39 40 41 42	Result Field 43 44 45 46 47 48	Field Length 49 50 51	Decimal Positions 52	Half Adjust (H) 53	Resulting Indicators: Plus / Minus / Zero or Blank	Compare: High 1>2 / Low 1<2 / Equal 1=2 54 55 56 57 58 59	Comments 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
01	C					CNVLBL	EXTCV	CONVRT	TRKADR	3					
02	C						KEYCV		KEYFLD						

Figure 117. Specifying a Conversion Routine which is not on the Calculation Sheet

Processing Limits of an Indexed-Sequential Organization

When an RAF is used to indicate what limits of a file (with Indexed-Sequential Organization) are to be processed, the following rules must be observed:

1. Only two record-address entries can be in each record.
2. The record-address entry must begin in position 1 of the record. The first entry indicates the low limit of the file to be processed. The second entry indicates the upper limit of the file. The program processes from the lower limit to the upper limit.
3. The second entry of the record must begin in the position immediately following the first entry. No blank spaces are allowed.

Multiple input files may be processed using either the matching record technique or chaining. These two concepts are discussed here.

SEQUENTIAL PROCESSING OF MULTIPLE INPUT FILES (MATCHING)

The Matching Fields entry, (entered in columns 61-62 on the Input Specifications sheet) determines which records of a secondary file are to be processed. Both files are processed sequentially. The following rules apply to the Matching Fields entry.

1. There can be three matching field specification entries (M1, M2, and M3) per record.
2. The locations of the matching fields within a record type of a file must remain fixed.
3. When there is more than one record type in an input file, the locations of the matching fields in the various types need not be the same.
4. Not all the record types in a file must have a matching field. If an entire file is specified without matching fields, it will be read completely and processed first.
5. If M1, M2 and M3 are specified in the primary file, M1, M2, and M3 must be specified in the secondary file. Incorrect results will be obtained if the same number of matching fields is not specified. For example, Figure 118 shows three record types. Record type AA has two matching fields, and record type BB has two matching fields. If record type BB has three fields, incorrect results would be obtained. Record type CC has no matching fields (refer to rule 4).

The following example may be used to illustrate how the Matching Fields specification is used in conjunction with primary and secondary files. Assume that two files (in sequential organization) are used as shown in Figure 119. The primary file has records which contain heading and rate

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Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
010	I	PRIMARY	AA			01	75		D	3											1	20		NAME	L1						
020	I																				22	30		AMT							
030	I																				35	45		CUSTNO		M1					
040	I																				46	49		ACCNT		M2					
050	I																														
060	I	TRANSFILBB				02	80	2	-												5	25		CUSNAM							
070	I																				40	50		NUMBR		M1					
080	I																				1	4		DEPT							
090	I																				52	70		ADDRS							
100	I																				76	79		SALSAC		M2					
110	I																														
120	I	INVOICE	CC			03	30	CX													12	20		PARTNO							
130	I																				21	25		PARTDS							
140	I																				27	33		ONHAND							
150	I																				35	45		ORDERS							
160	I																														

Figure 118. Matching Fields Entries

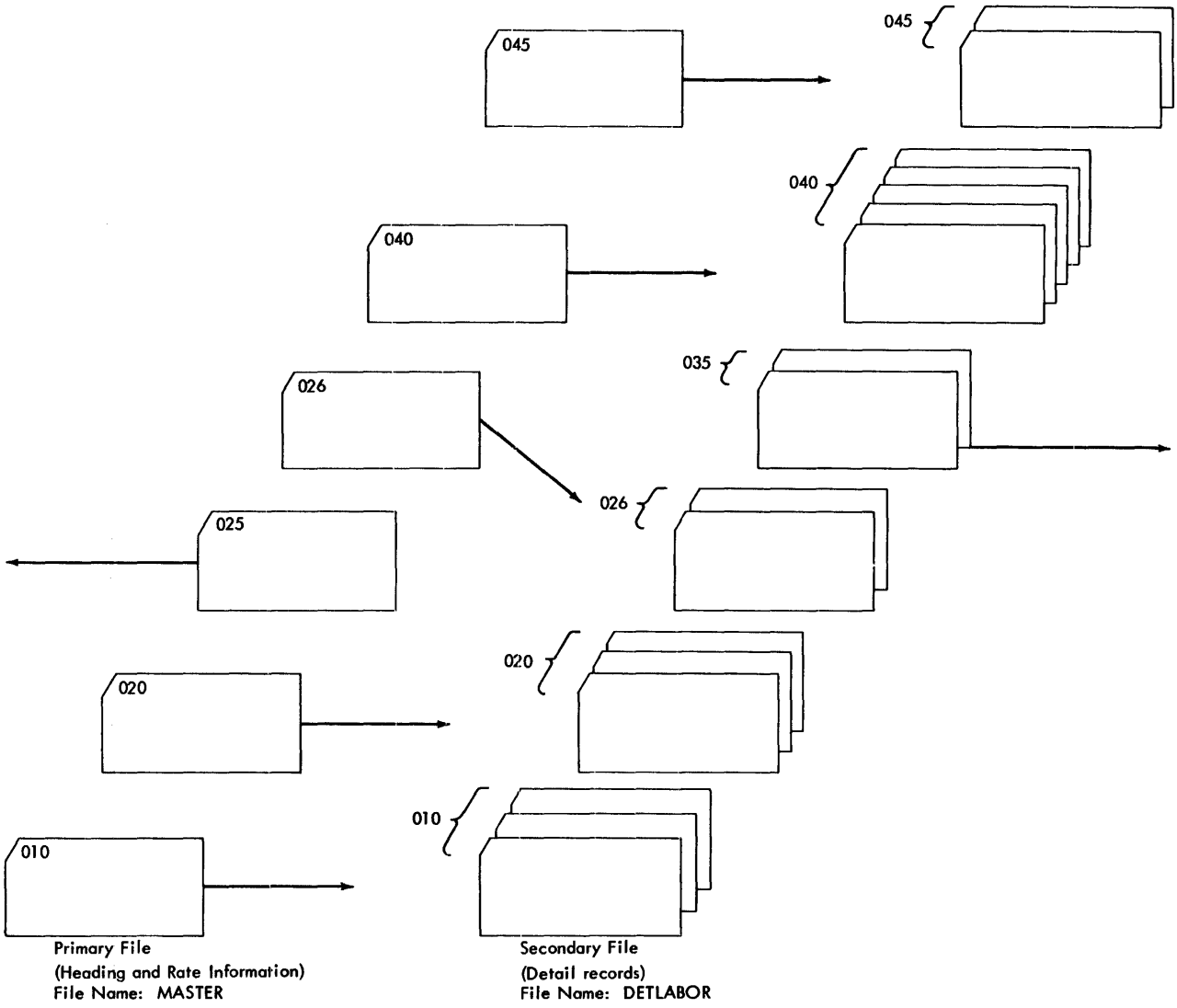

Figure 119. Two Input Files with Matching Records

information. The secondary file contains detailed information which supplements the primary file.

The input specifications required to match these records are shown in Figure 120.

The specifications M1 and M2 cause each detail record to be compared against the primary file's record that has just been read. The fields **DIVSON** and **DETDIV** in both files are identified by M2; the field department (**DEPT** and **DETDEP**) in both files is identified by M1.

Matching Record Indicator

The matching field entries of M1 and M2 (and also M3) have an associated internal indicator MR (Matching Record). This indicator, which is similar to a resulting indicator, is used to control functions specified on the Calculation and Output-Format Specifications sheets.

The MR Indicator is turned on when a record of a secondary file matches a record of the primary file. It remains on during

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Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C,Z,D	1: Character	2: Position	2: Not (N)	2: C,Z,D	2: Character	3: Position	3: Not (N)	3: C,Z,D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
010	I	MASTER	AA			16	80		Z	K																					
020	I																				1	18		DESC							
030	I																				19	23		RATE							
040	I																				24	27		DEPT	L2	M1					
050	I																				28	31		DIVSON	L3	M2					
060	I																														
070	I	DETLABORBB				14	35		D	5	80	N	Z	K																	
080	I																				1	4		DETDIV	L3	M2					
090	I																				5	8		DETDEP	L2	M1					
100	I																				9	14		EMPNO							
110	I																				15	28		NAME							
120	I																				46	50	0	FLDA							
130	I																				56	60	0	FLDB							
140	I																				66	70	0	FLDC							

Figure 120. Specifying Matching Fields

the complete processing of the record, and it is turned off when all total calculations and printing that may be caused for this record are completed.

If, as in Figure 119, a detail record does not have a matching primary record (card 035) or if a master record does not have a matching detail record (card 025), the indicator MR is not turned on.

This indicator can be used on the calculation specifications to prevent calculations upon a detail record contained in the secondary file. It could also be used on the output specifications to select unmatched detail cards.

The Matching Fields specification can be used even though not all of the record-types in the file contain the fields used for matching. When these record types are specified on the input sheet, the Matching Fields specification is left blank. This indicates to the program that these records types do not need to be checked for a matching field. These records are processed immediately after any total operations whose conditions are satisfied.

Matching Fields Specified as Numeric or Alphameric

Numeric

If a field, that is used as a matching-record field, has been specified as a numeric field (an entry has been made in Decimal Position) and it is not a packed field, all zone-bits in all positions of the record are removed before the comparison of matching fields is made.

Alphameric

If a field used as a matching record field has been specified as an alphameric field (blank decimal positions), no zone-bits are removed from the record before the comparison is made.

Sequence of Assigning Matching Fields

One, two, or three fields can be matched in one operation. However, if more than one

field is matched, the designations of M3, M2, and M1 must be assigned in the same sequence in which the fields are to be arranged for matching. M3 is assigned to the highest-order field, M2 to the next lower-order field, and M1 to the lowest-order field.

For example, in Figure 120, only two fields are matched. M1 is assigned to DEPT which is the low-order matching field, and M2 is assigned DIVSON, which is the high-order matching field.

The position in the record of the fields to be matched does not have to be the same in both files. For example, in Figure 120, the field DETDIV is located in positions 1-4 of the detail records, and the field DIVSON is located in positions 28-31 of the rate-header records.

Order of Processing Matched Records

Figure 121 illustrates a primary and a secondary file. The records in the two files will be processed according to four possibilities:

1. Whenever there is a matching primary record.
2. Whenever there is a matching secondary record.
3. Whenever there is an unmatched primary record.
4. Whenever there is an unmatched secondary record.

In Figure 121, indicator 01 is turned on whenever there is a primary record. Indicator 02 is turned on whenever there is a secondary record. Thus,

1. A matching primary record will be coded 01 and MR.
2. A matching secondary record will be coded 02 and MR.
3. An unmatched primary record will be coded 01 and NMR.
4. An unmatched secondary record will be coded 02 and NMR.

The order in which the primary file and the secondary file are processed is shown below. Sample Program Two uses the matching field specifications.

Primary File		Secondary File	
Matching Field In The Record	Processed	Matching Field In The Record	Processed
001	1st	001	3rd
001	2nd	001	4th
002	5th	002	6th
004	9th	003	7th
004	10th	003	8th
006	12th	005	11th

If more than one secondary file is specified, the secondary files will be processed in the sequence they are specified in the Input Specifications sheet.

NOTE: Input Specifications for each file must be in the same sequence as specified on the File Description Specifications sheet.

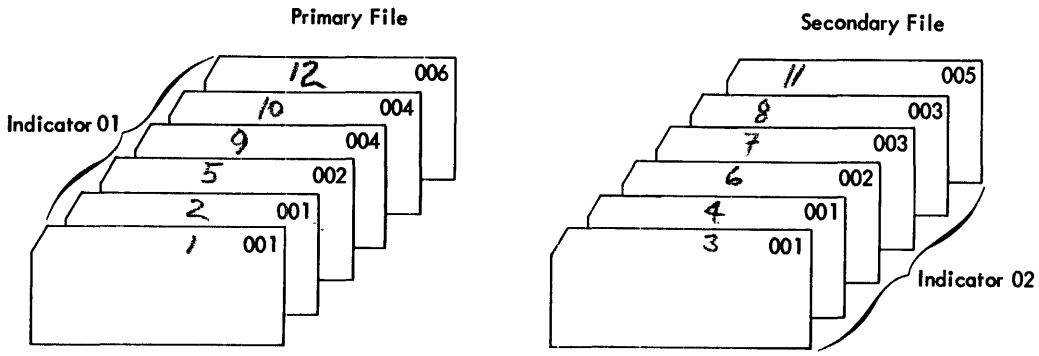


Figure 121. Order of Processing Matched Records

RANDOMLY PROCESSING MULTIPLE INPUT FILES (CHAINING)

To understand chaining, assume that an input file, as shown in Figure 122, contains information about transactions made with several customers. The card file contains the customer's number, but it does not contain his name, address, or balance. Another file called MASTCUS (Master Customer File) contains information about each customer. The RPG object program has the ability to use the second file, when preparing a customer report.

The master customer file has indexed-sequential organization, and it is to be processed randomly. The record key in each disk record contains the customer's numbers. The field in the transaction file, which contains the customer's number, can be used to chain the files together. The object program takes the customer's number and locates the record with the same record key. The additional information, such as the customer's name, address, balance, etc., is associated with each record key, and it is immediately available for processing.

The field which links or chains a record of one file to a record in another file is called a chaining field. The transaction file (CARDIN) is called the chaining file. The master customer file (MASTCUS) is the chained file because it is linked to the transaction file.

Up to nine chaining fields may be specified. The chaining fields can be located in one or more files. The chaining fields are designated by entering C1 through C9 in columns 61-62 of the Input Specifications sheet.

NOTE: There is no specific relationship between levels C1-C9 other than specifying the nine possibilities for chaining fields.

Chaining Example

Figure 123 illustrates coding used for chaining the transaction file CARDIN to the customer file MASTCUS.

File Description Specifications

On the File Description sheet, the card file is considered the primary file. When CARDIN is depleted, the program goes to the end-of-job routine (E in column 17).

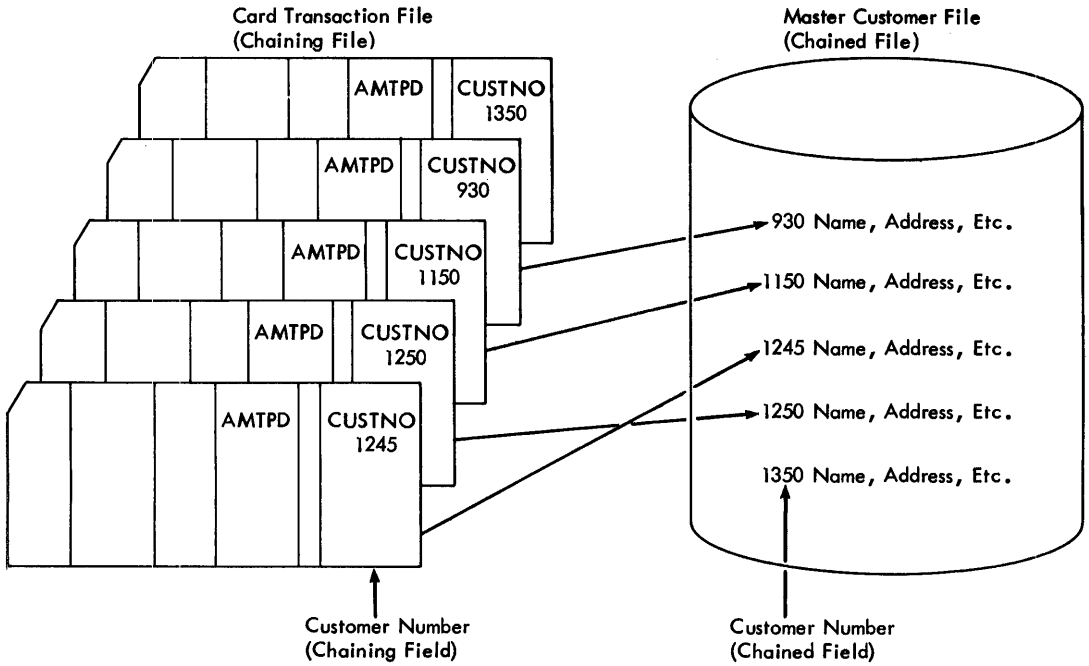
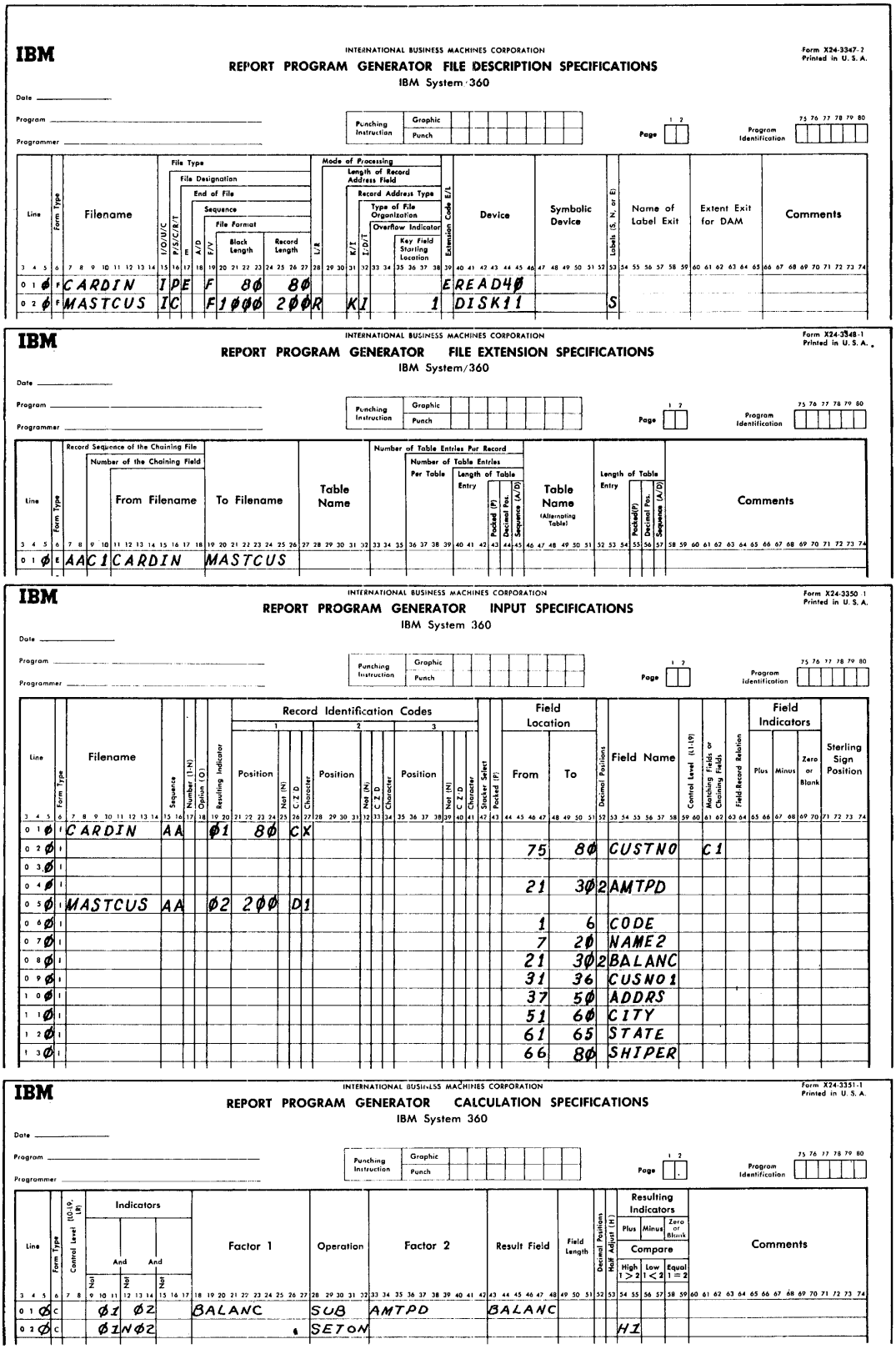


Figure 122. Using Chaining to Process an Indexed-Sequential File



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REPORT PROGRAM GENERATOR FILE DESCRIPTION SPECIFICATIONS

IBM System/360

Form X24-3347-2
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Date
Program
Programmer
Punching Instruction: Graphic / Punch
Page
Program Identification

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/E	L-D/T	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
010	F	CARDIN	I	P	E		F	80	80					E	READ40					
020	F	MASTCUS	I	C			F	1000	200	R	K	I	1		DISK11		S			

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REPORT PROGRAM GENERATOR FILE EXTENSION SPECIFICATIONS

IBM System/360

Form X24-3348-1
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Date
Program
Programmer
Punching Instruction: Graphic / Punch
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Program Identification

Line	Form Type	Record Sequence of the Chaining File	Number of the Chaining Field	From Filename	To Filename	Table Name	Number of Table Entries Per Record	Number of Table Entries	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Table Name (Alternating Table)	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Comments
010	E	AA	C1	CARDIN	MASTCUS													

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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System 360

Form X24-3350-1
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Date
Program
Programmer
Punching Instruction: Graphic / Punch
Page
Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C.Z.D	1: Character	2: Position	2: Not (N)	2: C.Z.D	2: Character	3: Position	3: Not (N)	3: C.Z.D	3: Character	Stacker Select	Packed (P)	Field Location From	Field Location To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field Record Relation	Field Indicators Plus	Field Indicators Minus	Field Indicators Zero or Blank	Sterling Sign Position
010	I	CARDIN	A	A		01	80		C	X																					
020	I																				75	80		CUSTNO		C1					
030	I																														
040	I																				21	30	2	AMTPD							
050	I	MASTCUS	A	A		02	200		D	1																					
060	I																				1	6		CODE							
070	I																				7	20		NAME2							
080	I																				21	30	2	BALANC							
090	I																				31	36		CUSNO1							
100	I																				37	50		ADDRS							
110	I																				51	60		CITY							
120	I																				61	65		STATE							
130	I																				66	80		SHIPER							

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System 360

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Date
Program
Programmer
Punching Instruction: Graphic / Punch
Page
Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators And	Indicators And	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators Plus	Resulting Indicators Minus	Resulting Indicators Zero or Blank	Compare High 1>2	Compare Low 1<2	Compare Equal 1=2	Comments
010	C		01	02	BALANC	SUB	AMTPD	BALANC										
020	C		01N02			SETON											HI	

Figure 123. Specifying Chaining

File Extension Specifications

The File Extension sheet contains the record sequence of the CARDIN file and the number of the chaining field.

Input Specifications

On the Input Specifications sheet, the two files are defined. CUSTNO is the field which chains the files.

Calculation Specifications

When chaining is used, the following situation may occur. A chaining record (for example, JONES) has no corresponding chained record. (JONES is not present in the chained file.) Such a situation may require special action by the program.

Indicators 01 and 02 are both on when a chaining record has a corresponding chained record. In this case 01 represents the chaining record, and 02 represents the chained record. When 01 and 02 are both on, AMPTD is subtracted from BALANC. However, if there is no corresponding record in the chained file (01N02), halt indicator H1 is turned on. Thus, the possibility of not having a corresponding record in the chained file is accounted for, and processing will terminate when this situation occurs.

NOTE: This example illustrates the only time that two resulting indicators (representing two different record types) can be on at the same time.

Additional Uses of Chaining

Figures 124 and 125 show two additional uses of chaining. In Figure 124, the card file contains two fields which are both used as chaining fields (salesman number and customer number). The field containing salesman number is chained to a file that is organized by salesman number. The field containing the customer's number is used to chain to the customer file.

In Figure 125, the card file is chained to the customer file. Within each customer record is a field which may be used to chain to another file. In this case, each record in the customer file contains an account number. The account number is used to chain to the account file.

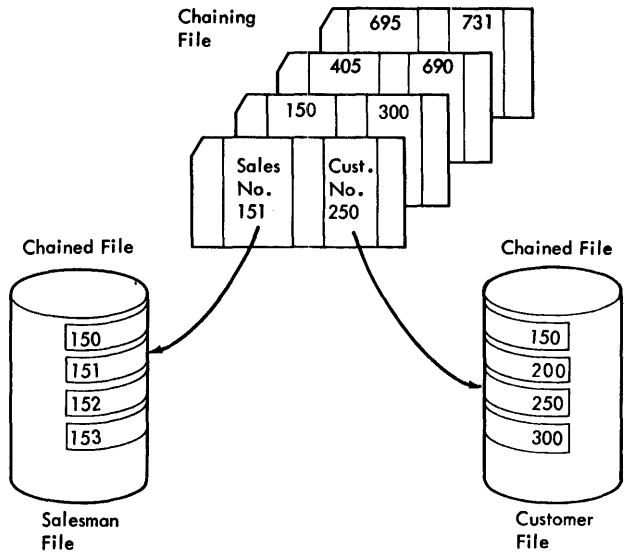


Figure 124. Chaining to Two Files

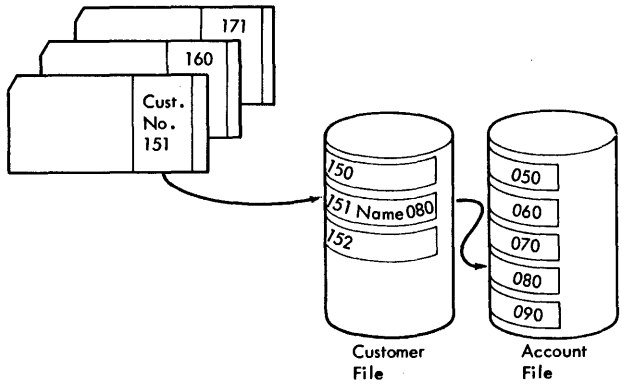


Figure 125. Using a Chained File as a Chaining File

Split Chaining Fields

Several fields that are not in adjoining positions in an input record can be specified as one chaining field. The fields are specified with the same chaining code (C1 for example) on the Input Specifications sheet, and the fields are then used as one chaining field. The fields are placed in the same sequence as they are defined on the Input Specifications sheet.

The first field defined on the input sheet is placed in the leftmost position, and the last field is placed in the rightmost position.

CONVERSION OF CHAINING FIELDS FOR DIRECT FILE ORGANIZATION

The data to be converted will be located in the fields designated as the chaining fields (Figure 126). The data field must be such that the record key or record ID can be derived from the conversion. The rules for conversion of a chaining field are the same as those for an RAF.

Figure 127 illustrates the conversion routine that converts the data contained in a chaining field (Figure 126) to the relative track address and record key of the record.

In this example, the conversion routine is coded on the Calculation Specifications sheet. On the File Description sheet, the two input files are described. TRANSREC is the primary file. MASTCUS is the DASD file that has direct organization and is

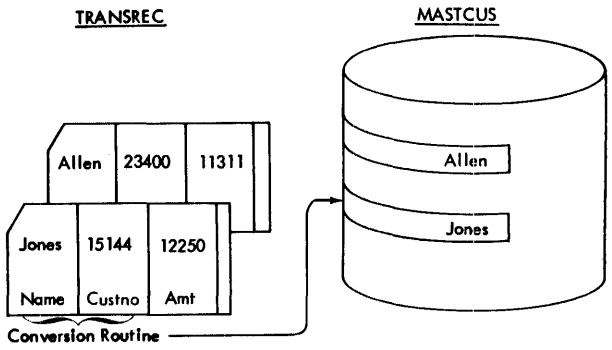


Figure 126. Specifying a Random Disk Address by Converting an Input Record (Chaining File)

processed randomly. Since in direct organization the key is separate from the data record, no entry is made in the Key Field Starting Location (columns 35-38). The conversion routine supplies the track address and the record key.

On the File Extension sheet, the record

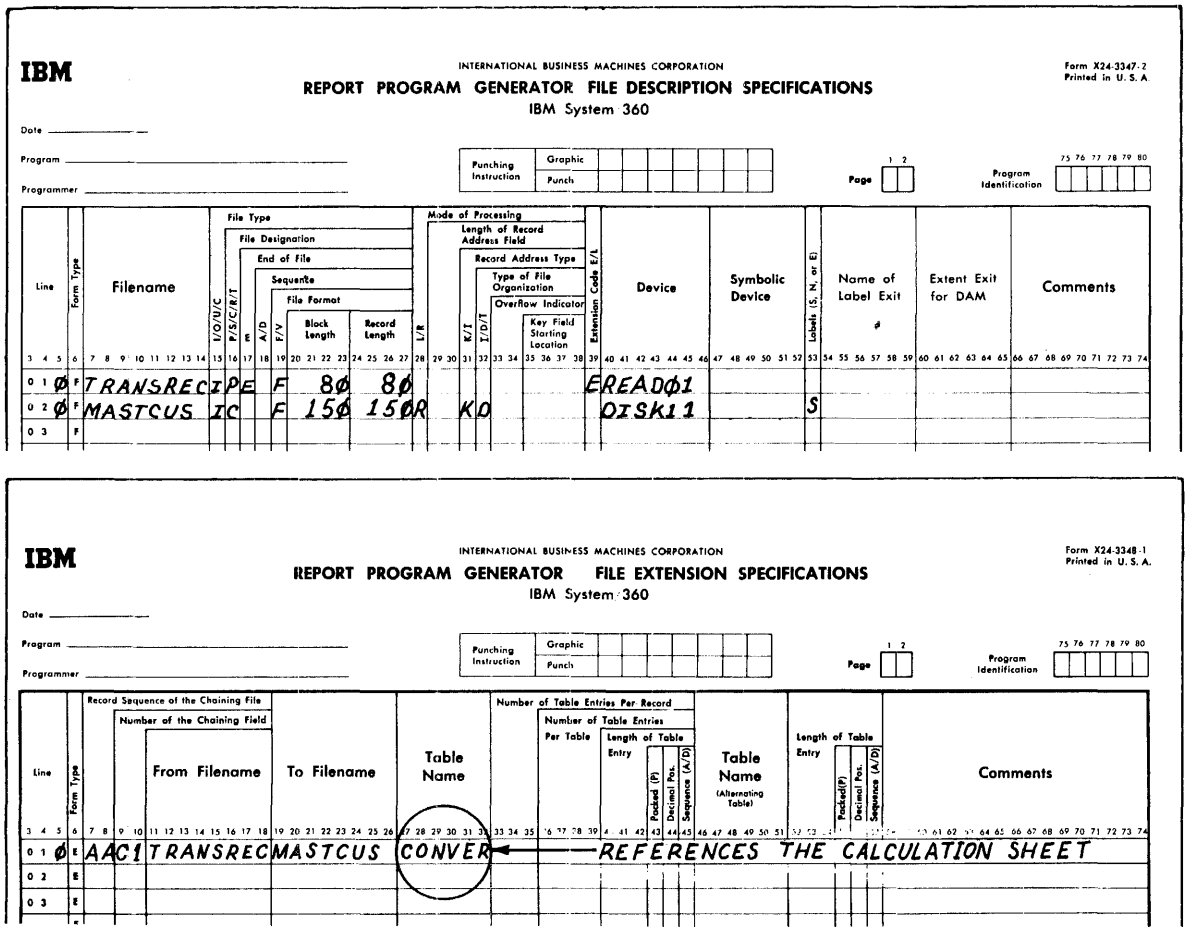
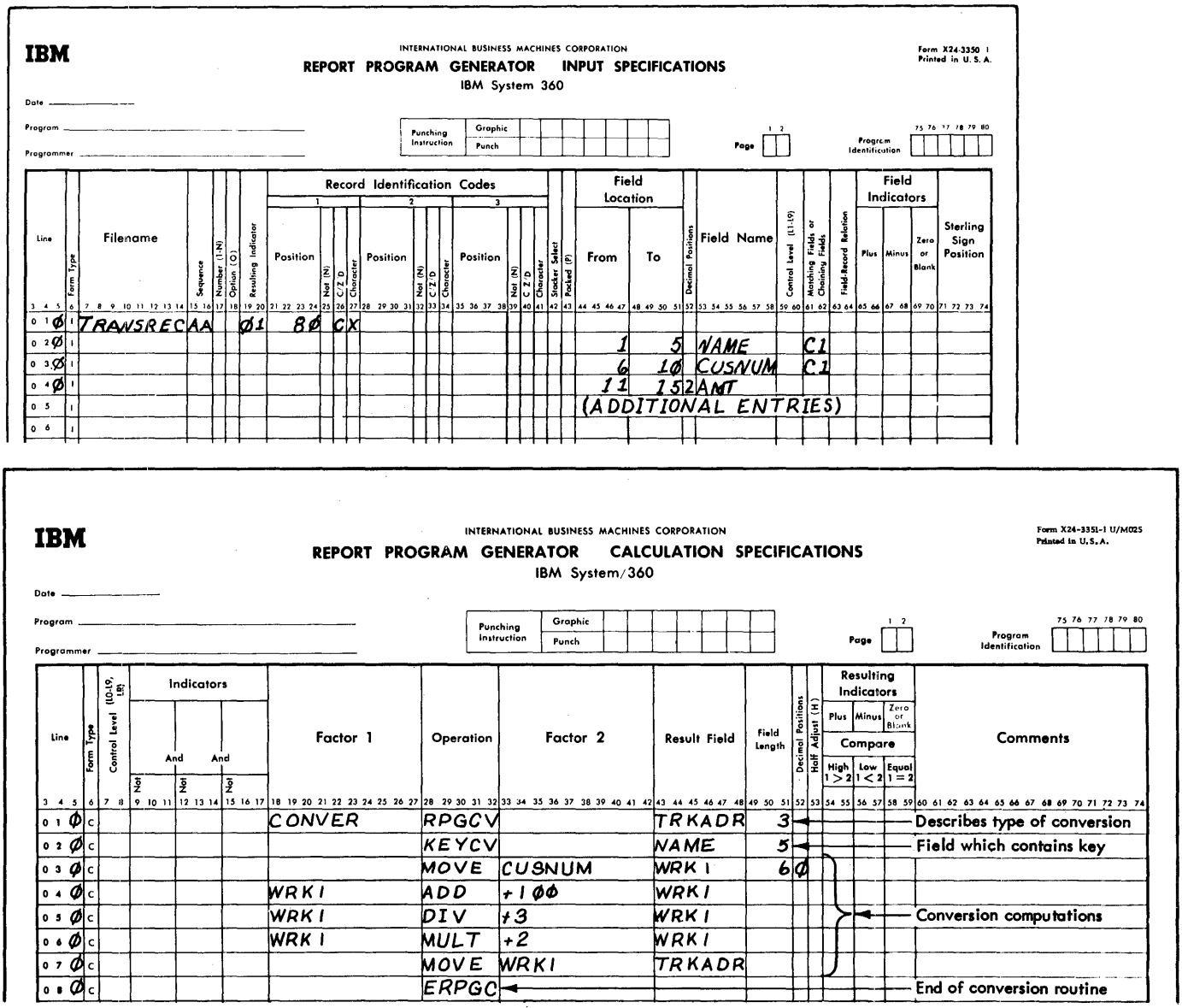


Figure 127. Conversion of a Chaining Field (Part 1 of 2)



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IBM System 360

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Date

Program

Programmer

Punching Instruction: Graphic / Punch

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Program Identification

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15 16	17	18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43	44 45 46 47	48 49 50 51	52	53 54 55 56 57 58	59 60	61 62	63 64	65 66	67 68	69 70	71 72 73 74
01Ø	I	TRANSRECAA				Ø1	8Ø		CX																						
02Ø	I																				1	5		NAME		C1					
03Ø	I																				6	1Ø		CUSNUM		C1					
04Ø	I																				11	152		AMT							
05	I																				(ADDITIONAL ENTRIES)										
06	I																														

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IBM System/360

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Date

Program

Programmer

Punching Instruction: Graphic / Punch

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Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And Not	Indicators: And Not	Indicators: And Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Resulting Indicators: Minus	Resulting Indicators: Zero or Blank	Compare: High 1>2	Compare: Low 1<2	Compare: Equal 1=2	Comments
3 4 5	6	7 8	9 10 11	12 13 14	15 16 17	18 19 20 21 22 23 24 25 26 27	28 29 30 31 32	33 34 35 36 37 38 39 40 41 42	43 44 45 46 47 48	49 50 51	52	53	54 55	56 57	58 59	60	61	62	60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
01Ø	C					CONVER	RPGCV		TRKADR	3									Describes type of conversion
02Ø	C						KEYCV		NAME	5									Field which contains key
03Ø	C						MOVE	CUSNUM	WRK1	6Ø									
04Ø	C					WRK1	ADD	+1ØØ	WRK1										Conversion computations
05Ø	C					WRK1	DIV	+3	WRK1										
06Ø	C					WRK1	MULT	+2	WRK1										
07Ø	C						MOVE	WRK1	TRKADR										
08Ø	C						ERPGC												End of conversion routine

Figure 127. Conversion of a Chaining Field (Part 2 of 2)

sequence of the chaining file (AA in column 17-18) is specified. The number of the chaining field is C1. Both AA and C1 are taken from the Input Specifications sheet. TRANSREC relates to MASTCUS, so these file names are entered in columns 11-18 and 19-26, respectively. The entry CONVER in columns 27-32 indicates that this label, when entered in Factor 1 of the Calculation Specifications sheet, specifies the conversion routine.

Two fields of the primary file, NAME and CUSNUM, are designated on the Input Specifications sheet as the chaining fields to be converted.

The conversion routine is coded on the Calculation Specifications sheet. The result field of the RPGCV entry (line 01Ø) defines the field which contains the relative track address. The customer number, CUSNUM, is converted to the relative track address (lines 04Ø-08Ø). The entry KEYCV defines the name of the field that contains the record key. In this example, the record key contains the customer's name which is obtained directly from the input data.

SUMMARY OF MULTIPLE FILE PROCESSING

RPG processes multiple files two ways:

1. Sequentially — by using the matching record technique
2. Randomly — by using the chaining technique

Figure 128 shows the processing possibilities for files which have Sequential, Indexed-Sequential, or Direct Organization.

The numbers 1, 2, and 3 refer to the major subjects listed below. The letters A, B, and C refer to the subgroups.

Files with Sequential Organization

1. A file with sequential organization is processed sequentially and controls the processing of records in:
   - A. Another Sequential Organization. Both files are processed sequentially, using matching records to govern processing.
   - B. An Indexed-Sequential Organization. If the file is processed sequentially, the matching-record technique is used to control processing of the indexed-sequential file.

     If the file is processed randomly, chaining fields in the sequential file specify which records in the indexed-sequential file are to be processed.
   - C. A Direct Organization. A direct organization is processed randomly, under control of the sequential file. The sequential file contains chaining fields which are converted to the relative track addresses of the records on the direct file.

Files with Indexed-Sequential Organization

2. A file with Indexed-Sequential Organization may be processed sequentially or randomly, and it controls processing of records in:
   - A. A Sequential Organization. The records in both files will be processed sequentially, using matching records to control processing.
   - B. Another Indexed-Sequential Organization. If the file is processed sequentially, matching records are used to control processing. (Both files are processed sequentially.)

     If the file is processed randomly, chaining fields are used to control processing.
   - C. A Direct Organization. Chaining fields in the indexed file are converted to supply the record locations in the direct file which is processed. The direct file is processed randomly.

Files with Direct Organization

3. A file with direct organization is processed randomly and controls processing of records in:
   - B. An Indexed-Sequential Organization. The indexed-file is processed randomly, and chaining fields in the direct file control processing of the indexed file.

     In both cases, the direct organization is processed randomly.
   - C. Another Direct Organization. Chaining fields contained within the direct file are converted to provide the location of the records in another direct organization. The records in both files are processed randomly.

Updating a DASD File

An RPG program may perform update processing of a DASD file. The file may be of either index-sequential or direct organization. The fields of records contained in the file may be changed, however, the size of the records may not be changed. It is not possible to add new records to a DASD file or to delete old records using RPG. Only records existing in the file may be processed. When an update file (U in Column 15 on the File Description sheet) is processed, only the fields to be updated must be entered on the Output-Format Specifications sheet. Although the entire record is to be retained, only the affected fields are entered on the output sheet.

		A	B	C
	From \ To	Sequential Organization	Indexed-Sequential Organization (DASD)	Direct Organization (DASD)
1	Sequential Organization	Sequential Processing (Matching)	Sequential Processing (Matching) or Random Processing (Chaining)	Random Processing (Chaining)
2	Indexed-Sequential Organization *	◘ Sequential Processing (Matching)	Sequential Processing ◘ (Matching) or Random Processing (Chaining)	Random Processing (Chaining)
3	Direct (DASD) Organization +	--	Random Processing (Chaining)	Random Processing (Chaining)

* A Record Address File may be used to supply the limits (in the case of sequential processing) or the actual Record Keys (in the case of random processing).
◘ The From File must be specified as sequential.
\+ A Record Address File is converted to supply the record locations on the DASD.

Figure 128. Processing Multiple Input Files

RPG JOB PROCESSING

The IBM System/360 Operating System (the operating system) consists of a control program and processing programs. The control program supervises execution of all processing programs, such as the RPG compiler, and all problem programs, such as an RPG program. Therefore, to execute an RPG program the programmer must first communicate with the operating system. The medium of communication between the programmer and the operating system is the job control language.

Job control language statements define two units of work to the operating system: the job and the job step. A job consists of executing one or more job steps. For example, three job steps are involved to compile, link edit and execute an RPG program.

1. Translate the source program into an object module by executing the RPG compiler component of the operating system.
2. Process the object module to produce a load module by executing the linkage editor component of the operating system.
3. Execute the compiled and link edited load module.

JOB CONTROL LANGUAGE

The RPG programmer uses the job control statements shown in Table 4 to compile, link edit, and execute programs.

These statements are discussed in this section as they are used to specify RPG job processing. A detailed explanation of each statement is given in IBM System/360, Operating System, Job Control Language.

Table 4. Job Control Statements

Statement	Function
JOB	Indicates the beginning of a new job and describes that job
EXEC	Indicates a job step and describes that job step; indicates the cataloged procedure or load module to be executed
DD	Describes data sets, and controls device and volume assignment
delimiter	Separates data sets in the input stream from control statements; it appears after each data set in the input stream

COMPILER PROCESSING

The names for DD statements (ddnames) relate I/O statements in the compiler with data sets used by the compiler. These ddnames must be used for the compiler. When the system is generated, names for I/O device classes are also established and must be used by the programmer.

Compiler Name

The program name for the RPG compiler is IESRPG. If the compiler is to be executed without using the supplied cataloged procedures in a job step (see Using Cataloged Procedures), the EXEC statement parameter, PGM = IESRPG, must be used.

Compiler ddnames

The compiler can use 7 data sets. To establish communication between the compiler and the programmer, each data set is assigned a specific ddname. Each data set has a specific function and device requirement. Table 5 lists the ddnames, functions, and device requirements for the data sets.

Table 5. Compiler ddnames

ddname	FUNCTION	DEVICE REQUIREMENTS
SYSIN	reading the source program	• card reader • intermediate storage
SYSPRINT	writing the storage map, listing, and messages	• printer • intermediate storage
SYSPUNCH	output data set for the object module deck	• card punch • intermediate storage
SYSUT1	work data set needed by the compiler during compilation	• direct-access • magnetic tape
SYSUT2	work data set needed by the compiler during compilation	• direct-access • magnetic tape
SYSUT3	work data set needed by the compiler during compilation	• direct-access • magnetic tape
SYSGO	output data set for the object module used as input to the linkage editor	• direct-access • magnetic tape

To compile an RPG source program, five of these data sets are necessary; SYSIN, SYSPRINT, SYSUT1, SYSUT2 and SYSUT3, along with the direct-access volume(s) that contains the operating system. With these five data sets, only a listing is generated by the compiler. If an object module is to be punched, a SYSPUNCH DD statement must be supplied. If an object module is to be passed to the linkage editor, a SYSGO DD statement must be supplied.

For the DD statement SYSIN or SYSPRINT or SYSPUNCH an intermediate storage device may be specified instead of the card reader or printer or card punch. The intermediate storage device can be magnetic tape or a direct access device.

If an intermediate device is specified for SYSIN, the compiler assumes that the source module deck was placed on intermediate storage by a previous job or job step. If an intermediate device is specified for SYSPRINT, the listing, and error/warning messages are written on that device; a new job or job step can print the contents of the data set. When the SYSPRINT data set is written on an intermediate storage device, carriage control characters are placed in the records.

Compiler Device Classes

Names for input/output device classes used for compilation are also specified by the operating system when the system is generated. The class names, functions, and types of devices are shown in Table 6.

The data sets used by the compiler must be assigned to the device classes listed in Table 7.

Table 6. Device Class Names

CLASS NAME	CLASS FUNCTIONS	DEVICE TYPE
SYSSQ	writing, reading, backspacing (sequential)	• magnetic tape • direct-access
SYSDA	writing, reading, backspacing, updating records in place (direct)	• direct-access
SYSCP	punching cards	• card punch
A	SYSOUT output	• printer • magnetic tape

Table 7. Correspondence Between Compiler ddnames and Device Classes

ddname	Possible Device Classes
SYSIN	SYSSQ, or the input stream device (specified by DD * or DD DATA)
SYSPRINT	A,SYSSQ
SYSPUNCH	SYSCP
SYSUT1	SYSSQ,SYSDA
SYSUT2	SYSSQ,SYSDA
SYSUT3	SYSSQ,SYSDA
SYSGO	SYSSQ,SYSDA

Compiler Options

Options are passed to the compiler through the PARM parameter in the EXEC statement.

PARM = [DECK / NODECK] [,LOAD / ,NOLOAD] [,LIST / ,NOLIST]

The programmer specifies the options which are defined as,

DECK The object module is placed on the device specified in the SYSPUNCH DD statement, (usually the card punch).

LOAD The object module is placed on the device specified in the SYSGO DD statement, (usually intermediate storage).

LIST An output listing is written on the device specified in the SYSPRINT DD statement, (see Compiler Output).

The prefix NO is used with any of these options to specify that the option is not wanted. If contradictory options are entered (e.g., LIST, NOLIST), the option with the prefix NO is used by the compiler.

The DECK option specifies that the compiler output (i.e., the object module) is written on the data set specified by the SYSPUNCH DD statement. NODECK specifies that no object module is written. A description of the deck is given in Compiler Output.

The LOAD option indicates that the object module is written on the data set specified by the SYSGO DD statement. This option must be used if a cataloged procedure to compile, link edit, and execute is used.

The NOLOAD option indicates that the object module is not written on a sequential data set. This option must not be used if a cataloged procedure to compile, link edit, and execute is used. If NOLOAD and DECK are specified, the resulting object deck may be used as input to the linkage editor.

If the LOAD and DECK options are specified, the object module is written on the two data sets, indicated by the SYSGO and SYSPUNCH DD statements.

If no options are specified, the RPG compiler assumes the default entry,

```
PARM=(NODECK,LOAD,LIST)
```

The cataloged procedures (see Cataloged Procedures) assume the default entry. However, the programmer may override any or all of the default options as described in Overriding Cataloged Procedures.

Compiler Output

The RPG compiler can generate a listing of the source specifications, diagnostic messages and a memory map showing the names and addresses of object program routines. The compiler can also produce on object module card deck (Figure 129).

The output listing (see Sample Program One) provides:

1. Listing of each specification with related statement number and error notes.
2. Resulting Indicator Table showing:
   a. Names of all RPG processor and user defined resulting indicators
   b. Address (6 places) of each defined resulting indicator
3. Field Name Table containing:
   a. Names of all fields
   b. Address (6 places) of each field. ENTRY or EXTERN type field names are denoted by ENTRY or EXTRN
4. Literal Table containing:
   a. All literals and edit words
   b. Address (6 places) of each literal or edit word

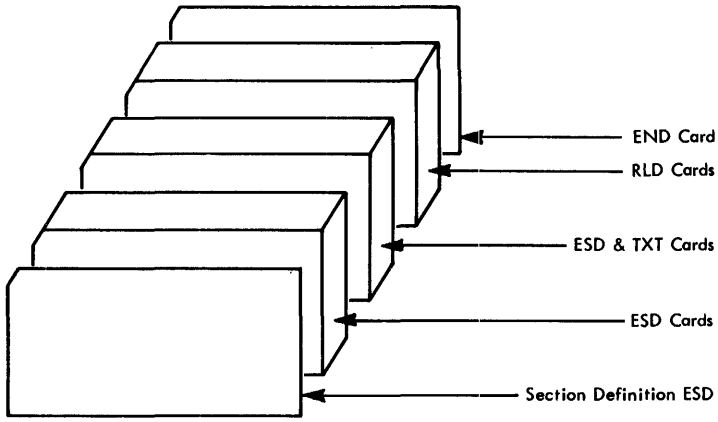


Figure 129. RPG Output Object Module Card Deck

5. Diagnostic listing of erroneous entries showing:
   a. Statement number
   b. Name of the erroneous field or resulting indicator
   c. Appropriate error note
6. Further specification diagnostics
   a. Statement number
   b. Appropriate error note
7. Diagnostic notes. Refer to Appendix G.
8. Memory Map listing names and addresses of RPG object program routines.
9. The length (in hexadecimal) of the compiled program not including the IOCS modules or any user subroutines.
10. END OF COMPILATION message.

Compiler Return Codes

Table 8 shows the return codes issued by the RPG compiler for use with the COND= parameter of JOB or EXEC statements.

LINKAGE EDITOR PROCESSING

The linkage editor processes RPG object modules, resolves any references to subprograms, and constructs a load module.

Table 8. Compiler Return Codes

Return Code	Explanation
0	no errors detected
4	minor errors detected; successful program execution is probable
8	errors detected; unsuccessful program execution is possible
12	serious errors detected; unsuccessful program execution is probable
16	critical errors detected; normal execution is impossible
20	unrecoverable I/O error occurred during compilation; compilation terminated
24	specified program interruption exit. For details refer to IBM System/360, Operating System, Control Program Services.

Note: the COND= parameter is explained in the Job Control Language publication.

To communicate with the linkage editor, the programmer supplies an EXEC statement and DD statements that define all required data sets; he may also supply linkage editor control statements.

Linkage Editor Name

The program name for the linkage editor is IEWL. If the linkage editor is executed without using cataloged procedures in a job step, the EXEC statement parameter, PGM= IEWL, must be used.

Linkage Editor Input and Output

The modules that are processed by the linkage editor are contained in data sets as

1. Primary input data set (principal input)
2. Call library (for automatic library call)
3. Additional primary input or call library data sets

The primary input data set is required for all linkage editor job steps. The call library is defined only if the automatic library call function is used. (Refer to IBM System/360, Operating System, Linkage Editor.) Additional sequential data sets or partitioned data sets are defined only as required.

The primary input is a sequential data set that contains object modules and linkage editor control statements. In an RPG compile, link and execute job the primary input data set contains the object modules produced by the job steps. The primary input can be a chain of sequential data sets. A library member can be specified on a DD statement to be processed as a sequential data set. For details refer to IBM System/360, Operating System, Job Control Language. The primary input data set must be specified by the ddname SYSLIN.

The linkage editor can accept input from other than the primary input source. Additional input sources such as user subroutines can be specified by the INCLUDE statement or automatic library call. For details of linkage editor control statements refer to IBM System/360, Operating System, Linkage Editor. Variations to incorporate user subroutines are discussed in Executing RPG — Input Stream Variations.

The output of the linkage editor is always placed in a PDS. Error messages and optional diagnostic messages are written on an intermediate storage device or a printer. In addition, a work data set is required by the linkage editor to do its processing.

Linkage Editor ddnames and Device Classes

The programmer communicates data set information to the linkage editor through DD statements identified by specific ddnames (similar to the ddnames used by the compiler). The ddnames, functions, and requirements for data sets are shown in Table 9.

Any data sets specified by SYSLIB or SYSLMOD must be partitioned data sets. (Additional inputs are partitioned data sets or sequential data sets.) The ddname for the DD statement that retrieves any additional libraries is written in INCLUDE and LIBRARY statements and is not fixed by the linkage editor.

The device classes used by the compiler (see Table 6) must also be used with the linkage editor. The data sets used by linkage editor may be assigned to the device classes listed in Table 10.

Table 9. Linkage Editor ddnames

ddname	FUNCTION	DEVICE REQUIREMENTS
SYSLIN	Primary input data, normally the output of the compiler	• direct access • magnetic tape • card reader
SYSLIB	automatic call library	• direct access
SYSUT1	work data set	• direct access
SYSPRINT	diagnostic messages	• printer • intermediate storage device
SYSLMOD	output data set for the load module	• direct access
user-specified	additional libraries and object modules	• direct access • magnetic tape

Table 10. Correspondence Between Linkage Editor ddnames and Device Classes

ddname	Possible Device Classes
SYSLIN	SYSSQ, SYSDA, or the input stream device (specified by DD* or DD DATA)
SYSLIB	SYSDA
SYSUT1	SYSDA
SYSLMOD	SYSDA
SYSPRINT	A, SYSSQ
user-specified	SYSDA, SYSSQ

LOAD MODULE EXECUTION

Execution ddnames

In the RPG source program the File Description specifications entries are used to identify the data sets (files). Data sets processed by the RPG load module must be defined by DD statements. The relationship is established between the data set defined in the source program and the DD statement by the ddname. The ddname must be the same as the entry in Filename (columns 7-14) on the File Description Specifications sheet.

Execution Object Module Cancellation

During execution of the load module (object program), job processing is cancelled when a halt indicator (H0-H9) is detected on (see Halt Indicators).

Execution Return Codes

Table 11 shows the return codes issued by the RPG load module (object program) for use with the COND= parameter of the JOB or EXEC statements.

USING CATALOGED PROCEDURES

Because writing job control statements can become time-consuming work for the programmer, IBM supplies three cataloged procedures to aid in the compiling, link editing, and executing of RPG programs.

Compile

The cataloged procedure for compilation is RPGEC. It is invoked by specifying the name RPGEC as the first parameter in an EXEC statement (refer to Cataloged Procedures).

With the procedure RPGEC, a DD statement RPG.SYSIN indicating the location of the source program must be supplied.

The control statements that can be used to invoke the procedure are,

```
//jobname JOB
//stepname EXEC RPGEC
//RPG.SYSIN DD *
   ┌ - - - - - - - - - - - - - - - ┐
   |      RPG Source Program       |
   └ - - - - - - - - - - - - - - - ┘
/*
```

Table 11. Load Module Return Codes

Return Code	Explanation
0	normal execution, no errors
20	unrecoverable I/O error occurred during load module execution
24	specified program interruption exit. Details are given in Control Program Services publication.
28	halt indicator, H0, on
32	halt indicator, H1, on
36	halt indicator, H2, on
40	halt indicator, H3, on
44	halt indicator, H4, on
48	halt indicator, H5, on
52	halt indicator, H6, on
56	halt indicator, H7, on
60	halt indicator, H8, on
64	halt indicator, H9, on

Note: The COND= parameter is explained in the Job Control Language publication.

Link Edit and Execute

The cataloged procedure to link edit RPG object modules and execute the resulting load module is RPGELG. It is invoked by specifying the name RPGELG as the first parameter in an EXEC statement.

The cataloged procedure to link edit and execute consists of the control statements shown in Cataloged Procedures.

With the procedure RPGELG, a DD statement LKED.SYSIN, which indicates the location of the object module, must be supplied.

The control statements that can be used to invoke the RPGELG cataloged procedure are,

```
//jobname JOB
//EXEC RPGELG
//LKED.SYSIN DD*
┌ - - - - - - - - - - - - - - - ┐
¦      RPG Object Module        ¦
└ - - - - - - - - - - - - - - - ┘
/*
```

When the RPG compiler is maintained in a private library, a JOBLIB DD statement is required in the input stream to process an RPG program. The JOBLIB DD statement is used to temporarily chain the private library with the system library. The format of the DD statement is,

```
//JOBLIB DD DSNAME= libname,
            DISP= (OLD,PASS), etc.
```

with libname being the fully qualified name of the RPG library. The JOBLIB DD statement must appear immediately before the first EXEC statement for the job. The concatenation is in effect only for the duration of the job.

Compile, Link Edit, and Execute

The cataloged procedure, RPGECLG, passes a source module through three procedure steps-compile, link edit, and execute. The cataloged procedure is invoked by specifying the name RPGECLG as the first parameter in an EXEC statement.

The statements that invoke the cataloged procedure RPGECLG are,

```
//jobname JOB
//stepname EXECRPGECLG
//RPG.SYSIN DD *
┌ - - - - - - - - - - - - - - - ┐
¦      RPG Source Program       ¦
└ - - - - - - - - - - - - - - - ┘
/*
```

The SYSIN data set (source module) must be defined to the compiler as a separate DD statement not contained in the cataloged procedure.

This section contains figures showing the job control statements used in the RPG cataloged procedures and a brief description of each procedure.

Compile

The cataloged procedure for compilation (RPGEC) is shown in Figure 130. The numbers to the right correspond to the numbered explanations that follow.

1. PARM= and COND= parameters can be added to this statement by the EXEC statement that calls the procedure. Refer to Overriding Cataloged Procedures. The system name IESRPG identifies the RPG compiler.
2. The destination for the compiler output listing is defined by this statement as the standard system output class, SYSOUT=A.
3. The data set (usually the card punch) that contains the object module produced by the compiler is described by this statement. The compiler option DECK causes the object module to be written on this data set.
4. The three compiler utility data sets are described by these statements. The SEP= subparameter in the last statement and the SPACE= parameter in each statement are effective only if the device assigned is a direct access device. The number of specifications in the source program determines the space requirement. The procedure provides an initial allocation of 60,000 bytes and additional allocations (if required) of 12,000 bytes.
5. This statement describes the compiler output (object module) produced for input to the linkage editor. The compiler option LOAD causes the object module to be written on this data set.

Link Edit and Execute

The cataloged procedure to link edit RPG object modules and execute the resulting load modules (RPGELG) is shown in Figure 131. The numbers to the right correspond to the numbered explanations that follow.

1. This statement initiates linkage editor execution. The options in the PARM= field cause the linkage editor to put out a cross-reference table, module map, and a list of all control statements processed. The LET option causes the linkage editor to mark the load module as executable even though errors were encountered during processing.
2. This statement indicates that the input to the linkage editor is from the input stream.
3. The output from the linkage editor is specified as a member of a temporary data set, residing on a direct access device, and is passed to a succeeding job step.
4. The utility data set for the linkage editor is described by this statement.
5. The destination for the linkage editor output listing is defined by this statement as the standard output class, SYSOUT=A.
6. This statement initiates execution of the link edited load module. The notation *.LKED.SYSLMOD identifies the load module as being in the data set described in the job step LKED by the DD statement named SYSLMOD.
7. The destination for an abnormal termination dump is described as the standard output class, SYSOUT=A.

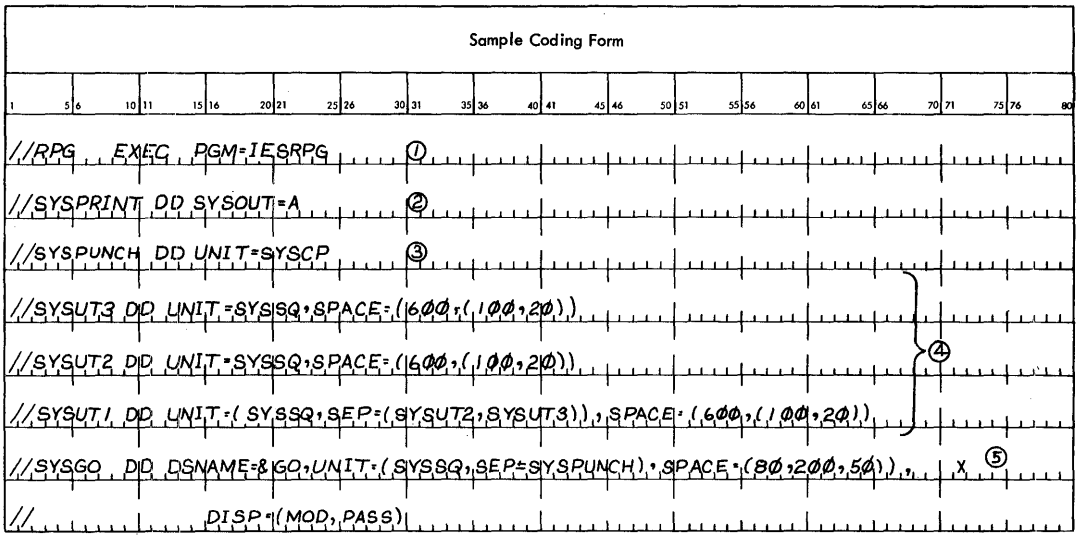


Figure 130. Compile Cataloged Procedure (RPGEC)

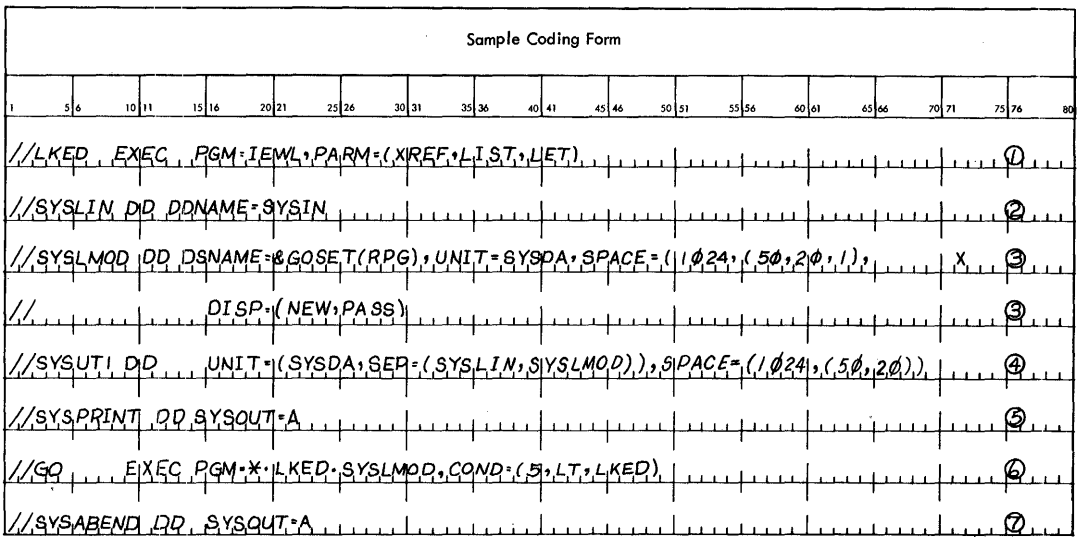


Figure 131. Link Edit and Execute Cataloged Procedure (RPGELG)

Compile, Link Edit, and Execute

The cataloged procedure (RPGECLG) to compile, link edit, and execute RPG source programs is shown in Figure 132.

The cataloged procedure RPGECLG consists of the statements in the RPGEC and RPGELG procedures, with the exception: the DD statement SYSLIN identifies the linkage editor input data set as the same data set produced as output by the compiler. The programmer must define the data set SYSIN (as a separate DD statement) for the compiler so that the source program can be read. He can also concatenate any input to the linkage editor from the input stream with the input from the compiler by using a DD statement LKED.SYSIN.

User Cataloged Procedures

The programmer can write his own cataloged procedures and tailor them to the facilities in his installation. He can also permanently modify the IBM-supplied cataloged procedures. For information about permanently modifying cataloged procedures, see the publication IBM System/360 Operating System, System Programmer's Guide.

Overriding Statements in Cataloged Procedures

EXEC and DD statements appearing in cataloged procedures can be overridden, in full or part. Such overriding of statements or fields is effective only for the duration

Sample Coding Form

```
//RPG EXEC PGM=IEGRPG
//SYSPRINT DD SYSOUT=A
//SYSPUNCH DD UNIT=SYSCP
//SYSUT3 DD UNIT=SYSSQ,SPACE=(600,(100,20)),
//SYSUT2 DD UNIT=SYSSQ,SPACE=(600,(100,20))
//SYSUT1 DD UNIT=(SYSSQ,SEP=(SYSUT2,SYSUT3)),SPACE=(600,(100,20))
//SYSGO DD DSNAME=&GO,UNIT=(SYSSQ,SEP=SYSPUNCH),SPACE=(80,(200,50)), X
//             DISP=(MOD,PASS)
//LKED EXEC PGM=IEWL,PARM=(XREF,LIST,LET),COND=(9,LT,RPG)
//SYSLIN DD DSNAME=&GO,DISP=(OLD,DELETE)
//             DD DDNAME=SYSIN
//SYSLMOD DD DSNAME=&GOSET(RPG),UNIT=SYSDA,SPACE=(1024,(50,20,1)), X
//             DISP=(NEW,PASS)
//SYSUT1 DD UNIT=(SYSDA,SEP=(SYSLIN,SYSLMOD)),SPACE=(1024,(50,20))
//SYSPRINT DD SYSOUT=A
//GO EXEC PGM=*.LKED.SYSLMOD,COND=((9,LT,RPG),(5,LT,LKED))
//SYSABEND DD SYSOUT=A
```

Figure 132. Compile, Link Edit, and Execute Cataloged Procedure (RPGECLG)

of the job step in which the statements appear. The statements, as stored in the procedure library of the system, remain unchanged.

Overriding for the purposes of respecification, addition, or nullification is accomplished by including in the input stream statements containing the desired changes and identifying the statements to be overridden.

Overriding Parameters in the EXEC Statement

The PARM= and COND= parameters can be added or, if present, modified by including in the EXEC statement calling the procedure the notation PARM.stepname=, or COND.stepname=, followed by the desired change. "Stepname" identifies the EXEC statement within the procedure to which the modification applies. Overriding the PGM= parameter is not possible.

If the procedure consists of more than one job step, a PARM.stepname= or COND.stepname= parameter may be entered for each step. The entries must be in order, i.e., PARM.step1=, PARM.step2=, etc.

Overriding and Adding DD Statements

A DD statement with the name "procstep.ddname" is used to override parameters in DD statements in cataloged procedures, or to add DD statements to cataloged procedures. The procstep identifies the step in the cataloged procedure. If ddname is the name of a DD statement

1. present in the step, the parameters in the new DD statement override parameters in the DD statement in the procedure step.
2. not present in the step, the new DD statement is added to the step.

In any case, the modification is only effective for the current execution of the cataloged procedure.

When overriding, the original DD statement in the cataloged procedure is copied, and the parameters specified in it are replaced by the corresponding parameters in the new DD statement. Therefore, only parameters that must be changed are specified in the overriding DD statement.

If more than one DD statement is modified, the overriding DD statements must be in the same order as the DD statements appear in the cataloged procedure. Any DD statements that are added to the procedure must follow overriding DD statements.

When the procedures RPGEC and RPGECLG are used, a DD statement must be added to define the SYSIN data set to the compile step in the procedures (see Using Cataloged Procedures). When the procedure RPGELG is used, a DD statement must be added to define the SYSLIN data set (see Using Cataloged Procedures).

Examples

In the procedure RPGEC (Figure 130), a punched object deck can be obtained and the UNIT= and SPACE= parameters of data set SYSUT1 respecified, by including the following statements in the input stream:

```
//stepname     EXEC   RPGEC,                X
//                    PARM.RPG=NOLOAD,DECK

//RPG.SYSUT1   DD     UNIT=2311,            X
                      SPACE=(200,(300,40))
```

In procedure RPGECLG (Figure 132) suppressing production of a listing and changing the COND= parameter to the EXEC statement which specifies execution of the linkage editor might be desired. In this case, the EXEC statement in the input stream would appear as follows:

```
//stepname EXEC RPGECLG,                          X
//              PARM.RPG=NOLIST,                  X
//              COND.LKED=(9,LT,stepname.RPG)
```

For this execution of procedure RPGECLG, no listing is produced. Execution of the linkage editor job step //LKED is suppressed if the return code issued by the compiler (step RPG) was greater than 8.

The Job Control Language and System Programmer's Guide publications provide additional description of overriding techniques.

RPG SOURCE PROGRAM DECK ARRANGEMENT

The deck prepared by the programmer is arranged as shown in Figure 133. The contents of the Operating System Job Control Statements are listed in the Job Control Language publication (see Preface).

The order in which the programmer places his control cards and source deck is as follows:

1. Operating System Job Control Statements
2. RPG Control Card (Processor Control Card)
3. File Description Specifications
4. File Extension Specifications
5. Line Counter Specifications
6. Input Specifications
7. Calculation Specifications
8. Output-Format Specifications

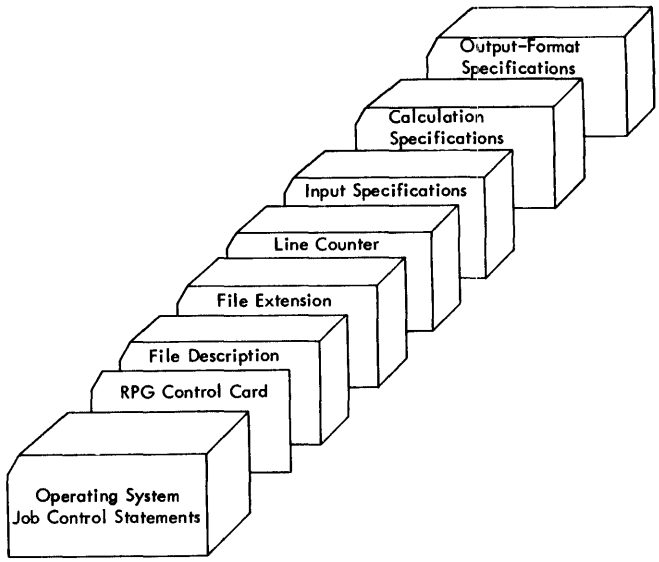


Figure 133. RPG Deck Arrangement in the Operating System Input Stream

RPG CONTROL CARD

The contents of the RPG control card follow.

Column	Contents	Explanation
1-5	XXXXX	Page and Line numbers of the control card (can be 00000).
6	H	Identifies the card as a header card.
7-16	blank	Not used; may be left blank.
17	1,2, or blank	If the Sterling shillings field on input is in the IBM format, punch 1 in this column. If it is in the BSI format, punch 2. Otherwise leave blank.
18	1,2, or blank	If the Sterling pence field on input is in the IBM format, punch 1. If it is in the BSI format, punch 2. Otherwise leave blank.
19	0,1,2, or blank	If the Sterling shillings field on output is in the IBM format, punch 1. If it is in the BSI format, punch 2. Otherwise leave blank or punch 0. The zero is allowed only for purposes of compatibility; it is treated the same as a blank.
20	0,1,2, or blank	If the Sterling pence field on output is in the IBM format, punch 1. If it is in the BSI format, punch 2. Otherwise leave blank or punch 0. The zero is allowed only for purposes of compatibility; it is treated the same as a blank.
21	I or blank	Inverted Print. If numeric literals and Edit words use the European conventions of punctuation (commas for decimal point and vice-versa), enter an I in this column. Otherwise leave blank.
22-25	blank	Not used; may be left blank.
26	A, or blank	Alternate Collating Sequence. Enter an A in this column, if

Column	Contents	Explanation
		an external subroutine is used to translate the sequence of a matching field to the collating sequence of the System/360. If an external translating subroutine is not used, leave this column blank.
		The name of the external subroutine is predefined by RPG to be ALTSEQ.
27-74	Blank	Not used; may be left blank
75-80	XXXXXX	Program Identification. Enter in these columns the program identification.
		If column 75 is blank, the name RPGOBJ is used for program identification.
		The first four characters of the identification will be punched in Columns 73-76 of each card in the object program deck. Columns 77-80 of the object deck cards will contain a sequence number.

EXECUTING RPG — INPUT STREAM VARIATIONS

The input stream varies considerably depending on the user's application. This section illustrates the input stream for various combinations of control statements, source decks, user subroutines and data decks.

IBM supplies three cataloged procedures that are explained in Cataloged Procedures and illustrated in Using Cataloged Procedures. Additional examples are included in this section to illustrate inclusion of user subroutines for execution with the RPG load module.

The EXIT operand can be used to incorporate subroutines in assembler language. For convenience, frequently used subroutines are maintained in a library. The following illustrates three methods for including user subroutines with the RPG object module as input to the linkage editor. The LIBRARY statement is used to call the library in order to resolve the designated external references (SUBR1,SUBR2). The LKED.SUBLIB DD statement defines the private library containing the subroutines.

```
//jobname  JOB
//stepname  EXEC RPGECLG
//RPG.SYSIN  DD *
     ┌ - - - - - - - - - - - - ┐
     ¦ RPG source program      ¦
     └ - - - - - - - - - - - - ┘
/*
//LKED.SUBLIB DD DSNAME=libname,DISP=OLD
//LKED.SYSIN DD *
  LIBRARY SUBLIB(SUBR1,SUBR2)
/*
```

The INCLUDE statement is used to cause the linkage editor to process the subroutine modules (SUBR1,SUBR2). The LKED.SUBLIB DD statement identifies the private library that contains the subroutines.

```
//jobname  JOB
//stepname  EXEC RPGECLG
//RPG.SYSIN DD *
     ┌ - - - - - - - - - - - - ┐
     ¦ RPG source program      ¦
     └ - - - - - - - - - - - - ┘
/*
//LKED.SUBLIB DD DSNAME=libname,DISP=OLD
//LKED.SYSIN DD *
  INCLUDE SUBLIB(SUBR1,SUBR2)
/*
```

The library members (SUBR1,SUBR2) are concatenated with the primary input (output from the compiler) to the linkage editor.

```
//jobname  JOB
//stepname  EXEC RPGECLG
//RPG.SYSIN DD *
     ┌ - - - - - - - - - - - - ┐
     ¦ RPG source program      ¦
     └ - - - - - - - - - - - - ┘
/*
//LKED.SYSIN DD DSNAME=libname(SUBR1),DISP-OLD
//DD DSNAME=libname(SUBR2),DISP=OLD
/*
```

The placement of the user subroutines that are included as object modules in the input stream of a compile and execute job is,

```
//jobname  JOB
//stepname  EXEC RPGECLG
//RPG.SYSIN DD *
      ┌- - - - - - - - - - - -┐
      ¦RPG source program     ¦
      └- - - - - - - - - - - -┘
/*
//LKED.SYSIN DD *
      ┌- - - - - - - - - - - -┐
      ¦SUBR1 object module    ¦
      └- - - - - - - - - - - -┘
      ┌- - - - - - - - - - - -┐
      ¦SUBR2 object module    ¦
      └- - - - - - - - - - - -┘
      ┌- - - - - - - - - - - -┐
      ¦SUBR3 object module    ¦
      └- - - - - - - - - - - -┘
/*
```

Subroutines can be included both from a library and in the input stream. The job shown below includes subroutines SUBR1 and SUBR2 from the library and SUBR3 from the input stream.

```
//jobname  JOB
//stepname  EXEC RPGECLG
//RPG.SYSIN DD *
      ┌- - - - - - - - - - - -┐
      ¦RPG source program     ¦
      └- - - - - - - - - - - -┘
/*
//LKED.SUBLIB DD DSNAME=libname,DISP=OLD
//LKED.SYSIN DD *
  INCLUDE SUBLIB(SUBR1,SUBR2)
      ┌- - - - - - - - - - - -┐
      ¦SUBR3 object module    ¦
      └- - - - - - - - - - - -┘
/*
```

The operating system provides the capability to assemble user subroutines within the same job as the RPG compilation. The assembly can either precede or follow or both precede and follow the RPG compilation. The job setup for an assembly following the RPG compilation is,

```
//jobname  JOB
//stepname  EXEC RPGEC
//RPG.SYSGO DD DSNAME=&LOADSET
//RPG.SYSIN DD *
      ┌- - - - - - - - - - - -┐
      ¦RPG source program     ¦
      └- - - - - - - - - - - -┘
/*
//stepname  EXEC ASMECLG
//ASM.SYSIN DD *
      ┌- - - - - - - - - - - - - - - -┐
      ¦source program for assembly    ¦
      └- - - - - - - - - - - - - - - -┘
/*
```

The first EXEC statement invokes the cataloged procedure for compilation (RPGEC). The RPG.SYSGO DD statement overrides the cataloged procedure renaming the data set that contains the object module to be the same data set as used by the assembler. The object module that is output from the assembly is added to the data set that subsequently is input to the linkage editor. The subparameter MOD specifies that the data set is added to and causes logical positioning after the last record in the data set.

The second EXEC statement invokes the cataloged procedure for assembly, link edit, and execute (ASMECLG). Refer to the Assembler (E) Programmer's Guide for a detailed description of cataloged procedures for assembly.

Execution must begin in the RPG produced object module. When an assembly precedes the RPG compilation, the RPG compiler is not the first program executed. Therefore, an ENTRY statement is required to specify the name of the RPG program. The job setup for assembly of the user subroutine preceding the RPG compilation is,

```
//jobname  JOB
//stepname  EXEC ASMEC
//ASM.SYSPUNCH DD DSNAME=&GO
//ASM.SYSIN DD *
      ┌- - - - - - - - - - - - - - - -┐
      ¦source program for assembly    ¦
      └- - - - - - - - - - - - - - - -┘
/*
//stepname  EXEC RPGECLG
//RPG.SYSIN DD *
      ┌- - - - - - - - - - - -┐
      ¦RPG source program     ¦
      └- - - - - - - - - - - -┘
/*
//LKED.SYSIN DD *
  ENTRY RPG program name
/*
```

The deck arrangement for jobs processing data files is,

```
//jobname  JOB
//stepname EXEC RPGECLG
//RPG.SYSIN DD *
     ┌- - - - - - - - - - - -┐
     ¦RPG source program      ¦
     └- - - - - - - - - - - -┘
/*
//GO.ddname (parameters)
//GO.ddname (parameters)
     .
     .
     .
     .
     .
//GO.ddname (parameters)
/*
```

Data sets (files) processed by an RPG program must be defined by DD statements (see Load Module Execution).

The deck arrangement for jobs processing data files and tables is,

```
//jobname  JOB
//stepname  EXEC RPGECLG
//RPG.SYSIN DD *
     ┌- - - - - - - - - - - - - -┐
     ¦RPG source program          ¦
     └- - - - - - - - - - - - - -┘
/*
//GO.ddname (parameters)
//GO.ddname (parameters)
//GO.SYSIN DD *
      ┌- - - - -┐
      ¦tables    ¦
      └- - - - -┘
 /*
```

APPENDIX A. SAMPLE PROGRAMS

Three complete sample programs are included in this section.

SAMPLE PROGRAM ONE

The input file in the first program consists of punched cards. Each card in the file contains a data record that includes from one to eighty characters of information. Each data record represents a purchase made from the reporting firm by a customer. The types of information and the card columns in which each appears are shown in Figure 134.

The labels assigned to the fields into which the object program will place the information are as follows:

Field	Label
Customer Name	NAME
Invoice Data — Month	MONTH
Invoice Data — Day	DAY
Invoice Number	INVNO
Customer Number	CUSTNO
Customer Location	STATE
Customer Location	CITY
Invoice Amount	INVAMT

Figure 135 is an output listing of the sample program.

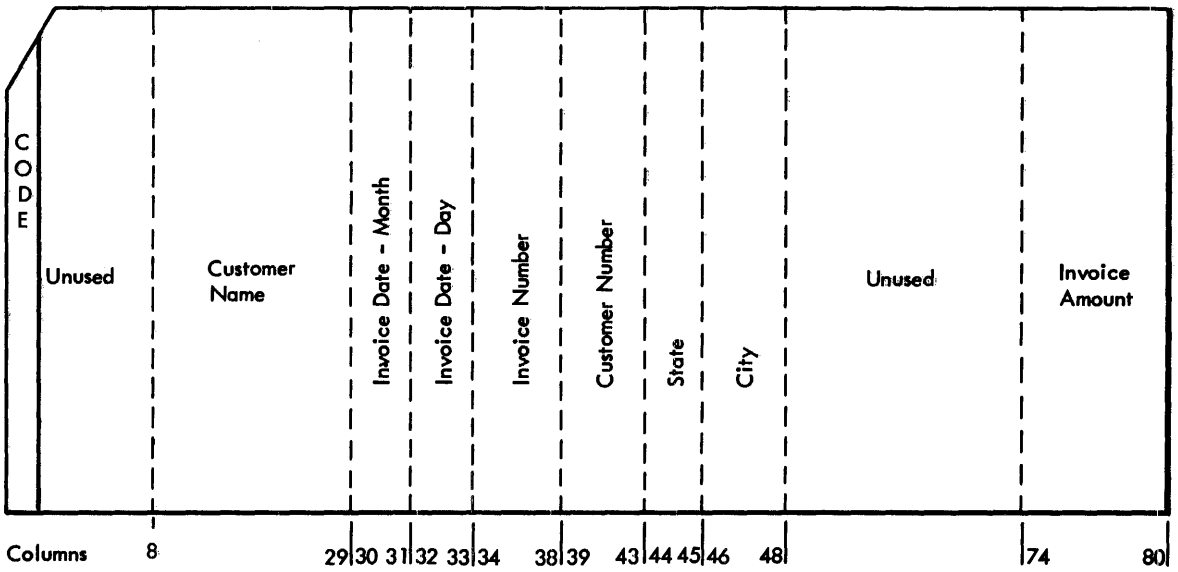
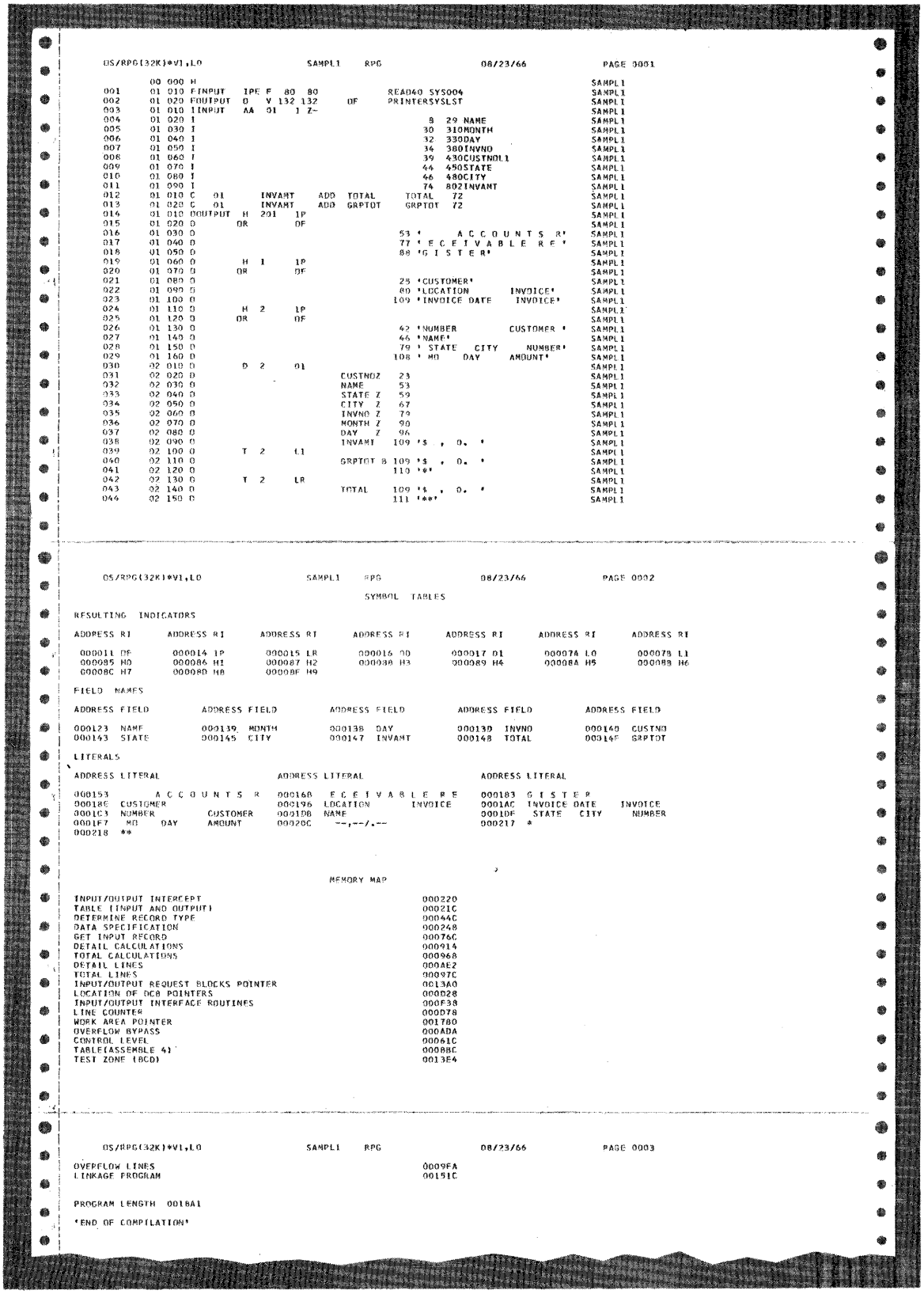


Figure 134. Input File-Card Format



```
OS/RPG(32K)*V1,L0                SAMPL1    RPG                08/23/66            PAGE 0001

          00 000 H                                                                  SAMPL1
001       01 010 FINPUT   IPE F  80  80           READ40 SYS004                    SAMPL1
002       01 020 FOUTPUT  O   V 132 132     OF    PRINTERSYSLST                    SAMPL1
003       01 010 IINPUT   AA  01   1 Z-                                            SAMPL1
004       01 020 I                                      8  29 NAME                 SAMPL1
005       01 030 I                                     30  31 0MONTH               SAMPL1
006       01 040 I                                     32  33 0DAY                 SAMPL1
007       01 050 I                                     34  38 0INVNO               SAMPL1
008       01 060 I                                     39  43 0CUSTNO L1           SAMPL1
009       01 070 I                                     44  45 0STATE               SAMPL1
010       01 080 I                                     46  48 0CITY                SAMPL1
011       01 090 I                                     74  80 2INVAMT              SAMPL1
012       01 010 C   01      INVAMT    ADD  TOTAL     TOTAL   72                   SAMPL1
013       01 020 C   01      INVAMT    ADD  GRPTOT    GRPTOT  72                   SAMPL1
014       01 010 OOUTPUT  H  201   1P                                             SAMPL1
015       01 020 O        OR        OF                                             SAMPL1
016       01 030 O                                    53 '      A C C O U N T S  R' SAMPL1
017       01 040 O                                    77 ' E C E I V A B L E  R E ' SAMPL1
018       01 050 O                                    88 'G I S T E R'             SAMPL1
019       01 060 O          H  1     1P                                            SAMPL1
020       01 070 O        OR        OF                                             SAMPL1
021       01 080 O                                    25 'CUSTOMER'                SAMPL1
022       01 090 O                                    40 'LOCATION       INVOICE'  SAMPL1
023       01 100 O                                   109 'INVOICE DATE    INVOICE' SAMPL1
024       01 110 O          H  2     1P                                            SAMPL1
025       01 120 O        OR        OF                                             SAMPL1
026       01 130 O                                    42 'NUMBER         CUSTOMER ' SAMPL1
027       01 140 O                                    64 'NAME'                    SAMPL1
028       01 150 O                                    79 ' STATE   CITY     NUMBER' SAMPL1
029       01 160 O                                   108 ' MO    DAY     AMOUNT'   SAMPL1
030       02 010 O          D  2     01                                            SAMPL1
031       02 020 O                           CUSTNOZ  23                          SAMPL1
032       02 030 O                           NAME     53                          SAMPL1
033       02 040 O                           STATE Z  59                          SAMPL1
034       02 050 O                           CITY  Z  67                          SAMPL1
035       02 060 O                           INVNO Z  79                          SAMPL1
036       02 070 O                           MONTH Z  90                          SAMPL1
037       02 080 O                           DAY   Z  96                          SAMPL1
038       02 090 O                           INVAMT   109 '$  ,  0.  '            SAMPL1
039       02 100 O          T  2     L1                                            SAMPL1
040       02 110 O                           GRPTOT B 109 '$  ,  0.  '            SAMPL1
041       02 120 O                                    110 '0'                      SAMPL1
042       02 130 O          T  2     LR                                            SAMPL1
043       02 140 O                           TOTAL    109 '$  ,  0.  '            SAMPL1
044       02 150 O                                    111 '**'                     SAMPL1

OS/RPG(32K)*V1,L0                SAMPL1    RPG                08/23/66            PAGE 0002

                                        SYMBOL  TABLES

RESULTING  INDICATORS

ADDRESS RI      ADDRESS RI      ADDRESS RI      ADDRESS RI      ADDRESS RI      ADDRESS RI      ADDRESS RI

 000011 OF       000014 1P       000015 LR       000016 90       000017 01       00007A L0       000078 L1
 000085 H0       000086 H1       000087 H2       000088 H3       000089 H4       00008A H5       00008B H6
 00008C H7       00008D H8       00008E H9

FIELD  NAMES

ADDRESS FIELD        ADDRESS FIELD        ADDRESS FIELD        ADDRESS FIELD        ADDRESS FIELD

000123  NAME         000139  MONTH        000138  DAY          00013D  INVNO        000140  CUSTNO
000143  STATE        000145  CITY         000147  INVAMT       000148  TOTAL        00014E  GRPTOT

LITERALS

ADDRESS LITERAL                  ADDRESS LITERAL                  ADDRESS LITERAL

000153       A C C O U N T S  R  000168  E C E I V A B L E  R E  000183  G I S T E R
00018E  CUSTOMER                 000196  LOCATION       INVOICE   0001AC  INVOICE DATE    INVOICE
0001C3  NUMBER       CUSTOMER    0001D6  NAME                     0001DE  STATE   CITY     NUMBER
0001F7  MO    DAY    AMOUNT      00020C    --,--/.--              000217  *
000218  **


                                        MEMORY MAP

INPUT/OUTPUT INTERCEPT                                  000220
TABLE (INPUT AND OUTPUT)                                0021C
DETERMINE RECORD TYPE                                   00044C
DATA SPECIFICATION                                      000248
GET INPUT RECORD                                        00076C
DETAIL CALCULATIONS                                     000914
TOTAL CALCULATIONS                                      000968
DETAIL LINES                                            000AE2
TOTAL LINES                                             00097C
INPUT/OUTPUT REQUEST BLOCKS POINTER                     0013A0
LOCATION OF DCB POINTERS                                000028
INPUT/OUTPUT INTERFACE ROUTINES                         000F38
LINE COUNTER                                            000D78
WORK AREA POINTER                                       001780
OVERFLOW BYPASS                                         000ADA
CONTROL LEVEL                                           00061C
TABLE(ASSEMBLE 4)                                       0008BC
TEST ZONE (BCD)                                         0013E4

OS/RPG(32K)*V1,L0                SAMPL1    RPG                08/23/66            PAGE 0003

OVERFLOW LINES                                          0009FA
LINKAGE PROGRAM                                         00151C

PROGRAM LENGTH  0018A1

'END OF COMPILATION'
```

Figure 135. Output Listing

To produce an object module capable of writing the report shown in Figure 136, the programmer must prepare a source program as shown in Figure 137. The entries in the RPG specifications sheet are described here.

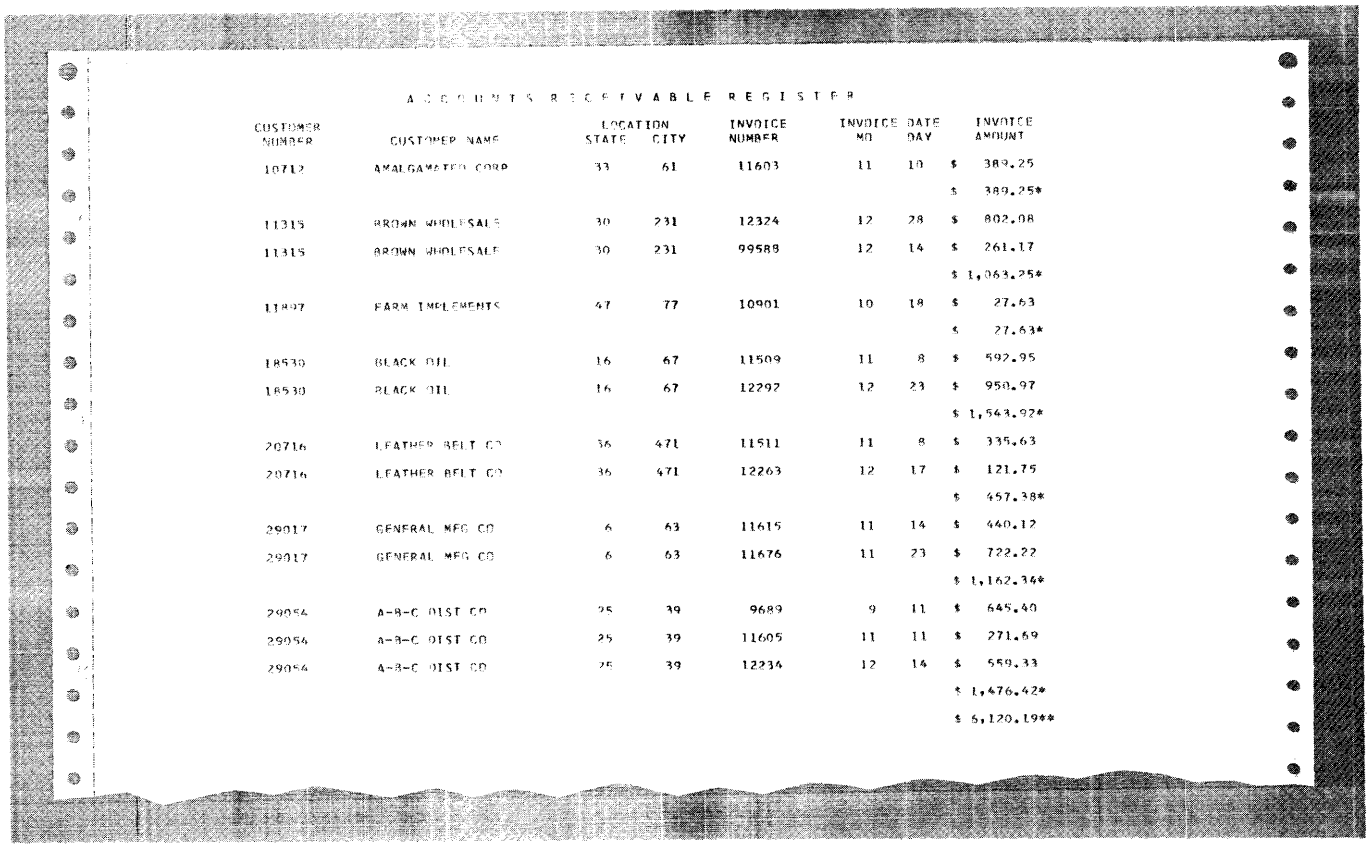
FILE DESCRIPTION SHEET

Two files (input and output) are described on this sheet. The input file INPUT (columns 7-11) is the primary file (column 16) It causes the end-of-job condition when it is depleted (column 17). The input records are fixed in length (column 19); the block length is 80 (columns 22 and 23); and the records are 80 characters in length (columns 26 and 27).

The output file OUTPUT is also defined on the File Description sheet. The format is variable; the block length is 132 and the records are 132 characters in length. The entry OF in columns 33-34 indicates that the output file defined on the line is to cause the overflow condition.

INPUT SPECIFICATIONS SHEET

The input file has a sequence of AA, and if column 1 contains the zone of a minus, Resulting Indicator 01 is turned on (as indicated by the entries in 19-20, 24 and 26-27). The locations of the fields which contain the input data are defined in columns 44-51. The names of the input fields are entered in columns 53-58. Whenever a



ACCOUNTS RECEIVABLE REGISTER

CUSTOMER NUMBER	CUSTOMER NAME	LOCATION STATE	LOCATION CITY	INVOICE NUMBER	INVOICE DATE MO	INVOICE DATE DAY	INVOICE AMOUNT
10712	AMALGAMATED CORP	33	61	11603	11	10	$ 389.25
							$ 389.25*
11315	BROWN WHOLESALE	30	231	12324	12	28	$ 802.08
11315	BROWN WHOLESALE	30	231	99588	12	14	$ 261.17
							$ 1,063.25*
11807	FARM IMPLEMENTS	47	77	10901	10	18	$ 27.63
							$ 27.63*
18530	BLACK OIL	16	67	11509	11	8	$ 592.95
18530	BLACK OIL	16	67	12292	12	23	$ 950.97
							$ 1,543.92*
20716	LEATHER BELT CO	36	471	11511	11	8	$ 335.63
20716	LEATHER BELT CO	36	471	12263	12	17	$ 121.75
							$ 457.38*
29017	GENERAL MFG CO	6	63	11615	11	14	$ 440.12
29017	GENERAL MFG CO	6	63	11676	11	23	$ 722.22
							$ 1,162.34*
29054	A-B-C DIST CO	25	39	9689	9	11	$ 645.40
29054	A-B-C DIST CO	25	39	11605	11	11	$ 271.69
29054	A-B-C DIST CO	25	39	12234	12	14	$ 559.33
							$ 1,476.42*
							$ 5,120.19**

Figure 136. Printed Report

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IBM System/360

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Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/I	L/D/T	Overflow Indicator	Key Field Starting Location	Extension Code	E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
		File Type									Mode of Processing											
		File Designation									Length of Record Address Field											
		End of File										Record Address Type										
		Sequence										Type of File Organization										
		File Format											Overflow Indicator									
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19	20 21 22 23	24 25 26 27	28	29 30	31	32 33 34	35 36 37 38	39		40 41 42 43 44 45 46	47 48 49 50 51 52	53	54 55 56 57 58 59	60 61 62 63 64 65	66 67 68 69 70 71 72 73 74
01	F	INPUT	I	P	E		F	80	80								READ40					
02	F	OUTPUT	O				V	132	132				OF				PRINTER					

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Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15 16	17	18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43	44 45 46 47	48 49 50 51	52	53 54 55 56 57 58	59 60	61 62	63 64	65 66	67 68	69 70	71 72 73 74
01	I	INPUT	AA			01	1	N		1																				
02	I																				8	29		NAME						
03	I																				30	31	0	MONTH						
04	I																				32	33	0	DAY						
05	I																				34	38	0	INVNO						
06	I																				39	43	0	CUSTNO	L1					
07	I																				44	45	0	STATE						
08	I																				46	48	0	CITY						
09	I																				74	80	2	INVAMT						
10	I																													

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Programmer _____

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Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Control Level (L0-L9, LR)	Indicators: Not	Indicators: And	Indicators: And	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Resulting Indicators: Minus	Resulting Indicators: Zero or Blank	Resulting Indicators: Compare High 1>2	Resulting Indicators: Compare Low 1<2	Resulting Indicators: Compare Equal 1=2	Comments
3 4 5	6	7 8	9 10 11	12 13 14	15 16 17	18 19 20 21 22 23 24 25 26 27	28 29 30 31 32	33 34 35 36 37 38 39 40 41 42	43 44 45 46 47 48	49 50 51	52	53	54 55	56 57	58 59	60	61	62	63 64 65 66 67 68 69 70 71 72 73 74
01	C		01			INVAMT	ADD	TOTAL	TOTAL	72									
02	C		01			INVAMT	ADD	GRPTOT	GRPTOT	72									

Figure 137. RPG Specification Sheets — Program One (Part 1 of 2)

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Page

Program Identification

Line	Form Type	Filename	Type (H/D/T)	Space: Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: And Not	Output Indicators: And	Output Indicators: And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Field (P) Packed	Constant or Edit Word	Sterling Sign Position
010	O	OUTPUT	H		2		01		1P									
020	O		OR						OF						53		\ A C C O U N T S R'	
030	O														77		\ E C E I V A B L E R E '	
040	O														88		\G I S T E R'	
050	O																	
060	O		H		1				1P									
070	O		OR						OF									
080	O														25		\CUSTOMER'	
090	O														80		\LOCATION INVOICE'	
100	O														109		\INVOICE DATE INVOICE'	
110	O		H		2				1P									
120	O		OR						OF									
130	O														42		\NUMBER CUSTOMER '	
140	O														46		\NAME'	
150	O														79		\ STATE CITY NUMBER'	
160	O														108		\ MO DAY AMOUNT'	
	O																	

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Page

Program Identification

Line	Form Type	Filename	Type (H/D/T)	Space: Stacker Select	Space: Before	Space: After	Skip: Before	Skip: After	Output Indicators: And Not	Output Indicators: And	Output Indicators: And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Field (P) Packed	Constant or Edit Word	Sterling Sign Position
010	O		D		2				01									
020	O											CUSTNO	Z		23			
030	O											NAME			53			
040	O											STATE	Z		59			
050	O											CITY	Z		67			
060	O											INVNO	Z		79			
070	O											MONTH	Z		90			
080	O											DAY	Z		96			
090	O											INVAMT			109		\$, 0. '	
100	O		T		1				L1									
110	O											GRPTOT		B	109		\$, 0. '	
120	O														110		*'	
130	O		T		2				LR									
140	O											TOTAL			109		\$, 0. '	
150	O														111		**'	
	O																	

Figure 137. RPG Specification Sheets — Program One (Part 2 of 2)

new customer number is read in, control level 1 is turned on (columns 59-60).

CALCULATION SPECIFICATIONS SHEET

The contents of the field TOTAL are added to the contents of the field INVAMT, and the result is stored in TOTAL. The result field has a length of seven positions, and two positions are reserved for the decimal portion. The field GRPTOT is added to INVAMT, and the result is stored in GRPTOT which is seven positions long, and has two decimal positions.

OUTPUT-FORMAT SPECIFICATIONS SHEET

OUTPUT, the name of the file to which the records defined on the line belong, is entered under Filename on the first line of the sheet. In column 15 the output types, H, D and T are entered to designate the heading, detail, and total lines.

The first heading line, ACCOUNTS RECEIVABLE REGISTER, prints either on the first page (1P) or overflow conditions (OF). The OR entered in columns 14 and 15 of the second line allows for printing on the first page or on overflow. The other heading lines also print on these conditions.

When Output Indicator 01 is on, the field entered in Field Name will print in the positions indicated in columns 40-43. Zero suppression occurs on CUSTNO, STATE, CITY, INVNO, MONTH, and DAY.

The total lines are to print whenever control fields L1 or LR are on. The group total GRPTOT prints when L1 is ON, and after it is printed, the contents of GRPTOT are blanked out. The final total is printed when the LR (last record) indicator is on.

SAMPLE PROGRAM TWO

This is similar to the previous program. In this example, however, two input files are used. The Transaction File is a card file with fields as shown in Figure 134 of the previous program. Another input file (Master Customer File), which is on tape, contains information about the firm's customers (Figure 138). The fields contained in the two input files are illustrated in Figure 139.

The program is to process the master customer file, using records from the transaction file, to produce printed receipts. The master file is updated, by producing a new master customer file. The coding required for this program is shown in Figure 140.

FILE DESCRIPTION SHEET

The four files are defined on this sheet. The two input files TRANSIN and MASTERIN are defined, and the two output files MASTEROT, which is the updated master file, and MASTLIST, which is the printed report, are defined on the file-description sheet. TRANSIN is designated as the secondary file because it may not contain transactions

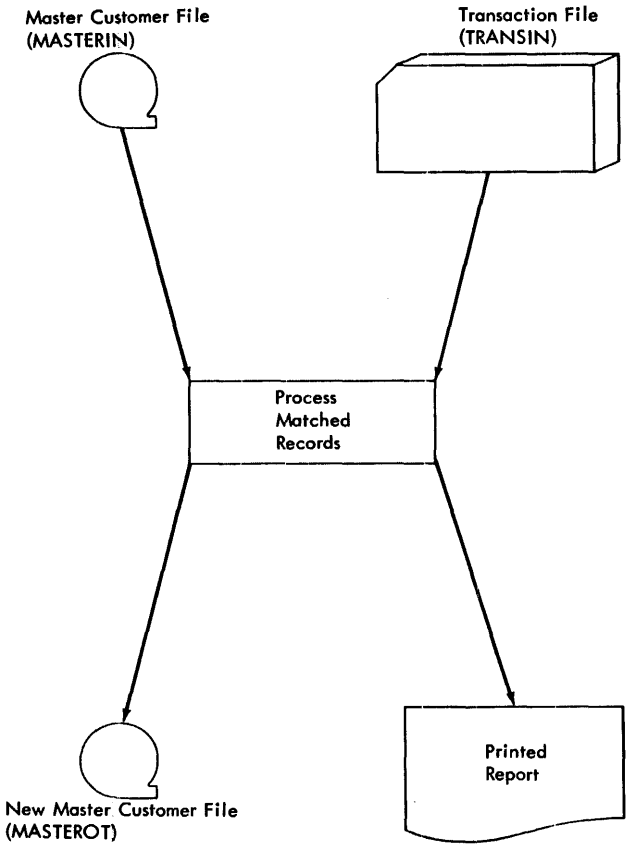


Figure 138. Sample Program Two

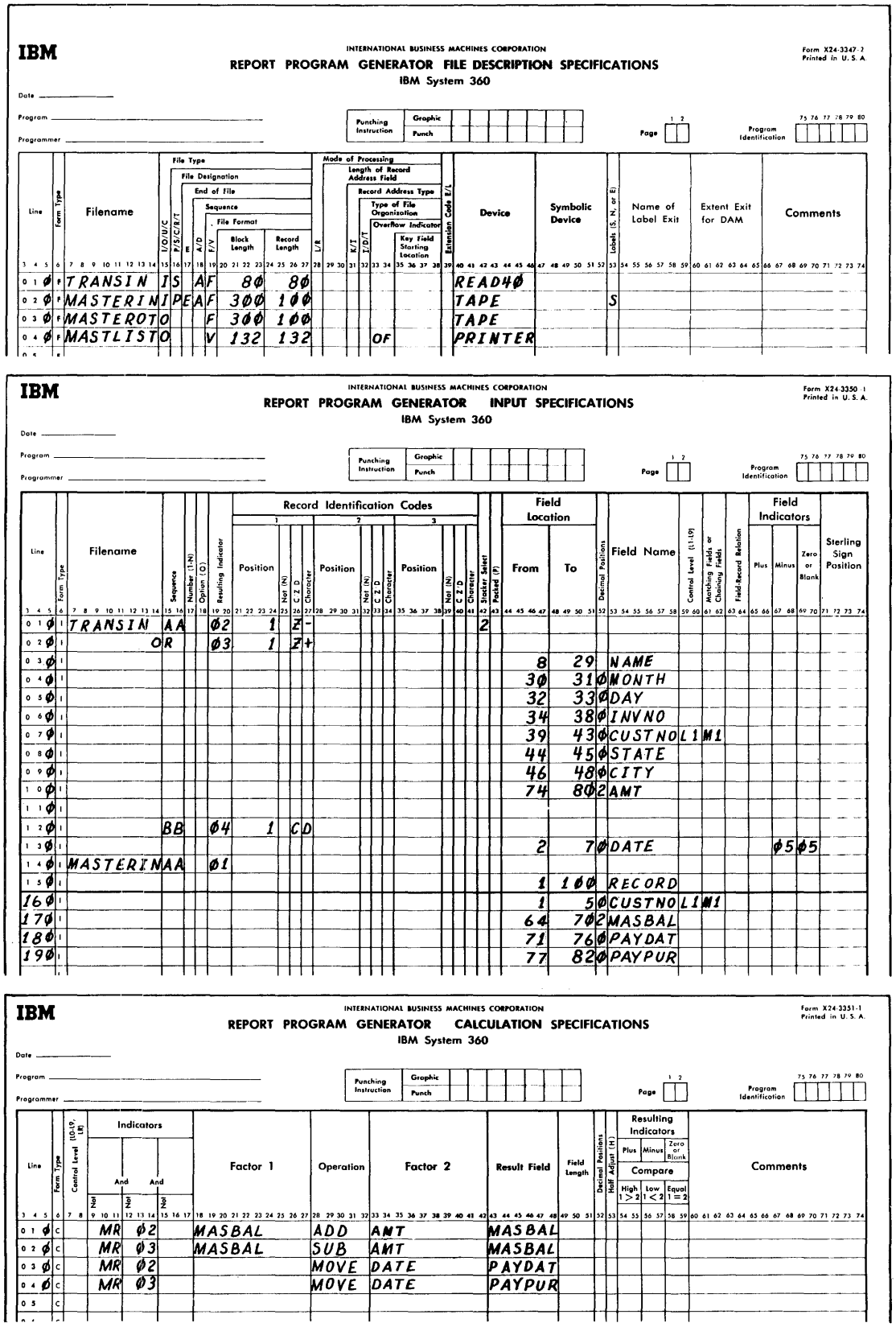
Transaction File

Field	Label	Card Columns
Code	Minus (-) Zone, or Plus (+) Zone	1
Customer Name	NAME	8-29
Invoice Date	MONTH	30-31
Invoice Date	DAY	32-33
Invoice Number	INVNO	34-38
Customer Number	CUSTNO	39-43
State	STATE	44-45
City	CITY	46-48
Invoice Amount / Amount Paid	AMT	74-80

Master Customer File

Field	Label	Location
Customer Number	CUSTNO	1-5
Customer Name	MASNAM	6-27
Street	MASTRT	28-46
City	MASCTY	47-57
State	MASTAT	58-62
Customer Balance	MASBAL	64-70
Date Of Last Payment	PAYDATE	71-76
Date Of Last Purchase	PAYPUR	77-82

Figure 139. Input Fields - Sample Program Two



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Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	I/O/U/C	File Type	File Designation	End of File	Sequence	File Format	Block Length	Record Length	L/R	Mode of Processing	Length of Record Address Field	Record Address Type	Type of File Organization	Overflow Indicator	Key Field Starting Location	Extension Code	E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
010	F	TRANSIN	I	S		A	F		80	80										READ40					
020	F	MASTERIN	I	P	E	A	F		300	100										TAPE		S			
030	F	MASTEROT	O				F		300	100										TAPE					
040	F	MASTLIST	O				V		132	132						OF				PRINTER					
050	F																								

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Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C	1: Z	1: D	1: Character	2: Position	2: Not (N)	2: C	2: Z	2: D	2: Character	3: Position	3: Not (N)	3: C	3: Z	3: D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
							1						2						3																			
010	I	TRANSIN	AA			02	1			Z	-														2												
020	I		OR			03	1			Z	+																										
030	I																										8	29		NAME							
040	I																										30	31	0	MONTH							
050	I																										32	33	0	DAY							
060	I																										34	38	0	INVNO							
070	I																										39	43	0	CUSTNO	L1	M1					
080	I																										44	45	0	STATE							
090	I																										46	48	0	CITY							
100	I																										74	80	2	AMT							
110	I																																				
120	I		BB			04	1		C	D																											
130	I																										2	7	0	DATE				05	05		
140	I	MASTERIN	AA			01																															
150	I																										1	100		RECORD							
160	I																										1	5	0	CUSTNO	L1	M1					
170	I																										64	70	2	MASBAL							
180	I																										71	76	0	PAYDAT							
190	I																										77	82	0	PAYPUR							

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Program

Programmer

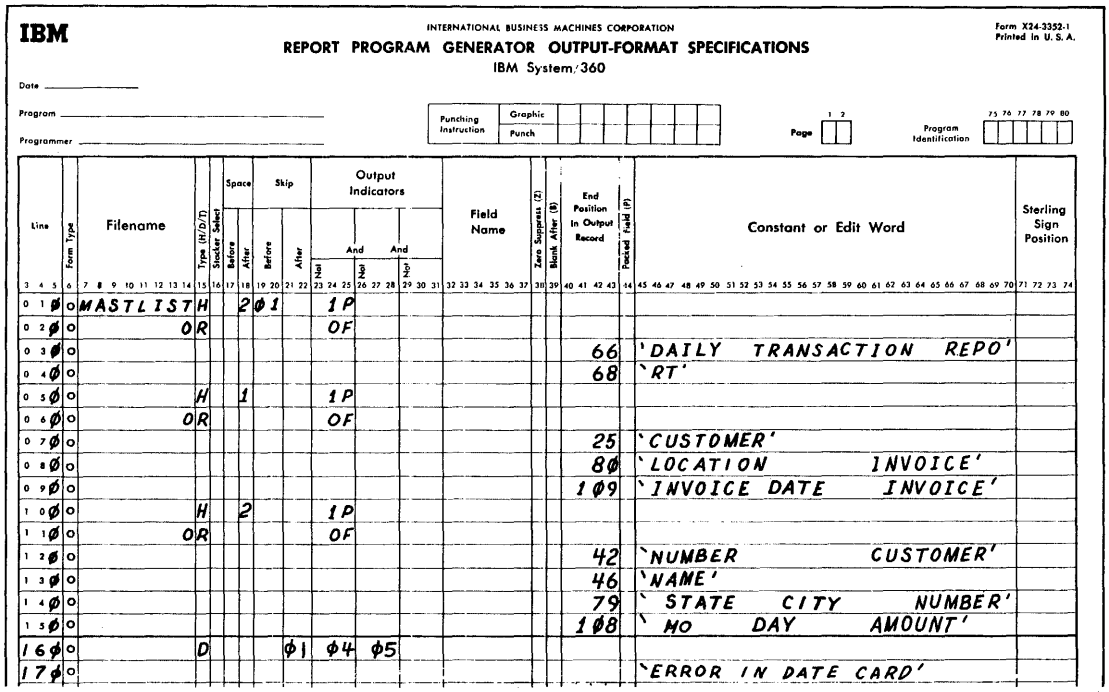
Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And	Not	Indicators: And	Not	Indicators: And	Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus	Resulting Indicators: Minus	Resulting Indicators: Zero or Blank	Compare: High 1 > 2	Compare: Low 1 < 2	Compare: Equal 1 = 2	Comments
010	C			MR	02				MASBAL	ADD	AMT	MASBAL										
020	C			MR	03				MASBAL	SUB	AMT	MASBAL										
030	C			MR	02					MOVE	DATE	PAYDAT										
040	C			MR	03					MOVE	DATE	PAYPUR										
050	C																					

Figure 140. Specifications for Sample Program Two (Part 1 of 2)



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IBM System/360

Form X24-3352-1
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Date

Program

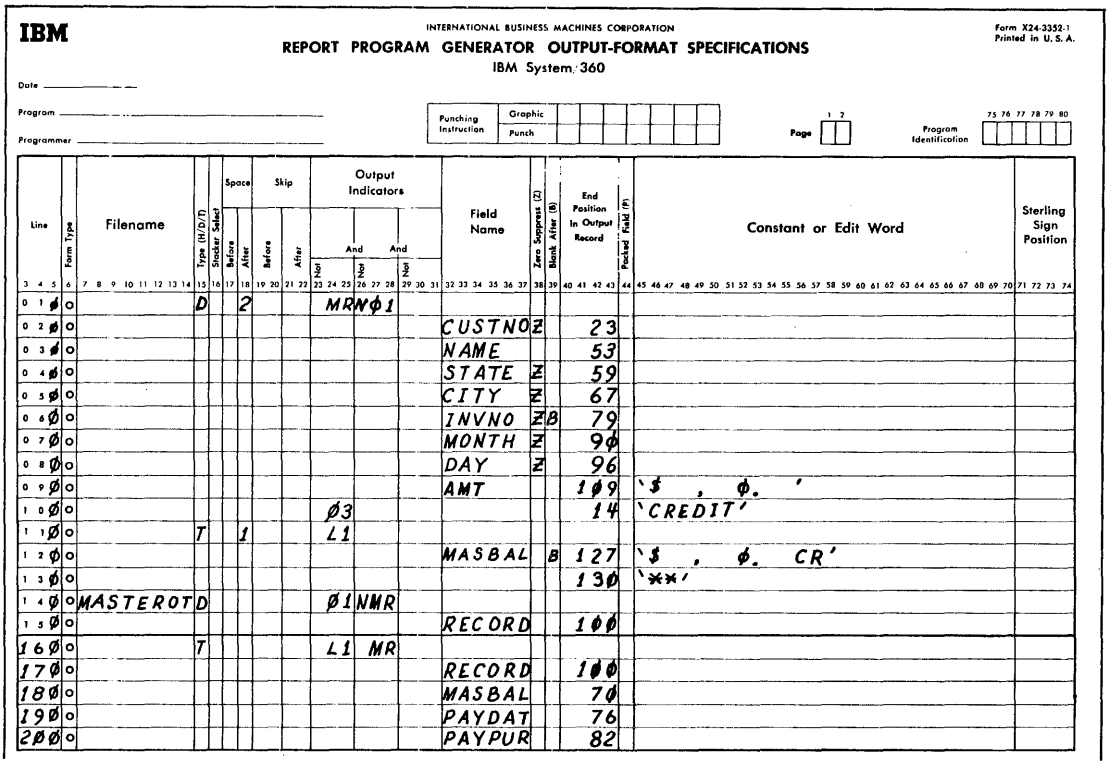
Programmer

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space Before	Space After	Skip Before	Skip After	Output Indicators And Not	Output Indicators And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17 18		19 20	21 22	23 24 25	26 27 28	29 30 31 32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
010	O	MASTLIST	H		2		01		1P								
020	O		OR						OF								
030	O													66		'DAILY TRANSACTION REPO'	
040	O													68		'RT'	
050	O		H		1				1P								
060	O		OR						OF								
070	O													25		'CUSTOMER'	
080	O													80		'LOCATION INVOICE'	
090	O													109		'INVOICE DATE INVOICE'	
100	O		H		2				1P								
110	O		OR						OF								
120	O													42		'NUMBER CUSTOMER'	
130	O													46		'NAME'	
140	O													79		' STATE CITY NUMBER'	
150	O													108		' MO DAY AMOUNT'	
160	O		D				01		04	05							
170	O															'ERROR IN DATE CARD'	



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Program

Programmer

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Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Type (H/D/T)	Stacker Select	Space Before	Space After	Skip Before	Skip After	Output Indicators And Not	Output Indicators And Not	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17 18		19 20	21 22	23 24 25	26 27 28	29 30 31 32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
010	O		D		2				MRN01								
020	O										CUSTNO	Z		23			
030	O										NAME			53			
040	O										STATE	Z		59			
050	O										CITY	Z		67			
060	O										INVNO	Z	B	79			
070	O										MONTH	Z		90			
080	O										DAY	Z		96			
090	O										AMT			109		'$, 0. '	
100	O								03					14		'CREDIT'	
110	O		T		1				L1								
120	O										MASBAL		B	127		'$, 0. CR'	
130	O													130		'**'	
140	O	MASTEROT	D						01	NMR							
150	O										RECORD			100			
160	O		T						L1	MR							
170	O										RECORD			100			
180	O										MASBAL			70			
190	O										PAYDAT			76			
200	O										PAYPUR			82			

Figure 140. Specifications for Sample Program Two (Part 2 of 2)

involving all the customers on the master customer file. TRANSIN is ascending in order. It has fixed-length records which are 80 characters long. The block length is 80.

MASTERIN is the primary file. If the transaction file does not have a corresponding customer number (specified by the Matching Fields specification on the input sheet) the master file is processed. Processing continues until all the records in the master customer file have been processed (indicated by the E in column 17). The input records contained in the master customer file are ascending in order, fixed in length, and have a block length of 300. Each record is 100 characters in length.

The file MASTLIST is the printed report. The format is variable. The length of the records can be 132. The overflow entry in columns 33-34 indicates that the overflow condition is to occur on the MASTLIST printer.

The output file MASTEROT is a tape file which contains the updated master customer records. The output records are fixed in length, and are 100 characters in length. The block length is 300.

NOTE: A blank in column 53 indicates that there are no labels in the output file.

INPUT SPECIFICATIONS SHEET

The two input files TRANSIN and MASTERIN are defined on the Input Specification sheet.

TRANSIN: The input records may be obtained from three types of cards.

Sequence AA has been assigned to two types. If card column 1 contains the zone of a minus, resulting indicator 02 is turned on. If card column 1 contains the zone of a plus, indicator 03 is turned on. The cards that have a minus in column 1 are selected into the 2 pocket (column 42). The locations of the input records and their labels are defined in columns 46-58 of the sheet.

The field CUSTNO (customer number) has entries in columns 59-60 (Control Level) and columns 61-62 (Matching Fields) of the Input Specifications sheet. Whenever a new customer number is read in, control level 1 (L1) is set on. This condition is tested on the Output-Format Specifications sheet to govern printing of total lines and to produce the updated customer file. The entry in matching fields specifies that customer number will be used to match another field (CUSTNO) in the MASTERIN file.

The first card in the transaction file is a date card. It is assigned sequence BB. Whenever column 1 contains a D, indicator 04 is turned on. The date is contained in columns 2-7 of the card. Indicator 05 is turned on whenever these columns are zero or minus.

MASTERIN: The tape input file that contains information about the firm's customers is assigned sequence AA. The first entry under field name defines the entire record. This entry (RECORD) is made to enable the entire record to be referenced on the Output-Format Specifications sheet. CUSTNO of the master file corresponds to CUSTNO in the transaction file. Whenever a new customer number is read in, L1 is set. The entry M1 indicates that the customer number in the master file will be matched with the customer number in the transaction file.

CALCULATION SPECIFICATIONS SHEET

Whenever the matching record indicator MR is on and indicator 02 is on, the contents of the field AMT are added to the MASBAL. The result is stored in MASBAL. The date is moved to the field PAYDAT.

Whenever the matching record indicator MR is on and indicator 03 is on, AMT is subtracted from MASBAL, and the result is stored in MASBAL. The date is moved to PAYPUR.

OUTPUT-FORMAT SPECIFICATIONS SHEET

The output file MASTEROT is the updated tape file. The entries in output indicators allow for the following. Whenever conditions 01 and NMR are satisfied (resulting indicator 01 is on and no matching record is present), the entire tape input record will be written out on tape. This condition results because there was no corresponding customer number in the transaction file for the master customer number.

To keep the master customer file complete, the old input record is written out on the updated tape file when no information is present in the transaction file.

If, however, L1 and MR are on, the input record is written out on tape. The entire record is written, but the fields MASBAL, PAYDAT, and PAYPUR contain the new entries based on the calculations. By coding the entries in this way, the new information for MASBAL, PAYDAT, and PAYPUR is entered on the master customer file, but the customer's name and address are retained.

The specifications for the printed report are listed under the name of the output file MASTLIST.

SAMPLE PROGRAM THREE

The third sample (Figures 141 and 142) illustrates some of the more complex capabilities of RPG.

1. Processing chained records on a Direct Access Storage Device (DASD).
2. Updating records on a DASD.
3. Multiple input and output files.
4. Creating exception records.
5. Providing for processing when a record in the chained file is missing.

CARDIN

Field	Card Column
Date Card	
Code	1
Date	2-7
Not Used	8-80
Transaction Card	
Code	1
Part Number	2-9
Receipts	10-13
Issues	14-17
Returns	18-21
Not Used	22-80

CARDOUT

Field	Card Column
Code	1
Part Number	2-9
Description	10-36
Vendor Number	37-42
Date	43-48
Not Used	49-80

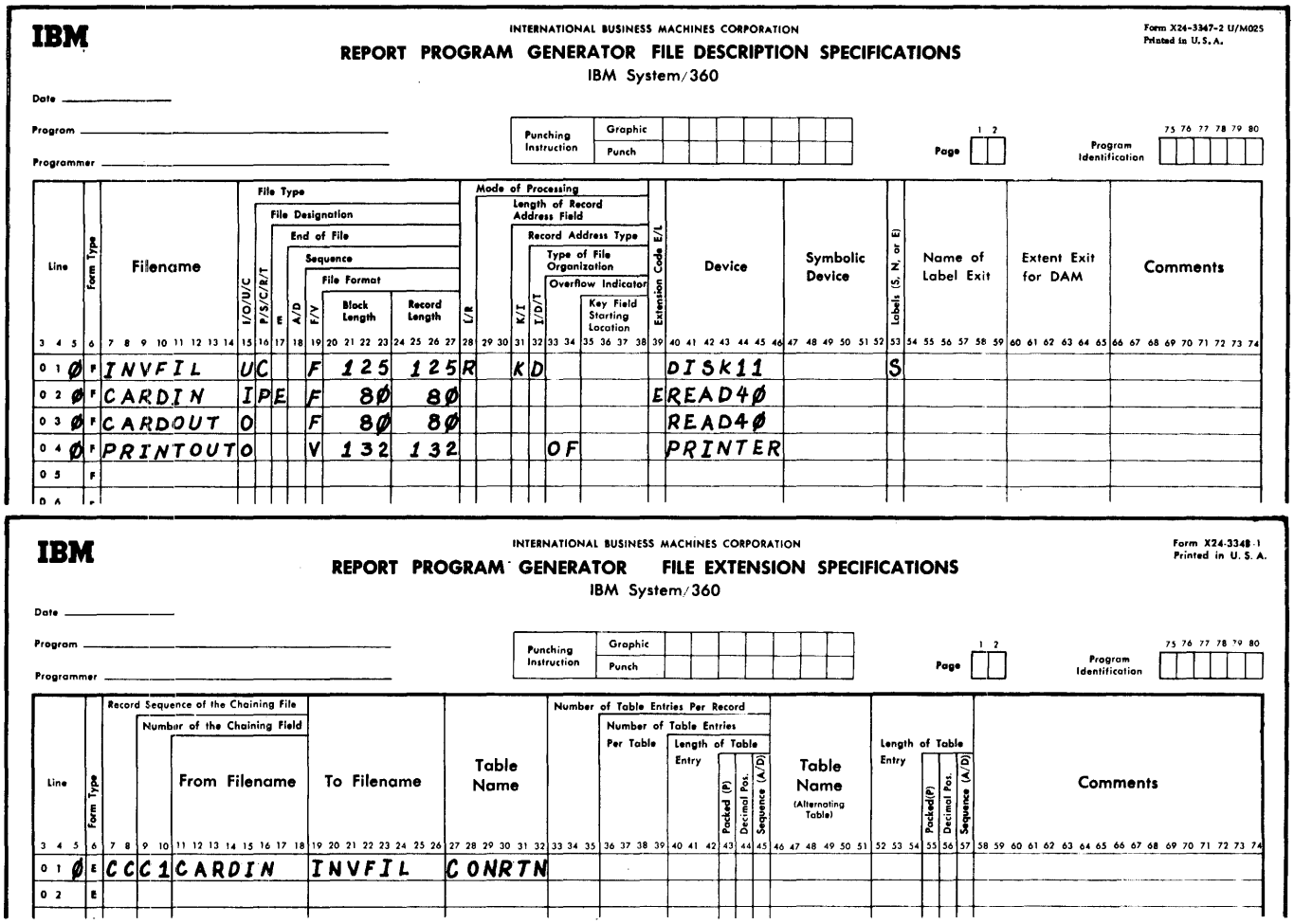
INVFIL

Field	Position
Code	1
Part Number	2-9
Description	10-36
Vendor Number	37-42
Not Specified	43-49
Minimum	50-53
On Hand	54-58
Not Specified	59-125

INVENTORY LISTING 5/28/66 PAGE 1

PART NUMBER	PART DESCRIPTION	MIN BAL	OLD BAL	RECEIPTS	ISSUES	RETURNS	NEW BAL	
00101238	HEX NUT	1,000	3,500	100	600		3,000	
00101239	WASHER	2,500	3,100	500	1,000		2,600	
00101240	LKWSHR	1,500	3,700		3,500	100	300	BELOW MINIMUM
00101241	BOLT,6-IN	500	650	50	100	50	650	
00101242	BOLT,8-IN	500	645	100	245		500	EXPEDITE
00101243	NO DISK RECORD FOR THIS PART							
00101244	MACHINE SCREW,1-IN	800	1,100	800	1,200	400	1,100	

Figure 141. Input and Output Formats for Sample Program Three



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REPORT PROGRAM GENERATOR FILE DESCRIPTION SPECIFICATIONS

IBM System/360

Form X24-3347-2 U/M025
Printed in U.S.A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	I/O/U/C	P/S/C/R/T	E	A/D	F/V	Block Length	Record Length	L/R	K/T	I/O/T	Key Field Starting Location	Extension Code E/L	Device	Symbolic Device	Labels (S, N, or E)	Name of Label Exit	Extent Exit for DAM	Comments
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19	20 21 22 23	24 25 26 27	28	31	32 33	35 36 37 38	39	40 41 42 43 44 45 46	47 48 49 50 51 52	53	54 55 56 57 58 59	60 61 62 63 64 65	66 67 68 69 70 71 72 73 74
01Ø	F	INVFIL	U	C			F	125	125	R	K	D			DISK11		S			
02Ø	F	CARDIN	I	P	E		F	8Ø	8Ø					E	READ4Ø					
03Ø	F	CARDOUT	O				F	8Ø	8Ø						READ4Ø					
04Ø	F	PRINTOUT	O				V	132	132			OF			PRINTER					
05	F																			
0A	F																			

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REPORT PROGRAM GENERATOR FILE EXTENSION SPECIFICATIONS

IBM System/360

Form X24-3348-1
Printed in U.S.A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Record Sequence of the Chaining File	Number of the Chaining Field	From Filename	To Filename	Table Name	Number of Table Entries Per Record	Number of Table Entries Per Table	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Table Name (Alternating Table)	Length of Table Entry	Packed (P)	Decimal Pos.	Sequence (A/D)	Comments
3 4 5	6	7 8	9 10	11 12 13 14 15 16 17 18	19 20 21 22 23 24 25 26	27 28 29 30 31 32	33 34 35	36 37 38 39	40 41 42	43	44	45	46 47 48 49 50 51	52 53 54	55	56	57	58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
01Ø	E	CC	C1	CARDIN	INVFIL	CONRTN												
02	E																	

Figure 142. Specifications for Sample Program Three (Part 1 of 5)

FILE DESCRIPTION SPECIFICATIONS

The primary input file, designated by a P in column 16, is on the card reader and is labeled CARDIN. This card file also acts as a transaction file for the updating of the inventory records contained on the file labeled INVFIL. The U in column 15 of the specification for INVFIL indicates that this DASD file is updated (used for both input and output). The file has direct organization indicated by the D in column 32, and is processed randomly as specified by the R in column 28.

The E in column 17 of the CARDIN file description entry directs the program to end execution when the last record of the CARDIN file has been processed. The E in column 39 indicates that a file extension specification has been coded for the CARDIN file.

The output files are an exception card file labeled CARDOUT and the printed transaction report labeled PRINTOUT.

CARDIN and CARDOUT consist of 80-character records. INVFIL has a block length of 125 characters and a record length of 125 characters. Record length for PRINTOUT is variable, with a maximum of 132 characters.

FILE EXTENSION SPECIFICATIONS

The file extension sheet identifies CARDIN as the chaining file, indicating that record

sequence CC contains the chaining field C1. INVFIL is the chained file and CONRTN is the RPG internal label of the specifications on the Calculation Specifications sheet for the external conversion routine that processes the chaining field to obtain the relative track address in the DASD file.

INPUT SPECIFICATIONS

The input card and DASD files are described on the Input Specifications sheet. Each field that is used is defined. The C1 in columns 61-62 of the transaction card file designates the field labeled DTLPAR as the chaining field. The conversion routine CONRTN, indicated on the Calculation Specifications sheet, makes the DTLPAR field available to the user's external conversion routine.

CALCULATION SPECIFICATIONS

Two sets of calculation specifications are described. After the label CONRTN, the operation code EXTCV is used to indicate that the conversion routine is to be performed. ADDCON is the symbolic address of

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REPORT PROGRAM GENERATOR INPUT SPECIFICATIONS

IBM System/360

Form X24-3350-1 U/M025 Printed in U.S.A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Resulting Indicator	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Stacker Select	Packed (P)	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field-Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15 16	17	18	19 20	21 22 23 24	25	26	27	28 29 30 31	32	33	34	35 36 37 38	39	40	41	42	43	44 45 46 47	48 49 50 51	52	53 54 55 56 57 58	59 60	61 62	63 64	65 66	67 68	69 70	71 72 73 74
01Ø	1	INVFIL	AA			Ø1	1		D	2																					
02Ø	1																				2	9		PART							
03Ø	1																				1Ø	36		DESC							
04Ø	1																				37	42Ø		VENDOR							
05Ø	1																				5Ø	53Ø		MIN							
06Ø	1																				54	58Ø		ONHAND							
07Ø	1	CARDIN	BB			Ø2	1		C	*									1												
08Ø	1																				2	7Ø		DATE							
09Ø	1		CC			Ø3	1		D	L									1												
10Ø	1																				2	9		DTLPAR		C1					
11Ø	1																				1Ø	13Ø		RECPTS							
12Ø	1																				14	17Ø		ISSUES							
13Ø	1																				18	21Ø		RETURN							
14	1																														

Figure 142. Specifications for Sample Program Three (Part 2 of 5)

the external conversion routine. TRKADR, the field that contains the relative track address in the DASD file, must have a length of three. The external routine can be a member of a library or in the form of an object module card deck. As a card deck it is included with the RPG object module as input to the linkage editor.

The operation code KEYCV states that the record key of the DASD record can be obtained directly from the field DTLPAR.

The calculations in lines 030-070 require the presence of corresponding chaining (CARDIN) and chained (INVFIL) records. The condition is indicated by the simultaneous setting of resulting indicators 01 and 03. The ONHAND field from the INVFIL record is zero and added to a work area (SAVE). Data fields RECPTS and RETURN from CARDIN records are added to SAVE: ISSUES are subtracted. When each input card for an INVFIL record is processed, the resulting new ONHAND field in SAVE is compared to the minimum balance. If ONHAND equals the minimum, resulting indicator 05 is set on. If ONHAND drops below the minimum, resulting indicator 04 is set on.

The entry on line 080 resets the H0 indicator which would otherwise terminate processing when a record in the chained file is missing. The printed output notes this error condition.

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REPORT PROGRAM GENERATOR CALCULATION SPECIFICATIONS

IBM System/360

Form X24-3351-1 Printed in U.S.A.

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Control Level (L0-L9, LR)	Indicators: And / Not	Factor 1	Operation	Factor 2	Result Field	Field Length	Decimal Positions	Half Adjust (H)	Resulting Indicators: Plus / Minus / Zero or Blank	Compare: High 1 > 2 / Low 1 < 2 / Equal 1 = 2	Comments
010	C			CONRTN	EXTCV	ADDCON	TRKADR	3					
020	C				KEYCV		DTLPAR						
030	C		01 03		Z-ADD	ONHAND	SAVE	50					
040	C		01 03	SAVE	ADD	RECPTS	SAVE						
050	C		01 03	SAVE	SUB	ISSUES	SAVE						
060	C		01 03	SAVE	ADD	RETURN	SAVE						
070	C		01 03	SAVE	COMP	MIN						04 05	
080	C		N01 03		SETOF						H0		
090	C												

Figure 142. Specifications for Sample Program Three (Part 3 of 5)

OUTPUT-FORMAT SPECIFICATIONS

The PRINTOUT file's heading information can be printed under control of either resulting indicator 02, which is set for the date card (the first card in the CARDIN file), or overflow (OF). The OF indicator governs all heading printing after the first page. The entry PAGE in line 030 causes the page number to be updated automatically for each new page.

The detail line described by the entries in lines 150 of Figure 142 (Part 4) through 050 of Figure 142 (Part 5) requires the presence of both the CARDIN and INVFIL records (resulting indicators 01 and 03 on). If resulting indicator 04 is on, the words BELOW MINIMUM indicate the stock violation.

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REPORT PROGRAM GENERATOR OUTPUT-FORMAT SPECIFICATIONS

IBM System 360

Form X24-3352-1
Printed in U. S. A.

Date

Program

Programmer

Punching Instruction: Graphic / Punch

Page

Program Identification

Line	Form Type	Filename	Type (H, D, T)	Stacker Select	Space Before	Space After	Skip Before	Skip After	Output Indicators And	And	And	Field Name	Zero Suppress (Z)	Blank After (B)	End Position in Output Record	Packed Field (P)	Constant or Edit Word	Sterling Sign Position
3 4 5	6	7 8 9 10 11 12 13 14	15	16	17	18	19 20	21 22	23 24 25 Not	26 27 28 Not	29 30 31 Not	32 33 34 35 36 37	38	39	40 41 42 43	44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74
010	O	PRINTOUT	H			3	01		02									
020	O		OR						OF									
030	O											PAGE	N		86			
040	O														83		'PAGE'	
050	O														50		'INVENTORY LISTING'	
060	O											DATE			67		' / / '	
070	O		H			2			02									
080	O		OR						OF									
090	O														19		'PART NUMBER'	
100	O														40		'PART DESCRIPTION'	
110	O														66		'MIN BAL OLD BAL'	
120	O														84		'RECEIPTS ISSUES'	
130	O														102		'RETURNS NEW BAL'	
140	O		D			2			01	03								
150	O											PART			17			
160	O											DESC			48			
170	O											MIN			56		' , '	
180	O											ONHAND			66		' , '	
190	O											RECPTS			75		' , '	
	O																	

Figure 142. Specifications for Sample Program Three (Part 4 of 5)

If indicator 05 is on, the message EXPEDITE is added.

The output line described in PRINTOUT entries 060-090 is the message printed when the error condition occurs of a CARDIN re cord, and no corresponding INVFIL record. This condition is identified by resulting indicator 01 being off when indicator 03 is on.

The exception file CARDOUT has a card punched for each transaction that results in a below-minimum of at-minimum stock level. These cards contain the part number and description, vendor number, date, and the E or B code for EXPEDITE or BELOW MINIMUM. Below minimum cards, identified by the simultaneous on settings of indicators 01, 03, and 04, are selected to stacker number P2. At minimum cards, with indicators 01, 03, and 05 on, are selected to stacker number RP3.

Lines 180 and 190 provide for the updating and writing out of the INVFIL records. If indicators 01 and 03 are both on, indicating that the INVFIL record has been updated by a CARDIN transaction, the new ONHAND is moved into its INVFIL location from the work area SAVE, and the record is written.

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Form X24-3352-1 U/M 025
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REPORT PROGRAM GENERATOR OUTPUT-FORMAT SPECIFICATIONS

IBM System/360

Date _____

Program _____

Programmer _____

Punching Instruction: Graphic / Punch

Page 1 2

Program Identification 75 76 77 78 79 80

Line (3 4 5)	Form Type (6)	Filename (7-14)	Type (H/D/T) (15)	Space: Stacker Select (16)	Space: Before (17)	Space: After (18)	Skip: Before (19 20)	Skip: After (21 22)	Output Indicators: And Not (23 24 25)	Output Indicators: And Not (26 27 28)	Output Indicators: And Not (29 30 31)	Field Name (32-37)	Zero Suppress (Z) (38)	Blank After (B) (39)	End Position in Output Record (40 41 42 43)	Packed Field (P) (44)	Constant or Edit Word (45-70)	Sterling Sign Position (71-74)
010	O											ISSUES			84		' , Ø'	
020	O											RETURN			92		' , Ø'	
030	O											SAVE			102		' , Ø'	
040	O								Ø4						117		'BELOW MINIMUM'	
050	O								Ø5						112		'EXPEDITE'	
060	O		D		2				N01	Ø3								
070	O											DTLPAR			17			
080	O														44		'NO DISK RECORD FOR THIS'	
090	O														48		'PART'	
100	O	CARDOUT	D	2					Ø1	Ø3	Ø4							
110	O		OR	3					Ø1	Ø3	Ø5							
120	O											PART			9			
130	O											DESC			36			
140	O											VENDOR			42			
150	O											DATE			48			
160	O								Ø5						1		'E'	
170	O								Ø4						1		'B'	
180	O	INVFIL	D						Ø1	Ø3								
190	O											SAVE			58			
	O																	

Figure 142. Specifications for Sample Program Three (Part 5 of 5)

APPENDIX B. INDICATOR CHART

Indicators	Where Specified	Where Used	Turned On	Turned Off	Notes
Resulting Indicator 00	Internal	Output Indicators on Output Specifications (Columns 24 - 25, 27 - 28, 30 - 31)	This indicator is always ON	Can never be turned OFF	
Resulting Indicators (01 - 99)	Input Specifications (Columns 19 - 20)	Indicators on Calculation Specifications (Columns 10-11, 13-14, 16-17) Output Indicators on Output Specifications (Columns 24-25, 27-28, 30-31)	When specified record type has been read and is ready for processing	Before the first record is read on the next processing cycle	Turning OFF and ON can also be accomplished by using SETON and SETOF operation codes
	Calculation Specifications (Columns 54-55, 56-57, 58-59)	Same as above	Whenever the specified field status condition is satisfied	The next time that this field status is to be tested	Same as above
Field Indicators (01 - 99)	Input Specifications (Columns 65-66, 67-68, 69-70)	Same as above	Same as above	Same as above	Same as above
Halt Indicators (H0 - H9)	Input Specifications (Columns 65-66, 67-68) Calculation Specifications (Columns 54-55, 56-57, 58-59)	Same as above	Same as above. H0 is automatically turned on for the conditions listed in Appendix H	Can only be turned OFF by SETOF operation code See Note	If these indicators remain ON, the object program will terminate before reading the next record
LR	Internal	Same as above and Calculation Specifications (Columns 7-8)	After processing the last record of the last file		All Control Level Indicators (L1-L9) are also turned ON when the LR is turned ON
Control Level Indicators (L1-L9)	Input Specifications (Columns 59-60)	Same as above and Calculation Specifications (Columns 7-8)	When the value in a control field changes. All indicators of the lower levels are also turned ON	Before the first record is read on the next processing cycle	Turning OFF and ON can be accomplished by using SETON and SETOF operation codes
L0	Internal	Indicators on Calculations Specifications (Columns 10-11, 13-14, 16-17) Output Indicators on Output Specifications (Cols. 24-25, 27-28, 30-31)	This indicator is always ON	Can never be turned OFF	
MR	Internal	Same as above	When multiple input files and the matching fields specification are used, this indicator is turned ON if a secondary file record matches the primary file record	Before the first record is read on the next processing cycle	
Overflow Indicators OA, OB, OC, OD OE, OF, OG, OV	File Description (Columns 33-34)	Same as above	One line after channel 12 of the carriage control tape is sensed	After the detail and heading records are written	These indicators remain ON for one complete processing cycle
1P	Internal	Output Indicators on Output Specifications (Columns 24-25, 27-28, 30-31)	This indicator is ON at the beginning of processing before any records are read	Before the first record is read	This indicator is used to govern printing of the first page of the report

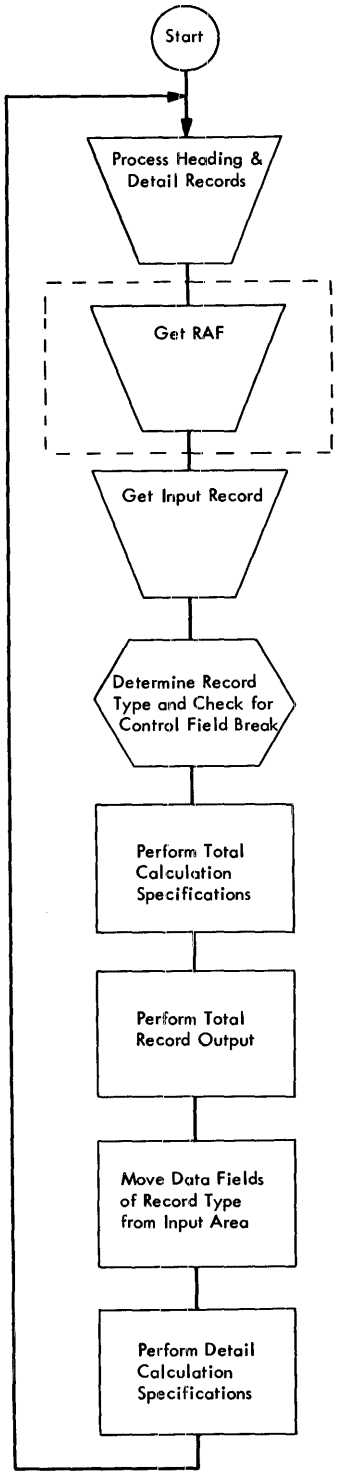

Chart 1. General Logic for RPG Object Module with RAF

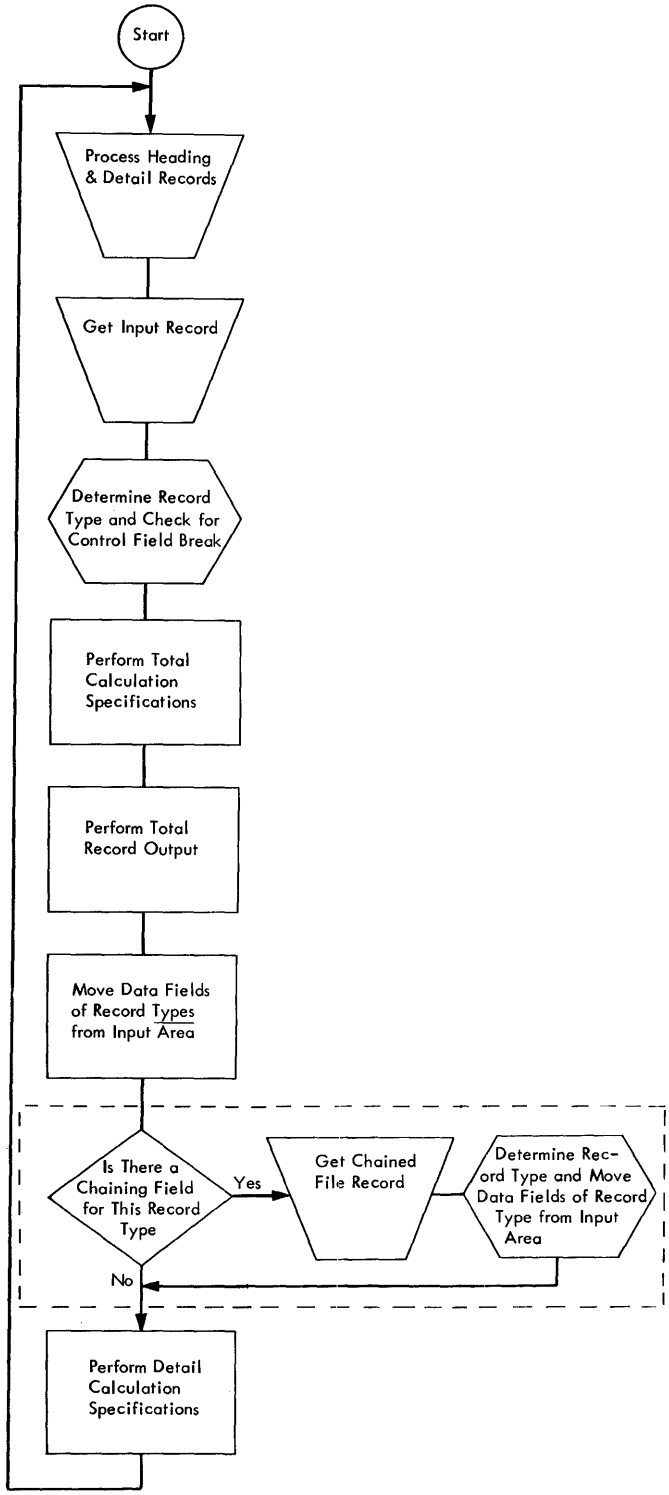

Chart 2. General Logic for RPG Object Module with a Chaining File

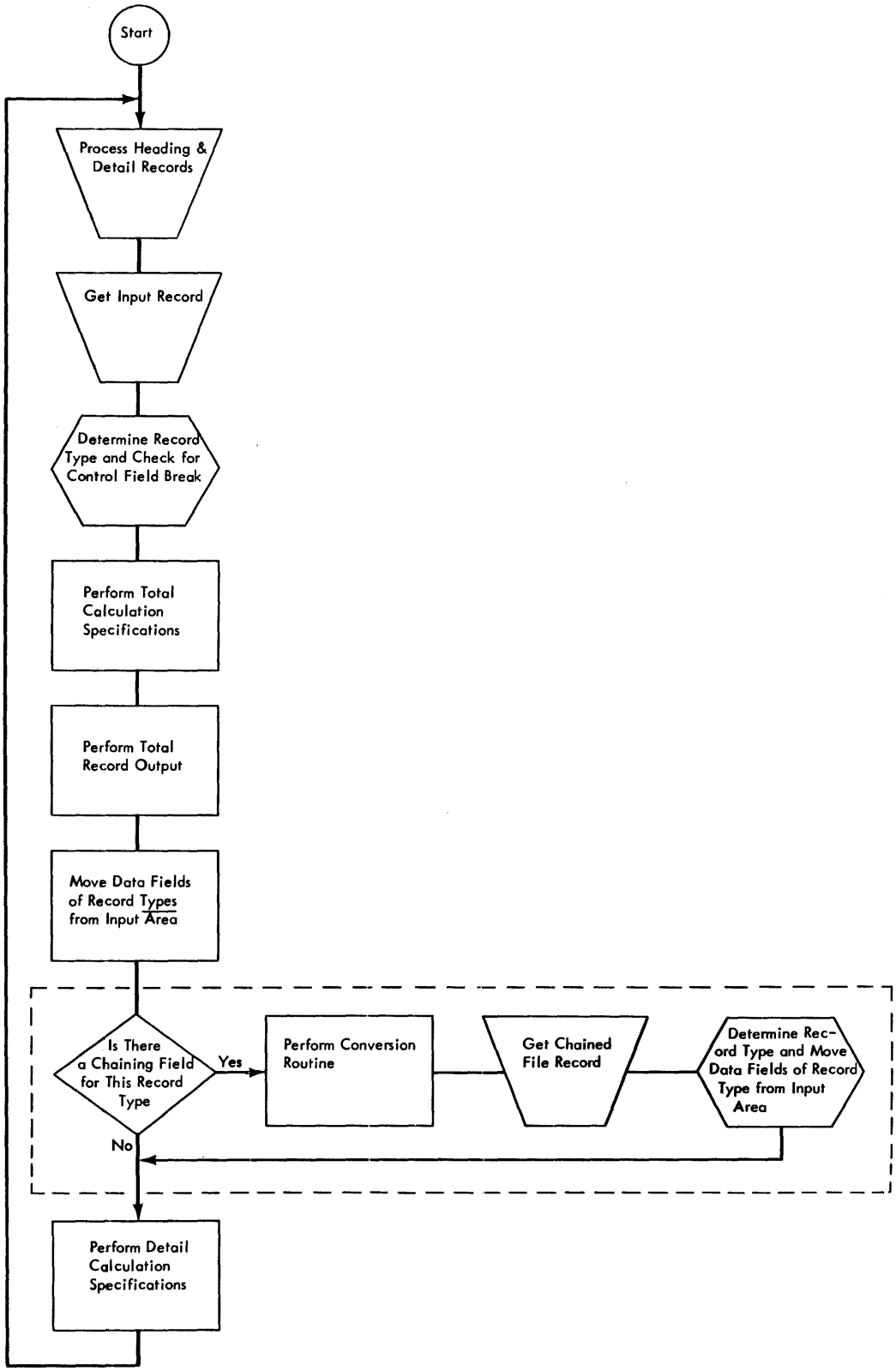

Chart 3. General Logic for RPG Object Module with Chaining File Which Requires Conversion

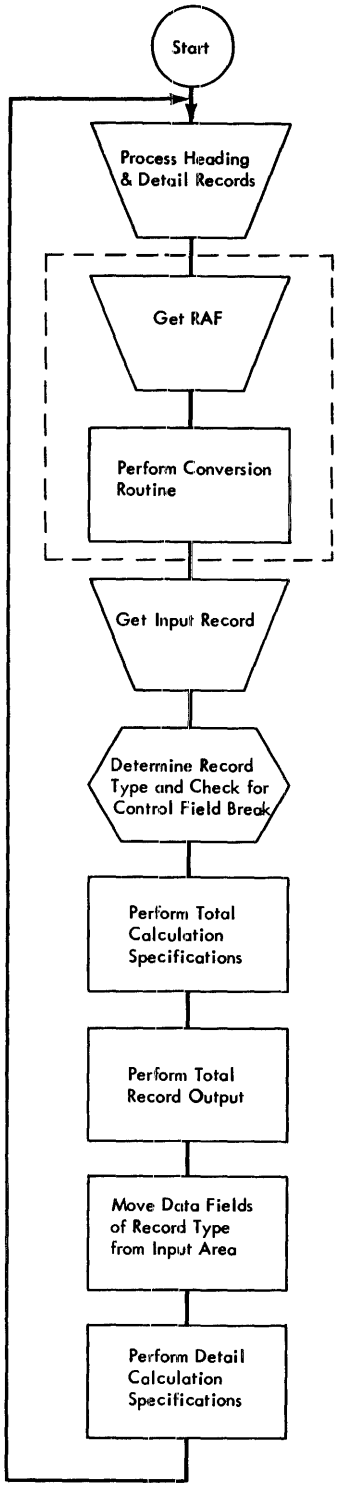

Chart 4. General Logic for RPG Object Module with RAF which Requires Conversion

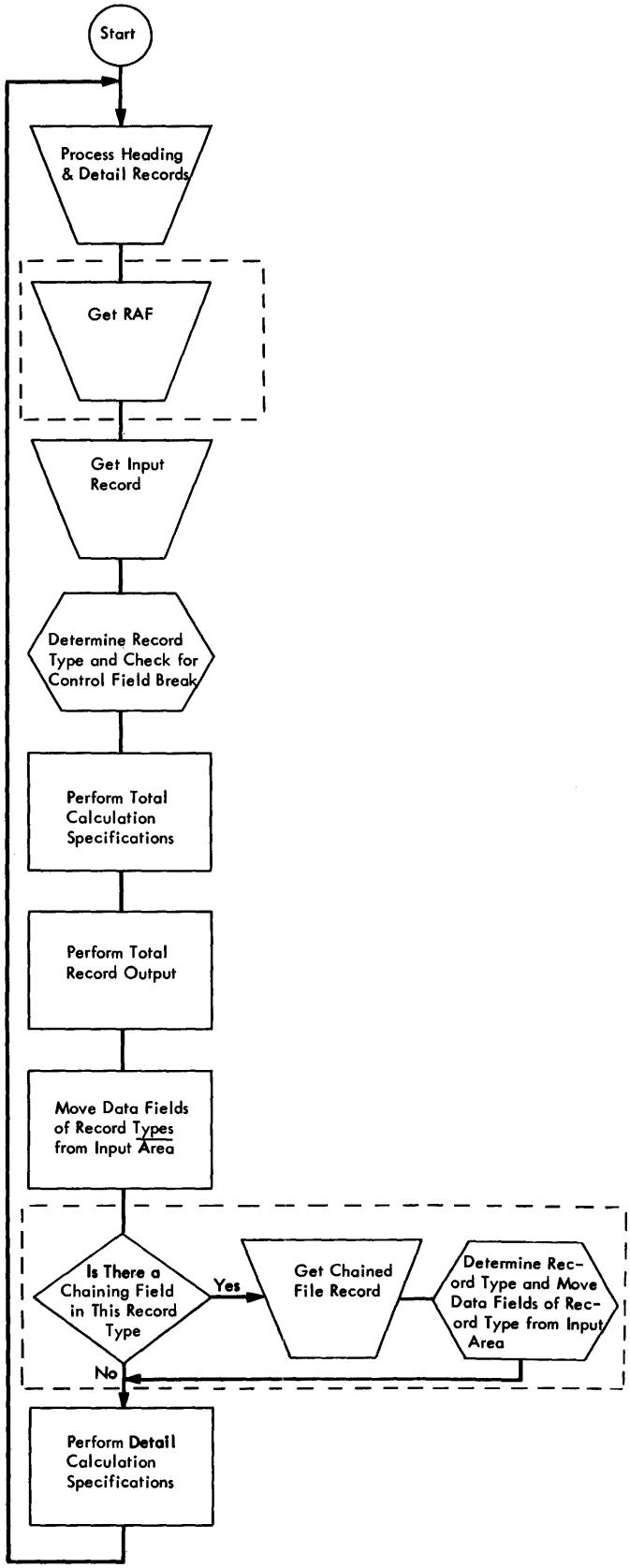

Chart 5. General Logic for RPG Object Module with RAF and Chaining Files

APPENDIX D. STERLING ROUTINES FOR THE REPORT PROGRAM GENERATOR

The RPG sterling routines furnish users with a convenient and time-saving means of handling sterling amounts. The presence of sterling fields is indicated to the RPG program by additional entries in the input and output specifications forms and in the control card. The file description, file extension, and calculation forms are not affected.

Sterling input information can be represented in two formats: IBM and BSI as described in the control card. The RPG sterling routines convert the input fields into a pence-format field. A pence-format field is a sterling amount represented in pence. If the output is to be printed, the fields are converted with shillings and pence printed in two positions each with zero suppression in effect in the tens position of each field. If the output is not printed, the output is converted to either BSI or IBM formats.

NOTE 1: On both input and output the pounds field must consist of at least one, and no more than nine positions.

NOTE 2: BSI or IBM input files of one program must use the same code combination throughout.

INPUT SPECIFICATIONS

The position of the sign must be specified in columns 71-74. Enter an S in column 74, if the sign is in the normal position. If the pence field has decimal positions, the normal position of the sign is in the rightmost decimal position of the pence field. If the pence field has no decimal positions, the normal position of the sign is in the units position of the pounds field.

NOTE 1: One of the digits 0, 1, 2, or 3 must be entered in column 52, to indicate the number of required decimal positions.

NOTE 2: It is not permissible to use the same name for both a sterling field and a decimal field.

NOTE 3: The sign of the field must contain a numeric underpunch.

OUTPUT FORMAT SPECIFICATIONS

The position of the sign for sterling output fields must be specified in columns 71-74 in the same manner as for sterling input fields. The sterling sign will always appear on output whether the field is plus, minus, or zero.

Output Which is Not Printed. The field may be specified as any combination of IBM or BSI shillings and pence formats. The sign may appear anywhere within the record. When outside the field, the sign will be supplied with a zero underpunch.

Printed Output. The normal sign position must be used. Insert the letter S in column 74 of the Output Specifications Sheet.

NOTE 1: Shillings and pence are printed in two positions each. When no edit word is specified zero suppression is in effect in the tens positions of each field.

NOTE 2: The pounds field consists of at least one and no more than 9 positions. Zero suppression on the pounds field may be obtained by placing Z in column 38 of the specification sheet. The sign will not be suppressed since its position depends on the presence or absence of decimal pence.

NOTE 3: If a field is defined as a sterling field in the input but not in the output specification, the output will be in pence format.

NOTE 4: Editing is allowed only on printed output files. The rules governing the use of edit control words are the same as those for decimal fields. The features available are:

1. Zero suppression in the pounds field.
2. Zero suppression in the shillings field, if both pound and shilling values are zero.
3. Zero suppression in the pence field, if pound, shilling and pence values are zero.
4. Suppression of zeros preceding signs, and suppression of separation marks between pounds and shillings, shillings and pence, and pence and decimals.

CONTROL CARD

To select the required sterling routines, the RPG program needs information regarding the input and output formats. This information is entered in four columns of the

RPG processor control card. The entries are are: 1 for IBM Code, 2 for BSI Code.

CALCULATION SPECIFICATIONS

While no additional entries are required in this form, the user should keep in mind that all calculations are done in pence format. This must be considered when defining the length of result fields or when using Factors 1 and 2.

Lengths of Pence-Format Fields

If a pence-format result field is to be reconverted into a sterling output field, the highest amount it is permitted to contain is 239, 999, 999, 999.999. This converts to a field containing nine pounds positions which is the maximum allowed.

NOTE: In order to avoid the possible loss of the high order digit, fields that are read in as IBM or BSI sterling always contain one more position when put out as IBM or BSI sterling. For example, the five position sterling input field 9919+ (IBM format) converts to the five position pence field 23999. Since the RPG compiler in putting out this field must allow for a five position pence field containing up to 99999 pence (which converts to 416133, IBM format), the field on output will be six positions long.

Pound Sterling Formats

In addition to the printed output format, RPG will support, on the input and output fields, two standards for pence and shilling portions of sterling fields: IBM or BSI. Columns 17-20 of the RPG processor control card indicate either the IBM or BSI formats. The formats for IBM and BSI are listed here.

Column 17 (Sterling-Shilling Field On Input) IBM Format. Two positions are allowed for the shilling option in the input fields: 00-19 for 0 to 19 shillings.

BSI Format. The shilling option in the input fields is indicated as listed here:

0-9 Shillings by a 0-9 punch,
10 Shillings by a 12-punch,
11-19 Shillings by an A-I punch.

Column 18 (Sterling-Pence Field on Input) IBM Format. The pence option on the input field is as listed here:

0-9 Pence by a 0-9 punch,
10 Pence by an 11-punch,
11 Pence by a 12-punch.

BSI Format. The pence option on the input field is as listed here:

0-9 Pence by a 0-9 punch,
10 Pence by a 12-punch,
11 Pence by an 11-punch.

Columns 19 (Sterling-Shillings Field on Output) IBM Format. Two position are allowed for the shilling option on the output field:

00-19 for 0-19 shillings

BSI Format. The shilling option on the output field is as listed here:

0-9 Shillings by a 0-9 punch,
10 Shillings by a 12-punch,
11-19 Shillings by an A-I punch.

Column 20 (Sterling-Pence Field on Output) IBM Format. The pence option on the output field is as listed here:

0-9 Pence by a 0-9 punch,
10 Pence by an 11-punch,
11 Pence by a 12-punch.

BSI Format. The pence option on the output field is as listed here:

0-9 Pence by a 0-9 punch,
10 Pence by a 12-punch,
11 Pence by an 11-punch.

APPENDIX E. CONVERSION ROUTINE OPERATION CODES

The following list shows the relationship between conversion routine operation codes and how they are specified.

CODE	FACTOR 1	FACTOR 2	RESULT FIELD	SPECIFICATIONS THAT MAY FOLLOW THIS ENTRY
RPGCV	Reference Name	No entry	Label of the field which will contain the track address of the record.	KEYCV
EXTCV	Reference Name	Name or Label of the user's routine.	Label of the field which will contain the track address of the record.	KEYCV
KEYCV	None	None	Label of the field which will contain the key of the record to be located.	If RPGCV has been used, the conversion steps follow KEYCV. If EXTCV has been used, any other RPG calculations follow.
ERPGC	None	None	None	Any other calculations in the RPG program.

This summary contains a brief column-by-column description of each of the six RPG specification forms. The purpose of the summary is to provide the user with a concise reference guide.

The first five items are common to all six specification forms.

Page 1-2

Enter number of specification page. Assign ascending numbers to the pages of each program specification set to collate in the following sequence:

File Description Specifications
File Extension Specifications
Line Counter Specifications
Input Specifications
Calculation Specifications
Output-Format Specifications

Line 3-5

First two digits of line number are preprinted. Use third position (column 5) to identify additional lines to be inserted between two preprinted lines.

Form Type 6

Contains a preprinted code (F, E, L, I, C, or O) which must be punched into all RPG specification cards.

Comments 7

Enter an asterisk (*) in each line to be used exclusively as a comments line.

Program Identification 75-80

Insert any information to identify certain cards or portions of an RPG source program.

FILE DESCRIPTION SPECIFICATIONS

Filename 7-14

Enter a name for each file used in the program. Names must be left-justified.

File Type 15

Enter one of the letters I, O, U, or C to identify Input, Output, Update, or Combined file.

File Designation 16

P for primary, S for secondary input or combined files. Enter P if only one input file or combined file is used. C for chained file, R for RAF or T for table file. Leave blank for output files.

End of File 17

Enter E for each input file or combined file that is to be checked to determine when the last record has been read and processed (LR indicator on). Leave blank if LR is to be turned on when the last record of all input and combined files has been read.

Sequence 18

Required when Matching Fields is used. A if the input file or combined file is in ascending sequence, D if it is in descending sequence. Leave blank for output files, or for input or combined files without Matching Fields.

File Format

F: Fixed-length records.

V: Variable-length records.

Block Length 20-23

Unblocked

If the records are unblocked, enter the length of a record. If variable-length records are used, enter the length of the longest record.

Blocked

If the records are blocked, enter the length of the largest block.

Record Length 24-27

Used to enter the length of the logical records contained in the file. If the file contains records that are variable in length, enter the length of the largest record.

Mode of Processing 28

Used to indicate the method or mode by which the file is processed. Enter an L in this column if a segment of the file is to be processed. Enter an R in this column if the records are to be processed randomly. If no entry is made in this column for the file, the entire file will be processed sequentially.

Length of Record Address Field 29-30

If the file is a record-address file, enter the number of positions that each entry in the RAF occupies.

Record Address Type 31

If the records from the file are retrieved by using record keys, enter a K in this column. If record ID is used to retrieve records, enter I in this column.

Type of File Organization 32

Leave blank if the file is organized sequentially. Enter an I if the file has indexed-sequential organization. Enter a D if the file has direct organization.

Overflow Indicator 33-34

If overflow indicators are used, enter the overflow indicator associated with the file. A maximum of eight overflow indicators is allowed: OA, OB, OC, OD, OE, OF, OG, and OV.

Key Field Starting Location 35-38

Indicates the location of the key field within the data record. Enter the starting position of the key field. This entry is required for indexed-sequential files.

Extension Code 39

Indicates that additional information about the file is coded on the File Extension Specifications sheet, or Line Counter Specifications sheet.

Enter an E if the file defined on the line is a:

Chaining file
Table file
Record Address file (RAF)

Device 40-46

Relates a file to a specific type of input or output unit.

If the output file is a printer, enter PRINTER.

If the file is an I/O file and it is associated with a card reader or card punch unit, enter:

READ01	IBM 2501 Card Reader
READ20	IBM 2520 Card Read-Punch
READ40	IBM 2540 Card Read-Punch
READ42	IBM 1442 Card Read-Punch

If the file is an I/O file and it is associated with a tape unit enter TAPE.

If the file is associated with a 2311 Disk Storage Drive, enter DISK11.

Symbolic Device 47-52

Not used.

Labels 53

S Standard Labels.
E Standard Labels Followed by user-standard Labels.
b No Labels.

Name of Label Exit 54-59

Enter the name of the routine to process user-standard labels. If the entry is shorter than six characters, it must be left-justified.

Extent Exit for DAM 60-65

Not used.

Comments 66-74

Enter any desired comments. An asterisk in column 7 must not be used if this type

of comments is in a line containing specifications.

FILE EXTENSION SPECIFICATIONS

Record Sequence of the Chaining File 7-8

Used only for chaining files. Enter the same entry that is made for the chaining file in Sequence on the Input Specifications sheet.

Number of the Chaining Field 9-10

Used only for chaining files. Enter the identifying number of the chaining field. This number is entered in Chaining Field of the Input Specifications sheet.

From Filename 11-18

Used in conjunction with To Filename to identify -- for the RPG program -- the relationship between two files. For example, they provide the name of a chaining file and the name of the file that is chained to it.

To Filename 19-26

(See description above)

Table Name 27-32

Enter name of table:
for alternating input format, enter name of table to which the first entry in each input record belongs;
for non-alternating input format, enter name of single table.

For a RAF or chaining file, specify the label of the address conversion routine. Table name must consist of 6 characters, the first 3 must be TAB, the remaining 3 may be any alphabetic or numeric characters.

Number of Table Entries Per Record 33-35

Enter the maximum number of table entries (arguments or functions) that are contained in each input record. The entry must be right-justified.

Number of Table Entries Per Table 36-39

Enter the maximum number of table entries (arguments or functions) contained in the table. The entry must be right-justified.

Length of Table Entry 40-42

Enter the length of each table entry. The maximum size of a numeric entry is 15 characters, of an alphameric entry 256 characters. The entry must be right-justified.

Packed 43

If the data for the table is in the packed-decimal format, enter P in this column. Otherwise leave this column blank.

Decimal Positions 44

If the data contained in the table is numeric, enter the number of decimal positions (1-9). Enter a zero if there are no decimal positions. If the field is alphameric, leave this column blank.

Sequence 45

If the data contained in the table is in ascending sequence, enter an A; in descending sequence, enter a D. Leave blank if the data is not in ascending or descending sequence or if this specification is not required.

Table Name 46-51

If alternating arguments and function tables are used, enter the second table name. It must be of the form TABnnn. The entry must be left-justified.

Length of Table Entry 52-54

Enter the length of each table entry. The maximum size of a numeric entry is 15 characters; of an alphameric entry 256 characters. The entry must be right-justified.

Packed 55

Enter a P if the data for the table is in the packed-decimal format. Otherwise leave this column blank.

Decimal Positions 56

If the data contained in the table is numeric, enter the number of decimal positions (1-9). Enter a zero if there are no decimal positions. If the field is alphameric, leave blank.

Sequence 57

If the data contained in the table is in ascending sequence, enter an A; in descending sequence, enter a D. Leave blank if the data is not in ascending or descending sequence or if this specification is not required.

Comments 58-74

Leave columns 58-74 blank, unless comments are entered in these columns.

LINE COUNTER SPECIFICATIONS

Filename 7-14

Enter the name of the output file.

Line Number (1) 15-17

Enter the number of the first line controlled by the carriage tape in columns 15-17.
The remaining specifications (items 2-12) perform the same function.

Channel Number (1) 18-19

Enter the channel number corresponding to the line number in columns 15-17. The remaining specifications (items 2-12) perform the same function.

INPUT SPECIFICATIONS

Filename 7-14

Enter a file name for each input or combined file, one entry per file. Must be left-justified; it may have up to 8 characters; first character must be alphabetic; remaining characters may be alphabetic or numeric; special characters or embedded blanks may not be used.

AND/OR Relationship 14-16

Enter AND to indicate that the AND-relationship of Record Identification Codes in the preceding line is to be continued. Enter OR (columns 14 and 15) to indicate that the entries in Record Identification Codes of this line are to be in an OR-relationship to the entries in the preceding line.

Sequence 15-16

Enter a number, beginning with 01 for each file and continuing in consecutive sequence to 99, to specify sequence-checking of card types. Enter leading zeros. Enter any two alphabetic characters to indicate that sequence-checking is not required. Lines with alphabetic entries in Sequence must precede lines with numeric entries.
Any numeric entry in Sequence requires an entry in Number.

Number 17

1 indicates that one and only one record of a specific record type should be present in each group.
N indicates that one or more records of a specific record type may be present in each group. (Used only with numeric entry in columns 15-16.)

Option 18

O indicates that a record of a specific control group used need not be present. Leave blank if a record must be present, or if records are non-sequential. (Used only with numeric entry in columns 15-16.)

Resulting Indicator 19-20

Enter any indicator from 01 through 99 to establish a two-digit code for the input-record type defined in Record Identification Codes. This sets special condition(s) in the object program each time the input record is read.

Record Identification Codes 21-41

This field is divided into three identical sub-fields: columns 21-27, 28-34, and 35-41. An AND-relationship exists between these three sub-fields.

Position. Enter the number of input record column containing the identifying code. Must be right-justified.

Not. Enter N if the code described must not be present in the position specified. Otherwise leave blank.

C/Z/D. Enter D if only the digit portion of the specified position is to be checked. Enter Z if only the zone portion is to be checked. Enter C if both portions are to be checked.

Character. If C/Z/D contains C or D, enter any one of the 256 EBCDIC characters.

If C/Z/D contains Z, enter: &, A through I, or $\overset{\circ}{0}$ to check for a 12-zone; -, J through R, or $\bar{0}$ to check for an 11-zone; S-Z for 0-zone; 0 through 9, or blank to check for the absence of zones.

NOTE: Record Identification Codes may be continued in the subsequent specification line by means of an AND entry for AND-relationships or an OR entry for OR-relationships.

Stacker Select 42

Enter number of stacker to which input cards are to be selected. Leave blank for single-stacker devices and for combined files.

Packed 43

P if input data in packed-decimal format. Blank if input data in standard format.

Field Location 44-51

This specification describes location of fields in input records.

From. Enter number of input card column containing first position of field specified in Field Name.

To. Enter number of input card column containing last position of field defined in Field Name. Entries must be right-justified; leading zeros may be omitted.

Decimal Positions 52

Used only for numeric fields. Enter a digit 0 through 9 to indicate number of decimal positions in input field. Leave blank for alphameric fields.

NOTE: Each input field that is to be used in arithmetic operations must have an entry in Decimal Positions. Also use this specification for fields that are to be edited or zero-suppressed.

Field Name 53-58

Enter the name of each field defined in Field Location. Field names may be up to 6 characters in length; left justified. First character must be alphabetic; remaining characters may be alphabetic or numeric. Special characters or embedded blanks may not be used.

Control Level 59-60

Enter any one of the control-level indicators L1 through L9 to identify control fields. (L1 for lowest level, L9 for highest level of control.)

Matching Fields or Chaining Fields 61-62

Enter any one of the codes M1, M2, or M3 to specify record-matching for two input files, or to specify sequence-checking for the fields of a single input file.

Enter the codes C1 through C9 to specify a chaining field.

Field-Record Relation 63-64

Enter any one of the indicators defined in columns 19-20 of the Input Specifications to provide field-record relation for identical fields contained in different locations (OR-relationships), or for selective processing of chaining fields.

Field Indicators 65-70

If the field is alphameric, i.e., if column 52 is blank, only the Zero or Blank specification may be used. Enter any one of the indicators 01 through 99 or H0 through H9, as required, in each of the fields. Indicator in Plus (columns 65 and 66) is turned on, if the field specified in columns 53-58 contains a positive value, except +0. Indicator in Minus (columns 67 and 68) is turned on if the field contains a negative value, except -0. Indicator in Zero or Blank (columns 69 and 70) is turned on if the field contains no other character than zero or blank. It is also turned on if the field is numeric and contains no other character than +0 or -0, or when a Blank After output specification is executed.

Sterling Sign Position 71-74

Used only for programs processing sterling currency amounts. If sign of Sterling field is in normal position, enter S in Column 74. If sign is not in normal position, enter the position in the record that contains the sign. Leave blank in all other RPG programs.

CALCULATION SPECIFICATIONS

Control Level 7-8

Enter one of control level indicators L1 through L9, L0, or LR to specify that the calculation contained in this line is to be performed at total time. Leave blank if calculation is to be performed at detail time.

Indicators 9-17

Enter one to three indicators to establish conditions controlling calculation specified in the line. Any of the indicators 01 through 99, L1 through L9, L0, LR, MR, or any halt or overflow indicator may be used. Columns 9, 12, and 15 may contain blank or N.

NOTE: If there is more than one indicator in a line, RPG assumes an AND-relationship between the individual indicators.

Factor 1 18-27

Field name — left-justified, maximum length 6 characters. Do not use special characters or embedded blanks. First character must be alphabetic. Must be defined in Input Specifications or as a result field in another calculation specification.

Literal — numeric: left-justified, maximum length ten characters, characters must be numeric (0 through 9), one decimal symbol and/or one sign (plus or minus) allowed. If a sign is present, it must be in the first position of the field.

alphameric: left-justified must be enclosed in apostrophe symbols ('), maximum length 8 characters, any one of the 256 EBCDIC characters may be used.

Apostrophe symbols required within constants must be represented as two consecutive apostrophe symbols.

Operation 28-32

Enter one of the RPG operation codes. An entry in this specification is required in each line, except in a comments line defined by an asterisk in column 7. Entries must be left-justified.

Factor 2 33-42

Enter field name or literal to be used in the specified operation. (For a definition of field name and literal. see Factor 1.) Entries must be left-justified.

Result Field 43-48

Enter field name to designate location in storage into which result of pertinent operation is to be placed. First character of field name must be alphabetic; remaining characters may be alphabetic or numeric, cannot contain special characters or embedded blanks. Must be left-justified.

Field Length 49-51

Enter number of storage positions to be reserved for result field on this line. Maximum length of numeric result fields is 15 digits. Maximum length of alphameric result fields is 256 characters. Must be right-justified. May be left blank, if length of result field specified in this line is defined in a previous line of calculation specifications, or in input specifications.

Decimal Positions 52

Enter number of decimal positions (0 through 9) to be reserved in result field. Required for all numeric result fields

used with arithmetic operations. Must be blank if the result field is alphameric.

NOTE: The number of decimal positions is included in Field Length specification in columns 49-51. E.g., if a number of decimal positions specified is 7, the maximum number of positions to the left of the decimal symbol is 15 - 7 = 8. (The maximum length of a numeric field is 15.)

Half Adjust 53

Enter H to specify half-adjustment of result field. Must be blank if result field is alphameric.

Resulting Indicators 54 - 59

Any one of the indicators 01 through 99, H0 through H9 and L1 through L9 may be used for this specification.

Arithmetic Operations: enter up to 3 indicators to be turned on whenever the result of an arithmetic operation is positive (Plus, columns 54 and 55), or negative (Minus, columns 56 and 57), or zero (Zero, columns 58 and 59).

Compare Operations: enter up to 3 indicators to be turned on whenever result of COMP operation is Factor 1 > Factor 2 (High, columns 54 and 55), or Factor 1< Factor 2 (Low, columns 56 and 57), or Factor 1 = Factor 2 (Equal, columns 58 and 59).

LOKUP Operations: enter one or two indicators in High, or Low, or Equal, or High and Equal, or Low and Equal. (This defines type of entry to be located by means of LOKUP operation.)

TESTZ Operations: enter up to 3 indicators to be turned on whenever a 12-zone (High, columns 54 and 55), or an 11-zone (Low, columns 56 and 57), or any other zone or no zone (Equal, columns 58 and 59) is detected in the field specified in Result Field of this line.

SETOF, SETON Operations: enter up to 3 indicators to be turned on (SETON) or off (SETOF). If more than 3 indicators are to be turned on (or off), specify another SETON (SETOF) statement in subsequent line. Any RPG indicator can be used, except L0 and 00.

NOTE: Headings High, Low, Equal do not apply to indicators specified in conjunction with SETOF or SETON operations.

Comments 60 - 74

Enter any desired comments. An asterisk in column 7 must not be used if this type of comment is in a line containing specifications.

OUTPUT-FORMAT SPECIFICATIONS

Filename 7 - 14

Enter name of each output file. Names must be left-justified.

AND/OR Relationships 14-16

Enter AND for records in an AND-relationship. Enter OR for records in an OR-relationship (Columns 14 and 15).

Type 15

H — identifies heading line
D — identifies detail time output
T — identifies total time output

Stacker Select 16

Enter number of stacker to which cards are to be selected. Leave blank for single-stacker devices.

Space 17 - 18

NOTE: At least one entry is required in columns 17-22 if the line is to be printed.

Before. Enter 0, 1, 2, or 3 to specify 0, 1, 2, or 3 lines spacing before printing. Leave blank if no space before printing is required.

After. Enter 0, 1, 2, or 3 to specify 0, 1, 2, or 3 lines spacing after printing. Enter zero to specify no space after printing.

Skip 19-22

Before. Enter any number from 01 through 12 to specify skipping before printing to channel 01 through 12 of the carriage control tape. Leave blank for no skip before printing.

After. Enter any number from 01 through 12 to specify skipping after printing 01 through 12 of the carriage control tape.

Output Indicators 23 - 31

Enter up to three RPG indicators to identify files or to describe fields. Columns 23, 26, 29 must contain blank or the letter N.

Field Name 32 - 37

Enter any field name defined in either Input Specifications or Calculation Specifications. Leave blank for constants specified in Constant or Edit Word. Use field name PAGE to cause automatic page numbering.

Zero Suppress 38

Enter Z if leading zeros of a numeric field are to be suppressed and the sign is to be stripped from the rightmost position. Leave blank if leading zeros are not suppressed, or if field specified in Field Name is alphameric or if line contains a constant or an edit word.

Blank After 39

Enter B to reset alphameric output fields to blanks or numeric output fields to zeros. Reset occurs after execution of the specified output operation.

End Position in Output Record 40 - 43

Enter position in output record to contain rightmost character of output field.

Packed Field 44

Enter P if output data in packed-decimal format. Leave blank if data in standard format.

Constant or Edit Word 45 - 70

Constant. Enter any required constant. Must be enclosed in apostrophe symbols. May consist of any of the 256 EBCDIC characters. Maximum length is 24 characters.

Apostrophe symbols required within constants must be represented as two consecutive apostrophe symbols.

Edit Word. Enter any edit word to specify editing with respect to punctuation, printing of dollar symbols, sign status, zero suppression, etc. Edit words must be enclosed in apostrophe symbols.

Sterling Sign Position 71 - 74.

Provided for programs processing sterling currency amounts. Leave blank for all other RPG programs.

IES000I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES001I FILE TYPE (COLUMN 15) IS INVALID. SPECIFICATION IS NOT PROCESSED.

IES002I INVALID ENTRY IN COLUMNS 28, 31, OR 32. SPECIFICATION IS NOT PROCESSED.

IES003I RECORD ADDRESS FIELD (COLUMNS 29-30) HAS INVALID LENGTH, IS MISSING OR IS NOT RIGHT-JUSTIFIED. ENTRY OF 03 IS ASSUMED.

IES004I MORE THAN ONE RECORD ADDRESS FILE IS PRESENT. SUCCEEDING ONES ARE NOT PROCESSED.

IES005I EXTENSION CODE (COLUMN 39) IS INVALID. ENTRY OF L IS ASSUMED.

IES006I INPUT FILE DESIGNATION (COLUMN 16) IS INVALID OR MISSING. ENTRY OF S IS ASSUMED.

IES007I OVERFLOW INDICATOR (COLUMN 33) IS NOT O. ENTRY OF O IS ASSUMED.

IES008I OVERFLOW INDICATOR (COLUMNS 33-34) IS INVALID. ENTRY OF OA IS ASSUMED.

IES009I MORE THAN ONE PRIMARY FILE IS SPECIFIED. FILE IS ASSUMED TO BE A SECONDARY FILE.

IES010I MODE OF PROCESSING (COLUMN 28) IS INVALID. ENTRY OF R IS ASSUMED.

IES011I FIXED FORMAT IS SPECIFIED, YET BLOCK LENGTH IS NOT A MULTIPLE OF RECORD LENGTH. BLOCK LENGTH IS INCREASED TO NEXT HIGHEST MULTIPLE.

IES012I TYPE OF FILE ORGANIZATION (COLUMN 32) IS NOT BLANK. ENTRY OF BLANK IS ASSUMED.

IES013I END-OF-FILE CODE (COLUMN 17) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES014I SEQUENCE (COLUMN 18) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES015I MODE OF PROCESSING (COLUMN 28) IS NOT BLANK. ENTRY OF BLANK IS ASSUMED.

IES016I RECORD ADDRESS TYPE (COLUMN 31) IS NOT BLANK. ENTRY OF BLANK IS ASSUMED.

IES017I EXTENSION CODE (COLUMN 39) IS INVALID. ENTRY OF E IS ASSUMED.

IES018I FILE FORMAT (COLUMN 19) IS INVALID. ENTRY OF F IS ASSUMED FOR INDEXED-SEQUENTIAL. OTHERWISE ENTRY OF V IS ASSUMED.

IES019I BLOCK LENGTH (COLUMNS 20-23) IS MISSING, INVALID, LESS THAN THE RECORD LENGTH, OR NOT RIGHT-JUSTIFIED. BLOCK LENGTH IS ASSUMED EQUAL TO RECORD LENGTH.

IES020I RECORD LENGTH (COLUMNS 24-27) IS MISSING, INVALID, OR NOT RIGHT-JUSTIFIED. RECORD LENGTH OF 0080 IS ASSUMED.

IES021I FILENAME (COLUMNS 7-14) IS MISSING, INVALID, OR NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES022I OUTPUT FILE DESIGNATION (COLUMN 16) IS NOT BLANK. ENTRY OF BLANK IS ASSUMED.

IES023I PROGRAM EXCEEDS LIMIT OF TEN VALID FILE NAMES. ADDITIONAL FILE DESCRIPTION SPECIFICATIONS WILL BE TREATED AS COMMENTS.

IES024I KEY FIELD STARTING LOCATION (COLUMNS 35-38) IS INVALID, NOT RIGHT-JUSTIFIED, OR NOT LESS THAN RECORD LENGTH. ENTRY OF 0001 IS ASSUMED.

IES025I DEVICE (COLUMNS 40-46) IS INVALID. SPECIFICATION IS NOT PROCESSED.

IES026I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES027I 'LABELS' (COLUMN 53) IS INVALID. ENTRY OF S IS ASSUMED.

IES028I NAME OF LABEL EXIT (COLUMNS 54-59) IS MISSING, INVALID, OR NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES029I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES030I MORE THAN ONE RECORD ADDRESS FILE IS SPECIFIED ON FILE EXTENSION SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES031I 'FROM FILENAME' (COLUMNS 11-18) IS NOT SPECIFIED AS ON FILE DESCRIPTION SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES032I EXTENSION CODE (COLUMN 39) IS NOT E. SPECIFICATION IS NOT PROCESSED.

IES033I LENGTH OF TABLE ENTRY (COLUMNS 40-42 OR 52-54) EXCEEDS 256 CHARACTERS FOR AN ALPHAMERIC FIELD. ENTRY OF 256 IS ASSUMED.

IES034I CHAINING FIELD (COLUMNS 9-10) IS MISSING, INVALID, OR NOT RIGHT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES035I NUMBER OF CONVERSION ROUTINES AND TABLE NAMES EXCEEDS ALLOCATED CORE STORAGE. ADDITIONAL SPECIFICATIONS CONTAINING CONVERSION ROUTINES OR TABLE NAMES WILL NOT BE PROCESSED.

IES036I 'TO FILENAME' (COLUMNS 19-26) IS NOT SPECIFIED AS ON CORRESPONDING FILE DESCRIPTION SPECIFICATION, OR FILE DESCRIPTION SPECIFICATION WAS NOT PROCESSED. SPECIFICATION IS NOT PROCESSED.

IES037I 'TO FILENAME' (COLUMNS 19-26) IS NOT SPECIFIED AS A CHAINED FILE ON FILE DESCRIPTION SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES038I LENGTH OF TABLE ENTRY (COLUMNS 40-42 OR 52-54) EXCEEDS 15 DIGITS FOR A NUMERIC FIELD. ENTRY OF 15 IS ASSUMED.

IES039I CONVERSION ROUTINE (COLUMNS 27-32) IS MISSING, INVALID, OR NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES040I 'TO FILENAME' (COLUMNS 19-26) IS NOT SPECIFIED AS A PRIMARY OR SECONDARY FILE ON FILE DESCRIPTION SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES041I TABLE SEQUENCE (COLUMNS 45 OR 57) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES042I TABLE NAME (COLUMNS 27-32 OR 46-51) IS MULTI-DEFINED. SPECIFICATION IS NOT PROCESSED.

IES043I 'TO FILENAME' (COLUMNS 19-26) IS NOT SPECIFIED AS ON FILE DESCRIPTION SPECIFICATION. ENTRY OF BLANKS IS ASSUMED.

IES044I 'TO FILENAME' (COLUMNS 19-26) IS NOT SPECIFIED AS AN OUTPUT FILE ON FILE DESCRIPTION SPECIFICATION. ENTRY OF BLANKS IS ASSUMED.

IES045I TABLE NAME (COLUMNS 27-32 OR 46-51) IS MISSING OR NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES046I LETTERS 'TAB' ARE MISSING IN TABLE NAME (COLUMNS 27-29 OR 46-48). ENTRY OF 'TAB' IS ASSUMED.

IES047I NUMBER OF TABLE ENTRIES PER RECORD (COLUMNS 33-35) IS MISSING, INVALID OR NOT RIGHT-JUSTIFIED. ENTRY OF 008 IS ASSUMED.

IES048I NUMBER OF TABLE ENTRIES PER TABLE (COLUMNS 36-39) IS MISSING, INVALID OR NOT RIGHT-JUSTIFIED. ENTRY OF 0150 IS ASSUMED.

IES049I 'LENGTH OF TABLE' ENTRY (COLUMNS 40-42 OR 52-54) IS MISSING, INVALID, OR NOT RIGHT-JUSTIFIED. ENTRY OF 010 IS ASSUMED.

IES050I 'PACKED' (COLUMN 43 OR 55) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES051I 'DECIMAL POSITIONS' (COLUMN 44 OR 56) IS INVALID. ENTRY OF ZERO IS ASSUMED.

IES052I RECORD SEQUENCE OF THE CHAINING FILE (COLUMNS 7-8) IS INVALID. BOTH POSITIONS MUST BE EITHER NUMERIC OR ALPHABETIC. SPECIFICATION IS NOT PROCESSED.

IES053I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES054I MAXIMUM NUMBER OF FILE EXTENSION SPECIFICATIONS CONTAINING TABLES HAS BEEN EXCEEDED. ADDITIONAL TABLE FILE EXTENSION SPECIFICATIONS WILL BE TREATED AS COMMENTS.

IES055I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES056I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES057I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES058I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES059I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES060I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES061I WARNING - MULTI-FILE PROGRAM (WITH PRIMARY AND SECONDARY FILES) IS SPECIFIED WITHOUT MATCHING FIELDS FOR THE PRIMARY FILE.

IES062I WARNING - MULTI-FILE PROGRAM (WITH PRIMARY AND SECONDARY FILES) IS SPECIFIED WITHOUT MATCHING FIELDS FOR THE SECONDARY FILE(S).

IES063I THE SUM OF THE LENGTHS OF THE MATCHING FIELDS FOR THE PRIMARY FILE DOES NOT EQUAL THAT OF EACH SECONDARY FILE. EXECUTION IS DELETED.

IES064I THE SUM OF THE LENGTHS OF THE MATCHING FIELDS IS NOT CONSTANT IN EACH RECORD WHICH SPECIFIED MATCHING FIELDS FOR A FILE. EXECUTION IS DELETED.

IES065I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES066I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES067I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES068I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES069I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES070I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES071I DETAIL CALCULATION SPECIFICATION FOLLOWS A TOTAL CALCULATION SPECIFICATION. DETAIL SPECIFICATION IS NOT PROCESSED.

IES072I UNDEFINED TABLE SPECIFIED IN LOKUP OPERATION. SPECIFICATION IS NOT PROCESSED.

IES073I KEYCV IS VALID ONLY WHEN PRECEDED BY RPGCV OR EXTCV. SPECIFICATION IS NOT PROCESSED.

IES074I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES075I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES076I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES077I THERE ARE NO VALID INPUT SPECIFICATIONS IN THIS PROGRAM. EXECUTION IS DELETED.

IES078I DECIMAL POSITION IS INVALID. ENTRY OF ZERO IS ASSUMED FOR NUMERIC FIELD. ENTRY OF BLANK IS ASSUMED FOR ALPHAMERIC FIELD.

IES079I CONVERSION NAME CANNOT BE USED TO DEFINE A FIELD. SPECIFICATION IS NOT PROCESSED.

IES080I FIELD INDICATOR IS SPECIFIED BUT IS NOT VALID. INDICATOR IS NOT PROCESSED.

IES081I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES082I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES083I FIELD LENGTH IS IMPROPERLY SPECIFIED OR IS NOT SPECIFIED. ENTRY OF ZERO IS ASSUMED FOR INVALID CHARACTER. WHEN REQUIRED LENGTH IS NOT SPECIFIED, ENTRY OF 3 IS ASSUMED FOR EXTCV AND RPGCV. ENTRY OF 4 IS ASSUMED FOR ALL OTHER OPERATION CODES.

IES084I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES085I RESULT FIELD LENGTH (COLUMNS 49-51) IS GREATER THAN ALLOWED. A LENGTH OF 256 IS ASSUMED FOR AN ALPHAMERIC FIELD. A LENGTH OF 15 IS ASSUMED FOR A NUMERIC FIELD.

IES086I OPERATION CODE (COLUMNS 28-32) IS INVALID OR MISSING. SPECIFICATION IS NOT PROCESSED.

IES087I REQUIRED ENTRY IN FACTOR 1 (COLUMNS 18-27) IS MISSING OR INVALID. SPECIFICATION IS NOT PROCESSED.

IES088I REQUIRED ENTRY IN FACTOR 2 (COLUMNS 33-42) IS MISSING OR INVALID. SPECIFICATION IS NOT PROCESSED.

IES089I REQUIRED ENTRY IN RESULT FIELD (COLUMNS 43-48) IS MISSING OR INVALID. SPECIFICATION IS NOT PROCESSED.

IES090I FORM TYPE (COLUMN 6) IS INVALID. SPECIFICATION IS NOT PROCESSED.

IES091I 'NOT' (COLUMNS 9, 12, OR 15) IS NOT N OR BLANK. ENTRY OF N IS ASSUMED.

IES092I CONTROL LEVEL IS IMPROPERLY SPECIFIED. ENTRY OF LO IS ASSUMED.

IES093I RESULTING INDICATOR IS INVALID. INDICATOR IS NOT PROCESSED.

IES094I INDICATOR LO IS SPECIFIED AS A FIELD INDICATOR, BUT IS NOT ALLOWED. INDICATOR IS IGNORED.

IES095I FIELD-RECORD RELATION (COLUMNS 63-64) IS INVALID. ENTRY OF 99 IS ASSUMED.

IES096I 'HALF ADJUST' ENTRY (COLUMN 53) IS INVALID. ENTRY OF H IS ASSUMED.

IES097I FIELD NAME IS IMPROPERLY USED. SPECIFICATION IS NOT PROCESSED.

IES098I INDICATOR (COLUMNS 10-11, 13-14, OR 16-17) IS INVALID. ENTRY OF 00 IS ASSUMED.

IES099I REQUIRED RESULTING INDICATOR (COLUMNS 54-55, 56-57, OR 58-59) IS NOT SPECIFIED. SPECIFICATION IS NOT PROCESSED.

IES100I 'MVR' DOES NOT FOLLOW 'DIV', OR FOLLOWS A 'DIV' WITH HALF ADJUST SPECIFIED. SPECIFICATION IS NOT PROCESSED.

IES101I 'FROM' (COLUMNS 44-47), 'TO' (COLUMNS 48-51) OR RECORD IDENTIFICATION POSITION (COLUMNS 21-24, 28-31, OR 35-38) IS ZERO. ENTRY OF 1 IS ASSUMED.

IES102I RESULT FIELD OF RPGCV OR EXTCV DOES NOT HAVE LENGTH OF 3. ENTRY OF 3 IS ASSUMED.

IES103I IF IBM SHILLING IS SPECIFIED, STERLING INPUT FIELD MUST HAVE MORE THAN THREE NON-DECIMAL POSITIONS. IF BSI SHILLING IS SPECIFIED, STERLING INPUT FIELD MUST HAVE MORE THAN TWO NON-DECIMAL POSITIONS. FIELD IS INITIALIZED TO ZERO AND NO INPUT IS ACCEPTED.

IES104I WARNING - INDICATOR 00 SHOULD BE USED ONLY IN OUTPUT SPECIFICATIONS.

IES105I FIELDS USED IN AN ALPHAMERIC COMPARE MUST BE EQUAL IN LENGTH OR MUST BE LESS THAN OR EQUAL TO 200 BYTES.

IES106I FIELD LENGTHS ARE INVALID FOR THIS OPERATION. SPECIFICATION IS NOT PROCESSED.

IES107I PLUS AND/OR MINUS RESULTING INDICATORS (COLUMNS 54-55 OR 56-57) ARE NOT ALLOWED FOR TESTING ALPHAMERIC FIELDS. INDICATORS ARE IGNORED.

IES108I FIELD TYPE IS INVALID FOR THIS OPERATION. SPECIFICATION IS NOT PROCESSED.

IES109I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES110I FORM TYPE (COLUMN 6) DOES NOT CONTAIN I, C, OR O, AND COLUMN 7 IS NOT AN ASTERISK. SPECIFICATION IS NOT PROCESSED.

IES111I UNDEFINED FILENAME. SPECIFICATION IS NOT PROCESSED.

IES112I FILENAME HAS BEEN PREVIOUSLY REFERENCED OR DEFINED AS A TABLE OR OUTPUT FILE TYPE. SPECIFICATION IS NOT PROCESSED.

IES113I 'AND' SPECIFICATION (COLUMNS 14-16) IS FIRST INPUT SPECIFICATION OR FOLLOWS FIELD DESCRIPTION SPECIFICATION, INVALID RECORD IDENTIFICATION, OR INVALID FILE NAME. SPECIFICATION IS NOT PROCESSED.

IES114I THERE ARE NO RECORD IDENTIFICATION CODES (COLUMNS 21-41) IN THE CARD BEFORE AN 'AND' CARD. SPECIFICATION IS NOT PROCESSED.

IES115I 'OR' SPECIFICATION (COLUMNS 14-15) IS FIRST INPUT SPECIFICATION OR FOLLOWS FIELD DESCRIPTION SPECIFICATION, INVALID RECORD IDENTIFICATION, OR INVALID FILE NAME. SPECIFICATION IS NOT PROCESSED.

IES116I RECORD IDENTIFICATION SPECIFICATION FOLLOWS INVALID FILE TYPE SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES117I FIELD NAME CONTAINS EMBEDDED BLANK. SPECIFICATION IS NOT PROCESSED.

IES118I FILE AND FIELD NAMES ARE BOTH PRESENT ON THE SAME SPECIFICATION. FILENAME IS ASSUMED.

IES119I SEQUENCE (COLUMNS 15-16) IS BLANK. ENTRY OF AA IS ASSUMED.

IES120I ALPHAMERIC SEQUENCE FOUND AFTER NUMERIC SEQUENCE. NUMERIC SEQUENCE 1 GREATER THAN PREVIOUS NUMERIC SEQUENCE IS ASSUMED.

IES121I NUMERIC SEQUENCE (COLUMNS 15-16) IS INVALID. ENTRIES MUST BEGIN WITH 01 AND BE CONSECUTIVE IN ASCENDING ORDER. NUMERIC SEQUENCE 1 GREATER THAN PREVIOUS VALID NUMERIC SEQUENCE IS ASSUMED.

IES122I NUMBER (COLUMN 17) IS NOT N OR 1, AND NUMERIC SEQUENCE IS FOUND. ENTRY OF N IS ASSUMED.

IES123I OPTION (COLUMN 18) IS NOT O OR BLANK. ENTRY OF O IS ASSUMED.

IES124I RESULTING INDICATOR (COLUMNS 19-20) IS BLANK OR INVALID. INDICATOR OF 99 IS ASSUMED.

IES125I STACKER SELECT (COLUMN 42) IS NOT BLANK OR NUMERIC. ENTRY OF BLANK IS ASSUMED.

IES126I 'POSITION' (COLUMNS 21-24, 28-31, OR 35-38) CONTAINS EMBEDDED BLANK. ENTRY OF ZERO IS ASSUMED.

IES127I 'POSITION' (COLUMNS 21-24, 28-31, OR 35-38) CONTAINS NON-NUMERIC CHARACTER. ENTRY OF ZERO IS ASSUMED.

IES128I 'NOT' (COLUMNS 25, 32, OR 39) IS NOT BLANK OR N. ENTRY OF N IS ASSUMED.

IES129I 'C/Z/D' (COLUMNS 26, 33, OR 40) IS NOT C, Z, OR D. ENTRY OF C IS ASSUMED.

IES130I FIELD DESCRIPTION SPECIFICATION IS FIRST INPUT SPECIFICATION OR FOLLOWS AN INVALID RECORD IDENTIFICATION OR FILE NAME. SPECIFICATION IS NOT PROCESSED.

IES131I FIELD NAME (COLUMNS 53-58) IS MISSING OR NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES132I FIELD NAME (COLUMNS 53-58) BEGINS WITH A NUMERIC CHARACTER. SPECIFICATION IS NOT PROCESSED.

IES133I 'FROM' (COLUMNS 44-47) OR 'TO' (COLUMNS 48-51) IS BLANK. ENTRY OF 1 IS ASSUMED.

IES134I 'FROM' (COLUMNS 44-47) OR 'TO' (COLUMNS 48-51) CONTAINS EMBEDDED BLANK. ENTRY OF ZERO IS ASSUMED FOR EACH BLANK.

IES135I 'FROM' (COLUMNS 44-47) OR 'TO' (COLUMNS 48-51) CONTAINS NON-NUMERIC CHARACTER. ENTRY OF ZERO IS ASSUMED.

IES136I 'FROM' (COLUMNS 44-47) SHOULD BE LESS THAN OR EQUAL TO 'TO' (COLUMNS 48-51). FIELD LENGTH OF 1 IS ASSUMED. 'TO' IS ASSUMED EQUAL TO 'FROM'.

IES137I DECIMAL POSITION (COLUMN 52) IS NOT NUMERIC. ENTRY OF ZERO IS ASSUMED.

IES138I EITHER AN UNPACKED NUMERIC FIELD IS MORE THAN 15 BYTES LONG, OR A PACKED NUMERIC FIELD IS GREATER THAN 8 BYTES LONG. LENGTH OF 15 IS ASSUMED FOR UNPACKED NUMERIC FIELD. LENGTH OF 8 IS ASSUMED FOR PACKED NUMERIC FIELD.

IES139I STERLING FIELD IS INDICATED WITH MORE THAN THREE DECIMAL POSITIONS. THE DECIMAL PORTION OF THE FIELD IS TRUNCATED TO THREE POSITIONS. THE 'TO' POSITION OF THE FIELD IS ALTERED TO ALLOW FOR THIS TRUNCATION.

IES140I PACKED INDICATOR (COLUMN 43) IS NEITHER BLANK NOR P. ENTRY OF P IS ASSUMED.

IES141I CONTROL LEVEL DOES NOT START WITH L IN COLUMN 59 (L IS ASSUMED), OR COLUMN 60 IS NOT NUMERIC (1 IS ASSUMED).

IES142I MATCHING/CHAINING FIELD (COLUMN 61) IS NOT C OR M (M IS ASSUMED), OR COLUMN 62 IS NOT NUMERIC (1 IS ASSUMED).

IES143I MATCHING VALUE (COLUMN 62) IS INVALID. ENTRY OF 3 IS ASSUMED IF COLUMN IS NUMERIC. ENTRY OF 1 IS ASSUMED IF COLUMN IS NON-NUMERIC.

IES144I ALPHAMERIC FIELD LENGTH IS GREATER THAN 256. LENGTH OF 256 IS ASSUMED.

IES145I NUMERIC RESULTING INDICATOR (COLUMNS 65-66 OR 67-68) IS SPECIFIED FOR AN ALPHAMERIC FIELD. INDICATOR IS SET OFF.

IES146I STERLING SIGN POSITION (COLUMNS 71-74) IS INVALID. NORMAL POSITION FOR SIGN IS ASSUMED.

IES147I STERLING SPECIFIED IN COLUMNS 71-74, BUT NOT SPECIFIED ON PROCESSOR CONTROL CARD. ENTRY OF BLANKS IS ASSUMED.

IES148I THE CALCULATED LENGTH OF THE STERLING FIELD IS GREATER THAN 15. LENGTH OF 15 IS ASSUMED.

IES149I FIELD EXTENDS BEYOND RECORD LENGTH. FIELD IS ASSUMED TO END IN LAST CHARACTER POSITION OF RECORD.

IES150I COLUMNS 16-18 OF 'OR' TYPE INPUT SPECIFICATION MUST BE BLANK. ENTRY OF BLANK IS ASSUMED.

IES151I COLUMNS 17-20 OF 'AND' TYPE INPUT SPECIFICATION MUST BE BLANK. ENTRY OF BLANK IS ASSUMED.

IES152I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES153I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES154I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES155I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES156I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES157I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES158I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES159I INAPPROPRIATE OUTPUT FIELD. SPECIFICATION IS NOT PROCESSED.

IES160I FILENAME (COLUMNS 7-14) IS MISSING, OR RECORD TYPE (COLUMN 15) IS IN WRONG ORDER. SPECIFICATION IS NOT PROCESSED.

IES161I CORRESPONDING FILENAME (COLUMNS 7-14) CANNOT BE DETERMINED. SPECIFICATION IS NOT PROCESSED.

IES162I 'STACKER SELECT' (COLUMN 16) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES163I 'SPACE BEFORE' (COLUMN 17) IS INVALID. ENTRY OF 1 IS ASSUMED.

IES164I 'SPACE AFTER' (COLUMN 18) IS INVALID. ENTRY OF 1 IS ASSUMED.

IES165I 'SKIP BEFORE' (COLUMNS 19-20) IS INVALID. ENTRY OF 01 IS ASSUMED.

IES166I 'SKIP AFTER' (COLUMNS 21-22) IS INVALID. ENTRY OF 01 IS ASSUMED.

IES167I RECORD TYPE (COLUMN 15) IS NOT H, D, OR T. SPECIFICATION IS NOT PROCESSED.

IES168I COLUMNS 17-22 MUST BE BLANK FOR 'AND' TYPE OUTPUT SPECIFICATIONS. ENTRY OF BLANK IS ASSUMED.

IES169I COLUMNS 7-13 MUST BE BLANK FOR 'AND' OR 'OR' TYPE OUTPUT SPECIFICATIONS. ENTRY OF BLANK IS ASSUMED.

IES170I CORRESPONDING RECORD IDENTIFICATION SPECIFICATION IS MISSING OR INVALID. SPECIFICATION IS NOT PROCESSED.

IES171I 'ZERO SUPPRESS' (COLUMN 38) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES172I 'PACKED FIELD' (COLUMN 44) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES173I FIELD NAME (COLUMNS 32-37) IS NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES174I 'END POSITION' (COLUMNS 40-43) IS INVALID OR MISSING. SPECIFICATION IS NOT PROCESSED.

IES175I LEADING OR CLOSING APOSTROPHE (') IN EDIT WORD IS NOT CORRECT. ENTRY OF BLANKS IN COLUMNS 45-70 IS ASSUMED.

IES176I 'BLANK AFTER' (COLUMN 39) IS INVALID. ENTRY OF BLANK IS ASSUMED.

IES177I PUNCH AND PRINT FUNCTIONS ARE SPECIFIED FOR THE SAME FILE. ENTRY OF BLANKS IS ASSUMED FOR COLUMNS 17-22.

IES178I ZERO SUPPRESSION (COLUMN 38) MAY NOT BE SPECIFIED FOR CONSTANTS OR EDIT WORDS. ENTRY OF BLANK IN COLUMN 38 IS ASSUMED.

IES179I FIELD NAME (COLUMNS 32-37) IS UNDEFINED. SPECIFICATION IS NOT PROCESSED.

IES180I WARNING - 'BLANK AFTER' (COLUMN 39) IS SPECIFIED FOR CONSTANT. ALL IDENTICAL CONSTANTS WILL BE BLANKED.

IES181I CONSTANT (COLUMNS 45-70) IS NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES182I EDIT WORD (COLUMNS 45-70) IS NOT LEFT-JUSTIFIED. ENTRY OF BLANKS IN COLUMNS 45-70 IS ASSUMED.

IES183I 'PACKED FIELD' (COLUMN 44) MAY NOT BE SPECIFIED WITH CONSTANT, EDIT WORD OR STERLING ENTRY. ENTRY OF BLANK IN COLUMN 44 IS ASSUMED.

IES184I FILENAME (COLUMNS 7-14) IS NOT LEFT-JUSTIFIED. SPECIFICATION IS NOT PROCESSED.

IES185I FILENAME (COLUMNS 7-14) CONTAINS NON-ALPHABETIC CHARACTER IN FIRST POSITION. SPECIFICATION IS NOT PROCESSED.

IES186I EDIT WORD (COLUMNS 45-70) CONTAINS NO DIGIT POSITIONS OR MORE THAN FIFTEEN (SIXTEEN FOR STERLING). ENTRY OF BLANKS IN COLUMNS 45-70 IS ASSUMED.

IES187I LEADING OR CLOSING APOSTROPHE (') IN CONSTANT IS NOT CORRECT. SPECIFICATION IS NOT PROCESSED.

IES188I 'AND' OR 'OR' FOLLOWING A FIELD NAME SPECIFICATION OR AS FIRST OUTPUT SPECIFICATION IS INVALID. SPECIFICATION IS NOT PROCESSED.

IES189I FIELD NAME (COLUMNS 32-38) CONTAINS NON-ALPHABETIC CHARACTER IN FIRST POSITION. SPECIFICATION IS NOT PROCESSED.

IES190I STERLING ENTRY (COLUMNS 71-74) MAY NOT BE SPECIFIED WITH CONSTANT OR PAGE(N). ENTRY OF BLANK IN COLUMNS 71-74 IS ASSUMED.

IES191I STERLING ENTRY (COLUMNS 71-74) IS INVALID. ENTRY OF BLANKS IS ASSUMED.

IES192I OUTPUT INDICATOR (COLUMNS 24-25, 27-28, OR 30-31) IS INVALID OR UNDEFINED. ENTRY OF LO IS ASSUMED.

IES193I OUTPUT INDICATORS SHOULD START IN COLUMNS 23-25, THEN 26-28, AND FINALLY 29-31. ENTRY IS SHIFTED LEFT.

IES194I 'NOT' (COLUMNS 23, 26, OR 29) IS NOT BLANK OR N. ENTRY OF N IS ASSUMED.

IES195I WARNING - OVERFLOW INDICATOR IS SPECIFIED IN 'AND' TYPE SPECIFICATION. RECORD WILL NOT BE PUT OUT AS OVERFLOW LINE.

IES196I DECIMAL POSITIONS MUST BE ZERO FOR PAGE(N) FIELD. ENTRY OF ZERO IS ASSUMED.

IES197I SPECIFICATION TYPE CANNOT BE DETERMINED. RECORD AND FIELD DEFINITIONS ARE SPECIFIED IN SAME LINE OR BOTH ARE BLANK. SPECIFICATION IS NOT PROCESSED.

IES198I FORM TYPE (COLUMN 6) IS INVALID (NOT O). SPECIFICATION IS NOT PROCESSED.

IES199I NO OUTPUT INDICATOR (COLUMNS 24-25, 27-28, OR 30-31) IS SPECIFIED FOR 'AND' OR 'OR' TYPE SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES200I FORM TYPE (COLUMN 6) IS INVALID OR OUT OF SEQUENCE. SPECIFICATION IS NOT PROCESSED.

IES201I FILE DESCRIPTION SPECIFICATIONS ARE MISSING. COMPILATION IS ABORTED.

IES202I WARNING - LINE COUNTER SPECIFICATION IS MISSING.

IES203I PRIMARY FILE IS NOT SPECIFIED. EXECUTION IS DELETED.

IES204I WARNING - FILE EXTENSION SPECIFICATION IS MISSING.

IES205I FILENAME (COLUMNS 7-14) IS MULTI-DEFINED. SPECIFICATION IS NOT PROCESSED.

IES206I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES207I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES208I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES209I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES210I WARNING - FILENAME (COLUMNS 7-14) IS DEFINED BUT NEVER USED.

IES211I FILENAME HAS BEEN REFERENCED PREVIOUSLY IN INPUT SPECIFICATIONS. SPECIFICATION IS NOT PROCESSED.

IES212I RESULTING INDICATOR IS INVALID OR UNDEFINED. ENTRY OF LO IS ASSUMED.

IES213I WARNING - RESULTING INDICATOR IS UNREFERENCED.

IES214I FIELD NAME IS UNDEFINED. FIELD IS PROCESSED WITH ASSUMED LENGTH OF 004.

IES215I WARNING - FIELD NAME IS MULTI-DEFINED.

IES216I WARNING - FIELD NAME IS UNREFERENCED.

IES217I THE COMBINED LENGTHS OF LITERALS AND FIELD NAMES EXCEEDS ALLOCATED CORE STORAGE. EXECUTION IS DELETED.

IES218I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES219I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES220I FILE SPECIFIED ON OUTPUT-FORMAT SPECIFICATIONS IS UNDEFINED OR NOT AN OUTPUT FILE (U, C, OR O). ENTIRE FILE IS DELETED FROM PROCESSING.

IES221I WARNING - FILENAME (COLUMNS 7-14) IS NOT REFERENCED ON OUTPUT SPECIFICATIONS.

IES222I NO VALID OUTPUT SPECIFICATIONS ARE PRESENT. COMPILATION IS ABORTED.

IES223I ALL OUTPUT LINES OF A PRINTER FILE MUST INDICATE SPACING AND/OR SKIPPING. SINGLE SPACING IS ASSUMED FOR ALL OUTPUT LINES OF NAMED FILE WHICH HAVE NO PRINT FUNCTION.

IES224I STACKER SELECT MAY NOT BE SPECIFIED WITH PRINT FILE. STACKER SELECT IS IGNORED AND SINGLE SPACING IS ASSUMED FOR ALL LINES OF NAMED FILE.

IES225I PRINT OR PUNCH FUNCTION MAY NOT BE SPECIFIED FOR AN OUTPUT RECORD OF TAPE OR DISK FILE. STACKER SELECT, SPACING, OR SKIPPING IS IGNORED ON ALL RECORDS OF NAMED FILE.

IES226I PRINT FUNCTION MAY NOT BE SPECIFIED FOR OUTPUT RECORD OF PUNCH FILE. SPACE AND SKIP ENTRIES ARE IGNORED FOR ALL RECORDS OF NAMED FILE.

IES227I IMPROPER USE OF PACKING OR ZERO SUPPRESSION ON ALPHAMERIC OR PACKED FIELD. ENTRY OF BLANK IS ASSUMED FOR INVALID CODE.

IES228I END POSITION SPECIFIED FOR THE FIELD IS GREATER THAN THE RECORD LENGTH. ALL OR PART OF THE FIELD IS LOST, STARTING FROM RIGHTMOST POSITION.

IES229I END POSITION IS LESS THAN THE FIELD LENGTH. FIELD IS NOT PROCESSED.

IES230I FIELD TO BE EDITED IS GREATER THAN THE EDIT WORD. RIGHTMOST DIGITS WILL BE LOST.

IES231I FIELD TO BE EDITED IS NOT NUMERIC. NO EDITING IS PERFORMED.

IES232I STERLING IS SPECIFIED FOR ALPHAMERIC FIELD. STERLING IS IGNORED.

IES233I STERLING SIGN POSITION IS SPECIFIED AS OTHER THAN NORMAL FOR PRINTED LINE. NORMAL POSITION IS ASSUMED.

IES234I LOCATION FOR STERLING SIGN EXCEEDS RECORD LENGTH. NORMAL POSITION FOR SIGN IS ASSUMED.

IES235I STERLING FIELD IS SPECIFIED WITH DECIMAL LENGTH GREATER THAN THREE. FIELD IS NOT PROCESSED.

IES236I STERLING FIELDS MAY BE EDITED ONLY FOR PRINT FILES. NO EDITING IS PERFORMED

IES237I NUMBER OF LINES OF OUTPUT EXCEEDS THE CAPACITY OF RPG. MAXIMUM NUMBER IS 1023. EXECUTION IS DELETED.

IES238I STERLING FIELD IS SPECIFIED WITH MORE THAN NINE POUNDS POSITIONS. LEFTMOST DIGITS WILL BE LOST.

IES239I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES240I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES241I FILENAME IS NOT SPECIFIED AS ON FILE DESCRIPTION SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES242I CHANNEL 1 OR 12 IS MISSING OR INVALID. SPECIFICATION IS NOT PROCESSED.

IES243I FILENAME IS NOT SPECIFIED AS AN OUTPUT FILE OR AN OUTPUT FILE REQUIRING A LINE COUNTER SPECIFICATION. SPECIFICATION IS NOT PROCESSED.

IES244I LINE NUMBER OR CHANNEL NUMBER IS INVALID OR MISSING. SPECIFICATION IS NOT PROCESSED.

IES245I CHANNEL NUMBER IS MULTI-DEFINED. SPECIFICATION IS NOT PROCESSED.

IES246I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES247I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES248I COLLATING SEQUENCE (COLUMN 26 OF RPG CONTROL CARD) IS INVALID. ALTERNATE SEQUENCE IS ASSUMED.

IES249I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES250I END OF FILE HAS BEEN ENCOUNTERED IN INPUT STREAM PRIOR TO AN OUTPUT SPECIFICATION. COMPILATION IS ABORTED.

IES251I NO ERROR MESSAGE ASSIGNED FOR THIS NOTE.

IES252I STERLING INPUT SPECIFICATION IS INVALID. IBM FORMAT IS ASSUMED.

IES253I STERLING OUTPUT SPECIFICATION IS INVALID. IBM FORMAT IS ASSUMED.

IES254I INVERTED PRINT ENTRY IS INVALID. ENTRY OF I IS ASSUMED.

IES255I RPG CONTROL CARD IS MISSING. COMPILATION IS ABORTED.

APPENDIX H. CONDITIONS THAT AUTOMATICALLY TURN ON HALT INDICATOR (H0)

The object program:

- Read an input record that was not defined on the Input Specifications sheet (columns 21-41).
- Found an input record out of the predetermined sequence of card type specified by the entry in Sequence (columns 15-16) on the Input Specifications sheet.
- Found an input record out of sequence when the entry in Matching Fields (columns 61-62) on the Input Specifications sheet was used for sequence checking a single input file.
- Encountered a chaining field in the chaining file that does not appear in the chained file during random processing of multiple input files.
- Did not find a record with the correct key at the designated track address during random processing by record key of a directly organized file.
- Did not find the record key that designates the lower limit (obtained from the RAF) during sequential processing between limits of an indexed-sequential file.
- Found a wrong length record during processing of an indexed-sequential file.
- Found an invalid length record (zero or too long) during random processing by record identification of a file on a DASD.
- Found a difference between the key length of a DASD record in an indexed-sequential file and the length as specified in Length of Record Address Field (columns 29-30) on the File Description Specifications sheet during processing with RAF support (random, or between limits).
- Found a difference between the key length in the chained indexed-sequential file and the length as specified (columns 44-51) on the Input Specifications sheet during chaining of multiple input files.
- Encountered a data check on the DASD during random processing of a directly organized file.
- Encountered a DASD error during sequential or random processing of an indexed-sequential file.

NOTE: Unless the H0 indicator is turned off by a SETOF Operation entry on the Calculation Specifications sheet (see Turning Indicators On or Off) the program terminates before the next input record is read.

NOTE NUMBER	RETURN CODE	NOTE NUMBER	RETURN CODE	NOTE NUMBER	RETURN CODE	NOTE NUMBER	RETURN CODE
000	NA	064	12	128	4	192	4
001	8	065	NA	129	4	193	4
002	8	066	NA	130	8	194	4
003	4	067	NA	131	8	195	4
004	8	068	NA	132	8	196	4
005	4	069	NA	133	4	197	8
006	4	070	NA	134	4	198	8
007	4	071	8	135	4	199	8
008	4	072	8	136	8	200	8
009	4	073	8	137	4	201	16
010	4	074	NA	138	4	202	4
011	4	075	NA	139	4	203	12
012	4	076	NA	140	4	204	8
013	4	077	12	141	4	205	8
014	4	078	4	142	4	206	NA
015	4	079	8	143	4	207	NA
016	4	080	8	144	4	208	NA
017	4	081	NA	145	4	209	NA
018	4	082	NA	146	4	210	4
019	4	083	4	147	4	211	8
020	4	084	NA	148	4	212	4
021	8	085	4	149	8	213	4
022	4	086	8	150	4	214	4
023	4	087	8	151	4	215	4
024	4	088	8	152	NA	216	4
025	8	089	8	153	NA	217	12
026	NA	090	8	154	NA	218	NA
027	4	091	4	155	NA	219	NA
028	8	092	4	156	NA	220	8
029	NA	093	4	157	NA	221	4
030	8	094	4	158	NA	222	16
031	8	095	4	159	8	223	4
032	8	096	4	160	8	224	4
033	4	097	8	161	8	225	4
034	8	098	4	162	4	226	4
035	4	099	8	163	4	227	4
036	8	100	8	164	4	228	4
037	8	101	4	165	4	229	8
038	4	102	4	166	4	230	8
039	8	103	4	167	8	231	4
040	8	104	4	168	4	232	4
041	4	105	4	169	4	233	4
042	8	106	8	170	8	234	4
043	4	107	4	171	4	235	8
044	4	108	8	172	4	236	4
045	8	109	NA	173	8	237	12
046	4	110	8	174	8	238	8
047	4	111	8	175	4	239	NA
048	4	112	8	176	4	240	NA
049	4	113	8	177	4	241	8
050	4	114	8	178	4	242	8
051	4	115	8	179	8	243	8
052	8	116	8	180	4	244	8
053	NA	117	8	181	8	245	8
054	4	118	4	182	4	246	NA
055	NA	119	4	183	4	247	NA
056	NA	120	4	184	8	248	4
057	NA	121	4	185	8	249	NA
058	NA	122	4	186	4	250	16
059	NA	123	4	187	8	251	NA
060	NA	124	4	188	8	252	4
061	4	125	4	189	8	253	4
062	4	126	4	190	4	254	4
063	12	127	4	191	4	255	16

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