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DOS
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IBM System/360
Disk and Tape Operating Systems
COBOL Language Specifications

COBOL DOS Program Number 360N-CB-452
COBOL TOS Program Number 360M-CB-402

COBOL (COmmon Business Oriented Language) is a programming language, similar to English, that is used for commercial data processing. It was developed by the Conference of Data Systems Languages (CODASYL).

This publication provides the programmer with rules for writing programs in COBOL for IBM System/360 Disk and Tape Operating Systems. Users unacquainted with COBOL should read the programmed instruction textbook COBOL Program Fundamentals, Form R29-0205, with its reference handbook, Form R29-0206.

Seventh Edition (October 1972)

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Specifications contained herein are subject to change from time to time. Any such change will be reported in subsequent revisions or Technical Newsletters.

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Specific technical changes to the text made as of this publishing date are indicated by a vertical bar to the left of the text. These bars will be deleted at any subsequent republication of the page affected.

This publication describes the COBOL language as implemented for the IBM System/360 Disk and Tape Operating Systems. Its purpose is to serve as a reference manual for writing COBOL D programs.

The reader should have some knowledge of the COBOL language before using this manual. Useful COBOL information can be found in the following publications:

COBOL Program Fundamentals: Text, Form R29-0205

COBOL Program Fundamentals: Reference Handbook, Form R29-0206

Writing Programs in COBOL: Text, Form R29-0210

Writing Programs in COBOL: Reference Handbook, Form R29-0211

COBOL Programming Techniques: Text, Form R29-0215

Detailed information and examples helpful to the COBOL D programmer, including information about compiling, linkage editing, and executing COBOL D programs, can be found in the IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide, Form C24-5025, which is a requisite to this publication.

The following features are IBM extensions to COBOL for IBM System/360 Disk and Tape Operating Systems, and are marked adjacent to the applicable features in this publication by the symbol [EXT].

1. The ORGANIZATION clause
2. Internal and external floating-point items and floating-point literals
3. The overflow-name test-condition
4. The RECORD-KEY clause
5. The Linkage Section of the Data Division
6. Options 1 and 2 of the USE sentence
7. The REWRITE statement
8. The TRANSFORM statement
9. The Debugging Language
10. Sterling Currency feature

ACKNOWLEDGMENT

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This section defines the minumum machine requirements for COBOL, the COBOL character set, and describes the formation of COBOL words. It also includes special topics such as punctuation, name qualification, and rules for writing COBOL source programs on a program sheet.

MACHINE REQUIREMENTS

Disk Operating System COBOL requires at least 24K bytes of main storage if the disk compiler is allocated 14K bytes of storage.

Tape Operating System COBOL operates in a 16K byte environment if the compiler is allocated 10K bytes of storage.

A summary of the functions of all devices supported, including intermediate (work) storage, follows:

Units Used by COBOL Processor	Functions			
	Input	Work	Output	List
1403				X
1404*				X
1442	X		X	
1443				X
2501	X			
2520	X		X	
2540	X		X	
2311**	D	D	D	D
2314**	D	D	D	D
2400-series**	X	X	X	X

Notes:

D - Indicates Disk Operating System COBOL only.
* - For continuous forms only.
** - For work files three logical files are required and they must be the same device type.

Compile and execute is provided in all systems if sufficient intermediate storage is available.

Intermediate (work) storage devices may not be mixed. Where 2400 series magnetic tape units are used, a minimum of three (3) units are required.

Expanded instruction sets may be required depending on the specific requirements of the language program utilized as follows:

For COBOL:

SYSTEM REQUIRES: Standard instruction set, decimal arithmetic set. (Floating-point option is required if floating-point literals are used.)

OBJECT PROGRAM REQUIRES: Standard instruction set, decimal arithmetic option. (Floating-point option is required if non-integer exponents or floating-point numbers are used.)

The device type dependency of problem programs is established at compile time. Problem programs compiled by COBOL support the following units:

1403
1404*
1442
1443
1445
2501
2520
2540
2400 series (7 or 9 track)
2311**
2314**
2321**

*For continuous forms only.

**For Disk Operating System only.

CHARACTER SET

The complete COBOL character set consists of the following 51 characters:

Digits 0 through 9
Letters A through Z
Special characters:
- Blank or space
- + Plus sign
- - Minus sign or hyphen
- * Check protection symbol, asterisk
- / Slash
- = Equal sign
- > Inequality sign (greater than)
- < Inequality sign (less than)
- $ Dollar sign
- , Comma
- . Period or decimal point
- ' Quotation mark (also called a prime or apostrophe; is a 5-8 card punch. Note: DOS does not use double quotation marks, which is a 7-8 punch.)
- (Left parenthesis
-) Right parenthesis
- ; Semicolon

Of the previous set, the following characters are used for words:

0 through 9
A through Z
- (hyphen)

The following characters are used for punctuation:

' Quotation mark
(Left parenthesis
) Right parenthesis

, Comma
. Period
; Semicolon

The following characters are used in arithmetic expressions:

\+ Addition
\- Subtraction
* Multiplication
/ Division
** Exponentiation

The following characters are used in relation tests:

> Greater than
< Less than
= Equal to

All of the preceding characters are contained in the COBOL character set. In addition, the programmer can use, as characters in non-numeric literals, any characters (except the quotation mark) included in the IBM Extended Binary-Coded-Decimal Interchange Code; however, such characters may be unacceptable to COBOL for other computers.

PUNCTUATION

The following general rules of punctuation apply in writing COBOL source programs:

1. When any punctuation mark is indicated in a format in this publication, it is required.

2. A period, semicolon or comma, when used, must not be preceded by a space, but must be followed by a space.

3. A left parenthesis must not be followed immediately by a space; a right parenthesis must not be preceded immediately by a space.

4. At least one space must appear between two successive words and/or parenthetical expressions and/or literals. Two or more successive spaces are treated as a single space, except in non-numeric literals.

5. When an arithmetic operator or an equal sign is used, it must be preceded by a space and followed by another space.

6. When the period or comma, or arithmetic operator characters are used in the PICTURE clause as editing characters, they are governed by rules for report items only.

7. A comma may be used as a separator between successive operands of a statement. A comma or semicolon may be used to separate a series of clauses. A comma or a semicolon or the word THEN may be used to separate a series of statements.

WORD FORMATION

A word is composed of a combination of not more than 30 characters, chosen from the following set of 37 characters:

0 through 9 (digits)
A through Z (letters)
- (hyphen)

A word must not begin or end with a hyphen. A word is ended by a space, or by proper punctuation. Embedded hyphens are permitted. All words in COBOL are either reserved words, which have preassigned meanings in COBOL, or programmer-supplied names. Each type of name is discussed in the section of this publication in which it is first mentioned.

TYPES OF NAMES

Several types of names are used in writing a COBOL program. Each type must conform to specific requirements.

DATA-NAMES

A data-name must contain at least one alphabetic character, and must be formed according to the rules for word formation. It is used to identify a data item in the Data Division.

EXTERNAL-NAMES

An external-name consists of quotation marks enclosing no more than eight alphabetic and numeric characters, the first of which must be an alphabetic character. For example:

```
'ABCDEFGH'
'Z123'
'L64M38'
```

PROCEDURE-NAMES

Procedure-names follow the rules for word formation. They may be composed solely of numeric characters, in which case they are equivalent only if they are composed of the same number of digits and have the same numeric value. For example, 00123 and 123, when used as procedure-names, are not equivalent.

PARAGRAPH-NAMES

Paragraph-names are procedure-names and therefore follow the rules for formation of procedure-names.

Other Names

The following name types take the same format used in the formation of data-names:

- FILE-NAMES
- CONDITION-NAMES
- RECORD-NAMES
- OVERFLOW-NAMES

QUALIFICATION OF NAMES

Every name used in a COBOL source program must be unique within the source program, either because no other name has the identical spelling, or because the name exists within a hierarchy of names (so that the name can be made unique by mentioning one or more of the higher levels of the hierarchy). The higher levels are called qualifiers when used in this way, and the process is called qualification.

The following rules apply to the qualification of names:

1. The word OF or IN must precede each qualifying name, and the names must appear in ascending order of hierarchy.

2. A qualifier must be of a higher level and within the same hierarchy as the name it is qualifying.

3. The same name must not appear at two levels in a hierarchy in such a manner that it would appear to qualify itself.

4. The highest level qualifier must be unique. Each qualifying name must be unique at its own level within the hierarchy of the immediately higher qualifier.

5. Qualification when not needed is permitted.

6. Qualifiers must not be subscripted, although the entire qualified name may be subscripted.

7. The total number of characters X in a qualified data-name cannot exceed 300 where:

   X = T + 4N

   T is the number of characters in all the data-names in the string, and N is the number of data-names.

   For example: PARTNAME IN MONTHLY-INVENTORY IN FACTORY-B IN STATE-C.

   There are four data-names, so N=4. There is a total of 41 characters in the four data-names, so T=41. Hence:

   X = 41 + 16 = 57.

8. Regardless of qualification, procedure names and data names must not be the same. The description of the OCCURS clause contains additional information regarding qualified names and subscripting.

COBOL PROGRAM SHEET

The purpose of the program sheet is to provide a standard way of writing COBOL source programs.

This program sheet, despite its necessary restrictions, is of a relatively free form. The programmer should note, however, that the rules for using it are precise and must be followed exactly. These rules take precedence over any other rules, with respect to spacing.

SEQUENCE NUMBER: (COLUMNS 1-6)

The sequence number must consist only of digits; letters and special characters should not be used. The sequence number has no effect on the source program and need not be written. If the programmer supplies sequence numbers in each program card, the compiler will check the source program cards and will indicate any errors in their sequence. If these columns are blank, no sequence error will be indicated.

CONTINUATION INDICATOR: (COLUMN 7)

A hyphen may be placed in this column for the continuation of non-numeric literals.

See Continuation of Non-Numeric Literals.

SOURCE PROGRAM STATEMENTS: (COLUMNS 8-72)

These columns are used for writing the COBOL source program. Conceptually, a blank is assumed to be appended after column 72 on every line of a program sheet except where a non-numeric literal spans more than one line. Hence, if the last character of a word is in column 72, a blank is assumed to be appended to it, thus terminating the word.

PROGRAM IDENTIFICATION CODE: (COLUMNS 73-80)

These columns can be used to identify the program. Any character from the COBOL character set may be used, including the blank. The program identification code has no effect on the object program or the compiler.

MARGIN RESTRICTIONS

There are two margins on the COBOL program sheet: Margin A (columns 8-11), and Margin B (columns 12-72).

A division-name must begin in Margin A, and be followed by a space, the word DIVISION, and a period. This entry must appear on a line by itself.

A section-name must begin in Margin A, and be followed by a space, the word SECTION, and then a period. This entry must appear on a line by itself, except in declarations and the INCLUDE verb.

A paragraph-name must also begin in Margin A, and must be followed immediately by a period and a space. Statements within a paragraph may start on the same line as the paragraph-name. Succeeding lines of the paragraph must begin in Margin B.

When a statement spans more than one line, and column 72 of the line-to-be-continued is used, the continuation line may begin at the Margin B column (no space is required).

The FD level indicator in the Data Division, must begin at Margin A. Names and clauses within these entries must not begin before column 12. The level numbers (01-49, 77, 88) of data description entries may begin in Margin A; however, the names and/or clauses of this entry (data-names and/or clauses) must not begin before column 12.

CONTINUATION OF NON-NUMERIC LITERALS

When a non-numeric literal occupies more than one line of a coding sheet, the following rules apply:

1. A hyphen is placed in column 7 of the continuation line.
2. A quotation mark is placed in Margin B preceding the continuation of the literal.
3. All spaces at the end of the continued line and any spaces following the quotation mark in the continuation line and preceding the final quotation mark of the literal are considered part of the literal.

FORMAT NOTATION

Throughout this publication, basic formats are prescribed for various elements of COBOL. These generalized descriptions are intended to guide the programmer in writing his own statements. They are presented in a uniform system of notation, explained in the following paragraphs. This notation is useful in describing COBOL, although it is not part of COBOL.

1. All words printed entirely in capital letters are reserved words. These are words which have preassigned meanings in the COBOL language and are not to be used for any other purpose. In all formats, words written in capital letters selected for use must be duplicated.
2. All underlined reserved words are required unless the portion of the format containing them is itself optional. These are key words. If any such word is missing or is incorrectly spelled, it is considered an error in the program. Reserved words not underlined may be included or omitted at the option of the programmer. These words are used only for the sake of readability, and are called optional words.
3. All punctuation and special characters (except those symbols cited in the following paragraphs) represent the actual occurrence of

those characters. Punctuation is essential where it is shown. Additional punctuation can be inserted, according to the rules for punctuation specified in this publication.

Note: The words 'DIVISION' and 'SECTION' will never be attached to other words by hyphens.

4. Lower-case words in formats represent information that must be supplied by the programmer. All lower-case words that appear in a format are defined in the accompanying text

5. In order to facilitate references to them in text, some lower-case words are followed by a hyphen and a digit, or letter. This modification does not change the syntactical definition of the word.

6. Certain hyphenated words in the formats consist of capitalized portions followed by lower-case portions. These designate clauses or statements that are described in other formats, in appropriate sections of the text.

7. Square brackets ([ ]) are used to indicate that the enclosed item may be used or omitted, depending on the requirements of the particular program. When two or more items are stacked within brackets, one or none of them may occur.

8. Braces ({ }) enclosing vertically stacked items indicate that one of the enclosed items is obligatory.

9. The ellipsis (...) indicates that the immediately preceding unit may occur once, or any number of times in succession. A unit means either a single lower-case word, or a group of lower-case words and one or more reserved words enclosed in brackets or braces. If a term is enclosed in brackets or braces, the entire unit of which it is a part must be repeated when repetition is specified.

10. Comments, restrictions, and clarifications on the use and meaning of every format are contained in the appropriate portions of the text.

INPUT/OUTPUT PROCESSING

IBM System/360 Disk and Tape Operating Systems COBOL support various data organizations, record formats, and access methods. The facilities available to the COBOL user are specified in this section.

In this publication, the term IOCS (Input/Output Control System) can be considered equivalent to the term "Data Management Routines" used in other IBM System/360 Disk and Tape Operating Systems publications.

DATA ORGANIZATION

IBM System/360 Disk and Tape Operating Systems COBOL provide three types of data organization: standard sequential, indexed, and direct.

The number and type of control fields used to locate logical records in a file differ, depending on which of these three types of data organization is used. Consequently, each type of data organization is incompatible with the other two. For example, a file created as a standard sequential file cannot then be read as an indexed file. The organization of an input file must be the same as the organization of the file at creation time.

Standard Sequential Data Organization

When standard sequential data organization is used, the logical records in a file are positioned sequentially in the order in which they are created, and are read sequentially in the order in which they were created (or in sequentially reversed order if the REVERSED option of the OPEN statement is written for tape files). This type of data organization must be used for tape or unit-record files, and may be used for files assigned to direct-access devices.

Standard sequential data organization is assumed when the ORGANIZATION clause is not written in the Environment Division.

Indexed Data Organization

When indexed data organization is used, the position of each logical record in a file is determined by indexes maintained by the system and created with the file. The indexes are based on symbolic keys provided by the user. Indexed files must be assigned to direct-access devices.

Indexed data organization is specified by writing the clause ORGANIZATION IS INDEXED in the Environment Division.

Direct Data Organization

When direct data organization is used, the positioning of the logical records in a file is determined by keys supplied by the user. ACTUAL keys are used to specify the track. SYMBOLIC keys are used in conjunction with actual keys to identify a record on a track.

On each track, records are positioned in the order in which they are written. Direct files must be assigned to direct-access devices.

Direct data organization is specified by writing the clause ORGANIZATION IS DIRECT in the Environment Division.

ACCESS METHODS

There are two access methods provided by System/360 COBOL:

SEQUENTIAL ACCESS: This is the method of reading and writing records of a file in a serial manner; the order of references is implicitly determined by the position of a record in the file, except when indexed data organization is specified.

RANDOM ACCESS: This is the method of reading and writing records of a file in a non-sequential manner; the control of successive references to the files is determined by specifically defined keys supplied by the user.

KEYS

When accessing indexed or direct files randomly, the user must provide information to identify the specific record desired. For both organizations, direct and indexed sequential, the user must provide a key to identify the desired record. These keys are defined as follows:

SYMBOLIC KEY: The SYMBOLIC KEY is a unique storage resident value that distinguishes a record from all other records in the file (for example, a stock-number in an inventory file or an employee's name or man-number in a payroll file).

RECORD KEY: The RECORD KEY is a unique value within the record that distinguishes it from all other records in the file.

ACTUAL KEY: The ACTUAL KEY is the location on the disk at which the record is located. Thus it is the actual track address.

These values are used by IOCS to determine where the record is located or where it should be placed. For a randomly accessed file, the values of the data-names for the symbolic and actual keys are never automatically modified by IOCS. The user has complete responsibility for ensuring that the correct values are in the data-names before reading, writing, or rewriting.

Depending on the type of random file organization, identification of a record is accomplished through the use of the SYMBOLIC, RECORD, or ACTUAL keys as follows:

ACCESSING A DIRECT FILE RANDOMLY

When accessing a direct file, the ACTUAL and SYMBOLIC KEYS are required.

IOCS uses the value of the ACTUAL KEY as the actual track address. After locating the track, for a read or rewrite operation, IOCS searches the track for a record that is preceded by a "key area" equal to the SYMBOLIC KEY. When a match is found, the data portion of the record is read or, if a rewrite operation, replaced by the new record. If, for a read, the desired record cannot be found on the specified track, IOCS searches the entire cylinder for the record. When APPLY RESTRICTED SEARCH option is used, the search is limited to the specified track.

For a write operation, after locating the actual track, IOCS searches for the last record on the track, and writes the new record (with control fields including a key field equal to the SYMBOLIC KEY provided).

For a direct organization file, before a read, write, or rewrite, the track address must be moved into the data-name specified by the ACTUAL KEY clause, and the symbolic key must be moved into the data-name specified by the SYMBOLIC KEY clause.

ACCESSING AN INDEXED FILE RANDOMLY

When accessing an indexed file randomly, the RECORD and SYMBOLIC KEYS are required.

For blocked files, a "key area" precedes the block that IOCS uses to determine which record keys are in the block. For unblocked files, a "key area" precedes each record that IOCS uses to identify the RECORD KEY within the record.

When reading or writing records, the track containing the record desired is determined by using the SYMBOLIC KEY and searching the file's index table. When the track has been determined for unblocked records, the record is identified by comparing the SYMBOLIC KEY to the key area preceding the record. When the track has been determined for blocked records, the record is identified by comparing the SYMBOLIC KEY to the key area preceding the block, and then to the RECORD KEY of the record itself.

Before reading or rewriting an indexed file, the symbolic key for the desired record must be moved into the data-name specified by the SYMBOLIC KEY clause.

ACCESSING AN INDEXED OR DIRECT FILE SEQUENTIALLY

When creating an indexed file sequentially, a RECORD KEY is required, and the SYMBOLIC KEY is optional.

When creating a direct file sequentially, the ACTUAL and SYMBOLIC KEYS are required.

Processing indexed or direct files sequentially is similar to processing a standard sequential file. Thus, IOCS determines where a record is to be found based solely upon the logical sequence in which records were placed in the file previously. For direct files, this log-

ical sequence corresponds exactly to the physical sequence of the records; for indexed files, this logical sequence corresponds to the sequence of keys, which must be in collating sequence. If the user accesses an indexed file sequentially, and specifies binary zeros in the SYMBOLIC KEY, retrieval begins with the first record of the file.

It should be noted that the preceding discussion applies specifically to files accessed or created by a COBOL program. It is possible in lower level languages to create other types of files. In general, such files may not be used by COBOL programs.

CREATION OF AN INDEXED FILE

Indexed files may be created by:

1. Describing files with the following clauses:

   - ORGANIZATION IS INDEXED
   - [ACCESS IS SEQUENTIAL]
   - ASSIGN TO DIRECT ACCESS
   - [SYMBOLIC KEY IS]
   - RECORD KEY IS

2. Opening the file-name as OUTPUT, writing the records in ascending key sequence, and closing the file.

CREATION OF A DIRECT FILE

A direct file may be created sequentially by:

1. Describing files with the following clauses:

   - ORGANIZATION IS DIRECT
   - [ACCESS IS SEQUENTIAL]
   - ASSIGN TO DIRECT ACCESS
   - SYMBOLIC KEY IS
   - ACTUAL KEY IS

2. Opening a file as an output file. When the file is opened, the capacity records (R0) are initialized for each XTENT specified for the output file.

3. Writing each record sequentially, specifying its SYMBOLIC KEY

An end-of-file record is automatically placed on the last track of the file at CLOSE.

Figure 1 summarizes the clause and statement specifications allowed for each of the three data organizations. Also, each file-name must be specified in a SELECT sentence in the Environment Division and must be defined by an FD entry in the File Section of the Data Division.

Figure 1. Permissible Data Organization Clauses and Statements

DISK AND TAPE OPER. SYSTEMS ORGANIZATION	DEVICE TYPE	ACCESS	OPEN	ORGANIZATION	RECORDING MODE	BLOCK CONTAINS	RESERVE ALTERNATE AREA	LABEL RECORDS	READ WRITE REWRITE	APPLY	KEY	CLOSE	ASSIGN
DTFCD	READER	[SEQUENTIAL]	INPUT	-	F	-	[1 / NO]	OMITTED	READ [INTO] AT END	-	-	CLOSE	UNIT-RECORD
DTFCD	PUNCH	[SEQUENTIAL]	OUTPUT	-	F	-	[1 / NO]	OMITTED	WRITE [FROM] [ADVANCING]	-	-	CLOSE	UNIT-RECORD
DTFPR	PRINTER	[SEQUENTIAL]	OUTPUT	-	F	-	[1 / NO]	OMITTED	WRITE [FROM] [ADVANCING]	-	-	CLOSE	UNIT-RECORD
DTFMT	TAPE	[SEQUENTIAL]	{INPUT [NO-REWIND / [REVERSED]] / OUTPUT [NO-REWIND]}	-	[F / U / V]	[n (except for U)]	[1 / NO]	{STANDARD / OMITTED / d - name}	READ AT END WRITE [FROM] [ADVANCING]	[WRITE ONLY][2]	-	[NO REWIND] [LOCK] [UNIT]	UTILITY
DTFSD	DISK	[SEQUENTIAL]	{INPUT / OUTPUT / I-O}	-	[F / U / V]	[n (not with U)]	[1 / NO]	{STANDARD / d - name}	READ AT END WRITE [FROM][2] REWRITE	[WRITE ONLY][2]	-	CLOSE [UNIT]	UTILITY DIRECT-ACCESS
DTFIS	DISK	[SEQUENTIAL]	{INPUT / OUTPUT / I-O}	INDEXED	F	[n]	[NO]	STANDARD	READ AT END REWRITE[1][INVALID KEY] WRITE[2]	-	[SYMBOLIC] RECORD	CLOSE	DIRECT-ACCESS
DTFDA	DISK	[SEQUENTIAL]	INPUT OUTPUT	DIRECT	{F / U}	-	[NO]	{STANDARD / d - name}	READ AT END WRITE	-	ACTUAL SYMBOLIC	CLOSE	DIRECT-ACCESS
DTFIS	DISK	RANDOM	{INPUT / I-O}	INDEXED	F	[n]	[NO]	STANDARD	READ INVALID KEY WRITE [INVALID KEY] REWRITE [INVALID KEY]	[CORE-INDEX]	SYMBOLIC RECORD	CLOSE	DIRECT-ACCESS
DTFDA	DISK	RANDOM	{INPUT / I-O}	DIRECT	{F / U}	-	[NO]	{STANDARD / d - name}	READ INVALID KEY WRITE [INVALID KEY] REWRITE [INVALID KEY]	[RESTRICTED SEARCH]	SYMBOLIC ACTUAL	CLOSE	DIRECT-ACCESS

1 - For I-O Option of OPEN clause
2 - For OUTPUT Option

SECTION 3: IDENTIFICATION DIVISION

The Identification Division is used to identify a program and to provide other pertinent information concerning the program. The format of the Identification Division is:

```
IDENTIFICATION DIVISION.
PROGRAM-ID.  'program-name'.
[AUTHOR.  sentence...]
[INSTALLATION.  sentence...]
[DATE-WRITTEN.  sentence...]
[DATE-COMPILED.  sentence...]
[SECURITY.  sentence...]
[REMARKS.  sentence...]
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
001|001| |IDENTIFICATION DIVISION.
001|002| |PROGRAM-ID. 'CALLPRGM .
001|003| |REMARKS. EXAMPLE OF A CALLING PROGRAM.
```

Refer to Appendix D, Figure 33, for the relationship between the example above and the sample program given therein.

Program-name consists of single quotation marks enclosing no more than eight alphabetic and numeric characters, the first of which must be alphabetic. Program-name identifies the object program to the control program.

IDENTIFICATION and the other COBOL words in the Identification Division must begin in Margin A. If sentences are written, they must be contained within Margin B. They may consist of any characters in the EBCDIC set.

GENERAL DESCRIPTION

The function of the Environment Division is to centralize the aspects of the total data processing problem that are dependent upon the physical characteristics of a specific computer. It provides a linkage between the logical concept of files and their records, and the physical aspects of the devices on which files are stored.

The Environment Division must begin in Margin A with the heading ENVIRONMENT DIVISION followed by a period.

The Environment Division is divided into two sections -- the Configuration Section and the Input-Output Section.

The Configuration Section, which deals with the overall specifications of computers, is divided into two paragraphs. They are: the Source-Computer paragraph, which defines the computer on which the COBOL compiler is to be run, and the Object-Computer paragraph, which defines the computer on which the program produced by the COBOL compiler is to be run.

The Input-Output Section deals with the definition of the external media (input/output devices) and with information needed to create the most efficient transmission and handling of data between the media and the object program. This section is divided into two paragraphs:

1. the external media,

2. the I-O-Control paragraph, which defines special input/output techniques.

CONFIGURATION SECTION

The format of the Configuration Section is:

```
CONFIGURATION SECTION.

[SOURCE-COMPUTER.   IBM-360 [model-number].]

[OBJECT-COMPUTER.   IBM-360 [model-number].]
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
001|004| |ENVIRONMENT DIVISION.
001|005| |CONFIGURATION SECTION.
001|006| |SOURCE-COMPUTER. IBM-360 D30.
001|007| |OBJECT-COMPUTER. IBM-360 D30.
```

Refer to Appendix D, Figure 33, for the relationship between the example above, and the sample program given therein.

INPUT-OUTPUT SECTION

The format of the Input-Output Section is:

```
INPUT-OUTPUT SECTION.
FILE-CONTROL.
     [SELECT file-name ASSIGN clause
     [RESERVE clause]...
     [ACCESS clause]
     [ORGANIZATION clause]
     [SYMBOLIC KEY clause]
     [ACTUAL KEY clause]
     [RECORD KEY clause]
     [TRACK-AREA clause].
I-O-CONTROL.
     [SAME clause.] ...
     [RERUN clause.] ...
     [APPLY clause.] ...
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
001|004| |ENVIRONMENT DIVISION.
                |      .
                |      .
                |      .
001|008| |INPUT-OUTPUT SECTION.
001|009| |FILE-CONTROL.
001|010| |      SELECT FILEA ASSIGN TO 'SYS004' UTILITY 2400 UNITS.
001|011| |      SELECT FILEB ASSIGN TO 'SYS005' UNIT-RECORD 2540R
          |      RESERVE NO ALTERNATE AREA.
```

Refer to Appendix D, Figure 33, for the relationship between the example above, and the sample program given therein.

The individual optional clauses that compose the File-Control and I-O-Control paragraphs may appear in any order within their respective sentences or paragraphs but must begin in Margin B. They are described in the following text. The Input-Output Section may be omitted if there are no files used in the program.

I-O-CONTROL may be omitted if none of the clauses in the paragraph are written. A period must follow the last clause in each SELECT sentence written in the File-Control paragraph, and must follow each clause written in the I-O-Control paragraph.

FILE-CONTROL PARAGRAPH

SELECT Sentence

The SELECT sentence must begin with the words SELECT file-name and must be given for each file named in the File-Control paragraph.

The name of each file must be unique within a program and must have a File Description (FD) in the Data Division of the source program. Conversely, every file named in an FD entry must be named in a SELECT sentence.

ASSIGN Clause

The ASSIGN clause is used to assign a file to a particular device.

The format of the ASSIGN clause is:

ASSIGN TO 'external-name' { DIRECT-ACCESS / UTILITY / UNIT-RECORD } device-number UNIT[S]

External-name specifies the name by which the file is known to the Control Program. External-name for files in the assign clause must be of the format 'SYSnnn' where nnn is a 3-digit number between 000 and 222.

DIRECT ACCESS, UNIT-RECORD, and UTILITY specify device classes. Each file must be assigned to a device class. Files assigned to UTILITY or UNIT-RECORD have sequential access only, and data contained on these files is organized in the standard sequential fashion. Files assigned to DIRECT ACCESS may have standard sequential, indexed, or direct organization. When organization is indexed or direct, access may be either sequential or random.

Device-number is used to specify a particular device type within a device class and is required.

The allowable device-numbers are:

UNIT-RECORD
1442R, 1442P, 1403, 1404 (continuous forms only), 1443, 1445, 2501, 2520R, 2520P, 2540R, 2540P

"R" indicates reader.
"P" indicates punch.

UTILITY
2400, 2311, 2314, 2321

DIRECT ACCESS
2311, 2314, 2321

ACCESS Clause

The ACCESS clause indicates the manner in which the records of a file are read or written.

The format of the ACCESS clause is:

```
[ACCESS IS {SEQUENTIAL}]
           {RANDOM    }
```

If this clause is not written, ACCESS IS SEQUENTIAL is assumed. If ACCESS IS RANDOM is written, the file must be assigned to a direct-access device and must be indexed or direct.

[EXT] ORGANIZATION Clause

The ORGANIZATION clause indicates the organization of the data associated with a particular file.

The format of the ORGANIZATION clause is:

```
[ORGANIZATION IS {INDEXED}]
                 {DIRECT }
```

This clause may be written only for files assigned to direct-access devices in a SELECT sentence. It must be written for files whose ACCESS IS RANDOM.

If the ORGANIZATION clause is omitted, a standard sequential file is assumed.

INDEXED specifies indexed data organization.

DIRECT specifies direct data organization.

RESERVE Clause

The RESERVE clause specifies the number of buffers reserved for a standard sequential file in addition to the standard minimum of one required for a file.

The format of the RESERVE clause is:

```
[RESERVE {NO} ALTERNATE AREA[S]]
         {1 }
```

If this clause is omitted, one additional buffer is assumed. If NO is written, no additional buffer will be reserved.

Note: The integer 1 cannot be specified for files which have either direct or indexed organization, i.e., the integer 1 can be specified only when the ORGANIZATION clause has been omitted (thereby specifying a standard sequential file).

SYMBOLIC KEY Clause

The symbolic key identifies a record by specifying the contents of the data field used:

1. When reading or rewriting, to locate the matching key;

2. When writing, to create the key associated with the record.

The format of the SYMBOLIC KEY clause is:

[SYMBOLIC KEY is data-name.]

Data-name must be defined in the Working-Storage section; it must never be defined in any file or in the Linkage Section. It may be any fixed-length item less than 256 bytes in length, with the exception of floating-point or report items. Section 5 contains a discussion of the formation of data-names.

This clause is allowed only when the ORGANIZATION clause is specified, and is required if ACCESS IS RANDOM is specified. The SYMBOLIC KEY clause is also required for a sequential file having an ORGANIZATION IS DIRECT clause. The symbolic identity of the record will be placed into data-name whenever a READ statement is executed for the file. Any changes the programmer may make to data-name will not affect the order in which records are read from the file.

If the file is specified as ACCESS IS RANDOM, the symbolic identity of the record to be read or written must be placed in data-name before the READ or WRITE statement for that record is executed. The symbolic identity will be used by IOCS to determine the physical location from which the record is to be read or onto which it is to be written.

ACTUAL KEY Clause

The actual key specifies the track address at which the record is to be placed, or at which the search for the record is to start.

The format of the ACTUAL KEY clause is:

[ACTUAL KEY IS data-name]

Data-name must be defined as an 8-byte data item in the Working-Storage Section; it must never be defined in any file description or in the Linkage Section.

This clause is required for a file whose organization is direct and must not be specified for a file under any other circumstances.

The functions of this clause are similar to those of the SYMBOLIC KEY clause, except that this clause specifies a data item that will contain the track address on which a record is to be found or placed.

The actual key in Operating System/360 specifies a relative track address. In the Disk Operating System it specifies the actual track or hardware address. The actual key field contains the track address as specified for the system in the publication IBM System/360 Disk Operating System: Data Management Concepts, Form C24-3427.

EXT

RECORD KEY Clause

The RECORD KEY clause, used with indexed organization files, specifies the item within the data record that contains the key for the record.

The format of the RECORD KEY clause is:

[RECORD KEY IS data-name]

Data-name must be defined in the FILE SECTION of the DATA DIVISION.

Data-name must be defined to exclude the first byte of the record in the following types of files:

1. Files whose records are unblocked
2. Files from which records are to be deleted
3. Files any one of whose keys might start with a delete code character (HIGH-VALUE)

This restriction exists for reasons of compatability with the IBM System/360 Operating System.

With these exceptions, the item specified by data-name may appear anywhere within the record.

Data-name may be any fixed-length item less than 256 bytes in length, with the exception of floating-point or report items.

When more than one record description is associated with a file, each description must contain a field for the record key. This field must be in the same relative position from the beginning of each record. It may be identified by different names in different record descriptions.

TRACK-AREA Clause

The TRACK-AREA clause may be used when adding records to an indexed sequential file in the random access mode. It allows reading and writing of more than one physical record per I/O operation, thus increasing efficiency.

The format of this clause is:

[TRACK-AREA IS integer CHARACTERS.]

The size of the area may be defined to hold from one to all the blocks on a track including their key fields. 'Integer' must be at least 24 + N(50 + RECORD KEY length + block size), where N is any number from 2 to the maximum number of blocks on a track. 'Integer' must not exceed 32,767 bytes (see the Data Management Concepts publication cited above). Key length is the length of the record key.

Although 'integer' must not exceed 32,767, for optimum use of core storage 'integer' should not exceed the size of one track. For example, on the 2311 one track equals 3,625 bytes. To define 'integer' greater

than the length of one track would be a waste of storage. For additional information, see the discussion of the ADD function for an indexed sequential file in the publication IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide, Form C24-5025.

I-O-CONTROL PARAGRAPH

SAME Clause

The SAME clause is used to specify that two or more files are to use the same main storage area for processing.

The format of the SAME clause is:

[SAME AREA FOR file-name-1 file-name-2 [file-name-3...].]

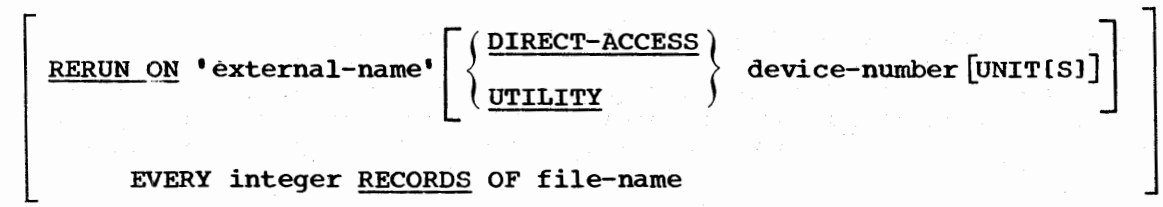
Only one of the files named in this clause may be open at any time.

More than one SAME clause may appear in a COBOL program, but no filename may appear in more than one SAME clause.

RERUN Clause

The RERUN clause specifies that checkpoint records are to be written on the unit specified by 'external-name'.

The format of the RERUN clause is:



A checkpoint record is a recording of the status of the computer at a given point in the execution of the object program. It contains the information necessary to restart the program from that point.

Note: The external-name used in the RERUN clause should not be the same as an external-name used in the ASSIGN clause of the FILE-CONTROL paragraph in the Environment Division. The purpose of the restriction on this duplication is to prevent checkpoint records from being interspersed among the file records.

The user can specify whether the checkpoint file is to be recorded on a direct-access or a tape device. A direct-access device is specified by the DIRECT-ACCESS clause with or without a direct-access device number (e.g., 2311) or by the UTILITY clause with a direct-access device number. A tape device is specified by the UTILITY clause with or without a tape device number (e.g., 2400). If neither DIRECT-ACCESS nor UTILITY is specified, UTILITY 2400 is assumed. If an IBM 2314 direct-access device is available, it should be used in preference to an IBM 2311 direct-access device since the IBM 2314 offers the advantage of longer track records.

A maximum of 20 external devices (only one of which can be a direct-access unit) may be used to store checkpoint records. Files may also share a unit used to store checkpoint records. Thus, the following example is correct:

```
RERUN ON 'SYS030' EVERY 200 RECORDS OF INPUT-MASTER
RERUN ON 'SYS030' EVERY 200 RECORDS OF OUTPUT-MASTER
RERUN ON 'SYS031' DIRECT-ACCESS 2311 EVERY 400 RECORDS OF
  TRANSACTION-FILE
RERUN ON 'SYS032' EVERY 50 RECORDS OF ERROR-TAPE
```

Checkpoint records are written immediately preceding the execution of integer READ, WRITE, or REWRITE statements directed to file-name. Integer may never exceed 8388607.

If a COBOL program is written in modules and the object program is restarted from a checkpoint taken in one of the modules, files in those modules containing RERUN clauses will be repositioned by means of the restart procedures. Therefore, it would be advantageous to design the program in such a way that all modules containing files which are open and which would require repositioning when restarting contain RERUN clauses.

After restart procedures have been executed, any interrupt handling facilities set up by the user may be lost.

APPLY Clause

There are four options of the APPLY clause, each with its own function.

The formats of the APPLY clause are:

Option 1

[APPLY overflow-name TO FORM-OVERFLOW ON file-name.]

This option is used to specify overflow-name, which may be used in tests for form-overflow of a printer to which the file named by file-name is assigned. The condition is true when channel 12 is sensed by an on line printer.

Overflow-names, which are condition names, follow the rules for data-name formation. Data-name formation is discussed in Section 1. Data-names are discussed in Section 5; overflow tests are discussed in Section 6.

An overflow-name may be written in conjunction with a WRITE statement with an ADVANCING option in order to control spacing of printed records. Thus, the following statement could be written (with a programmer-supplied overflow-name):

```
IF overflow-name WRITE X AFTER
ADVANCING 0 LINES ELSE WRITE X
AFTER ADVANCING 2 LINES
```

Only one overflow-name may be applied to a file and only one buffer reserved (see discussion of the RESERVE clause).

Option 2

[APPLY WRITE-ONLY ON file-name...]

This option of the APPLY clause is used to make optimal use of buffer and device space allocated for a file with blocked V type records (permitted only on standard sequential files). Records must be built in a work area, and written with a WRITE...FROM clause.

The only I-O reference to the record may be in a WRITE...FROM statement. The APPLY WRITE-ONLY clause permits records to be added to a buffer even though the maximum size record cannot fit. Normally, a buffer is truncated when the maximum size record no longer fits. Use of this option will cause a buffer to be truncated only when the next record does not fit in the unused remainder of the buffer.

Subfields of these records may never be referenced.

Option 3

[APPLY RESTRICTED SEARCH OF integer TRACKS ON file-name...]

Integer can only be 1.

This clause is used to control the extent of the search made for a specified record. This option may refer only to files specified as ACCESS IS RANDOM and ORGANIZATION IS DIRECT. In normal operation, execution of a READ statement for a file starts the search at the track specified by the actual key, and continues until the record is found or until the entire cylinder is searched. When RESTRICTED SEARCH is written, the search is limited to the specified track. If the desired rec-

ord cannot be found in the case of a READ or REWRITE, the INVALID KEY option of the READ or REWRITE statement will be executed.

The INVALID KEY option will also be executed when the specified track is outside the limits of the last cylinder containing the file. It is the programmer's responsibility to determine which condition produced the invalid key condition.

Option 4

[APPLY CORE-INDEX TO data-name ON file-name-1 [file-name-2...].]

This option of the APPLY clause is used to reserve an area of main storage to hold the cylinder index when performing random retrieval on an indexed sequential file. The area defined by data-name must be at least (3 + N) * (6 + key length), where 'N' is the number of entries to be read into main storage at one time, and key length is the length of the record key. Data-name must be a level 01 or 77 entry of fixed length in the Working-Storage Section. Note that data-name must not contain an OCCURS...DEPENDING ON clause. The PICTURE specification of data-name should be alphanumeric.

If multiple file-names are specified for the same data-name, only one of these files can be open at any given time. At no time may a given file have more than one data-name associated with it. When using the REDEFINES clause, care should be taken that two data-names, referencing the same storage area, are not associated with two fields which are both open at the same time.

Data-name should not be referenced by Procedure Division statements.

All or part of the cylinder index can reside in main storage. If the core storage area assigned to the cylinder index is large enough for all the index entries to be read into main storage at one time, no presorting of the record keys is necessary. If, however, the area assigned to the cylinder index is not large enough, the keys of the records to be processed should be presorted in order to fully utilize the resident cylinder index area. The publication IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide, Form C24-5025, contains additional information on this option in the discussion of random retrieval of an indexed sequential file, Section VIII.

Use of this option will cause the core index byte of the DTF to be set to Index Skip.

Note: This option will be suppressed during program execution if irrecoverable input/output errors are encountered while the indexes are being read into core.

SECTION 5: DATA DIVISION

GENERAL DESCRIPTION

The Data Division of a COBOL source program describes the information to be processed by the object program. This information falls into the following categories:

1. Data contained in files, entering or leaving the internal storage of the computer.

2. Data developed internally and placed in intermediate or working storage, and constant data defined by the user.

3. Linkage data descriptions for communication between main program and subprograms.

The Data Division must begin in Margin A with the header DATA DIVISION followed by a period. Each of the sections of the Data Division begins with a fixed section-name, and is followed by the word SECTION and a period, as follows:

```
DATA DIVISION.
FILE SECTION.
    File Description entries
    Record Description entries
WORKING-STORAGE SECTION.
    Record Description entries
LINKAGE SECTION.
    Record Description entries
```

The sections must appear in this order. If any section is not required, both it and its section-name may be omitted.

ORGANIZATION OF THE DATA DIVISION

The Data Division is subdivided into sections, according to types of data. Each section consists of entries, rather than sentences and paragraphs. An entry consists of a level indicator, a data-name or filename, and a series of clauses, separated by commas or semicolons, which define the data. The clauses (except the REDEFINES clause) may be written in any sequence. Each entry must terminate with a period and a space.

FILE SECTION

The File Section describes the content and organization of files. Each File Description entry is followed by related Record Description entries.

The Record Description entries used in conjunction with a File Description entry describe the individual items contained in a data record of a file.

WORKING-STORAGE SECTION

The Working-Storage Section consists solely of Record Description entries. These entries describe the areas of storage where intermediate results are stored at object program execution time, and constants along with their values.

LINKAGE SECTION

The Linkage Section is a required part of any COBOL subprogram that contains an ENTRY statement with the USING option, and serves as a data-linking mechanism between the main program and the subprogram. It consists only of Record Description entries that provide dummy names for linkage to data in the main program. This is the only Data Division section whose entries do not cause object program data storage areas to be allocated.

When passing COMPUTATIONAL, COMPUTATIONAL-1, or COMPUTATIONAL-2 fields, refer to Appendix B for a discussion on alignment requirements.

CONCEPTS OF DATA DESCRIPTION

The following material defines the basic terms and concepts used in describing data. Rules which govern the writing of data descriptions appear later in this section.

LEVELS OF DATA ITEMS

Level indicators are used to show how data items are related to each other. The most inclusive grouping of data is the file. The level indicator for a file is FD.

For purposes of processing, the contents of a file are divided into logical records, with level number 01 specifying a logical record. Subordinate data items that constitute a logical record are grouped in a hierarchy and identified with level numbers 02 to 49. A level number less than 10 may be written as a single digit preceded by a blank.

Level number 77 identifies a Record Description entry in the Linkage Section or the Working-Storage Section. The level number 77 cannot appear in the File Section. Those constants which are likely to be changed should be defined in the Working-Storage Section as 77-level entries and referenced in the Procedure Division by the data-name assigned to them. Then, when the values of these constants change, it is a simple matter to change the single constant entry to the current value and recompile.

Level number 88 is used to define a condition-name for a related conditional variable.

Levels allowing specification of subdivisions of a record are necessary to refer to data. Once a subdivision is specified, it may be subdivided further to permit more detailed data reference. This may be illustrated by the following weekly time-card record, which is divided into four major items: name, employee-number, date, and hours, with more specific information appearing for name and date.

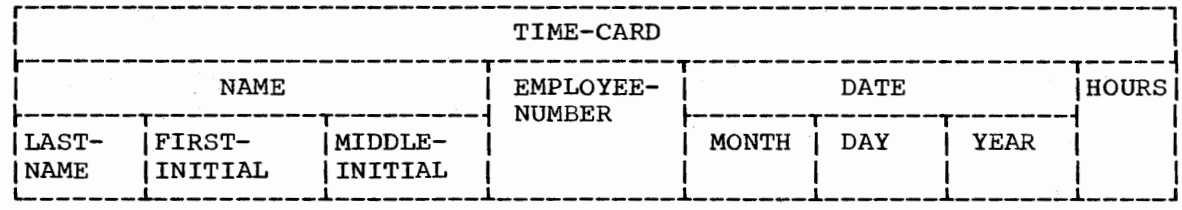


Figure 2. Subdivisions of a Weekly Time-Card Record

Subdivisions of a record that are not themselves further subdivided are called elementary items. Data items that contain subdivisions are known as group items. When a Procedure Division statement refers to a group item, the reference applies to the area reserved for the entire group. Less inclusive groups are assigned higher level numbers. Level numbers of items within groups need not be consecutive. A group includes all groups and elementary items described under it until a level number less than or equal to the level number of the group is encountered. Separate entries are written in the source program for each level. To illustrate level numbers and group items, the weekly time-card record in the example may be described by Data Division entries having the following level numbers and data-names described in Figure 2.

Only the level numbers and data-name of each entry have been given in Figure 3; data defining clauses were omitted.

Throughout the Data Division, level-01 items are adjusted to a doubleword boundary; level 77 binary or internal floating-point items are adjusted to the next available halfword, fullword, or doubleword boundary, as appropriate. For blocked files, refer to the discussion on Intrarecord Slack bytes in Appendix B.

```
 01  TIME-CARD
     04 NAME
        06 LAST-NAME
        06 FIRST-INITIAL
        06 MIDDLE-INITIAL
     04 EMPLOYEE-NUMBER
     04 DATE
        06 MONTH
        06 DAY
        06 YEAR
     04 HOURS
```

Figure 3. Example of Data Levels

DATA-NAMES

A data-name is a name assigned by the programmer to identify a data item used in a program. A data-name refers to a kind of data, not to a particular value; the item it refers to usually assumes a number of values during the course of a program.

A data-name must contain at least one alphabetic character. A data-name or the key word FILLER must be the first word following the level number in each Record Description entry, as shown in the following general format:

level-number { data-name / FILLER }

The data-name is the defining name of the entry, and is the means by which the references to the area (containing the value of a data item) are made. The key word FILLER may be used in place of a data-name if the item is not to be referred to directly or used as a qualifier. For example, if some of the characters in a record are not used in the processing steps of a program, then the data description of these characters need not include a data-name. In this case, FILLER is written in lieu of a data-name after the level number.

If the same data-name is assigned to more than one item in a program, it must be qualified in all references to it in the Procedure Division, Data Division, or Environment Division, except in the REDEFINES clause where the position of the clause will eliminate the possibility of ambiguity.

A data-name is qualified by writing either IN or OF after it, followed by the name of one or more groups, or the record or file in which it is contained. A highest level qualifier must, however, be unique.

Any combination of qualifiers that will ensure uniqueness may be used. More qualifiers may be used than are absolutely needed. In Figure 3, if YEAR OF DATE is needed to make YEAR unique, YEAR OF DATE IN TIME-CARD is also permitted.

A data-name cannot be subscripted when it is used as a qualifier. However, the entire qualified data-name may be subscripted.

LITERALS

A literal is a constant that is not identified by a data-name in a program, but is completely defined by its own identity. A literal is either non-numeric (alphabetic or alphanumeric), numeric, or floating-point.

Non-Numeric Literals

A non-numeric literal must be bounded by quotation marks and may consist of any combination of characters in the IBM EBCDIC set, except quotation marks. All spaces enclosed by the quotation marks are included as part of the literal. A non-numeric literal may not exceed 120 characters in length.

The following are examples of non-numeric literals:

```
'EXAMINE CLOCK NUMBER'
'12565'
'PAGE 144 MISSING'
```

Numeric Literals

A numeric literal must contain at least one and not more than 18 digits. A numeric literal may consist of the characters 0 through 9, the plus sign or the minus sign, and the decimal point. It may contain only one sign character and only one decimal point. The sign, if present, must appear as the leftmost character in the numeric literal. If a numeric literal is unsigned, it is assumed to be positive.

A decimal point may appear anywhere within the numeric literal, except as the rightmost character. If a numeric literal does not contain a decimal point, it is considered to be a whole number.

The following are examples of numeric literals:

```
1506798
+12572.6
-256.75
.16
```

EXT

Floating-Point Literals

A floating-point literal must have the form:

```
[+]          [+]
[-]mantissa E[-]exponent
```

The plus or minus signs preceding the mantissa and exponent are the only optional characters within the format. The mantissa consists of one to 16 digits with a required decimal point.

Immediately to the right of the mantissa, the exponent is represented by the symbol E, followed by a plus or minus sign (if a sign is given), and one or two digits. The magnitude of the number represented by a floating-point literal must not exceed .72*(10**76). A zero exponent must be written as 0 or 00.

The value of the literal is the product of the mantissa and ten raised to the power given by the exponent. A floating-point literal must appear as a continuous string of characters with no intervening spaces.

The following are examples of floating-point literals:

```
12.3E2
-.34566E+17
+2.56E-6
```

FIGURATIVE CONSTANTS

A figurative constant is a special type of literal; it represents a value to which a standard data-name has been assigned. Figurative constants must not be bounded by quotation marks.

ZERO may be used in many places in a program as a numeric literal. It may not, however, be used in an arithmetic statement. The use of ZERO as a non-numeric literal is permitted. All other figurative constants are considered non-numeric. The singular and plural forms of figurative constants are equivalent and may be used interchangeably.

The following are the figurative constants and their meanings:

ZERO ZEROS ZEROES	Represents one or more zeros.

SPACE SPACES	Represents one or more blanks or spaces.
HIGH-VALUE HIGH-VALUES	Represents one or more appearances of the highest value in the computer's collating sequence. (Hexadecimal 'FF')
LOW-VALUE LOW-VALUES	Represents one or more appearances of the lowest value in the computer's collating sequence. (Hexadecimal '00')
ALL 'character'	Represents one or more occurrences of the single character bounded by quotation marks. Character may not be a quotation mark.
QUOTE QUOTES	Represents the character '. Note that the use of the word QUOTE to represent the character ' at object time is not equivalent to the use of the symbol ' to bound a non-numeric literal.

When a figurative constant is used in such a way that the exact number of characters required cannot be determined, only one character is generated. For example, the statement DISPLAY ZEROES would produce one zero character since, in this case, the length of the sequence of zeros to be displayed cannot be determined.

The following are examples of the use of figurative constants in the Data Division:

```
02 FILLER PICTURE A(10) VALUE SPACES.
02 HEADING PICTURE X(20) VALUE ALL '*'.
```

CONDITION-NAMES

The general form of a condition-name entry is:

```
88 condition-name VALUE IS literal.
```

Each level 88 entry must be preceded by either an elementary item or another level 88 entry (in the case of several consecutive condition-names pertaining to an elementary item).

Every condition-name pertains to an elementary item in such a way that the condition-name may be qualified by the name of the elementary item and the elementary item's qualifiers. A condition-name is used in the Procedure Division in place of a simple relational condition.

A condition-name may pertain to an elementary item (a conditional variable) requiring subscripts. In this case the condition-name, when written in the Procedure Division, must be subscripted according to the same requirements of the associated elementary item. Subscripting is discussed later in this text.

The literal in a condition-name entry must be consistent with the data type of the conditional variable.

Figure 4 is an example of Data Division entries and a Procedure Division statement that might be written using level 88 and the condition-name-test. (Details on the condition-name-test appear in Section 6 under the subsection Test Conditions.)

Data Division Portion:

```
01  TIME-CARD.
02 NAME, PICTURE X(20).
02 PAY-CODE, PICTURE 9.
     88  MONTHLY, VALUE IS 1.
     88  HOURLY, VALUE IS 2.
     88  SUBCONTRACTOR, VALUE 3.
02 SALARY, PICTURE 9999.
02 RATE-PER-HOUR, REDEFINES SALARY PICTURE 9V999,
   DISPLAY.
02 PER-DIEM, REDEFINES SALARY PICTURE 99V99,
   DISPLAY.
```

Procedure Division Portion:

```
IF HOURLY COMPUTE GROSS = 40 * RATE-PER-HOUR,
ELSE IF MONTHLY COMPUTE GROSS = SALARY / 4.334,
ELSE IF SUBCONTRACTOR COMPUTE GROSS = 5 * PER-DIEM,
ELSE PERFORM ERROR-PROCESS.
```

Figure 4. Condition-name Example

TYPES OF DATA ITEMS

Several types of data items can be described in a COBOL source program. These data items are described in the following text. The format of the Record Description entry used to describe each of these items appears under the discussion of Record Description entries.

Group Items

A group item is defined as a field having further subdivisions, so that it contains one or more elementary items. In addition, a group item may contain other groups. An item is a group item if, and only if, its level number is less than the level number of the immediately succeeding item, unless the succeeding level is 88. If an item is not a group item, then it is an elementary item, or, in the case of level 88, it is a condition-name.

The maximum length for any elementary or group item in a tape system is 4092 bytes. For a disk file, maximum length depends upon the particular disk model; 3625, 4096, and 2000 bytes for the IBM 2311, 2314, and 2321 direct-access devices respectively. An exception to these stated lengths is the use of a fixed-length Working-Storage group item, which may be as long as 32,767 bytes. If an IBM 2314 direct-access device is available, it should be used since it offers the advantage of longer track records.

Group items never have a picture associated with them.

Elementary Items

An elementary item is a data item containing no subordinate items. For example, an 03 level data item followed immediately by another 03 item is an elementary item. Elementary items always have the picture clause specified.

Alphabetic Item

An alphabetic item may contain any combination of the characters A through Z and space. Each alphabetic character is stored in a separate byte.

Alphanumeric Item

An alphanumeric item consists of any combination of characters in the IBM EBCDIC set. Each alphanumeric character is stored in a separate byte.

Report Item

A report item is an alphanumeric item containing only digits and/or special editing characters. It must not exceed 127 characters in length. A report item can be used only as a receiving field for numeric data. Each report character is stored in a separate byte (see PICTURE and BLANK WHEN ZERO clauses), except P and V which occupy no storage, and CR and DB which occupy two bytes each.

Fixed-Point Items

Fixed-point items may be defined as external decimal, internal decimal, or binary. External decimal corresponds to the form in which information is represented initially for card input, or finally for printed or punched output. Such items may be converted (by moving) to the internal machine formats described as internal decimal or binary. Except when an item is a single digit in length, these formats require less storage than the external decimal format and can be used to save space on input/output units. The binary mode of representation is particularly efficient for data-names used as subscripts. Computational results are the same, regardless of the particular format selected.

External Decimal Item: Decimal numbers in the System/360 zoned format are external decimal items. Each digit of a number is represented by a single byte, with the four low-order bits of each 8-bit byte containing the value of a digit. The four high-order bits of each byte are zone bits; the zone bits of the low-order byte represent the sign of the item. The maximum length of an external decimal item is 18 digits. For items whose PICTURE does not contain an S the sign position is occupied

by a bit configuration interpreted as positive but which does not represent an overpunch.

Figure 5 contains illustrations of this data type.

Internal Decimal Item: An internal decimal item consists of numeric characters 0 through 9 plus a sign, and represents a value not exceeding 18 digits in length. It appears in storage as packed decimal. One byte contains two digits with the low-order byte containing the low-order digit followed by the sign of the item. For items whose PICTURE does not contain an S, the sign position is occupied by a bit configuration interpreted as positive but which does not represent an overpunch.

Figure 5 contains illustrations of this data type.

Binary Item: A binary item may be considered decimally as consisting of numeric characters 0 through 9 plus a sign. It occupies two bytes (a halfword), four bytes (a fullword), or eight bytes (two words), corresponding to specified decimal lengths of 1 to 4 digits, 5 to 9 digits, and 10 to 18 digits, respectively. The leftmost bit of the reserved area is the operational sign.

If the item is used as a resultant data-name in an arithmetic statement, and no ON SIZE ERROR option is specified, the area may be set to a number greater than that specified in the PICTURE clause.

If the item is used as an operand, it is assumed that the area contains a number less than or equal to that specified in the PICTURE clause.

Figure 5 contains an illustration of this data type.

EXT

Floating Point Items

External and internal floating-point formats define data items whose potential range of value is too great for fixed-point representation. The magnitude of the number represented by a floating-point item must not exceed .72 * (10 ** 76).

EXT

External Floating-Point Item: An external floating-point item consists of a combination of the characters +, -, blank, decimal point, E and digits 0 through 9, appearing in a specific format which represents a number in the form of a decimal number followed by an exponent. The exponent specifies a power of ten that is used as a multiplier. External floating-point items (also called scientific decimal items) are scanned at object time for conversion to the equivalent internal floating-point value, when used as numeric operands. (See fp-form of PICTURE clause.) Each character of the PICTURE, except V, represents a single byte of storage reserved for the item. The PICTURE and the printout display of an external floating-point item include the letter E which denotes the exponent.

Figure 5 contains an illustration of this data type.

EXT

Internal Floating-Point Item: An internal floating-point item may be considered equivalent to an external floating-point item in capability and purpose. Internal floating point numbers occupy four or eight bytes, depending on the length of the fractions.

In the short-precision format, the fraction appears in the rightmost three bytes; in the long-precision format, the fraction appears in the rightmost seven bytes. The sign of the fraction is the leftmost bit in either format, and the exponent appears in bit positions 1 through 7.

Figure 5 contains illustrations of this data type.

Item	Value	Usage	Internal Representation
External-Decimal	-1234	DISPLAY PICTURE 9999	|Z1|Z2|Z3|F4| byte
		DISPLAY PICTURE S9999	|Z1|Z2|Z3|-4| byte
Internal-Decimal	+1234	COMPUTATIONAL-3 PICTURE 9999	|01|23|4F| byte
		COMPUTATIONAL-3 PICTURE S9999	|01|23|4+| byte
Binary	+1234	COMPUTATIONAL PICTURE S9999	|0000|0100|1101|0010| S byte
External Floating-Point	+12.34E+2	DISPLAY PICTURE 99.99E-99	|+|1|2|.|3|4|E|b|0|2| byte
Internal Floating-Point		COMPUTATIONAL-1	|S|Characteristic|Fraction| 0 1 7 8 31
		COMPUTATIONAL-2	|S|Characteristic|Fraction| 0 1 7 8 63

The codes used within the Internal Representation column are:

Z = zone

Hexadecimal F = non-printing plus sign

S = the sign position of a numeric field: a '1' in position S means the number is negative; whereas a '0' means the number is positive.

b = blank

Figure 5. Representation of Numeric Items

ALIGNMENT OF DATA FIELDS

The compiler assigns storage so that the starting byte of a binary or internal floating-point item is on the next available half-word, full-word, or doubleword boundary, as appropriate. In this way, an internal floating-point or binary item is properly aligned at the storage location required by the computer.

If a data hierarchy contains binary or floating-point items intermixed with other elementary items, "slack bytes" may be present which have been inserted to assure the necessary byte alignment (implicit synchronization).

Slack bytes exist in a record not only in main storage but on files. The compiler inserts slack bytes on output and expects them on input.

A further discussion of slack bytes is contained in Appendix B.

FILE SECTION

The file section of the Data Division describes the logical characteristics of the files, and the organization of areas used for receiving input or output data.

A file comprises one or more blocks on input/output devices. A block may be described by the programmer as comprising one logical record. Several logical records may also occupy a block; this is a physical record.

A buffer is the area into which a block is read or from which a block is written.

The descriptions of the kinds of logical records that may be contained in a block are specified in the File Section by one or more level 01 Record Description entries, and by the entries subordinate to them. A block may contain one or more logical records, each of which may conform to any of the descriptions specified for the records in the file.

The term volume indicates a unit or reel on which a file is recorded such as a reel of magnetic tape or a disk pack. In this context, volume and the COBOL reserved words UNIT and REEL are identical in meaning.

In COBOL there are two classes of files:

1. A file for which there is only one 01-level record description subordinate to the FD entry, called a single-record file.

2. A file for which there is more than one 01-level record description subordinate to the FD entry, called a multiple-record file.

There are also two classes of records that may be contained in a file -- fixed-length records and variable-length records. Variable-length records contain an OCCURS clause with a DEPENDING ON option; fixed-length records do not.

A SINGLE-RECORD file may contain either:

1. fixed-length records, or

2. variable-length records.

A MULTIPLE-RECORD file may contain records with three different characteristics:

1. EQUAL - Each record described is fixed in length and all the lengths are equal.

2. DIFFERING - Each record described is fixed in length but at least two record descriptions have different lengths.

3. VARIABLE - One or more of the records described is variable in length.

Record Formats

The Disk Operating System's data management defines three record formats to be used; a file used within the Disk Operating System has records that are either fixed (F), variable (V) or unspecified (U).

1. A file with format F records is one in which the size of all the logical records in the file is fixed, and in which logical records are not preceded by a control word.

2. A file with format V records is one in which the sizes of the logical records are not necessarily the same. Each logical record is preceded by a control word indicating the size of the particular logical record. This control word must not be described in any Record Description entry and cannot be referred to by the user.

3. A file with format U records is one in which the sizes of the logical records are not necessarily the same. Unlike format V records, there is no control word preceding the logical records indicating the size of the record. Files with format U records are considered by the COBOL compiler to contain one logical record per block. The READ statement makes one block available for processing; if there is more than one logical record per block, the user must do his own deblocking.

The choice of record format, which is specified in COBOL via the RECORDING MODE clause, is dependent on the record descriptions. Files for which there is only one record description with an unchanging size (that is, no entry in the record description has an Option 2 OCCURS clause) or for which all record descriptions indicate the same unchanging size may have format F or format V records.

The sizes of the logical records of a file may vary if (1) there is more than one data record description for the file so that the size of each data record described may differ; or (2) an element within the file is described with an Option 2 OCCURS clause. In the latter case, the size of the same logical record may vary from the execution of one READ or WRITE statement of the record to the next. These files may have records of format V or format U.

Note: In DOS only one OCCURS...DEPENDING ON clause is allowed per record.

FILE SECTION ENTRIES

The following is the format of a File Description entry, which must appear once in the File Section for each file. There may be a number of Record Description entries associated with it.

The clauses associated with each File Description entry may appear in any order. FD must appear in Margin A. All associated clauses must begin in Margin B.

```
FD file-name
                                  {CHARACTERS}
[BLOCK CONTAINS integer           {RECORDS   } ]

[RECORDING MODE IS mode]

[RECORD CONTAINS [integer-1 TO] integer-2 CHARACTERS]
```

```
     {RECORD IS  }  {STANDARD  }
LABEL{RECORDS ARE}  {OMITTED   }
                    {data-name }

     {RECORD IS  }
DATA {RECORDS ARE}  record-name....
```

An example of the use of this format is:

```
|-------------------------------------------------------------------|
|                        COBOL PROGRAM SHEET                        |
|-------------------------------------------------------------------|
|SEQUENCE  A     B                                                  |
|---|---|-|-|-----------------------------------------------------|
|1  |  6|7|8    12                                                 |
|---|---|-|-|-----------------------------------------------------|
|   |   | | |                                                     |
|001|012| |DATA DIVISION.                                         |
|001|013| |FILE SECTION.                                          |
|001|014| |FD    FILEA, DATA RECORD IS RECORD-1, LABEL RECORDS    |
|001|015| |      ARE STANDARD, BLOCK CONTAINS 5 RECORDS, RECORDING|
|   |   | |      MODE IS F.                                       |
|001|016| |01    .                                               |
|   |   | |      .                                                |
|   |   | |      .                                                |
|001|018| |FD    FILEB DATA RECORD IS RECORD-2, LABEL RECORDS     |
|   |   | |      ARE OMITTED.                                     |
|001|019| |01                                                     |
|   |   | |                                                       |
|---|---|-|-|-----------------------------------------------------|
```

Refer to Appendix D, Figure 33, for the relationship between the example above, and the sample program given therein.

Notes:

1. The FD entry must describe each data file to be processed by the object program.

2. File-name is the highest level qualifier for its Record Description entries.

Clauses

The following are the formats and descriptions of each of the clauses that make up file descriptions.

BLOCK CONTAINS Clause

The BLOCK CONTAINS clause specifies the number of logical records of maximum length or the maximum number of characters (bytes) in a physical record. The format for this clause is:

```
BLOCK CONTAINS integer{RECORDS   }
                      {CHARACTERS}
```

In the File Section of the Data Division, the statement BLOCK CONTAINS 5 will set up a 5-character I/O area. If this statement is

intended to describe a blocking factor of 5, it should be written BLOCK CONTAINS 5 RECORDS.

The BLOCK CONTAINS clause must not be written if the UNIT-RECORD clause is specified in the Environment Division, or if U type records are used.

If CHARACTERS is written, integer must include the number of bytes occupied by slack bytes contained in the physical records.

If this clause is omitted, it is assumed that records are not blocked.

To determine the number of characters to be specified in the BLOCK CONTAINS clause, the following must be taken into consideration:

Output Files with Format F Records: Multiply the logical record length by the number of records to be contained in the block. For example, if the programmer desires to block five card images (logical length of 80), BLOCK CONTAINS 400 or BLOCK CONTAINS 400 CHARACTERS should be specified. The compiler utilizes the following formula to calculate the number of fixed-length output blocks per 2314 track:

$$7294 \div \left(\frac{\text{BLOCKSIZE X 534 + 101}}{512}\right) = \text{No. of Blocks}$$

If the remainder of the divide operation is greater than the BLOCKSIZE, 1 is added to the number of blocks per track.

Output Files with Format V Records: The minimum value of integer must equal the size of the largest logical record defined for the file and must include the 4-byte count field that precedes each format V record, but not the 4-byte count field that precedes the block. (The latter count field is automatically generated at execution time.) Therefore, if two types of records are to be written, one 400 characters long and the other 200 characters long, the minimum integer that can be specified in the CHARACTERS of the BLOCK CONTAINS clause is 404 (BLOCK CONTAINS 404 or BLOCK CONTAINS 404 CHARACTERS).

Note: If a file contains records with COMPUTATIONAL, COMPUTATIONAL-1, or COMPUTATIONAL-2 entries, it is the programmer's responsibility to add any necessary inter-record slack bytes. These slack bytes are part of the record description and must be included in the value of integer.

It should be noted that Option 2 of the APPLY clause (APPLY WRITE-ONLY) is used to make optimal use of buffer space allocated for a file with format V records. In the above example, if a record 200 characters long was placed in the block specified, there would not be enough space allocated for another record even if the next record was also 200 characters long, because the 4-byte count field preceding each format V record could not be accommodated. Therefore, given the above facts, the programmer should specify BLOCK CONTAINS 408 and use the APPLY WRITE-ONLY option. If the APPLY WRITE-ONLY option is not specified for a file, the buffer is truncated and the block is written out whenever the space remaining in the buffer is not sufficient for the maximum size record (400 characters in the above example) defined for the file.

The programmer can specify how many maximum size format V records are to fit into a block by means of the RECORDS option of the BLOCK CONTAINS clause. The compiler uses the value of integer to compute the length of the block by multiplying the length of the longest record by integer, adding enough space to accommodate a 4-byte count field for the block and a 4-byte count field for each record. Therefore, if two types of records are to be written, one 400 characters long and the other 200

characters long, and if the programmer specifies BLOCK CONTAINS 3 RECORDS, the compiler reserves a block of 1216 characters. Depending on the actual size of the records written, more than integer records may be contained in the block. Given the above facts, it is possible for a block to contain five 200-character records (5*204+4<1216).

RECORD CONTAINS Clause

The RECORD CONTAINS clause is used to specify the maximum size of logical records. The format for this clause is:

RECORD CONTAINS [integer-1 TO] integer-2 CHARACTERS

Integer-1 and integer-2 are used to specify minimum and maximum record sizes, respectively. If the file contains only fixed-length records, integer-1 (if specified) and integer-2 must be equal. If the file contains variable-length records, integer-1 is ignored and integer-2 is assumed to be the maximum size that any record in the file will have. Record lengths are determined by the compiler regardless of whether or not the clause is specified.

The RECORD CONTAINS clause is not necessary for a file having equal length records.

When the BLOCK CONTAINS clause is not written, the compiler assumes that integer-2 specifies the number of characters contained in the block.

When the RECORD CONTAINS clause differs from the sum of the elementary data items as calculated by the compiler, a message is given stating that the discrepancy will be resolved by the use of the compiler-generated total.

LABEL RECORDS Clause

This clause specifies the presence of standard or non-standard labels on a file, or the absence of labels. The format of this clause is:

$$\text{LABEL} \left\{\begin{matrix}\text{RECORD IS} \\ \text{RECORDS ARE}\end{matrix}\right\} \left\{\begin{matrix}\text{STANDARD} \\ \text{OMITTED} \\ \text{data-name}\end{matrix}\right\}$$

The COBOL equivalents for the options of the LABEL statement are:

No labels	OMITTED
Non-standard labels	OMITTED
Standard labels	STANDARD
Standard and user labels	data-name

The OMITTED option must be specified for files assigned to unit record devices. It may be specified for files assigned to magnetic tape units. Use of the OMITTED option does not result in automatic bypassing of non-standard labels on input. It is the user's responsibility to either process or bypass non-standard labels on input, and create them on output.

The OMITTED option must be specified for unlabeled tape input files. For these files, an end-of-file condition occurs upon reaching the end-

of-volume for each volume of the file. The user must determine and indicate in his AT END routine whether or not additional volumes must be processed.

The STANDARD option must be specified for files with indexed organization. It may be specified for any files except as noted in the preceding text.

The data-name option may be specified for files with standard sequential organization, with the exception of unit-record files, or for files with direct organization. The use of this option indicates that, in addition to standard labels, user labels are to be processed (see Options 1 and 2 of the Procedure Division USE section). Data-name, in this option, is a 01 or 77 level data-name in the Linkage Section of the Data Division which describes the label. This data-name is then available for reference by a declarative procedure written by the user for label processing. Label processing declarative procedures are discussed in Section 6. Data-name may not be subscripted.

A user label is 80 characters in length. A user header label is characterized by the appearance of UHL in character positions 1 through 3; a user trailer label has UTL in character positions 1 through 3. For both types, the fourth character position in a user label shows the relative position (1 through 8) of the label within a group of labels. The remaining 76 characters are formatted according to user choice. See the publication IBM System/360 Disk and Tape Operating Systems: COBOL Programmers Guide, Form C24-5025, for the formats of standard labels on tape and disk.

Figure 6 is a chart showing available options and their valid use. An "X" in the figure indicates that the option is permitted.

	Device				
	Unit Record	Tape	Direct-Access Storage Device Organization is:		
LABEL RECORDS ARE Option			Standard Sequential	Indexed Sequential	Direct
OMITTED	X	X			
STANDARD		X	X	X	X
Data-name		X	X		X

Figure 6. Relationship Between Labels and Device Assignment

DATA RECORDS Clause

This clause specifies the names of the logical records in a file.

Its format is:

```
DATA {RECORD IS  } record-name...
     {RECORDS ARE}
```

Record-name is a data-name described with a 01 level number following the FD entry in the File Section.

RECORDING MODE Clause

The RECORDING MODE clause specifies the format of the logical records comprising the file. The format for this is:

```
[RECORDING MODE IS mode]
```

Mode may be specified as either U, F, or V, each indicating a record format.

The F mode (fixed-length format) may be specified when all the logical records in a file are the same length. This implies that no OCCURS DEPENDING ON clauses are associated with any entries in the data record descriptions. If more than one data record description is given following the FD entry, all record lengths calculated from the data record descriptions must be equal.

All UNIT-RECORD files must be F mode (fixed format).

The V mode (variable-length format) may be specified for any combination of record descriptions. A logical record of this format has a control field preceding it containing the length of the logical record.

The U mode (unspecified format) may be used with any combination of record descriptions. It may be compared to V mode records which are not blocked and do not contain the preceding count control field.

The RECORDING MODE clause must be specified for files with F or U type records. If this clause is omitted, V type records are assumed.

RECORD DESCRIPTION ENTRY

A Record Description entry specifies the characteristics of each item in a data record. Every item must be described in a separate entry in the same order in which the item appears in the record. Each Record Description entry consists of a level number, a data-name, and a series of independent clauses followed by a period.

The general format of a Record Description entry is:

```
                  {data-name}
level-number      {FILLER   } [REDEFINES-clause]

          [PICTURE-clause] [BLANK-clause]

          [OCCURS-clause] [VALUE-clause]

          [JUSTIFIED RIGHT]

          [USAGE-clause].
```

An example of the use of this format is:

```
|                          COBOL PROGRAM SHEET                          |
|SEQUENCE  A     B                                                      |
|1   |  6|7|8    12                                                     |
|    |   | |                                                            |
|001 |012| |DATA DIVISION.                                              |
|    |   | |      .                                                     |
|    |   | |      .                                                     |
|    |   | |      .                                                     |
|001 |015| |01    RECORD-1.                                             |
|001 |016| |      02 SUB-FIELDA PICTURE IS X(68).                       |
|001 |017| |      02 SUB-FIELDB PICTURE IS X(12).                       |
|    |   | |      .                                                     |
|    |   | |      .                                                     |
|    |   | |      .                                                     |
|001 |019| |01    RECORD-2 PICTURE IS X(80).                            |
|    |   | |                                                            |
```

Refer to Appendix D, Figure 33, for the relationship between the example above, and the sample program given therein.

When this format is applied to the various specific items of data, it is limited by the nature of the data being described. The allowable format for the description of each data type appears below. Clauses which are not shown in a format are specifically forbidden in that format. Clauses that are mandatory in the description of certain data items are written without brackets.

The function of each clause is discussed after the following descriptions of data items.

GROUP ITEM

A group item must have items that are subordinate to it. An item is subordinate to another by having a level number that is numerically higher than the immediately preceding item.

Format:

```
                 {data-name}
level-number     {FILLER   } [REDEFINES-clause]

  [OCCURS-clause] [USAGE-clause]
```

Example:

```
01 GROUP-NAME.
     02 FIELD-B PICTURE X.
     02 FIELD-C PICTURE 9.
```

ELEMENTARY ITEMS

An elementary item is one having no items subordinate to it.

Alphabetic Item

Format:

```
                 {data-name}
level-number     {FILLER   } [REDEFINES-clause] [OCCURS-clause]

  PICTURE IS alpha-form [USAGE IS DISPLAY]

  [VALUE IS alphabetic-literal] [JUSTIFIED RIGHT].
```

Example:

```
02 EMPLOYEE-NAME PICTURE A(20).
```

Alphanumeric Item

Format:

```
                 {data-name}
level-number     {FILLER   } [REDEFINES-clause]  [OCCURS-clause]

     PICTURE IS an-form [USAGE IS DISPLAY]

     [VALUE IS non-numeric-literal] [JUSTIFIED RIGHT].
```

Examples:

```
     02 MISC-1 PICTURE X(53).

     02 MISC-2 PICTURE XXXXXXXX.
```

Report Item

Format:

```
                 {data-name}
level-number     {FILLER   } [REDEFINES-clause]  [OCCURS-clause]

                 {numeric-form BLANK WHEN ZERO }
PICTURE IS       {report-form [BLANK WHEN ZERO]}

[USAGE IS DISPLAY].
```

Example:

```
      02 TOTAL PICTURE $999,999.99-.
      02 RLT PICTURE 999 BLANK ZERO.
```

External Decimal Item

Format:

```
                 {data-name}
level-number     {FILLER   } [REDEFINES-clause] [OCCURS-clause]

     [USAGE IS DISPLAY] PICTURE IS numeric-form

     [VALUE IS numeric-literal].
```

Example:

```
     02 HOURS-WORKED PICTURE 99V9, DISPLAY.

     02 HOURS-SCHEDULED PICTURE 99V9.
```

Internal Decimal Item

Format:

```
level-number {data-name}
             {FILLER  } [REDEFINES-clause] [OCCURS-clause]
     PICTURE IS numeric-form USAGE IS COMPUTATIONAL-3
     [VALUE IS numeric-literal].
```

Example:

```
     02 YEAR-TO-DATE PICTURE S99999999V99 COMPUTATIONAL-3.
```

Binary Item

Format:

```
level-number {data-name}
             {FILLER  } [REDEFINES-clause] [OCCURS-clause]
     PICTURE IS numeric-form USAGE IS COMPUTATIONAL
     [VALUE IS numeric-literal].
```

Example:

```
     03 SUBSCRIPT PICTURE S999 COMPUTATIONAL.
```

[EXT] External Floating-Point Item

Format:

```
level-number {data-name}
             {FILLER  } [REDEFINES-clause] [OCCURS-clause]
     PICTURE IS fp-form [USAGE IS DISPLAY].
```

Example:

```
     02 GAMMA PICTURE +.9(8)E+99.
```

EXT Internal Floating-Point Item

Format:

```
                 {data-name}
level-number     {FILLER   } [REDEFINES-clause] [OCCURS-clause]

     [          {COMPUTATIONAL-1}]
     [USAGE IS  {COMPUTATIONAL-2}]

     [VALUE IS floating-point-literal] .
```

Example:

```
02 DEVIATION COMPUTATIONAL-1.
```

Following is a discussion of the clauses used to describe data items.

USAGE Clause

The USAGE clause describes the form in which data is represented.

The USAGE clause may be written at any level. At a group level, it applies to each elementary item in the group. The usage of an elementary item must not contradict the usage explicitly stated for a group to which the item belongs. If USAGE is not specified, the usage of an item is assumed to be DISPLAY. The format of the USAGE clause is:

```
[          {DISPLAY          }]
[          {COMPUTATIONAL    }]
[USAGE IS  {COMPUTATIONAL-1  }]
[          {COMPUTATIONAL-2  }]
[          {COMPUTATIONAL-3  }]
```

The DISPLAY option specifies that the item is stored in character form, one character per byte.

The COMPUTATIONAL option specifies a binary data item occupying two, four, or eight character positions corresponding to specified decimal lengths of 1-4, 5-9, and 10-18, respectively. For example, if

```
02 FICA PICTURE IS S999V99 COMPUTATIONAL
```

is specified, the binary data item will occupy four character positions. The leftmost bit of the reserved area is the operational sign. Computational items are aligned at the next halfword or fullword boundary, as appropriate.

The COMPUTATIONAL-1 option specifies a data item stored in short-precision floating-point format. The COMPUTATIONAL-2 option specifies a data item stored in long-precision floating-point format. The COMPUTATIONAL-3 option specifies that the item is stored in packed decimal format: two digits per character position, with the low-order half character containing the sign.

If a data hierarchy contains binary or floating-point items intermixed with other elementary items, slack bytes may be inserted to assure necessary byte alignment. See Appendix B for a detailed discussion of slack bytes.

PICTURE Clause

The PICTURE clause specifies a detailed description of an elementary level data item and may include specification of special report editing.

The general format of the PICTURE clause is:

```
[                    (alpha-form  )  ]
[                    (an-form     )  ]
[PICTURE IS          {numeric-form}  ]
[                    (report-form )  ]
[                    (fp-form     )  ]
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
003|008| |DATA DIVISION.
    |   | |       .
    |   | |       .
    |   | |       .
003|013| |02    A PICTURE X(68).
003|014| |02    B PICTURE X(12).
```

Refer to Appendix D, Figure 34, for the relationship between the example above, and the sample program given therein.

The options are described in the following text.

ALPHA-FORM OPTION: This option represents an alphabetic item. The PICTURE of an alphabetic item can contain only the character A. An A indicates that the character position will always contain one of the 26 letters of the English alphabet or a space.

AN-FORM OPTION: This option applies to alphanumeric items. The PICTURE of an alphanumeric item can contain only the character X. An X indicates that the character position will always contain a character from the EBCDIC set.

NUMERIC-FORM OPTION: This option refers to a fixed-point numeric item. The PICTURE of a numeric item may contain a valid combination of the following characters:

CHARACTER	MEANING
9	The character 9 indicates that the actual or conceptual digit position contains a numeric character.
V	The character V indicates the position of an assumed decimal point. Since a numeric item cannot contain an actual decimal point, an assumed decimal point is used to provide the compiler with information concerning the decimal alignment of items involved in computations. Storage is never reserved for the character V.

P — The character P represents a numeric digit position for which storage is never reserved and which always is treated as if it contained a zero. For example, an item composed of the digits 123 would be treated by an arithmetic procedure statement as 123000 if its PICTURE were 999PPPV; or as .000123 if its PICTURE were VPPP999. The character V may be used or omitted as desired. When used, V must be placed in the position of the assumed decimal point, to the left or right of the P or Ps that have been specified.

S — The character S indicates the presence of an operational sign. If used, it must be the leftmost character of the PICTURE. For a binary item a sign is always present in the item; hence, the presence of S in a numeric-form PICTURE is required. For internal and external decimal items developed by the execution of COBOL statements, the compiler will develop a sign if and only if an S is written in the PICTURE. If an S is not written, the sign position is occupied by a bit configuration interpreted as positive, but which does not represent an overpunch.

REPORT-FORM OPTION: This option refers to a report item. The editing characters that may be combined to describe a report item are: 9 V P . Z * CR DB , 0 B $ + -. The characters 9, P, and V have the same meaning as for a numeric item. The meanings of the other allowable editing characters are described in the following text.

CHARACTER MEANING

. — The decimal point character (.) specifies that an actual decimal point is to be inserted in the indicated position and the source item is to be aligned accordingly. Numeric character positions to the right of an actual decimal point in a PICTURE must consist of characters of one type (i.e., * or Z or 9 or $ or + or -).

Z — The character Z is the zero suppression character. Each Z in a PICTURE represents a digit position. Leading zeros to be placed in positions defined by Z are suppressed, leaving the position blank. Zero suppression terminates upon encountering the decimal point (. or V). Z may appear to the right of the decimal point only if all digit positions are represented by Zs. (A Z cannot appear to the right of a 9 anywhere.) The PICTURE ZZZ.ZZ is equivalent to a combination of the BLANK clause and the PICTURE ZZZ.99.

* — The asterisk is the "check protection" replacement character which is similar to Z, except that leading zeros are replaced by asterisks. An * must not appear anywhere to the right of a 9. The BLANK WHEN ZERO clause may not be applied to an item having an * in its PICTURE.

CR DB	CR and DB are called credit and debit symbols and may appear only at the right end of a picture. These symbols occupy two character positions and indicate that the specified symbol is to appear in the indicated positions if the value of a source item is negative. If the value is positive or zero, spaces will appear instead.
, 0 B	The comma, zero, and B specify insertion of comma, zero, and space, respectively. Each insertion character is counted in the size of the data item, but does not represent a digit position. The presence of zero suppression(Z) or check protection (*) indicates that suppression of leading insertion characters also takes place with associated space or asterisk replacement. These characters may also appear in conjunction with a floating string, as described in the following text.

A floating string is defined as a leading, continuous series of either $, + or -, or a string composed of one such character interrupted by Bs and/or commas and/or V or actual decimal point. For example:

```
$$,$$$,$$$
++++
--,---,--
$$$B$$$
+(8)V++
$$,$$$.$$
```

A floating string containing n+1 occurrences of $, + or - defines n digit positions. When moving a numeric value into a report item, the appropriate character floats from left to right, so that the developed report item has exactly one actual $, + or - immediately to the left of the most significant nonzero digit. Blanks are placed in all character positions to the left of the single developed $, + or -. If the most significant digit appears in a position to the right of positions defined by a floating string, then the developed item contains $, + or - in the rightmost position of the floating string, and nonsignificant zeros may follow. The presence of an actual or implied decimal point in a floating string is treated as if all digit positions to the right of the point were indicated by the PICTURE character 9, and a BLANK WHEN ZERO clause was written for the item. In the following examples, b represents a blank in the developed items.

PICTURE	Numeric Value	Developed Item
$$$999	14	bb$014
--,---,999	-456	bbbbbb-456

A floating string need not constitute the entire PICTURE of a report item, as shown in the preceding examples.

When B, comma, or zero appear to the right of a floating string, the string character floats through these characters in order to be as close to the leading digit as possible.

The character B in a floating string indicates that an embedded blank is to appear in the indicated position, unless the position immediately precedes the nonzero, leading significant digit. Embedded Bs in a PICTURE need not be single characters. Thus, $$BB$$$ is a valid PICTURE for a report item. The character comma in a floating string operates similarly, except that the appropriate character appears in the developed item instead of a blank.

The character V in a floating string serves merely to indicate alignment of the assumed decimal point.

$ + -	The character $, + or - may appear in a PICTURE either singly or in a floating string. As a fixed sign control character, the + or - must appear as either the first or last symbol in the PICTURE, but not both. The plus sign means that the sign of the item is indicated by either a plus or minus placed in the character position, depending on the algebraic sign of the numeric value placed in the report field. The minus sign means that a blank is placed in the character position if the algebraic sign of the numeric value placed in the report field is positive. A minus is placed in the character position, if the algebraic sign of the numeric value is negative. As a fixed insertion character, the dollar sign may appear only once in a PICTURE.

Other rules for a report item PICTURE are as follows:

1. The appearance of one type of floating string precludes any other floating string.

2. There must be at least one digit position character.

3. If there are no 9's, BLANK WHEN ZERO is implied unless all numeric positions are *.

4. The appearance of a floating sign string or fixed plus or minus insertion characters precludes the appearance of any other of the sign control insertion characters, namely, + - CR or DB.

5. The characters in a PICTURE to the left of an actual decimal point (or in the entire PICTURE if no decimal point is given), excluding the characters that comprise a floating string, are subject to the following restrictions:

   a. Z may not follow * or 9 or a floating string.

   b. * may not follow 9 or Z or a floating string.

6. The characters to the right of a decimal point up to the end of a PICTURE, excluding the fixed insertion characters + - CR DB (if present), are subject to the following restrictions:

   a. Only one type of digit position character may appear. That is, asterisks, Z's, 9's, and floating string digit position characters $ + - are mutually exclusive.

   b. If any of the numeric character positions to the right of a decimal point is represented by + or - $ or Z or *, then all the numeric character positions must be represented by the same characters.

7. A floating string must begin with at least two consecutive appearances of + or - or $.

8. The PICTURE character 9 can never appear to the left of a floating or replacement character.

9. Floating or replacement characters + - Z $ or * cannot be mixed in a PICTURE description. They may appear with fixed characters as follows:

a. * or Z with fixed $,

b. $ (fixed or floating) with fixed rightmost + or -,

c. * or Z with fixed leftmost + or -,

d. * or Z with fixed rightmost + or -.

FP-FORM OPTION: This option refers to an external floating-point item. The PICTURE of an external floating-point item consists of all of the following:

1. + or - (+ indicates that a plus sign represents positive values and that a minus sign represents negative values; - indicates that a blank represents positive values and that a minus sign represents negative values).

2. One to 16 9's representing mantissa with a decimal point or V,

3. The letter E,

4. + or - (see note 1 above),

5. Two 9's representing the exponent.

General Notes: The following considerations pertain to use of the PICTURE clause.

1. A PICTURE clause must only be used at the elementary level.

2. An integer enclosed in parentheses and following A X 9 Z * 0 P - B $ or + indicates the number of consecutive occurrences of the PICTURE character.

3. All characters, except P V and S are counted in the total size of a data item. CR and DB occupy two character positions.

4. A maximum of 30 character positions is allowed in a PICTURE character string. For example, PICTURE A(79) consists of five PICTURE characters.

5. A PICTURE must consist of at least one of the characters A X 9 * Z or at least a pair of one of the characters + or - or $.

6. The characters . S V CR and DB can appear only once in a picture. CR and DB may not both appear in the same PICTURE.

7. An item can possess only one sign.

The examples in Figure 7 illustrate the use of PICTURE to edit data. In each example a movement of data is implied, as indicated by the column headings.

Source Area		Receiving Area	
PICTURE	Data Value	PICTURE	Edited Data
S99999	-12345	-ZZ,ZZ9.99	-12,345.00
S99999V	00123	$ZZ,ZZ9.99	$ 123.00
S9(5)	00100	$ZZ,ZZ9.99	$ 100.00
9(5)	00000	$ZZ,ZZZ.99	$ .00
9(5)	00000	$ZZ,ZZZ.ZZ	
999V99	123.45	$ZZ,ZZ9.99	$ 123.45
V99999	.12345	$ZZ,ZZ9.99	$ 0.12
9(5)	12345	$**,**9.99	$12,345.00
9(5)	00123	$**,**9.99	$***123.00
9(5)	00000	$**,***.99	$******.00
9(5)	00000	$**,***,**	**********
99V999	12.345	$**,**9.99	$****12.34
9(5)	12345	$$$,$$9.99	$12,345.00
9(5)	00123	$$$,$$9.99	$123.00
9(5)	00000	$$$,$$9.99	$0.00
9(4)V9	1234.5	$$$,$$9.99	$1,234.50
V9(5)	.12345	$$$,$$9.99	$0.12
S99999V	-12345	-ZZZZ9.99	-12345.00
S9(5)V	12345	-ZZZZ9.99	12345.00
S9(5)	-00123	-ZZZZ.99	- 123.00
S99999	12345	ZZZZ9.99-	12345.00
S9(5)	-12345	ZZZZ9.99-	12345.00-
S9(5)	01234	------.99	1234.00
S9(5)	-00001	------.99	-1.00
S9(5)	12345	+ZZZZZ.99	+12345.00
S9(5)	-12345	+ZZZZZ.99	-12345.00
S9(5)	12345	ZZZZZ.99+	12345.00+
S9(5)	-12345	ZZZZZ.99+	12345.00-
S9(5)	00123	++++++.99	+123.00
S9(5)	00001	------.99	1.00
9(5)	00123	++++++.99	+123.00
9(5)	00123	------.99	123.00
9(5)	12345	BB999.00	345.00
S9(5)	-12345	$$$$$$.99CR	$12345.00CR
S9(5)	12345	$$$$$$.99CR	$12345.00

Figure 7. Editing Applications of the PICTURE Clause

BLANK Clause

The BLANK WHEN ZERO clause specifies that the item being described is filled with spaces whenever the value of the item is zero. The BLANK clause may only be used for report items specified at an elementary level.

The format of the BLANK clause is:

[BLANK WHEN ZERO]

VALUE Clause

The VALUE clause defines condition-name values and specifies the initial value of working storage items.

The format of this clause is:

[VALUE IS literal]

The size of a literal given in a VALUE clause must be less than or equal to the size of the item as given in the PICTURE clause, with the provision that the literal must also include leading or trailing zeros to reflect Ps in the PICTURE. The positioning of the literal within a data area is the same as the positioning that would result from specifying a MOVE of the literal to the data area. The type of literal written in a VALUE clause depends on the type of data item.

If the literal specified is a figurative constant, the size of the item generated is the size specified in the PICTURE clause.

When an initial value is not specified, no assumption should be made regarding the initial contents of an item in Working-Storage.

The VALUE clause can only be specified for elementary items other than report and external floating point.

In the File Section and Linkage Section the VALUE clause can only appear in conjunction with a level 88 item.

The VALUE clause must not be written in a Record Description entry that also has an OCCURS or REDEFINES clause, or in an entry that is subordinate to an entry containing an OCCURS or REDEFINES clause. In the latter case, an 88 level VALUE clause may be subordinate to the OCCURS or REDEFINES clause.

REDEFINES Clause

This clause specifies that the same area is to contain different data items, or provides an alternative grouping or description of the same data.

The format of the REDEFINES clause is:

level-number data-name-1 [REDEFINES data-name-2]

Data-name-2 is the name associated with the previous data description entry of equal level number. Data-name-1 is an alternate name for the same area. When written, the REDEFINES clause must be the first clause following data-name-1.

When an area is redefined, all descriptions of the area remain in effect. Thus, if B and C are two separate items that share the same storage area due to redefinition, the procedure statements MOVE X TO B or MOVE Y TO C could be executed at any point in the program. In the first case, B would assume the value of X and take the form specified by the description of B. In the second case, the same physical area would receive Y according to the description of C. A redefinition does not cause any data to be erased and does not supersede a previous description.

Moving a data item to a second data item which redefines the first one (for example, MOVE B TO C when C redefines B), may produce unexpected results. The reverse (MOVE B TO C when B redefines C), may also produce unexpected results.

The REDEFINES clause must not be used for logical records associated with the same file (i.e., it must not be used at the 01 level in the

File Section), since implied redefinition exists. The level number of data-name-2 must be identical to that of the item containing the REDEFINES clause. Redefinition starts at data-name-2, and ends when a level number less than or equal to that of data-name-2 is encountered. Data-name-1 and data-name-2 must be the same length.

The entries giving the new description of the area must immediately follow the entries describing the area being redefined, where the description of an area can mean a group item and all associated elementary items. However, additional entries that redefine the same area may intervene.

If data-name-1 is described as COMPUTATIONAL, COMPUTATIONAL-1, or COMPUTATIONAL-2, then data-name-2 must start on a halfword, fullword, or doubleword boundary, as appropriate.

A REDEFINES clause may be specified for an item within the scope of an area being redefined; that is, REDEFINES clauses may be specified for items subordinate to items containing REDEFINES clauses.

Except for condition-name entries, entries containing or subordinate to a REDEFINES clause must not contain any VALUE clauses.

The description of data-name-1 or of any item subordinate to data-name-1 may not contain an OCCURS clause with a DEPENDING ON option. Data-name-1 may not be subordinate to an item containing an OCCURS clause. Data-name-2 may not contain an OCCURS clause in its description nor may it be subordinate to an item described by an OCCURS clause. No item subordinate to data-name-2 may be described by an OCCURS clause with a DEPENDING ON option.

Between data-name-2 and data-name-1 there may be no entries having a lower level number than the level number of data-name-2 and data-name-1.

The length of data-name-1, multiplied by the number of occurrences of data-name-1, must be equal to the length of data-name-2.

Data-name-2 need not be written with qualifiers to ensure uniqueness.

Examples of the REDEFINES clause are contained in Figure 4.

OCCURS Clause

The OCCURS clause is used in defining related sets of repeated data, such as tables, lists, vectors, matrices, etc. It specifies the number of times that a data item with the same format is repeated. Record Description clauses associated with an item whose description includes an OCCURS clause apply to each repetition of the item being described. When the OCCURS clause is used, the data-name that is the defining name of the entry must be subscripted whenever it appears in the Procedure Division. If this data-name is the name of a group item, then all data-names belonging to the group must be subscripted whenever they are used.

The OCCURS clause must not be used in any Record Description entry having a level number 01 or 88.

The OCCURS clause has the following formats:

Option 1

[OCCURS integer TIMES]

In Option 1, integer represents the exact number of occurrences.

Option 2

[OCCURS integer TIMES DEPENDING ON data-name]

In Option 2, integer refers to the maximum number of occurrences. The use of Option 2 does not imply that the length of the data item is variable, but that the number of occurrences of the item may vary. The record containing the variable number of occurrences of the item is, however, of variable length, as is any group containing the variable number of occurrences.

In Option 2, the actual number of occurrences is equal to the value at object-time of the elementary item called data-name. This value must be a positive integer. Hence, the PICTURE for data-name must describe an integer. Data-name must be an internal decimal, external decimal, or binary item. If data-name appears within the record in which the current Record Description entry also appears, then data-name must precede the variable portion of the record which depends on it. Data-name should be qualified, when necessary, but subscripting is not permitted.

Option 2 has the following restrictions.

1. Only one such clause per logical record is allowed.
2. The clause must appear in the description of either a group that contains the last elementary item of the record, or in the description of the last elementary item itself.
3. The item having an OCCURS clause with a DEPENDING ON option may not itself be contained in a group having any OCCURS clause.

If the value of data-name changes during the course of program execution, the size of any group described by or containing the related OCCURS clause will reflect the new value of data-name.

Subscripting: Subscripting provides the facility for referring to data items in a table or list that have not been assigned individual data-names. Subscripting is determined by the appearance of an OCCURS clause in a data description. If an item has an OCCURS clause or belongs to a group having an OCCURS clause, it must be subscripted whenever it is used.

A subscript is a positive nonzero integer whose value determines to which element a reference is being made within a table or list. The subscript may be represented either by a literal or a data-name that has an integral value. Whether the subscript is represented by a literal or a data-name, the subscript is enclosed in parentheses and appears after the terminal space of the name of the element. A subscript must be an internal decimal, external decimal, or binary item. In the case of a literal, the subscript must be unsigned.

Binary subscripting of data-names, in general, results in more efficient coding.

Tables may be defined so that more than one level of subscripting is required to locate an element within them. Such a case exists when a

group item described with an OCCURS clause contains one or more items also described with OCCURS clauses. A maximum of three levels of subscripting is permitted by COBOL. Multilevel subscripts are always written from left to right, in decreasing order of inclusiveness of the groupings in the table. Subscripts are written within a single pair of parentheses and are separated by a comma followed by a space. A space should also separate the data-name from the subscript expression. For example:

```
01     ARRAY.
  02     VECTOR, OCCURS 2 TIMES.
    03     ELEMENT, OCCURS 3, PICTURE S9(9)
           USAGE IS COMPUTATIONAL.
```

The preceding example would be allocated storage, as shown in Figure 8.

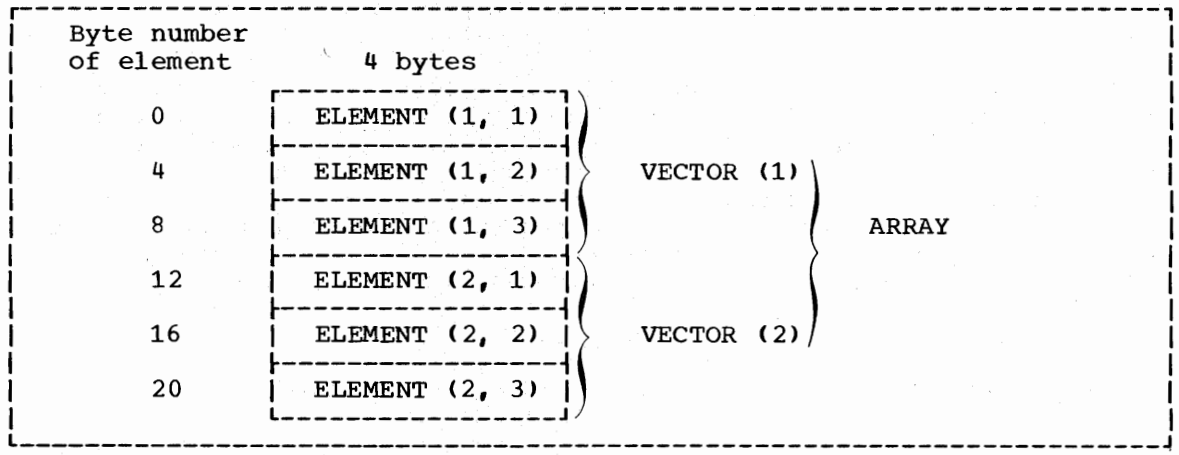


Figure 8. An Example of Subscripting for a Defined Array

A data-name may not be subscripted when it is being used as:

1. A subscript.
2. A qualifier.
3. The defining name of a record description entry.
4. Data-name-2 in a REDEFINES clause.
5. Data-name in the DEPENDING ON option of the OCCURS clause or GO TO clause.
6. Data-name in a SYMBOLIC KEY, ACTUAL KEY, and RECORD KEY clause.
7. Data-name in a LABEL RECORDS clause.
8. Data-name in an APPLY CORE-INDEX clause.

Subscripting A Qualified Data-Name

Qualification is necessary when the same data-name is used for several different items of data; subscripting is necessary when some of the elements of a table or list have not been assigned individual names.

In subscripting a qualified data-name the following rules are significant:

1. A data-name can be qualified even though it does not need qualification to make it unique.

2. Data-names used as qualifiers are considered part of the data-name being qualified and cannot be subscripted. In the example below, the higher level data-name 'VECTOR' is used to qualify the data-name 'ELEMENT', forming the new data-name 'ELEMENT IN VECTOR' followed by its subscripts. 'VECTOR' cannot be subscripted.

As a result of these rules there are several correct ways of expressing subscripted data-names. For example, referring to Figure 8, the following expressions are all correct references to the second ELEMENT in the second VECTOR:

```
ELEMENT IN VECTOR (2, 2)
ELEMENT (2, 2)
```

The first of these examples is unnecessary, although permissible, qualification, assuming that ELEMENT and VECTOR occur only in this hierarchy. However, if the name ELEMENT is used elsewhere, the qualification must be used. Note that the following forms of expression are incorrect:

```
ELEMENT (2, 2) IN VECTOR
ELEMENT (2) IN VECTOR (2)
```

JUSTIFIED RIGHT Clause

This clause may be written only for an elementary alphabetic or alphanumeric item. Its format is:

[JUSTIFIED RIGHT]

When non-numeric data is moved to a field for which JUSTIFIED RIGHT has been specified, the data is so aligned that rightmost source characters are accommodated in the rightmost positions of the receiving field. If the receiving field is shorter than the source field, an appropriate number of leftmost source characters are truncated. If the receiving field is longer than the source field, excess leftmost positions in the receiving field are filled with spaces.

WORKING-STORAGE SECTION

The Working-Storage Section is used to describe areas of storage reserved for intermediate processing of data. This section consists of a series of Record Description entries, each of which describes an item in a work area.

An independent Working-Storage entry describes a single item that is not subdivided and is not itself a subdivision of some other item. Each of these items is defined in a separate Record Description entry, which begins with the special level number 77. All independent Working-Storage entries must precede any items having any of the level numbers 01 through 49.

Data items in the Working-Storage Section that bear a definite relationship to each other must be grouped into records according to the

rules for formation of record descriptions. All clauses that are used in Record Description entries may be used in Working-Storage record descriptions. Each data-name in the Working-Storage Section that identifies a record (01 or 77 level) must be unique, since it cannot be qualified by a file-name. Subordinate data-names need not be unique, if they can be made unique by qualification.

No assumption should be made about the initial values of Working-Storage items when these items have not had their initial values defined in a VALUE clause.

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
    |   | |
003|008| |DATA DIVISION.
003|009| |WORKING-STORAGE SECTION.
003|010| |77    MODIFICATION PICTURE X(12), VALUE IS 'PUT ANY DATA'.
    |   | |
```

Refer to Appendix D, Figure 34, for the relationship between the example above, and the sample program given therein.

[EXT] LINKAGE SECTION

The Linkage Section describes data passed from another program, or user label record areas.

Record description entries in the Linkage Section provide names and descriptions but storage within the program is not reserved, since the data exists elsewhere. Any Record Description clause may be used to describe items in the Linkage Section, with one exception: the VALUE clause may not be specified for other than level 88 items. In the Linkage Section, level 01 items are assumed to start on a doubleword boundary. Refer to Appendix B for a discussion of record alignment.

The Linkage Section is required in any program in which a LABEL RECORDS clause with a data-name option or an ENTRY statement with a USING option appears. A complete discussion of ENTRY is contained in Section 6.

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1    |  6|7|8     12
     |   | |
003|008|  |DATA DIVISION.
     |   | |       .
     |   | |       .
     |   | |       .
003|011|  |LINKAGE SECTION.
003|012|  |01     PASS FIELD.
003|013|  |    02 A PICTURE X(68).
003|014|  |    02 B PICTURE X(12).
     |   | |
```

Refer to Appendix D, Figure 34, for the relationship between the example above, and the sample program given therein.

SECTION 6: PROCEDURE DIVISION

PURPOSE

The Procedure Division of a source program specifies those procedures needed to solve a given problem. These steps (computations, logical decisions, input/output, etc.) are expressed in meaningful statements, similar to English, which employ the concept of verbs to denote actions, statements and sentences to describe procedures. The Procedure Division must begin in Margin A with the header PROCEDURE DIVISION followed by a period.

SYNTAX

The discussion that follows describes the units of expression that constitute the Procedure Division and the way in which they may be combined.

Its constituent parts, in order of hierarchy, are:

- Section
- Paragraph
- Sentence
- Expression
- Statement

SECTIONS

A section is composed of one or more successive paragraphs and must begin with a section-header beginning in Margin A. A section-header consists of a unique section-name conforming to the rules for procedure-name formation, followed by the word SECTION and a period. A section header must appear on a line by itself, except in the Declaratives portion of the Procedure Division, where it may only be followed immediately by a USE sentence or an INCLUDE statement. The INCLUDE statement is discussed in Section 7. A section-name need not immediately follow the words PROCEDURE DIVISION or END DECLARATIVES. A section ends at the next section-name or at the end of the Procedure Division, or, in the case of Declaratives, at the next section-name or at END DECLARATIVES.

PARAGRAPHS

A paragraph is a logical entity consisting of one or more sentences. Each paragraph must begin with a paragraph-name starting in Margin A.

A paragraph-name must not be duplicated within the same section. When used as operands in Procedure Division statements, non-unique

paragraph-names may be uniquely qualified by writing IN or OF after the paragraph-name, followed by the name of the section in which the paragraph is contained. A paragraph ends at the next paragraph-name or section-name, or at the end of the Procedure Division. In the case of Declaratives, a paragraph ends at the next paragraph-name, section-name, or at END DECLARATIVES.

SENTENCES

A sentence is a single statement or a series of statements terminated by a period and followed by a space. A single comma or semicolon or the word THEN may be used as a separator between statements. A sentence must be contained within Margin B.

EXPRESSIONS

An expression may be defined as a meaningful combination of names, literals, COBOL words, and/or operators which may be reduced to a single value. This definition will become clear after the reader has studied the two types of expressions employed in COBOL, the "arithmetic" expression and the "conditional" expression.

STATEMENTS

A statement consists of a COBOL verb or the word IF or ON, followed by any appropriate operands (data-names, file-names, or literals) and other COBOL words that are necessary for the completion of the statement. The three types of statements are: compiler-directing, imperative, and conditional.

Types of Statements

COMPILER-DIRECTING STATEMENT: A compiler-directing statement directs the compiler to take certain actions at compilation time. A compiler-statement contains one of the compiler-directing verbs and its operands. Compiler-directing statements (except for NOTE, COPY, and INCLUDE) must appear as separate single sentences.

IMPERATIVE STATEMENT: An imperative statement specifies an unconditional action to be taken by the object program. An imperative statement consists of a COBOL verb and its operands, excluding the compiler-directing verbs and the conditional statements. An imperative statement may also consist of a series of imperative statements.

CONDITIONAL STATEMENT: A conditional statement is a statement containing a condition that is tested to determine which of alternate paths of program flow to take.

The following are conditional statements:

1. A READ statement,

2. A WRITE statement with the INVALID KEY option,

3. A REWRITE statement with the INVALID KEY option,

4. An arithmetic statement with the SIZE ERROR option,

5. An ON statement,

6. An IF statement.

Although IF and ON are not verbs in the grammatical sense, they are regarded as such in COBOL, inasmuch as they are the key words associated with a particular statement form. An ON statement with an UNTIL or ELSE option may not be used with an IF statement.

The conditions evaluated in conditional statements are:

1. AT END or INVALID KEY in a READ statement

2. INVALID KEY in a WRITE or REWRITE statement

3. SIZE ERROR in a arithmetic statement

4. The count-condition in an ON statement

5. One of four tests in an IF statement

The conditions in 1 to 4 above are called 'event-conditions.' The conditions in 5 above are called 'test-conditions.'

The formats for the conditions named in 1 to 4 above are discussed in the text for their respective statements. The types of conditions evaluated in an IF statement are discussed in the section "Test-Conditions."

CONDITIONALS

IF Statement

The format of the IF statement is:

```
IF condition [THEN] {statement-1...  }
                    {NEXT SENTENCE   }

    [{ELSE     } {statement-2...  }]
    [{OTHERWISE} {NEXT SENTENCE   }]
```

When statement-1 is used instead of NEXT SENTENCE, then ELSE (or OTHERWISE) NEXT SENTENCE may be omitted if it immediately precedes the period for the sentence.

Examples of IF Statement:

```
IF SALES IS NOT EQUAL TO SALES-QUOTA COMPUTE STANDARD-RATE = SALES *
BASE.

IF AMOUNT IS LESS THAN 200000 MOVE ' INVENTORY-COUNT' TO PRINTER-AREA.

IF MONTH EQUAL TO 100 GO TO HIT ELSE GO TO LOOP.
```

EVALUATION OF CONDITIONAL STATEMENTS: When a condition is evaluated the following action is taken:

1. If the condition is true, the statements immediately following the condition are executed.

2. If the condition is false, the next sentence or the statements following ELSE or OTHERWISE (or the next sentence) are executed.

The AT END, INVALID KEY, and SIZE ERROR conditions are followed by a series of imperative statements. In an ON count-conditional statement, the count-condition is followed by a series of imperative statements (or NEXT SENTENCE) and may be followed by the words ELSE or OTHERWISE followed by a series of statements (or NEXT SENTENCE). The formats of the IF statement describe what may follow the condition in the IF statement.

A series of imperative statements is terminated by one of the following:

1. A period.

2. ELSE or OTHERWISE associated with a previous IF or ON.

In a series of imperative statements executed if a condition is true, only the last statement may be an Option 1 GO TO statement or a STOP RUN statement; otherwise, the series of statements would contain statements to which control cannot flow. For example, in the following paragraph, the statement MOVE A TO B could never be executed whether or not the AT END condition were found to be false.

```
W.  READ PAYROLL-RECORD AT END GO TO Y MOVE A TO B.
```

Figure 9 is a flowchart showing how an IF or ON conditional statement is evaluated. Figure 10 is a flowchart showing how a conditional statement other than IF or ON is evaluated.

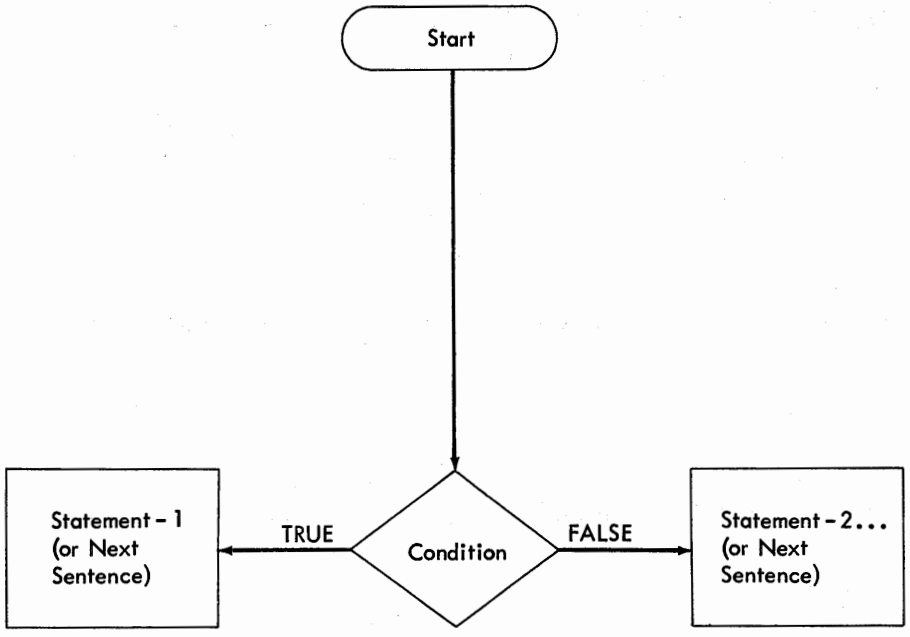


Figure 9. Evaluation of IF or ON Conditional Statement

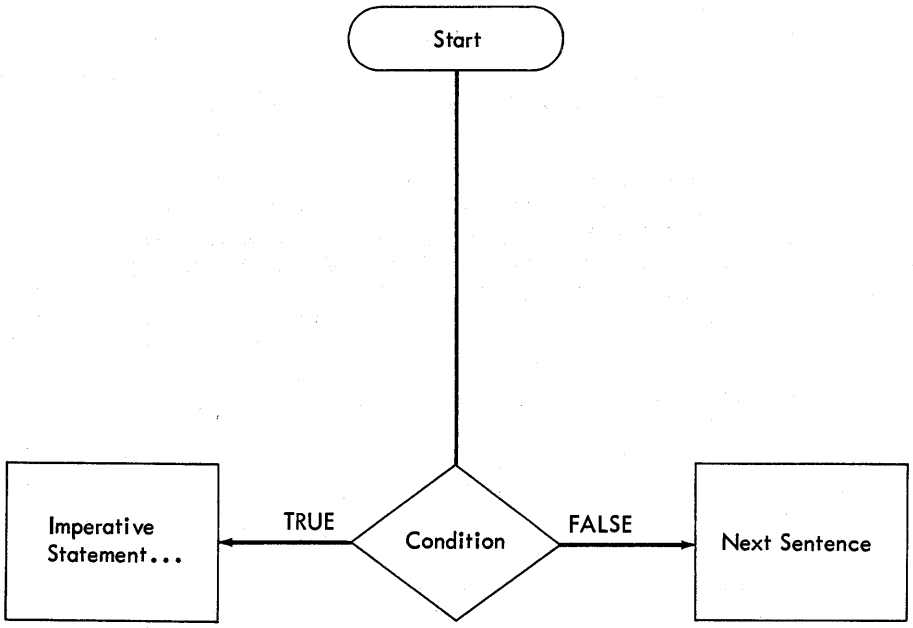
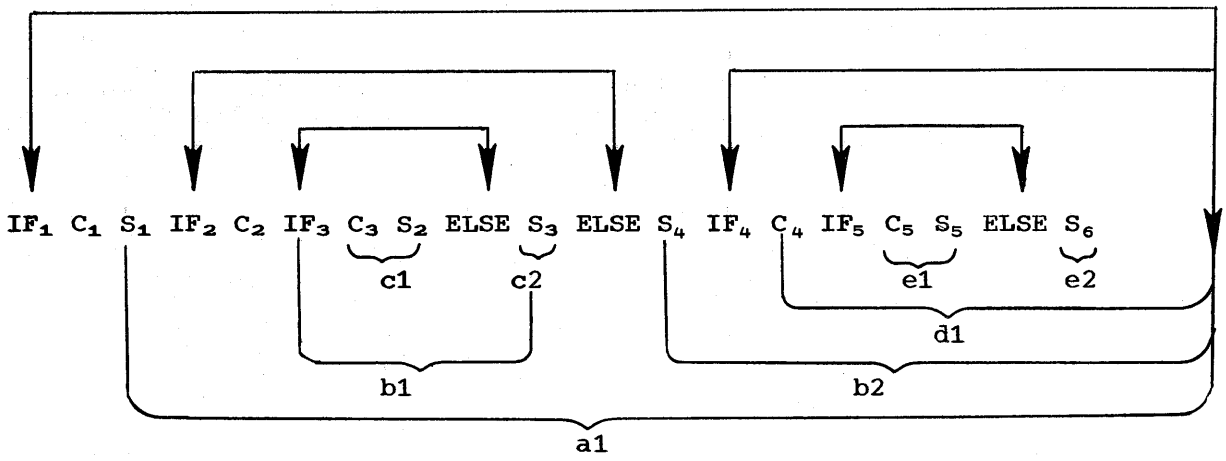


Figure 10. Evaluation of Conditional Statement other than IF or ON



a1 - Statement-1 for IF_1
(If C_1 is false, the next sentence is executed, since there is no ELSE for it.)
b1 - Statement-1 for IF_2
b2 - Statement-2 for IF_2
c1 - Statement-1 for IF_3
c2 - Statement-2 for IF_3
d1 - Statement-1 for IF_4
(If C_4 is false, the next sentence is executed, since there is no ELSE for it.)
e1 - Statement-1 for IF_5
e2 - Statement-2 for IF_5

Figure 11. Conditional Statements with Nested IF Statements

NESTED IF STATEMENTS: Statement-1 and statement-2 in IF statements may consist of one or more imperative statements and/or a conditional statement. If a conditional statement appears as statement-1 or as part of statement-1, it is said to be nested. Nesting statements is much like specifying subordinate arithmetic expressions enclosed in parentheses and combined in larger arithmetic expressions.

IF statements contained within IF statements must be considered as paired IF and ELSE combinations, proceeding from left to right. Thus, any ELSE encountered must be considered to apply to the immediately preceding IF that has not already been paired with an ELSE. In the conditional statement in Figure 11, C stands for condition; S stands for any number of imperative statements; and the pairing of IF and ELSE is shown by the lines connecting them.

Figure 12 is a flowchart indicating the logical flow of the conditional statement in Figure 11.

TEST-CONDITIONS: A test-condition is an expression that, taken as a whole, may be either true or false, depending on the circumstances existing when the expression is evaluated.

There are five types of simple test-conditions which, when preceded by the word IF, constitute one of five types of tests: relation test, sign test, class test, condition-name test, overflow test.

The word NOT may be used in any simple test-condition to make the relation specify the opposite of what it would express without the word NOT. For example, AGE NOT GREATER THAN 21 is the opposite of AGE GREATER THAN 21. NOT may also precede an entire condition, as in NOT (AGE GREATER THAN 21). AGE NOT GREATER THAN 21 and NOT (AGE GREATER THAN 21) are identical in meaning.

Relation Test: A relation test involves the comparison of two operands, either of which can be a data-name, a literal, or an arithmetic expression. Neither the comparison of two literals nor the comparison of an arithmetic expression to a non-numeric data-name is permitted. A figurative constant may be used instead of either literal-1 or literal-2 in a relation test.

The format for a relation test is:

```
{data-name-1                 }
{arithmetic-expression-1     } IS[NOT] {>                 }
{figurative-constant-1       }         {<                 }
{literal-1                   }         {=                 }
                                       {GREATER THAN      }
                                       {LESS THAN         }
                                       {EQUAL TO          }

    {data-name-2                 }
    {arithmetic expression-2     }
    {figurative constant-2       }
    {literal-2                   }
```

The symbol > is equivalent to the reserved words GREATER THAN. The symbol < is equivalent to the reserved words LESS THAN. The equal sign is equivalent to the reserved words EQUAL TO.

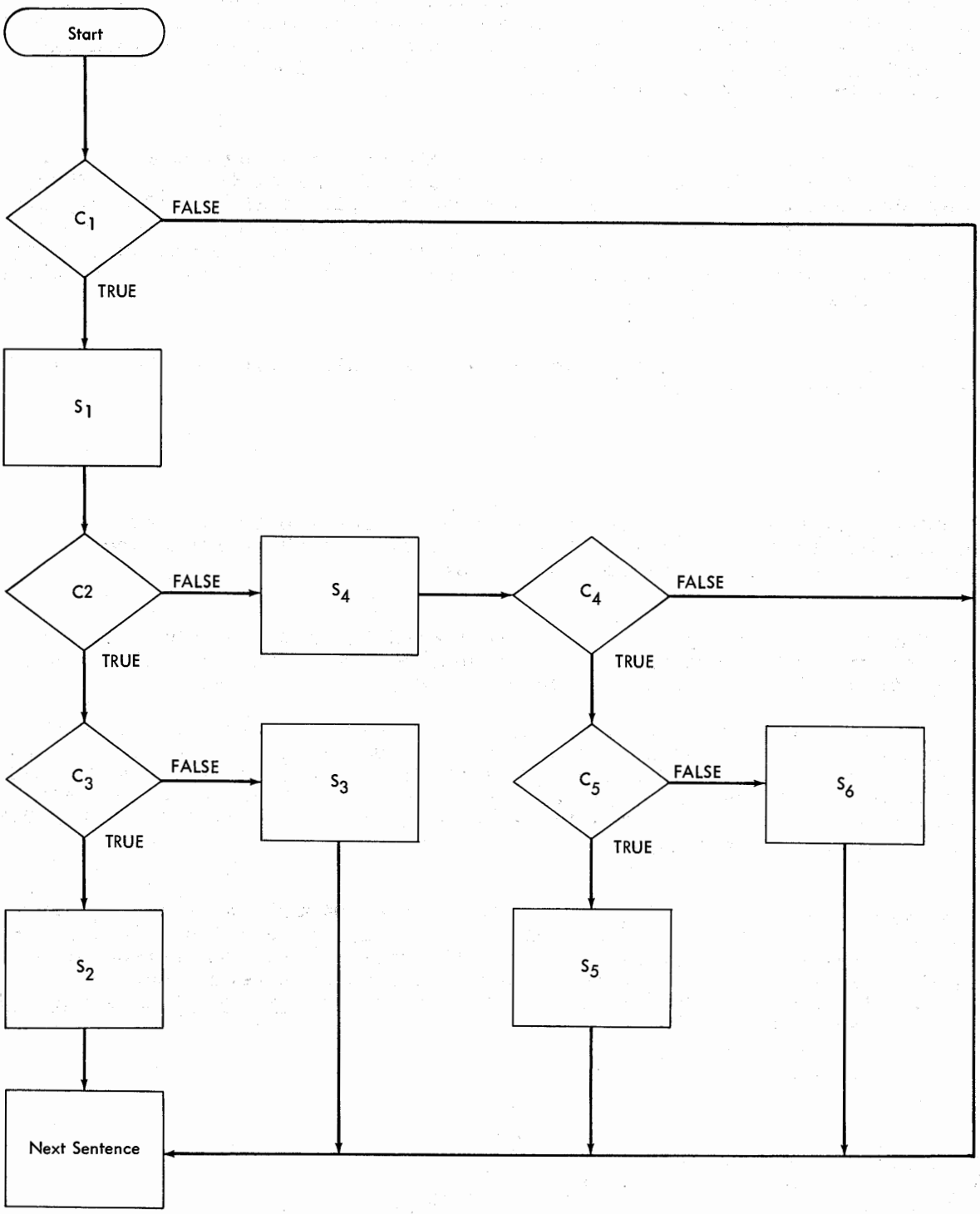


Figure 12. Logical Flow of Conditional Statement with Nested IF Statements

COMPARISON OF NUMERIC ITEMS: For numeric items, a relation test determines that the value of one of the items is less than, equal to, or greater than the other, regardless of the length. Numeric items are compared algebraically after alignment of decimal points. Zero is considered a unique value, regardless of length, sign, or implied decimal-point location of an item. In the statement, IF SALES EQUAL TO QUOTA GO TO A, the relation test SALES EQUAL TO QUOTA would be evaluated as follows:

Data-name	PICTURE	Value at time of compare
SALES	9999V99	212.00
QUOTA	999	212

The evaluation is TRUE.

COMPARISON OF NON-NUMERIC ITEMS: For non-numeric items, a comparison results in the determination that one of the items is less than, equal to, or greater than the other, with respect to the binary collating sequence of characters in the EBCDIC set.

If the non-numeric items are of the same length, the comparison proceeds by comparing characters in corresponding character positions, starting from the high-order position and continuing until either a pair of unequal characters or the low-order position of the item is compared. The first pair of unequal characters encountered is compared for relative position in the collating sequence. The item containing the character that is positioned higher in the collating sequence is the greater item. The items are considered equal after the low-order position is compared.

If the non-numeric items are of unequal length, comparison proceeds as described for items of the same length. If this process exhausts the characters of the shorter item, the shorter item is less than the longer, unless the remainder of the longer item consists solely of spaces, in which case, the items are equal. In the statement, IF SALES EQUAL TO QUOTA GO TO A, the relation test SALES EQUAL TO QUOTA would be evaluated as follows:

Data-name	PICTURE	Value at time of compare
SALES	X(4)	0212
QUOTA	X(3)	212

The evaluation is FALSE

Figure 13 indicates the characteristics of the items being compared and the type of comparison made. NN indicates a comparison as described for non-numeric items; NU means a comparison as described for numeric items. A blank box indicates that the test is not permitted.

		SECOND OPERAND									
		GR	AL	AN	ED	ID	BI	EF	IF	RP	FC
FIRST OPERAND	Group Item (GR)	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
	Alphabetic Item (AL)	NN	NN	NN							NN[1]
	Alphanumeric (non-report) Item (AN)	NN	NN	NN	NN[5]					NN	NN
	External Decimal Item (ED) 99999	NN		NN[5]	NU	NU	NU	NU	NU		NU[3]
	Internal Decimal Item (ID) COMP-3	NN			NU	NU	NU	NU	NU		NU[2]
	Binary Item (BI)	NN			NU	NU	NU	NU	NU		NU[2]
	External Floating-point Item (EF)	NN			NU	NU	NU	NU	NU		NU[2]
	Internal Floating-point Item (IF)	NN			NU	NU	NU	NU	NU		NU[2]
	Report Item (RP)	NN		NN						NN	NN[4]
	Figurative Constant (FC)	NN	NN[1]	NN	NU[3]	NU[2]	NU[2]	NU[2]	NU[2]	NN[4]	

[1]Permitted with the figurative constants SPACE and ALL 'character where character must be alphabetic.
[2]Permitted only if figurative constant is ZERO.
[3]Permitted only if fugurative constant is ZERO or ALL 'character' where character must be numeric.
[4]Not permitted with figurative constant QUOTE.
[5]External decimal field must consist of integers.

Figure 13. Permissible Comparisons

Sign Test: This type of condition tests whether or not the value of a numeric item is less than zero (NEGATIVE), greater than zero (POSITIVE), or is zero (ZERO). The value zero is considered neither positive nor negative.

The format for a sign test is:

$$\left\{\begin{array}{l}\text{data name}\\ \text{arithmetic-expression}\end{array}\right\} \quad \text{IS}[\underline{\text{NOT}}] \quad \left\{\begin{array}{l}\underline{\text{POSITIVE}}\\ \underline{\text{ZERO}}\\ \underline{\text{NEGATIVE}}\end{array}\right\}$$

The following are examples of the use of the SIGN test:

```
PERFORM A UNTIL RESULT IS NEGATIVE.
IF A * B - C IS NOT ZERO GO TO D.
```

Class Test: When a class test is specified, determination is made as to whether or not an item consists solely of the following:

1. The characters 0 through 9 (NUMERIC),

2. The characters A through Z and space (ALPHABETIC).

The ALPHABETIC test may be performed on elementary alphabetic or alphanumeric items.

The NUMERIC test may be performed on elementary alphanumeric, internal decimal, or external decimal items.

The format for the class test is:

```
                          {NUMERIC   }
data-name IS [NOT]        {ALPHABETIC}
```

If the last character of an otherwise numeric field contains a digit with a sign over punch, the field is considered numeric. For a single character alphanumeric field containing a digit with a sign overpunch, the tests IF NUMERIC and IF ALPHABETIC will both be considered true while the NOT form of the tests will both be false. For example, if a 1-character alphanumeric field called FIELD is being tested and contains the hexadecimal configuration C1, both of the following will be true because the hexadecimal C1 could be interpreted either as an 'A' or a '+1':

```
IF FIELD IS ALPHABETIC MOVE 'A' TO CODE-A.
IF FIELD IS NUMERIC MOVE 'A' TO CODE-A.
```

Hence, a numeric class test will always be true for an alphanumeric item containing numeric data if the low-order byte is any of the letters A through R, because these letters are treated as signed numbers.

Condition-name Test: The format for a condition-name test is:

```
[NOT] condition-name
```

A condition-name test is one in which a conditional variable is tested to see whether or not its value is equal to the value specified for a condition-name associated with it. For example, in a program processing a payroll, the data item MARITAL-STATUS (the conditional variable) might be a code indicating whether an employee is married, divorced, or single. Assume that if MARITAL-STATUS has the value of 1, the employee is single; if it has the value of 2, he is married; and if it has the value of 3, he is divorced. To determine whether or not an employee is married, the programmer could test this condition by using a simple relational condition in a conditional statement such as IF MARITAL-STATUS = 2 SUBTRACT MARRIED-DEDUCTION FROM GROSS. Alternatively, he can associate a condition-name with each value that MARITAL-STATUS might assume. Thus, in the Data Division, the condition-names SINGLE, MARRIED, and DIVORCED might be associated with values 1, 2, and 3, respectively. For example:

```
02 MARITAL-STATUS PICTURE 9.
88 SINGLE VALUE IS 1.
88 MARRIED VALUE IS 2.
88 DIVORCED VALUE IS 3.
```

Then, as a shorthand form of the simple relational condition MARITAL-STATUS = 1, the programmer could write the single condition-name SINGLE. Therefore, the following two statements would produce identical results:

```
IF MARITAL-STATUS = 1 GO TO Z.
IF SINGLE GO TO Z.
```

The condition-name test, then, is an alternative way of expressing certain conditions which could be expressed by a simple relational condition.

EXT Overflow Test: This type of condition tests for form overflow of a printer to which a file named in an option 1 APPLY clause is assigned.

The format for the overflow test is:

[NOT] overflow-name

Overflow-name is true if a "form-overflow" situation exists. Form-overflow exists when an end of page is sensed by an on-line printer. Overflow-name follows the rules for data-name formation.

The following statement could be written (with a programmer-supplied overflow-name):

```
IF OVERFLOW-NAME-ONE WRITE X AFTER
  ADVANCING 0 LINES ELSE WRITE X AFTER
  ADVANCING 2 LINES.
```

The form-overflow condition should not be tested unless the associated, file has been opened.

COMPOUND CONDITIONS: Simple test-conditions can be combined with logical operators according to specified rules to form compound conditions. The logical operators are AND, OR, and NOT. Two or more simple conditions combined by AND and/or OR make up a compound condition.

The word OR is used to mean either or both. Thus, the expression A OR B is true if: A is true, B is true, or both A and B are true. The word AND is used to mean both. Thus, the expression A AND B is true only if both A and B are true. The word NOT is used in the manner described in the subsection "Test-Conditions." Thus, the expression NOT (A OR B) is true if A and B are false; and the expression NOT (A AND B) is true if A is false, B is false, or if both A and B are false.

The logical operators and truth values are shown in Figure 14, where A and B represent simple test-conditions.

Condition		Related Conditions				
A	B	NOT A	A AND B	A OR B	NOT (A AND B)	NOT (A OR B)
True	True	False	True	True	False	False
False	True	True	False	True	True	False
True	False	False	False	True	True	False
False	False	True	False	False	True	True

Figure 14. Truth Table

Parentheses may be used to specify the order in which conditions are evaluated. Parentheses must always be paired. Logical evaluation begins with the innermost pair of parentheses and proceeds to the outermost. If the order of evaluation is not specified by parentheses, the expression is evaluated in the following way:

1. AND and its surrounding conditions are evaluated first, starting at the left of the expression and proceeding to the right.

2. OR and its surrounding conditions are then evaluated, also working from left to right.

Thus, the expression: A IS GREATER THAN B OR A IS EQUAL TO C AND D IS POSITIVE would be evaluated as if it were parenthesized as follows:

(A IS GREATER THAN B) OR ((A IS EQUAL TO C) AND (D IS POSITIVE)).

The rules for formation of symbol pairs are shown in Figure 15. The letter C stands for conditional expression. P means that the combination is permissible. A dash means that the combination is not permissible.

First Symbol	Second Symbol: C	OR	AND	NOT	(	)
C	-	P	P	-	-	P
OR	P	-	-	P	P	-
AND	P	-	-	P	P	-
NOT	P	-	-	-	P	-
(	P	-	-	P	P	-
)	-	P	P	-	-	P

Figure 15. Formation of Symbol Pairs

COMPILER-DIRECTING DECLARATIVES

Declarative sections are identified by compiler-directing statements that specify the circumstances under which a procedure is to be executed in the object program. A declarative section consists of a section-name, followed by the word SECTION and a period, and a USE sentence followed by procedural statements. The USE sentence must begin immediately after the section header, on the same line. Declarative sections must be grouped together at the beginning of the Procedure Division, preceded by the key word DECLARATIVES in Margin A, and followed by the key words END DECLARATIVES, where END must also appear in Margin A. DECLARATIVES and END DECLARATIVES must be followed by a period. A declarative section is terminated by the occurrence of another section or the words END DECLARATIVES.

Although declarative sections are located at the beginning of the Procedure Division, execution of the object program starts with the first procedure following the termination of the declarative section.

The general form for declaratives is:

```
PROCEDURE DIVISION.
DECLARATIVES.
{section-name SECTION. USE-sentence.
{paragraph-name.  sentence...  .} ...} ...
END DECLARATIVES.
```

A declarative section may not be referred to by any PERFORM or GO TO statement outside the declarative. Within a given declarative section, there may be no reference to a point outside the declarative, except as stated below.

If there are two or more logical paths within a declarative procedure, these paths must lead to a common path within the section containing them. For options 1 and 2, an ALTER, PERFORM, or GO TO statement within a declarative section must not refer to paragraph-names or section-names outside that declarative section, except that a GO TO statement in an Option 1 or Option 2 USE section may refer to the reserved word MORE-LABELS. For option 3, a GO TO statement within a declarative section can refer to paragraph-names or section-names outside that declarative section.

USE Statement

The USE statement identifies the type of declarative.

There are three options of the USE statement. Each is associated with the following types of procedures.

1. Label-writing procedures
2. Label-checking procedures
3. Error-checking procedures

The formats of the USE statements are:

EXT

Option 1

```
USE FOR CREATING [BEGINNING] LABELS ON OUTPUT file-name...  .
                 [ENDING   ]
```

EXT

Option 2

```
USE FOR CHECKING [BEGINNING] LABELS ON INPUT file-name...  .
                 [ENDING   ]
```

Options 1 and 2 are used to provide user label processing procedures. CHECKING refers to an input file; CREATING refers to an output file. In this context, "input" means all files opened as INPUT or I-O.

The file can be either an input or output file but not both.

The word BEGINNING refers to user header labels; the word ENDING refers to user trailer labels. If neither word is specified, the declarative section will process both header and trailer labels.

ENDING is not supported for direct-access files since they do not have trailer labels.

When using Option 1 or 2, the programmer must specify LABEL RECORDS ARE data-name in the File Description entry for the file. Data-name must be described as a level 01 or 77 data item in the Linkage Section of the Data Division. (See the LABEL RECORDS clause in Section 5.)

An OPEN statement encountered in the in-line portion of the Procedure Division causes execution of the statements associated with the USE sentence for the file in which BEGINNING LABELS is specified. A CLOSE statement encountered in the in-line portion of the Procedure Division

causes execution of the statements associated with the USE sentence for the file in which ENDING LABELS is specified.

In a declarative section containing Option 1 of the USE sentence, there must be a path of program flow through the last statements of the section, so that writing of user labels can be terminated.

For options 1 and 2, records associated with the file being opened or closed cannot be referenced within the declarative section. Conversely, the label records can be referenced only while the declarative is being executed.

The exit from an option 1 or option 2 declarative section is inserted by the compiler following the last statement in the section. All logical program paths within the section must lead to this point, with one exception: a special exit may be specified by the statement GO TO MORE-LABELS. When an exit is made from a label processing declarative section by means of this statement, IOCS will do one of the following:

1. Read an additional user header label or user trailer label and then re-enter the declarative section for further checking of labels. In this case, IOCS will only re-enter the declarative section if there exists another user label to check. Hence, there need not exist a program path that flows through the last statement in the section. The point of return to the declarative section, after exit by means of a GO TO MORE-LABELS statement, is the beginning of the section.

2. Write the current user header label or user trailer label and then re-enter the declarative section for further creation of labels. A label, created in an IOCS area, is written each time an exit from the declarative section takes place.

If no GO TO MORE-LABELS statement is executed, then the declarative section is not re-entered to check or create any immediately succeeding user labels.

Option 3

Option 3 is used to provide user input/output error-processing procedures in addition to the procedures supplied by IOCS for tape or disk. The format of this option of the USE declarative is:

USE AFTER STANDARD ERROR PROCEDURE ON file-name.

Within the section, the file associated with the USE sentence cannot be referred to by an OPEN, READ, WRITE, or REWRITE statement. Only a CLOSE statement can be given for the file.

An exit from this type of declarative section can be effected by executing the last statement in the section (normal return), or by means of a GO TO statement. Figure 16 summarizes the facilities and limitations associated with each file-processing technique when an error occurs.

File-Processing Technique		No Error-Processing Declarative Section Written	Type of I/O Statement	Error-Processing Declarative Section Written	
ACCESS	ORGANIZATION			Normal Return	GO TO Exit
SEQUENTIAL (or not specified)	Standard sequential tape	End of job	READ	Continue Processing of file permitted	User limited to CLOSE for file-name
	Standard sequential disk	Diagnostic error message is printed, job is terminated	READ		
			WRITE REWRITE		Not applicable
	INDEXED DIRECT		READ WRITE REWRITE		
RANDOM	INDEXED DIRECT		READ WRITE REWRITE		

Figure 16. Error-Processing Summary

CONTINUED PROCESSING OF FILE

Refer to Figure 16 normal return. Continued processing of a file is permitted under the following conditions.

1. An error processing procedure exists in the declarative section.
2. Detection of a standard error results in an automatic transfer to the error processing procedure, which enables the user to examine the error condition before continuing to process.
3. At the conclusion of processing an error, it is the programmer's responsibility to update the parameters normally returned by IOCS to the programmer (such as the ACTUAL KEY, in the case of sequential retrieval of a direct file).

COBOL VERBS

The COBOL verbs are the basis of the Procedure Division of a source program.

The organization of the remainder of this section is based on the classifications used in the following list:

Input/Output Verbs
- OPEN
- READ
- WRITE
- REWRITE
- CLOSE
- ACCEPT
- DISPLAY

Data Manipulation Verbs
- MOVE
- EXAMINE
- TRANSFORM

Arithmetic Verbs
- ADD
- SUBTRACT
- MULTIPLY
- DIVIDE
- COMPUTE

Procedure-Branching Verbs
- STOP
- GO TO
- ALTER
- PERFORM

Compiler-Directing Verbs
- ENTER
- EXIT
- NOTE

INPUT/OUTPUT STATEMENTS

The COBOL input/output verbs provide the means of storing data on an external device (such as magnetic tape, disk units, etc.) and obtaining such data from external devices. The following is a discussion of the verbs associated with these functions.

OPEN Statement

The OPEN statement initiates the processing of files.

The format of an OPEN statement is:

```
        ⎧ INPUT {file-name [WITH NO REWIND] [REVERSED]}...
        ⎪    [OUTPUT {file-name [WITH NO REWIND]}....]
        ⎪      [I-O {file-name}...]
OPEN    ⎪ OUTPUT {file-name [WITH NO REWIND]}...
        ⎪    [INPUT {file-name [WITH NO REWIND] [REVERSED]}...]
        ⎪      [I-O {file-name}...]
        ⎪ I-O {file-name}...[OUTPUT {file-name [WITH NO REWIND]}...]
        ⎩    [INPUT {file-name [WITH NO REWIND] [REVERSED]}...]
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
001|020| |PROCEDURE DIVISION.
001|021| |START. OPEN INPUT FILEB OUTPUT FILEA.
```

Refer to Appendix D, Figure 33, for the relationship between the example above and the sample program given therein.

The OPEN statement for a file must be executed prior to any other input/output statement for the file. The OPEN statement, by itself, does not make an input record or area available for processing; a READ statement must be executed to obtain the first data record. For an output file, an OPEN statement makes available an area for development of the first output record. A second OPEN statement for a given file cannot be executed prior to the execution of a CLOSE statement for that file. Moreover, the following additional restriction must be observed for indexed sequential files:

The physical position in the source program of each CLOSE statement must be:

1. After its associated OPEN statement.

2. Before any other OPEN statement for that file.

Note, however, that an indexed sequential file opened as OUTPUT (i.e., created) may not be opened using the same FD in any other OPEN statement in the program.

For a direct organization file, an FD description is required for each option applied to the file. Thus, the same file opened as OUTPUT, INPUT, and I-O must be described by three FD's.

The INPUT option initiates IOCS label checking, when applicable, and permits reading the file.

The OUTPUT option initiates IOCS label creation, when applicable, and permits creating a file.

The I/O option permits the opening of a direct-access file when access is random for reading, updating, or adding records. When access is sequential, reading or updating can be done.

The NO REWIND option should only be written for files assigned to UTILITY device-numbers for which rewinding is possible, e.g., 2400. This option suppresses the rewinding normally associated with opening a file.

The REVERSED option can only be applied to files assigned to specific devices for which the reverse-read feature is available. The REVERSED option may only be used for a file containing type F records.

An example of the OPEN statement is:

```
OPEN OUTPUT X-FILE, INPUT Y-FILE REVERSED, Z-FILE.
```

Note: Z-FILE is not opened REVERSED.

READ Statement

The functions of the READ statement are:

1. For sequential file processing, to make available the next logical record from an input file and to allow performance of specified imperative statements when end-of-file is detected.

2. For nonsequential file processing, to make available a specific record from a direct-access file and to allow execution of statements if the contents of the associated symbolic and/or actual key is found to be invalid.

The format of the READ statement is:

```
READ file-name RECORD [INTO data-name]

        { AT END       }
        { INVALID KEY  }   imperative statement...
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
001|020| |PROCEDURE DIVISION.
   |   | |       .
   |   | |       .
001|022| |START2. READ FILEB AT END GO TO LABA.
```

Refer to Appendix D, Figure 33, for the relationship between the example above and the sample program given therein.

When a READ statement is executed, the next logical record in the named file becomes accessible in the input area defined by the associated Record Description entry. The file-name must be defined by a File Description entry in the Data Division.

The record remains available in the input area until the next READ statement (or a CLOSE statement) for that file is executed. No reference can be made by any statement in the Procedure Division to information that is not actually present in the current record. Thus, it is not permissible to refer to the nth occurrence of data that appears fewer than n times. If such a reference is made, no assumption should be made about results in the object program.

If more than one logical record is described for the file, implicit redefinition of the area exists. It is the programmer's responsibility to identify which record is present in the area at any given time.

The INTO data-name option is equivalent to a READ statement and a MOVE statement. The data-name specified must be an 01 level entry in the Data Division. If it is not, the compiler, after listing the Data Division map, will abort the job and dump core. There will be no message printed on the console typewriter. When this option is used, the current record becomes available in the input area, as well as in the area specified by data-name. Data is moved into the data-name area in accordance with the COBOL rules for moving an item into the first record specified for that file description. If the INTO option is specified, there should be only one record description associated with the file; otherwise, reference is made only to the first description for that file.

The AT END option is required for files for which access is sequential. The AT END portion of the READ statement is executed when an end-of-file condition is detected.

Logical records in a data file are no longer available to the program once the end-of-file condition for that file is detected. Thus, imperative statements in the AT END portion of a READ command may not refer to the I/O area described in the related FD unless subsequent CLOSE and OPEN statements have been executed.

If the INVALID KEY option is specified, the statements following INVALID KEY are executed when the contents of actual key and/or symbolic key are invalid. See the publication, IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide, Form C24-5025, for a detailed discussion of the invalid key condition.

If ACCESS IS RANDOM is specified for the file, the symbolic key and/or the actual key of the file must be set to the desired values prior to the execution of the READ statement.

If the file being read is an unlabeled tape file (described as LABEL RECORD IS OMITTED), an end-of-volume condition is considered to be end-of-file. Thus, for multivolume unlabeled tape files, the user's AT END routine must be designed to determine true end-of-file and to continue processing of any succeeding volumes of the file.

If the file being read is an unlabeled tape file (described as LABEL RECORD IS OMITTED), an end-of-volume condition is considered to be end-of-file. Thus, for multivolume unlabeled tape files, the user's AT END routine must be designed to determine true end-of-file and to continue processing of any succeeding volumes of the file.

Each time an end-of-volume condition occurs on a file other than an unlabeled tape file, the READ statement causes the following operations to take place:

1. The volume trailer label checking procedure of IOCS is executed. The user trailer label checking procedures specified in a USE Option 2 sentence are executed, if such labels exist.

2. A volume switch occurs.

3. The volume header label checking procedure subroutine of IOCS is executed. The user header label checking procedures specified in a USE Option 2 sentence declarative are executed, if such labels exist.

4. The next logical record in the file is made available for processing.

If the end-of-volume is also the logical end of file, only the operations specified in item 1 are done and then the statements following AT END are executed.

The following are examples of READ statements:

```
READ INVENTORY AT END GO TO FINISH.
READ PAYROLL-FILE INTO AREA-1 AT END GO TO CALC-2.
READ PERSONNEL-FILE INVALID KEY GO TO ERR.
```

WRITE Statement

The function of Option 1 of the WRITE statement is to release a logical record for a file specified as OUTPUT or I/O in an OPEN statement and to allow performance of specified imperative statements if the contents of the associated actual key and/or symbolic key are found to be invalid.

Option 1 of the WRITE statement has the following format:

WRITE record-name [FROM data-name-1] [INVALID KEY imperative statement...]

Option 2 of the WRITE statement is used for output destined to be printed or punched. (This option may not be used for files assigned to direct-access devices.)

Note: If the Option 1 form of the WRITE statement is used in conjunction with the debugging language statements "EXHIBIT", "TRACE", or "DISPLAY", overprinting of lines may occur.

Option 2 of the WRITE statement has the following format:

```
WRITE record-name [FROM data-name-1]
                  [AFTER ADVANCING { data-name-2 } LINES]
                                   { integer     }
```

An OPEN statement must be executed prior to executing the first WRITE statement for a file. After the WRITE statement is executed, the logical record named by record-name is no longer available.

The WRITE verb must not be used to add new records to an existing sequential disk file.

When the FROM option is used, data-name-1 must not be the name of an item in the file containing record-name. This form of the WRITE statement is equivalent to the statement MOVE data-name-1 to record-name followed by the statement WRITE record-name. Moving takes place according to the rules specified for the MOVE statement.

After execution of a WRITE statement with the FROM option, the information in record-name is no longer available, but the information in data-name-1 is available.

When the end-of-volume condition occurs, the WRITE statement causes the following operations to take place:

1. The trailer-label writing procedure of IOCS is executed. The user trailer-label creating procedure is executed if specified in a declarative section with Option 1 of the USE sentence.

2. A volume switch occurs.

3. The header-label writing procedure of IOCS is executed. The user header-label writing procedure is executed if specified in a declarative section containing Option 1 of the USE sentence.

4. The next logical record area in the output file is made available.

If ACCESS IS RANDOM is specified, the symbolic key and/or actual key must be set to the desired values prior to the execution of the WRITE.

If the INVALID KEY option is written, the statements following INVALID KEY are executed when the contents of the actual key and/or symbolic key are invalid. See the publication, IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide, Form C24-5025, for a detailed discussion of invalid key conditions.

When Option 2 on the WRITE statement is used, the first character in each logical record for the file must be reserved for the control character. Therefore, a printed line of 132 positions must be expressed as 133 positions. It is the user's responsibility to see that the appropriate channels are punched in the carriage control tape. If a WRITE statement with an ADVANCING option is written for a record in a file, every WRITE statement for records in the same file must contain an ADVANCING option. When the AFTER ADVANCING option is used and integer is specified, integer must be unsigned and have the value 0, 1, 2, or 3. The value 0 designates a carriage-control "eject" (i.e., skip to next page). The value 1 designates single spacing; the value 2, double spacing; and the value 3, triple spacing. If 0 is used, COBOL will skip to a 1 punch in the carriage tape.

Data-name-2 must be an alphanumeric item of length one (i.e., must have PICTURE X). The following chart shows the values that data-name-2 may assume and its interpretations.

Value	Interpretation
b (blank)	single spacing
0	double spacing
-	triple spacing
+	suppress spacing
1 through 9	skip to channel 1 through 9, respectively
A,B,C	skip to channel 10, 11, 12, respectively
V,W	pocket select 1 or 2, respectively, on the IBM 1442 or 2520, and P1 or P2 on the IBM 2540

The following are examples of the WRITE statement:

```
WRITE SALARY-RECORD FROM OLD-RECORD AFTER ADVANCING 0 LINES.

WRITE NEW-RECORD FROM OLD-CARD INVALID KEY GO TO END.
```

[EXT] REWRITE Statement

The function of the REWRITE statement is to replace a logical record on a direct-access device with a specified record, if the contents of the associated actual key and/or symbolic key are found to be valid.

The format of the REWRITE statement is:

```
REWRITE record-name [FROM data-name]
    [INVALID KEY imperative-statement...]
```

The READ statement for a file must be executed before a REWRITE statement for a file can be executed. A REWRITE statement can only be written for files opened as I-O. Issuing a REWRITE for a file opened as other than I-O can produce unpredictable results.

When the FROM option is used, data-name must not be the name of an item in a file containing record-name. This form of the REWRITE statement is equivalent to the statement MOVE data-name TO record-name followed by the statement REWRITE record-name. Moving takes place according to COBOL rules for moving.

After the REWRITE statement is executed, the logical record named by record-name is no longer available. This also applies to the use of the FROM option.

For direct-access files, the INVALID KEY procedure is executed when the contents of the actual key and/or the symbolic key are invalid for the file.

If ACCESS IS RANDOM is specified for the file, the actual key and/or the symbolic key must be set to the desired values prior to the execution of the REWRITE statement. Since a REWRITE statement must always apply to the most recent record read, the values associated with the symbolic and/or actual keys must be the same for the REWRITE statement as they were for the READ statement.

CLOSE Statement

The CLOSE statement is used to terminate the processing of one or more units or files. The format of the CLOSE statement is:

```
CLOSE { file-name [ UNIT ] [ WITH { NO REWIND } ] } ...
      {           [ REEL ]        { LOCK      } }
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1    |  6|7|8     12
     |   | |
001|020|  |PROCEDURE DIVISION.
001|021|  |START. OPEN INPUT FILEB OUTPUT FILEA.
001|022|  |START2. READ FILEB AT END GO TO LABA.
     |   | |       .
     |   | |       .
     |   | |       .
002|006|  |LABA. CLOSE FILEA, FILEB STOP RUN.
     |   | |
```

Refer to Appendix D, Figure 33, for the relationship between the example above and the sample program given therein.

When a CLOSE statement is specified, IOCS closing procedures are executed for the current unit of the file. The CLOSE statement may only be specified for a file that is open. After a CLOSE statement has been executed for a file, an OPEN statement must be executed before any other reference can be made to that file.

The following restriction must be observed for indexed sequential files:

The physical position in the source program of each CLOSE must be:

1. After its associated OPEN.

2. Before any other OPEN for that file.

If the UNIT or REEL option is specified, the IOCS volume switching procedures are instituted.

A CLOSE statement with the UNIT or REEL option or with the UNIT or REEL WITH LOCK option should only be written for files assigned to tape. A REEL or UNIT option is not a true CLOSE; therefore, an OPEN statement must not be executed before processing the next reel. The LOCK option causes the current reel of the tape file to be rewound and unloaded.

The NO REWIND option should be written only for files assigned to UTILITY device-numbers for which rewinding is possible, e.g., 2400. This option suppresses rewinding normally associated with closing a file.

DISPLAY Statement

The function of the DISPLAY statement is to write data on a low-volume device. The format of the DISPLAY statement is:

```
          {data-name}                [UPON CONSOLE  ]
DISPLAY   {literal  } ...            [UPON SYSPUNCH ]
```

When UPON SYSPUNCH or UPON CONSOLE is omitted, the system logical printing device (SYSLST) is assumed. When UPON SYSPUNCH is written, the system logical punch device is assumed.

If the input/output device specified by a DISPLAY statement is the same one designated by a WRITE statement, the output resulting from the statements may not be in the order in which the statements were encountered. For example, suppose the system logical output device was designated and the statements

```
WRITE WEEKS-PAY.
DISPLAY 'ABC'.
```

were encountered (where the contents of WEEKS-PAY is 123.00). The output on SYSLST might be:

```
ABC
123.00
```

When UPON SYSPUNCH or UPON CONSOLE is written, the sum of the sizes of the operands may not exceed 72 character positions. When UPON SYSPUNCH and UPON CONSOLE are omitted, the sum of the sizes of the operands may not exceed the maximum logical record length for the system logical printing device (SYSLST). However, in no case may the number of operands in the DISPLAY statement exceed 19, even if the sum of the sizes of the operands does not exceed the specified maximum.

Any spaces desired between displayed multiple operands must be explicitly specified.

When SYSPUNCH is written, an 80-character output record is produced, with positions 73 through 80 of the record containing the identification of the originating program (PROGRAM-ID). If the message size exceeds 72 characters, it is truncated; if less than 72, the remaining positions are filled with spaces.

Data-names described as USAGE COMPUTATIONAL, COMPUTATIONAL-1, COMPUTATIONAL-2, or COMPUTATIONAL-3 are converted automatically to external format as follows:

1. Internal decimal and binary items are converted to external decimal. Only negative values cause a low-order sign overpunch to be developed.

2. Internal floating-point items are converted to external floating-point. No other data items require conversion.

For example, if two binary items have values -32 and 32, then they will be displayed as 3K and 32, respectively.

ACCEPT Statement

The function of the ACCEPT statement is to obtain data from the system logical input device (SYSIPT), or from the console.

The format of the ACCEPT statement is:

ACCEPT data-name [FROM CONSOLE]

Data-name may be either a fixed-length group item or an elementary alphabetic, alphanumeric, external decimal or external floating-point item. One logical record is read and the appropriate number of characters is transferred from left to right into the area reserved for data-name. No editing or error-checking of the incoming data is done.

If the input/output device specified by an ACCEPT statement is the same one as designated for a READ statement, the results may be unpredictable.

When FROM CONSOLE is specified, data-name may not exceed 72 character positions in length.

When an ACCEPT statement with the FROM CONSOLE option is executed, the following action is taken:

1. A system-generated message AWAITING REPLY is automatically displayed.

2. Execution is suspended. When a console input message is identified by the Control Program, execution of the ACCEPT statement is resumed and the message is transferred to the specified data-name.

When the FROM CONSOLE option is not written, one logical record is read from the system logical input device (SYSIPT).

If the system logical input device used in an ACCEPT statement is also used for a file, the results are unpredictable.

Figure 17 states restrictions of input/output statements. Y means that the statement may appear; R indicates it may appear with restrictions.

The following are examples of ACCEPT statements:

```
ACCEPT CONTROL-CARD-AREA.
ACCEPT IN-REC FROM CONSOLE.
```

	Appearing In:			
Statement	Label Checking Declarative	Label Creating Declarative	Main Body of Procedure Division	Debug Packet
OPEN CLOSE	R[1]	R[1]	Y	Y
READ WRITE REWRITE	R[1]	R[1]	Y	Y
DISPLAY EXHIBIT TRACE	Y[2]	Y[2]	Y	Y
ACCEPT FROM CONSOLE	Y	Y	Y	Y
ACCEPT (from SYSIPT)	Y[3]	Y[3]	Y	Y

[1]Only permitted for files other than the one for which entry into the declarative was made.
[2]Except for the first execution of any of DISPLAY, EXHIBIT, or procedure-name affected by READY TRACE in the program.
[3]Except for the first execution in the program.

Figure 17. Restrictions for Input/Output Statements

MOVE Statement

The MOVE statement is used to transfer data from one area of main storage to another and to perform conversions and/or editing on the data that is moved. The MOVE statement has the following format:

```
      {data-name-1}
MOVE  {literal    }TO data-name-2 ...
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
003|015| |PROCEDURE DIVISION.
   |   | |       .
   |   | |       .
   |   | |       .
003|019| |MODIFY. MOVE MODIFICATION TO B.
```

Refer to Appendix D, Figure 34, for the relationship between the example above, and the sample program given therein.

The data represented by data-name-1 or the specified literal is moved to the area designated by data-name-2. The same information is also moved to any additional receiving areas mentioned in the statement.

When a group item is involved in a simple move, the data is moved as a group without regard to descriptions of items subordinate to the group (i.e. without editing, data conversion etc.).

The following considerations pertain to moving items:

1. Numeric (external decimal, internal decimal, binary, external floating, internal floating, numeric literals, and ZERO) to numeric or report:

   a. The items are aligned by decimal points, with insertion of zeros or truncation on either end, as required.

   b. When the USAGE of the source field and receiving field differs, conversion to the USAGE of the receiving field takes place.

   c. The items may have special editing performed on them with suppression of zeros, insertion of a dollar sign, commas, etc., and decimal point alignment, as specified by the receiving area.

2. All other permissible combinations:

   a. The characters are placed in the receiving area from left to right, unless the receiving field is specified as JUSTIFIED RIGHT.

   b. If the receiving field is not completely filled by the data being moved, the remaining positions are filled with spaces.

c. If the source field is longer than the receiving field, the move is terminated as soon as the receiving field is filled.

Figure 18 contains several examples illustrating MOVE.

Source Field		Receiving Field		
PICTURE	Value	PICTURE	Value before MOVE	Value after MOVE
99V99	1234	99V99	9876	1234
99V99	1234	99V9	987	123
9V9	12	99V999	98765	01200
XXX	A2B	XXXXX	Y9X8W	A2Bbb
9V99	123	99.99	87.65	01.23
AAAAAA	REPORT	AAA	JKL	REP

Figure 18. Examples of Data Movement

Note that, in the fourth example, the information in any excess positions of a non-numeric receiving area is replaced by spaces at the right.

Figure 19 illustrates all permissible moves for the various data classifications. Y means the move is permitted; N means the move is not permitted.

EXAMINE Statement

The EXAMINE statement is used to replace certain occurrences of a given character and/or to count the number of such occurrences in a data item.

Source Field	Receiving Field								
	GR	AL	AN	ED	ID	BI	EF	IF	RP
Group (GR)	y	y	y	N	N	N	N	N	N
Alphabetic (AL)	y	y	y	N	N	N	N	N	N
Alphanumeric (AN)	y	y	y	N	N	N	N	N	N
External Decimal (ED)	y	N	y[1]	y	y	y	y	y	y
Internal Decimal (ID)	y	N	y[1,2]	y	y	y	y	y	y
Binary (BI)	y	N	y[1,2]	y	y	y	y	y	y
External Floating-Point (EF)	y	N	N	y	y	y	y	y	y
Internal Floating-Point (IF)	y	N	N	y	y	y	y	y	y
Report (RP)	y	N	y	N	N	N	N	N	N
ZEROS	y	N	y	y	y	y	y	y	y
SPACES	y	y	y	N	N	N	N	N	N
All 'character', HIGH-VALUES, LOW-VALUES, QUOTES	y	N	y	N	N	N	N	N	N

[1] For integers only.
[2] Data is converted to external decimal.

Figure 19. Permissible Moves

The EXAMINE statement has the following two formats:

Option 1

```
EXAMINE data-name  TALLYING { ALL       } 'character-1'
                            { LEADING   }
                            { UNTIL FIRST }

    [REPLACING BY 'character-2']
```

Option 2

```
EXAMINE data-name  REPLACING { ALL       }  'character-1'
                             { LEADING   }
                             { UNTIL FIRST }
                             { FIRST     }

    BY 'character-2'
```

Data-name in each option must refer to a data item whose USAGE is DISPLAY.

Character-1 and character-2 must be single-character non-numeric literals (i.e., enclosed in quotation marks) and members of the set of allowable characters for the data item. For example, a "2" cannot replace an "A" in an alphabetic item, but may do so in an alphanumeric item.

The use of figurative constants instead of 'character-1' or 'character-2' is permitted.

When Option 1 is used, a count is made at object time of the number of occurrences of the specified character in data-name, and this count replaces the value of the special binary data item TALLY, whose length is five decimal digits. TALLY is a compiler-established counter; therefore, it should not be defined by the user program. TALLY may also be used as a data-name in other procedural statements.

The count at object time depends on which of the following three TALLYING options is employed:

1. If ALL is specified, all occurrences of character-1 in the data item are counted.

2. If LEADING is specified, the count represents the number of occurrences of character-1 prior to encountering a character other than character-1. Examination proceeds from left to right.

3. If UNTIL FIRST is specified, the count represents the number of characters other than character-1 encountered prior to the first occurrence of character-1. Examination proceeds from left to right. If the end of the data item is encountered prior to encountering character-1, TALLY will contain a number equal to field-size.

When the REPLACING option is used (either in Option 1 or Option 2), the replacement of characters depends on which of the following four REPLACING options is employed:

1. If ALL is specified, character-2 is substituted for each occurrence of character-1.

2. If LEADING is specified, the substitution of character-2 for character-1 terminates when a character other than character-1 is encountered, or when the righthand boundary of the data item is reached. Examination proceeds from left to right.

3. If UNTIL FIRST is specified, the substitution of character-2 terminates as soon as the first character-1 is encountered, or when the righthand boundary is reached. Examination proceeds from left to right.

4. If FIRST is specified, only the first occurrence of character-1 is replaced by character-2. Examination proceeds from left to right.

Sample EXAMINE statements showing the effect of each statement on the associated data item and the TALLY are shown in Figure 20.

EXAMINE Statement	ITEM-1 Before	Data After	Resulting Value of TALLY
EXAMINE ITEM-1 TALLYING ALL '0'	101010	101010	3
EXAMINE ITEM-1 TALLYING ALL '1' REPLACING BY '0'	101010	000000	3
EXAMINE ITEM-1 REPLACING LEADING '*' BY SPACE	**7000	7000	unchanged
EXAMINE ITEM-1 REPLACING FIRST '*' BY '$'	**1.94	$*1.94	unchanged

Figure 20. Examples of Data Examination

[EXT] TRANSFORM Statement

The TRANSFORM statement is used to alter characters according to a transformation rule. For example, it may be used to change the characters in an item to a different collating sequence.

The format of the TRANSFORM statement is:

TRANSFORM data-name-3 CHARACTERS

FROM { figurative-constant-1 / non-numeric-literal-1 / data-name-1 } TO { figurative-constant-2 / non-numeric-literal-2 / data-name-2 }

Data-name-3 must be an elementary alphabetic, alphanumeric, or report item, or a group item.

The combination of the FROM and TO options determines what the transformation rule is. These combinations are:

Option	Transformation Rule
FROM figurative-constant-1 TO figurative-constant-2	All characters in data-name-3 equal to the single character figurative-constant-1 are replaced by the single character figurative-constant-2.
FROM figurative-constant-1 TO non-numeric-literal-2	All characters in data-name-3 equal to the single character figurative-constant-1 are replaced by the single character non-numeric-literal-2.
FROM figurative-constant-1 TO data-name-2	All characters in data-name-3 equal to the single character figurative-constant-1 are replaced by the single character in data-name-2.
FROM non-numeric-literal-1 TO figurative-constant-2	All characters in data-name-3 that are equal to any character in non-numeric-literal-1 are replaced by the single character figurative-constant-2.
FROM non-numeric-literal-1 TO non-numeric-literal-2	Non-numeric-literal-1 and non-numeric-literal-2 must be equal in length or non-numeric-literal 2 must be a single character. If equal in length, any character in data-name-3 equal to a character in non-numeric-literal-1 is replaced by the character in the corresponding position of non-numeric-literal-2. If the length of non-numeric-literal-2 is one, all characters in data-name-3 that are equal to any character appearing in non-numeric-literal-1 are replaced by the single character given in non-numeric-literal-2.
FROM non-numeric-literal-1 TO data-name-2	Non-numeric-literal-1 and data-name-2 must be equal in length or data-name-2 must be a single-character item. If equal in length, any character in data-name-3 equal to a character in non-numeric-literal-1 is replaced by the character in the corresponding position of data-name-2. If the length of data-name-2 is one, all characters in data-name-3 that are equal to any character appearing in non-numeric-literal-1 are replaced by the single character given in data-name-2.
FROM data-name-1 TO figurative-constant-2	All characters in data-name-3 that are equal to any character in data-name-1 are replaced by the single character figurative-constant-2.
FROM data-name-1 TO non-numeric-literal-2	Data-name-1 and non-numeric-literal-2 must be of equal length or non-numeric-literal-2 must be one character. If equal in length, any character in data-name-3 equal to a character in data-name-1 is replaced by the character in the corresponding position of non-numeric-literal-2.

Option	Transformation Rule
	If the length of non-numeric-literal-2 is one, all characters in data-name-3 that are equal to any character appearing in data-name-1 are replaced by the single character given in non-numeric-literal-2.
FROM data-name-1 TO data-name-2	Any character in data-name-3 equal to a character in data-name-1 is replaced by the character in the corresponding position of data-name-2. These items can be one or more characters, but must be equal in length.

The following rules pertain to the operands of the FROM and TO options:

1. Non-numeric-literals require enclosing quotation marks, as specified in the section, "Literals."
2. Data-name-1 and data-name-2 must be elementary alphabetic, or alphanumeric items, or fixed length group items less than 257 characters in length.
3. A character may not be repeated in non-numeric-literal-1 or in the area defined by data-name-1. If a character is repeated the results will be unpredictable.
4. The allowable figurative-constants are: ZERO, ZEROS, ZEROES, SPACE, SPACES, QUOTE, QUOTES, HIGH-VALUE, HIGH-VALUES, LOW-VALUE, and LOW-VALUES.

When either data-name-1 or data-name-2 appears as a determinant of the transformation rule, the user can change the transformation rule during object time.

Figure 21 contains examples of data-name-3 results, using the figurative-constant-1 to figurative-constant-2, non-numeric-literal-1 to non-numeric-literal-2, and data-name-1 to data-name-2 combinations, respectively. (The lower case 'b' represents a blank.)

Data-name-3 Before	FROM	TO	Data-name-3 After
1b7bbABC	SPACE	QUOTE	1'7''ABC
1b7bbABC	'17CB'	'QRST'	QbRbbATS
1b7bbABC	b17ABC	CBA71b	BCACC71b
1234WXY89	98YXW4321	ABCDEFGHI	IHGFEDCBA

Figure 21. Examples of Data Transformation

ARITHMETIC STATEMENTS

The following rules apply to the arithmetic statements:

1. All data-names used in arithmetic statements must represent elementary numeric data items that are defined in the Data Division of the program, except that operands of the GIVING option can be either elementary numeric or report.

2. The maximum size of any data-name or literal is 18 decimal digits.

3. Intermediate result fields generated for the evaluation of fixed-point arithmetic expressions assure the accuracy of the result field, except where high order truncation is necessary.

4. Decimal point alignment is supplied automatically throughout computations.

The ROUNDED and SIZE ERROR options apply to all the arithmetic statements. The GIVING option applies to all arithmetic statements but COMPUTE.

OPTIONS:

GIVING Option: If the GIVING option is written, the value of the data-name that follows the word GIVING will be made equal to the calculated result of the arithmetic operation. The data-name that follows GIVING is not used in the computation and may contain editing symbols.

If the GIVING option is not written, the operand following the words TO, FROM, BY, and INTO in the ADD, SUBTRACT, MULTIPLY, and DIVIDE statements must be a data-name. This data-name is used in the computation and is made equal to the result.

ROUNDED Option: If, after decimal-point alignment, the number of places in the calculated result are greater than the number of places associated with the data-name whose value is to be set equal to the calculated result, truncation occurs unless the ROUNDED option has been specified.

When the ROUNDED option is specified, the least significant digit of the resultant data-name has its value increased by 1 whenever the most significant digit of the excess is greater than or equal to 5.

Rounding of a computed negative result is performed by rounding the absolute value of the computed result and then making the final result negative (unless the final result is zero).

Figure 22 illustrates the relationship between a calculated result and the value stored in an item that is to receive the calculated result.

	Item to Receive Calculated Result		
Calculated Result	PICTURE	Value After Rounding	Value After Truncating
12.36	99V9	12.4	12.3
8.432	9V9	8.4	8.4
35.6	99V9	35.6	35.6
65.6	99V	66	65
.0055	V999	.006	.005

Figure 22. Relationship Between Calculated Value and Value Stored

SIZE ERROR Option: Whenever the number of integral places in the calculated result exceeds the number of integral places specified for the resultant data-name, a size error condition arises.

If the SIZE ERROR option has been specified and a size error condition arises, the value of the resultant data-name is not altered and the series of imperative statements specified for the condition is executed.

If the SIZE ERROR option has not been specified and a size error condition arises, no assumption should be made about the final result; however, the program flow is not interrupted.

It should be noted that the SIZE ERROR option applies only to final calculated results. When a size error occurs in the handling of intermediate results, no assumption should be made about the final result.

An arithmetic statement, if written with a SIZE ERROR option, is not an imperative statement. Rather, it is a conditional statement and is prohibited in contexts where only imperative statements are allowed.

Refer to Appendix C for a discussion on significant positions retained in arithmetics.

ADD Statement

The ADD statement adds two or more numeric values and substitutes the resulting sum for the current value of an item. The ADD statement has the following format:

```
        ⎧numeric-literal          ⎫          ⎧TO     ⎫
ADD     ⎨floating-point-literal   ⎬ ... [ ⎨GIVING ⎬ ] data-name-n
        ⎩data-name-1              ⎭          ⎩       ⎭

[ROUNDED] [ON SIZE ERROR imperative-statement...]
```

When the TO option is used, the values of all the data-names (including data-name-n) and literals in the statement are added, and the resulting sum replaces the value of data-name-n. At least two data-names and/or numeric literals must follow the word ADD when the GIVING option is written.

The maximum number of operands that may be specified in an ADD statement is 23.

The following are examples of the ADD statement:

```
ADD INTEREST DEPOSIT TO BALANCE.
ADD REGULAR-TIME OVERTIME GIVING NEW-WEEKLY.
```

The first example would result in the total sum of INTEREST, DEPOSIT and BALANCE being placed at BALANCE. The second example would result in the sum of REGULAR-TIME and OVERTIME being placed at the location NEW-WEEKLY.

SUBTRACT Statement

The SUBTRACT statement subtracts one or a sum of two or more numeric data items from a specified item and sets the value of a data item equal to the difference.

The SUBTRACT statement has the following format:

```
           ⎧data-name-1              ⎫
SUBTRACT   ⎨numeric-literal-1        ⎬ ...
           ⎩floating-point-literal-1 ⎭
```

```
        ⎧data-name-m [GIVING data-name-n]                    ⎫
FROM    ⎨numeric-literal-m GIVING data-name-n                ⎬
        ⎩floating-point-literal-m GIVING data-name-n         ⎭

    [ROUNDED] [ON SIZE ERROR imperative statement...]
```

The effect of the SUBTRACT statement is to add the values of all the operands that precede FROM and then to subtract the sum from the value of the item following FROM. A literal can follow FROM only when the GIVING option is specified.

The maximum number of operands that may be specified in a SUBTRACT statement is 23.

MULTIPLY Statement

The MULTIPLY statement multiplies two numeric data items and sets the value of data-name-2 (unless data-name-3 is specified) equal to the product.

The format of the MULTIPLY statement is:

```
          ⎧data-name-1          ⎫
MULTIPLY  ⎨numeric-literal-1    ⎬
          ⎩floating-point-literal-1⎭

        ⎧data-name-2 [GIVING data-name-3]                    ⎫
BY      ⎨numeric-literal-2 GIVING data-name-3                ⎬
        ⎩floating-point-literal-2 GIVING data-name-3         ⎭

    [ROUNDED] [ON SIZE ERROR imperative statement...]
```

When the GIVING option is omitted, the second operand must be a data-name, and the product replaces the value of the data-name. For example, the following would result in the product being placed at BALANCE:

```
MULTIPLY INTEREST-RATE BY BALANCE.
```

DIVIDE Statement

The DIVIDE statement divides one numeric data item into another and sets the value of data-name-2 (unless data-name-3 is specified) equal to the quotient.

The format of a DIVIDE statement is:

```
          ⎧data-name-1          ⎫
DIVIDE    ⎨numeric-literal-1    ⎬
          ⎩floating-point-literal-1⎭

          ⎧data-name-2 [GIVING data-name-3]                  ⎫
INTO      ⎨numeric-literal-2 GIVING data-name-3              ⎬
          ⎩floating-point-literal-2 GIVING data-name-3       ⎭

[ROUNDED] [ON SIZE ERROR imperative statement...]
```

Division by zero results in a SIZE ERROR condition.

If the GIVING option is not used, the second operand must not be a literal.

When the GIVING option is omitted and the second operand is a data-name, division results in this data-name being set equal to the quotient. For example, the following would result in the quotient being placed at HOURS:

```
DIVIDE COUNT INTO HOURS.
```

COMPUTE Statement

The COMPUTE statement assigns to a data item the value of a numeric data item, literal, or arithmetic expression. The format of a COMPUTE statement is:

```
COMPUTE data-name-1 [ ROUNDED ] = { data-name-2              }
                                  { numeric-literal          }
                                  { floating-point-literal   }
                                  { arithmetic-expression    }

[ON SIZE ERROR imperative statement...]
```

The data-name, specified to the left of the equal sign, must be an elementary report, binary, internal decimal, external decimal, internal floating-point, or external floating-point item.

The ON SIZE ERROR option applies only to the final result and not to any of the intermediate results.

Example: COMPUTE ANNUAL-PREMIUM = AGE * RATE * YEAR + BASE.

The following are examples of the COMPUTE verb:

```
COMPUTE OVER-TIME-PAY = REGULAR-PAY * 1.5.
COMPUTE TOTAL-WAGE = A.
```

Note: The second statement gives the same result as MOVE A TO TOTAL-WAGE.

Arithmetic Expressions

An arithmetic expression consists of arithmetic operators, data-names, and/or literals representing items on which arithmetic may be performed.

The following five arithmetic operators may be used in arithmetic expressions:

Operator	Operation
+	Addition
-	Subtraction
*	Multiplication
/	Division
**	Exponentiation

Parentheses may be used to indicate the hierarchy of operations on elements in an arithmetic expression.

When the hierarchy of operations in an expression is not completely specified by parentheses, the order of operations is assumed to be exponentiation, then multiplication and division, and finally addition and subtraction. Thus, the expression A + B / C + D ** E * F - G is taken to mean A + (B / C) + ((D ** E) * F) - G.

When the order of a sequence of consecutive operations on the same hierarchical level (i.e., consecutive multiplications and divisions or consecutive additons and subtractions) is not completely specified by parentheses, the order of operation is assumed to be from left to right. Thus, certain expressions ordinarily considered ambiguous are permitted in COBOL. For example, A / B * C and A / B / C are taken to mean (A / B) * C and (A / B) / C, respectively. The expression A * B / C * D is taken to mean ((A * B) / C) * D. The expression A ** B ** C is taken to mean (A ** B) ** C.

Exponentiation of a negative value is allowed only if the exponent is a literal or data-name having an integral value.

Exponentiation is performed in floating-point when an exponent is a fractional literal or is a data-name whose PICTURE describes a fractional number.

Plus and minus are allowable unary operators (having only one operand). The unary sign must be the first character of an arithmetic expression or must be immediately preceded by a left parenthesis. Two operators may not be adjacent to each other.

PROCEDURE BRANCHING STATEMENTS

In the GO TO, ALTER, and PERFORM statements, procedure-name signifies paragraph-name or section-name.

STOP Statement

The STOP statement is used to terminate or delay execution of the object program. The format of this statement is:

```
STOP  {RUN    }
      {literal}
```

The STOP RUN statement terminates execution of the object program and returns control to the operating system or, if the program containing the STOP RUN has been invoked by another program, to the invoking program.

The STOP literal statement causes the specified literal to be displayed on the console, and the object program to pause. The program may be resumed only by operator intervention. End of block must be keyed on the console to resume execution. The size of the literal is restricted to 72 characters.

GO TO Statement

The GO TO statement transfers control from one portion of the program to another. The GO TO statement has the following formats:

Option 1

GO TO [procedure-name]

Option 1 of the GO TO statement provides a means of transferring the path of flow of a program to a designated paragraph or section.

When Option 1 (unconditional GO TO) is used and a procedure-name is not specified, the GO TO statement must be preceded by a paragraph-name, must be the only statement in the paragraph, and must be modified by an ALTER statement prior to the first execution of the GO TO statement. The paragraph-name assigned to the GO TO statement is referred to by the ALTER statement in order to modify the sequence of the program. If procedure-name is omitted and the GO TO statement has not been preset by an ALTER statement prior to the first execution of the GO TO statement, execution of the program will lead to unexpected results.

Option 2

GO TO procedure-name-1 [procedure-name-2...] DEPENDING ON data-name

In Option 2, data-name must be an elementary integral numeric item whose length does not exceed four digits and whose usage is either DISPLAY, COMPUTATIONAL, or COMPUTATIONAL-3. Data-name may not be subscripted.

Option 2 specifies alternative branch points; control is transferred to the point specified by the value of data-name. Control goes to the 1st, 2nd,...,nth procedure-name as the value of data-name is 1, 2,...,n. If data-name has a value outside the range 1 to n, no transfer takes place, and control passes to the next statement after the GO TO statement.

ALTER Statement

The ALTER statement is used to modify an unconditional GO TO statement elsewhere in the Procedure Division, thus changing the sequence in which program steps are to be executed.

The format of the ALTER statement is:

ALTER {procedure-name-1 TO PROCEED TO procedure-name-2}...

Procedure-name-1 designates a paragraph containing a single sentence consisting only of an Option 1 GO TO statement. The effect of an ALTER statement is to replace the procedure-name specified in Option 1 of the GO TO statement with procedure-name-2 of the ALTER statement, where the paragraph-name containing the GO TO statement is procedure-name-1 in the ALTER statement.

The following are examples of the ALTER statement:

Example 1:

```
        ALTER STEP-1 TO PROCEED
        TO PROCESS-2.
        .
        .
        .
STEP-1. GO TO PROCESS-1.
        .
        .
        .
```

Example 2:

```
        ALTER STEP-1 TO
        PROCEED TO PROCESS-2.
        .
        .
        .
STEP-1. GO TO.
        .
        .
        .
```

In both cases, when STEP-1 is executed, an unconditional branch is taken to PROCESS-2.

PERFORM Statement

The PERFORM statement specifies a transfer of control from one portion of a program to another, in order to execute some procedure a specified number of times, or until a condition is satisfied. It directs that control is to be returned to the statement immediately following the point from which the transfer was made.

The PERFORM statement has the following four formats:

Option 1

PERFORM procedure-name-1 [THRU procedure-name-2]

Option 1 is the simple PERFORM statement. A procedure referred to by this type of PERFORM statement is executed once, and then control passes to the next statement after the PERFORM statement. All statements in the paragraphs or sections named by procedure-name-1 (through procedure-name-2) constitute the range of the PERFORM statement.

Option 2

PERFORM procedure-name-1 [THRU procedure-name-2]

{integer / data-name TIMES}

Option 2 is the TIMES option of the PERFORM statement. When the TIMES option is used, the procedure is performed the number of times specified by data-name or integer. Control is then transferred to the statement following the PERFORM statement. Data-name must have an integral value and data-name or integer must have a positive non-floating point value, less than 32,768. If the value of the data-name is negative, zero, or greater than 32,767, control is passed immediately to the statement following the PERFORM statement.

Option 3

```
PERFORM procedure-name-1      [THRU procedure-name-2]

    UNTIL test-condition
```

Option 3 is the UNTIL option of the PERFORM statement. Test-condition may be simple or compound. The procedures specified by the procedure-names are performed until the condition specified by the UNTIL option is true. At this time, control is transferred to the statement following the PERFORM statement. If the condition specified by the UNTIL option is true at the time the PERFORM statement is encountered, the specified procedure is not executed.

The following is an example of an Option 3 PERFORM statement:

```
PERFORM ROUTINE-1 UNTIL ITEM-1 IS LESS THAN ITEM-2
```

Option 4

```
PERFORM procedure-name-1 [THRU procedure-name-2]

  VARYING data-name-1     FROM {numeric-literal-2}
                               {data-name-2      }

  BY {numeric-literal-3}  UNTIL test-condition-1
     {data-name-3      }

[AFTER data-name-4        FROM {numeric-literal-4}
                               {data-name-5      }

  BY {numeric-literal-6}  UNTIL test-condition-2 ]
     {data-name-6      }

[AFTER data-name-7        FROM {numeric-literal-8}
                               {data-name-8      }

  BY {numeric-literal-9}  UNTIL test-condition-3 ]
     {data-name-9      }
```

Option 4 is the VARYING option of the PERFORM statement. Test-condition may be simple or compound. The VARYING option may be used to increment or decrement the value of one or more data-names depending on whether the BY value is positive or negative.

When one data-name is varied, data-name-1 is set equal to its starting value (FROM) when commencing the PERFORM statement. Then, test-condition-1 is evaluated. If it is true, control passes to the next statement following the PERFORM statement; if false, procedure-name-1 through procedure-name-2 is executed once. The value of the increment (BY) is added to data-name-1, and the condition (UNTIL) is evaluated again. The cycle continues until test-condition-1 is true, at which point control is passed to the statement following the PERFORM statement.

All data-names and literals used must represent non-floating-point numeric values; they may be positive, negative, or zero.

Data-name-1, data-name-4, and data-name-7 must not be alternate names for the same data items. For all options, the first statement of procedure-name-1 is the point to which sequence control is transferred by the PERFORM statement.

When two data-names are varied, the value of data-name-4 goes through a complete cycle (FROM, BY, UNTIL) each time that data-name-1 is aug-

mented with its BY value. For three data-names, the value of data-name-7 goes through a complete cycle (FROM, BY, UNTIL) each time that data-name-4 is augmented with its BY value, which in turn goes through a complete cycle each time data-name-1 is varied.

Regardless of the number of data-names being varied, as soon as test-condition-1 is found to be true, control is transferred to the next statement after the PERFORM statement.

The return of control is from a point determined as follows:

1. If procedure-name-1 is a paragraph-name and procedure-name-2 is not specified, the return is made after the last statement of the procedure-name-1 paragraph.

2. If procedure-name-1 is a section-name and procedure-name-2 is not specified, the return is made after the last statement of the last paragraph of the procedure-name-1 section.

3. If procedure-name-2 is specified and is a paragraph-name, the return is made after the last statement of the procedure-name-2 paragraph.

4. If procedure-name-2 is specified and is a section-name, the return is made after the last statement of the last paragraph of the procedure-name-2 section.

GO TO statements and other PERFORM statements are permitted between procedure-name-1 and the last statement of procedure-name-2. Furthermore, the time sequence of execution of exits established by PERFORM statements must be in the inverse order in which they were established.

A procedure referred to by one PERFORM statement can be referred to by other PERFORM statements. Moreover, a procedure referred to by one or more PERFORM statements can also be executed by "dropping through," that is, by entering the procedure through the normal passage of control from one statement to the next, in sequence. Accordingly, if procedure-name-1 were the next statement following the PERFORM statement, the procedure would be executed once more than specified by the PERFORM statement because, after execution of the PERFORM statement, control would pass to procedure-name-1 in the normal continuation of the sequence.

Note, however, a routine which is being performed should not be left without returning to its normal end. Failure to do so leaves the RETURN statement at the end of the performed routine, and sets up the possibility of a return to an undesired location at a later time.

Figures 23, 24, and 25 illustrate the logical flow of Option 4 PERFORM statements, varying one, two, and three data-names, respectively.

Figure 26 states restrictions on the appearance of procedure-branching statements. Y means that the statement may appear; N indicates that it must not; text indicates the outcome if the statement does appear.

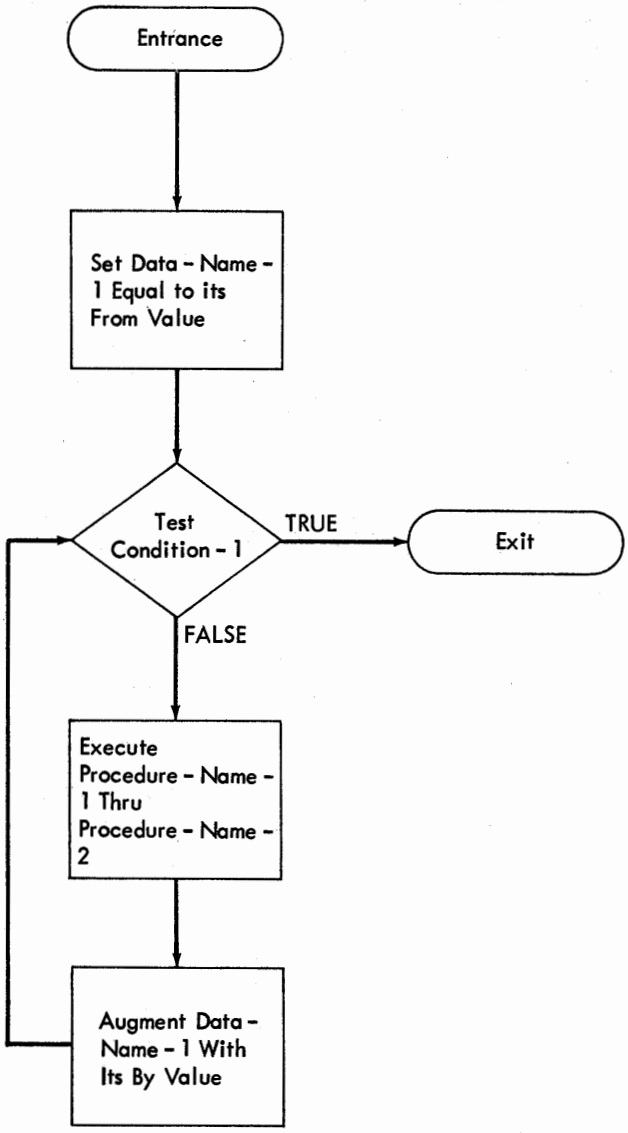


Figure 23. Logical Flow of Option 4 PERFORM Statement Varying One Data-name

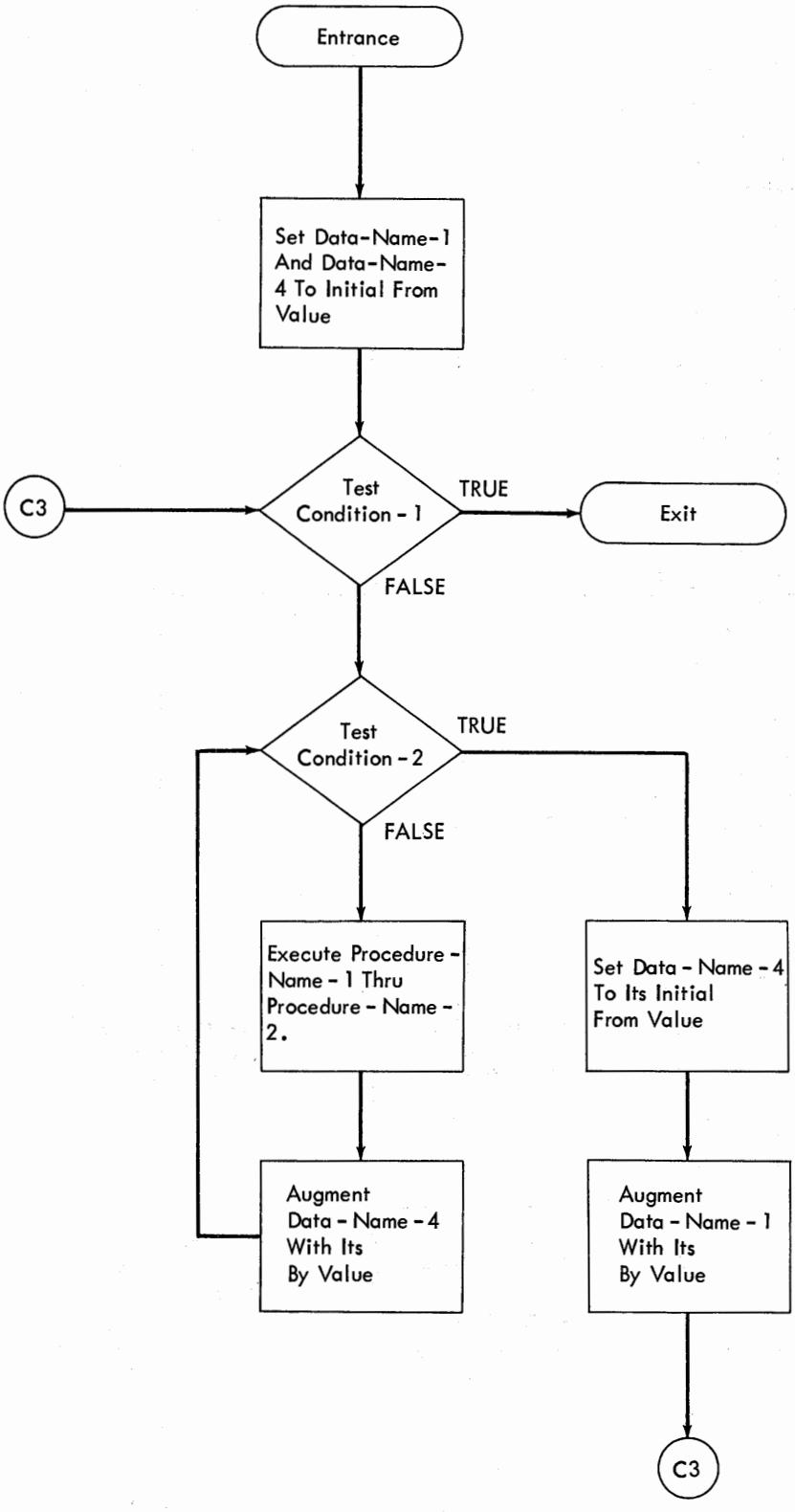


Figure 24. Logical Flow of Option 4 PERFORM Statement Varying Two Data-names

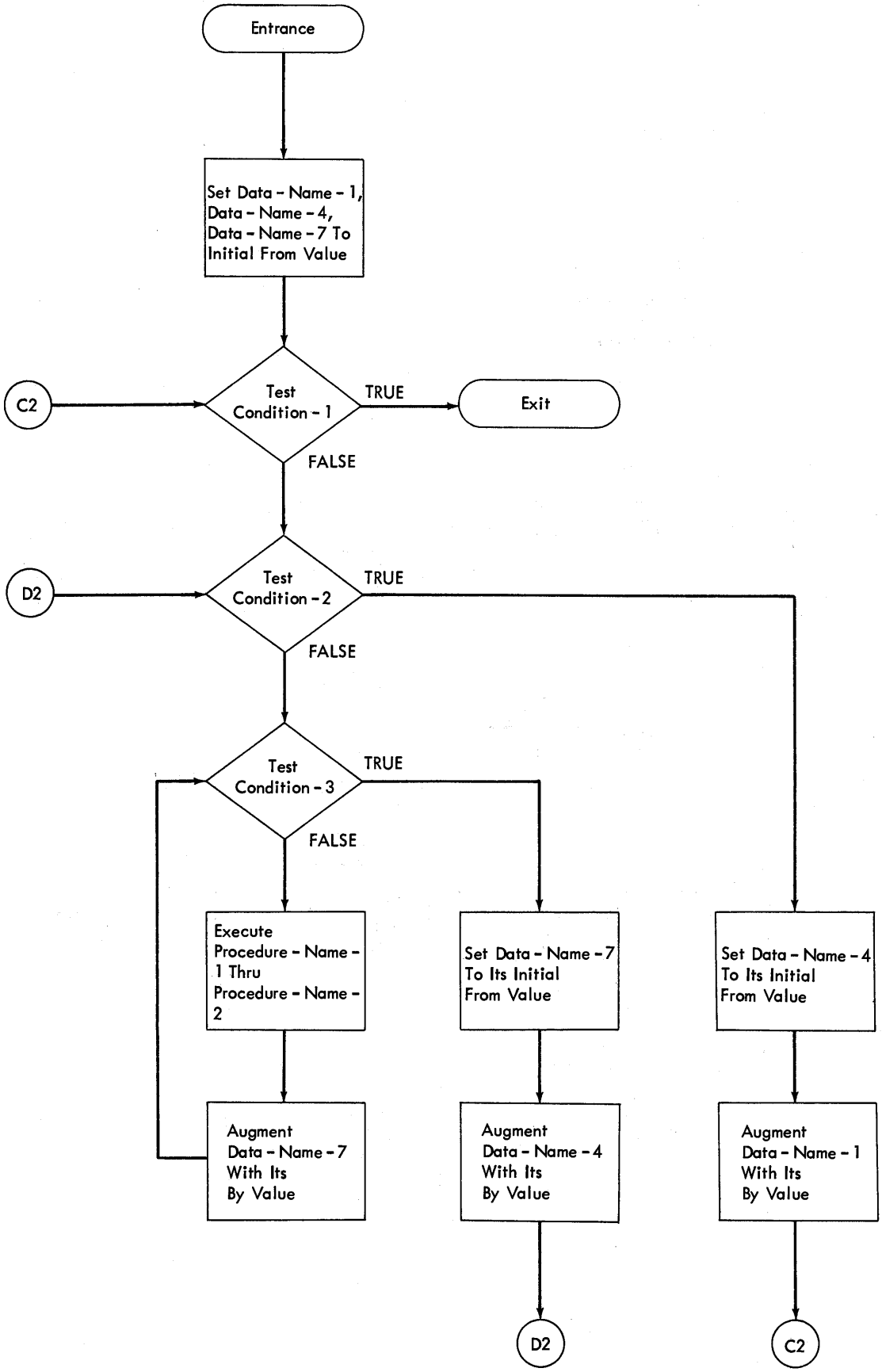


Figure 25. Logical Flow of Option 4 PERFORM Statement Varying Three Data-names

	Appearing In:			
Statement	Label Checking Declarative	Label Creating Declarative	Main Body of Procedure Division	Debug Packet
GO TO PERFORM ALTER	Y[1]	Y[1]	Y[2]	Y[3]
STOP RUN	N	N	end of execution	abnormal end of execution
STOP Literal	Y	Y	Y	Y

[1]Operands of these statements must be procedure-names appearing in the declarative containing the statement.
[2]Operands of these statements must be procedure-names appearing in the main body of the Procedure Division.
[3]Operands of these statements may be procedure-names appearing either in the main body of in any debug packet.

Figure 26. Restrictions for Procedure-Branching Statements

COMPILER-DIRECTING STATEMENTS

Compiler-directing statements must be separate sentences.

ENTER Statement

The ENTER statement, used in conjuction with CALL or ENTRY statements, permits communication between a COBOL object program and COBOL called programs or called subprograms in other languages.

The ENTER statement has the following two formats:

Option 1 (Used in calling program)

```
ENTER LINKAGE.
CALL entry-name [USING argument...].
ENTER COBOL.
```

Option 2 (Used in a COBOL subprogram)

```
ENTER LINKAGE.
ENTRY entry-name [USING data-name...].
ENTER COBOL.
                    .
                    .
                    .
          called program statements
                    .
                    .
                    .
ENTER LINKAGE.
RETURN.
ENTER COBOL
```

An example of the use of this format is:

```
                        COBOL PROGRAM SHEET
SEQUENCE  A     B
1   |  6|7|8     12
001|020| |PROCEDURE DIVISION.
   |   | |       .
   |   | |       .
   |   | |       .
002|001| |       ENTER LINKAGE.
002|002| |       CALL 'SUBPRGM' USING RECORD-2.
002|003| |       ENTER COBOL.
```

Refer to Appendix D, Figure 33, for the relationship between the example above, and the sample program given therein.

Entry-name is an external name and must follow the rules for external name formation. It must not be the same as the program-name specified in the Program-ID clause.

Option 1 is used to effect transfer of control to a called program. Entry-name represents the name of the called program's entry point.

In the USING option, an argument may be one of the following:

1. A data-name when calling a COBOL program;

2. A data-name, file-name, or a procedure-name when calling a program written in a language other than COBOL.

Note: When calling a COBOL program, it is permissible to use a file-name as an argument in order to pass the DTF address of the file. See the publication, IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide , Form C24-5025, for further information on this usage.

Option 2 is used to establish an entry point in a COBOL called program. Control is transferred to the entry point by a CALL statement in another program. Entry-name defines the entry point where parameters are saved for eventual return and address parameters are obtained.

Each data-name in the USING portion of the ENTRY statement must be defined in the Linkage Section of the Data Division, and must have level number 01 or 77.

Computer base addresses of data items named in the USING list of an ENTRY statement are obtained from the USING list of the associated CALL statement. Names in the two USING lists (that of the CALL in the main program, and that of the ENTRY in the called program) are paired in one-to-one correspondence.

There is no necessary relationship between the actual names used for such paired names, but the data descriptions must be equivalent. When a group data item is named in the USING list of an ENTRY statement, names subordinate to it in the called program's Linkage Section may be employed in subsequent called program procedural statements.

RETURN enables restoration of the necessary registers saved at an entry point. The return from a subprogram is always to the first instruction following the last instruction in the calling sequence of the main program.

Called programs may, in turn, call other programs. However, a called program may not contain a CALL statement that directly or indirectly calls the calling program.

There must be no path of program flow to an ENTRY statement within the program containing the ENTRY statement. Hence, the statement should not have a paragraph-name.

EXIT Statement

The EXIT statement may be used when it is necessary to provide an end point for a procedure that is to be executed by means of a PERFORM statement or for a procedure that is a declarative.

The format for the EXIT statement is:

paragraph-name. EXIT.

EXIT must appear in the source program as a one-word paragraph preceded by a paragraph-name.

When the PERFORM statement is used, an EXIT paragraph-name may be the procedure-name given as the object of the THRU option. In this case, a statement in the range of a PERFORM being executed may transfer to an EXIT paragraph, bypassing the remainder of the statements in the PERFORM range. In all other cases, EXIT paragraphs have no function and control passes sequentially through them to the first sentence of the next paragraph.

NOTE Statement

The NOTE statement permits the programmer to write explanatory comments in the Procedure Division of a source program, which will be produced on the listing but serve no other purpose. The format of the NOTE statement is:

NOTE comment... .

There are two methods of specifying NOTE statements:

1. NOTE may be the first word of a paragraph, in which case any remaining sentences within the paragraph are also considered notes. Rules for proper paragraph structure must be observed.

2. A single sentence beginning with the word NOTE may appear within a paragraph. In this case a period terminates the note.

In both cases, any combination of the characters from the COBOL character set may appear following the word NOTE.

C-level diagnostic messages are generated for words in a NOTE statement longer than 30 characters.

SECTION 7: SOURCE PROGRAM LIBRARY FACILITY

Prewritten source program entries can be included in a COBOL program at compile time. Thus, an installation can utilize standard file descriptions, record descriptions, or procedures without having to recode them. These entries and procedures are contained in a user-created library. They are included in a source program by means of a COPY clause or an INCLUDE statement.

COPY CLAUSE

The COPY clause permits the user to include prewritten Data Division entries or Environment Division clauses in his source program. The COPY clause is written in one of the following forms:

Option 1
(Within the Input-Output Section)

{FILE-CONTROL.} COPY library-name.
{I-O-CONTROL. }

Option 2
(Within the File-Control Paragraph)
SELECT file-name COPY library-name.

Option 3
(Within a file area description entry or within the Working-Storage or Linkage Section)
01 data-name COPY library-name.

Option 4
(Within the Working-Storage or Linkage Section)
77 data-name COPY library-name.

Option 5
(Within the File Section)
FD file-name COPY library-name.

Library-name is contained in the user's library and identifies the entries to be copied. It is an external-name and must follow the rules for external-name formation; that is, a library-name consists of quotation marks enclosing no more than eight alphabetic and numeric characters, the first of which must be alphabetic.

Information copied from the library must not contain a COPY clause.

When Options 1, 2, or 5 are written, the words COPY library-name are replaced within the compiler by the information identified by library-name. This information comprises the sentences or clauses needed to complete the paragraph, sentence, or entry containing the COPY clause.

When Options 3 and 4 are written, the entire entry is replaced by the information identified by library-name, except that the data-name replaces the corresponding data-name in the library. This information comprises a 01 or 77 level entry and any immediately subsequent entries with level numbers higher than 01 or 77.

The data-name replacement is for the compilation, but is not shown on the listing.

The words preceding COPY library-name must conform to COBOL margin restrictions. A COPY clause may be preceded by other information on a source program card, and may be written on more than one card; however on a given card, containing the completion of a COPY clause, there must be no information beyond the clause-terminating period. The material introduced into the source program by the COPY statement will follow the COPY statement on the listing, beginning on the next line.

INCLUDE STATEMENT

The INCLUDE statement permits the user to include prewritten procedures in the Procedure Division of his source program. The INCLUDE statement has the following formats:

Option 1 (For insertion of a paragraph):
paragraph-name. INCLUDE library-name.

Option 2 (For insertion of a section):
section-name SECTION. INCLUDE library-name.

Library-name is contained in the user's library. It identifies the entries to be copied. It is an external name and must follow the rules for external name formation. The library-name must be enclosed in quotation marks.

The words preceding INCLUDE library-name must conform to COBOL margin restrictions. On a given source program card containing the completion of an INCLUDE statement, there must be no information beyond the clause-terminating period. The material from the library will follow the INCLUDE statement on the listing.

When the INCLUDE statement is written, the words INCLUDE library-name are replaced by the information identified by library-name. This information comprises the paragraphs or sentences needed to complete the section or paragraph containing the INCLUDE statement.

The library entries for paragraphs and sections must not contain INCLUDE statements.

Refer to IBM System/360 Disk and Tape Operating Systems: System Control and System Service Programs, Form C24-5034, for a description of library facilities.

STERLING CURRENCY FEATURE

System/360 COBOL provides facilities for handling sterling currency items by means of an extension of the PICTURE clause. Additional options and formats, necessitated by the non-decimal nature of sterling and by the conventions by which sterling amounts are represented in punched cards, are also available.

Note: Sterling currency statements can be compiled on the disk system only.

System/360 COBOL provides a means to express sterling currency in pounds, shillings, and pence, in that order. There are 20 shillings in a pound, and 12 pence in a shilling. Although sterling amounts are sometimes expressed in shillings and pence only (in which case the number of shillings may exceed 99), within machine systems shillings will always be expressed as a 2-digit field. Pence, when in the form of integers, likewise will be expressed as a 2-digit field. However, provision must be made for pence to be expressed as decimal fractions as well, as in the form 17s.10.237d.

The IBM method for representing sterling amounts in punched cards uses two columns for shillings and one for pence. Tenpence (10d.) is represented by an '11' punch and elevenpence (11d.) by a '12' punch. The British Standards Institution (B.S.I.) representation uses single columns for both shillings and pence. The B.S.I. representation for shillings consists of a '12' punch for ten shillings, and the alphabetic punches A through I for 11 to 19 shillings, respectively.

Note: The B.S.I. representation for shillings precludes the use of more than 19 shillings in a sterling expression; therefore, 22/10 (that is, 22 shillings 10 pence) must be expanded, by the user, to £1/2/10. Similarly, the guinea (21 shillings) or any multiple thereof, must be expanded to pounds and shillings.

The indicated representations may be used separately or in combination, resulting in four possible conventions.

1. IBM shillings and IBM pence
2. IBM shillings and B.S.I. pence
3. B.S.I. shillings and IBM pence
4. B.S.I. shillings and B.S.I. pence

Any of these conventions may be associated with any number of digits (or none) in the pound field and any number of decimal places (or none) in the pence field. In addition, sign representation may be present as an overpunch in one of several allowable positions in the amount, or may be separately entered from another field.

Two formats are provided by System/360 COBOL in the PICTURE clause for the representation of sterling amounts: sterling report format (used for editing) and sterling non-report format (used for arithmetic). In COBOL D, neither a sterling report format nor a sterling non-report format can contain more than 15 digits in the pound and pence decimal-fraction fields combined.

In the formats that follow, n stands for a positive integer other than zero. This integer enclosed in parentheses and following the symbols 9,B, etc., indicates the number of consecutive occurrences of the preceding symbol. For example, 9(6) and 999999 are equivalent.

The characters 6 7 8 9 C D * , / B Z V . £ : s d CR DB + - are the PICTURE characters used to describe sterling items. (The character £ is the sterling equivalent of the character $.)

Note: The lower case letters "s" and "d" are represented by an 11-0-2 punch and a 12-0-4 punch, respectively.

STERLING NON-REPORT

The format of the PICTURE clause for a sterling non-report data item is:

```
PICTURE IS 9[(n)]D[8]8D {6[6]}
                        {7[7]}
   [[V]9[(n)]] DISPLAY-ST
```

Note: For a sterling non-report picture to be valid, it must contain a pound field, a shilling field, and a pence field.

The representation for pounds is 9[(n)]D where:

a. The character 9 indicates that a character position will always contain a numeric character, and may extend to n positions.

b. The character D indicates the position of an assumed pound separator.

The representation for shillings is [8]8D where:

a. The characters [8]8 indicate the position of the shilling field, and the convention by which shillings are represented in punched cards. 88 indicates IBM shilling representation occupying a two-column field. 8 indicates B.S.I. single-column shilling representation.

b. The character D indicates the position of an assumed shilling separator.

The representation for pence is {6[6]} [[V]9(n)]
{7[7]}

a. The character 6 indicates IBM single-column pence representation wherein 10d. is represented by an '11' punch and 11d. by a '12' punch. The characters 66 indicate 2-column representation of pence, usually from some external medium other than punched cards.

b. The character 7 indicates B.S.I. single-column pence representation wherein 10d. is represented by a '12' punch and 11d. by an '11' punch. The characters 77 indicate 2-column representation of pence. Consequently, 66 and 77 serve the same purpose and are interchangeable.

c. The character V indicates the position of an assumed decimal point in the pence field. Its properties and use are identical with that of V in dollar amounts. Decimal positions in the pence field may extend to n positions.

d. The character 9 indicates that a character position will always contain a numeric character, and may extend to n positions.

Example: Assume that a sterling currency data item used in arithmetic expressions is to be represented in IBM shillings and IBM pence, and that this data item will never exceed £99/19s/11d. Its picture should be:

```
PICTURE 9(2)D88D6 DISPLAY-ST.
```

Sterling Sign Representation

Signs for sterling amounts may be entered as overpunches in one of several allowable positions of the amount. A sign is indicated by an embedded S in the non-report PICTURE immediately to the left of the position containing the overpunch. Allowable overpunch positions are the high-order and low-order positions of the pound field, the high-order shilling digit in 2-column shilling representation, the low-order pence digit in 2-column pence representation, or the least significant decimal position of pence.

The following are examples of sterling currency non-report data items showing sign representation in each of the allowable positions:

```
PICTURE S99D88D6V9(3) DISPLAY-ST

PICTURE 9S9D88D6V9(3) DISPLAY-ST

PICTURE 9(2)DS88D6V9(3) DISPLAY-ST

PICTURE 9(2)D88D6S6V9(3) DISPLAY-ST

PICTURE 9(2)D88D6V99S9 DISPLAY-ST
```

STERLING REPORT

The format for the PICTURE clause for a sterling currency report data item is shown in Figure 27.

The sterling currency report data item is composed of four portions: pounds, shillings, pence, and pence decimal fractions.

The delimiter characters C and D primarily serve to indicate the end of the pounds and shillings portions of the picture. In addition, they serve to indicate the type of editing to be applied to separator characters to the right of the low-order digit (of the pounds and shillings integer portions of the item).

The delimiter character D indicates that separator character(s) to the right of the low-order digit position (of the field delimited) are always to appear; that is, no editing is performed on the separator character(s).

The delimiter character C indicates that if the low-order digit position (of the field delimited) is represented by other than the edit character 9, then editing continues through the separator character(s). For example, a value of zero moved to a sterling report item represented by the picture

```
**/CZ9s/D99d
```

would result in

```
***b0s/00d
```

whereas if the picture were

```
**/DZ9s/D99d
```

the result would be

```
**/b0s/00d.
```

The delimiter C is equivalent to D when the low-order digit position is represented by a 9. That is, the following two pictures are equivalent:

```
ZZ9/CZ9/C99
ZZ9/DZ9/D99
```

The delimiters used for the pounds and shillings portion of the picture need not be the same.

Editing applications are shown in Figure 28.

Note: Although the pound-report-string and the pound-separator-string are optional, a delimiter character (either C or D) must be present: thus, when programming for shillings and pence only, the PICTURE clause must begin PICTURE IS C (or D)... .

The separator characters (those characters required to distinguish one portion of the data item from the next) that may be used in a sterling currency report picture are B : / s (for shillings) d (for pence) and a period. Any of these characters may be used in any position in which a separator character is permitted.

The pound-report-string is subject to the same rules as a normal report picture with the following exceptions:

1. The allowable characters are 9 Z * + - 0 (zero) B and a comma.
2. The character is the sterling equivalent of $.
3. Termination is explicitly specified by the character C or D.
4. Editing of separator characters to the right of the low-order digit varies (depending on the use of C or D as a delimiter).

The representation of digits positions in both the shillings and pence integers portion of the picture is identical. The edit character 8 is treated as a 9 if any digit to the left is nonzero; but, if the digits to the left of the edit character 8 are zeros, the 8 is treated as the character that precedes it (either Z or *).

PROCEDURE DIVISION CONSIDERATIONS

Only the MOVE, ADD, and SUBTRACT statements may contain data-names described as sterling items.

Sterling items are not considered as integral items and should not be used where an integer is required.

1. The functions of the period and the comma may be exchanged in the PICTURE character string and in numeric literals by specifying the INVED option of the COBOL Control Card (see the publication IBM System/360 Disk and Tape Operating Systems: COBOL Programmer's Guide, Form C24-5025).

2. The PICTURE clause of report items may terminate with the currency symbol in cases where the graphic $ is replaced by a particular national currency symbol.

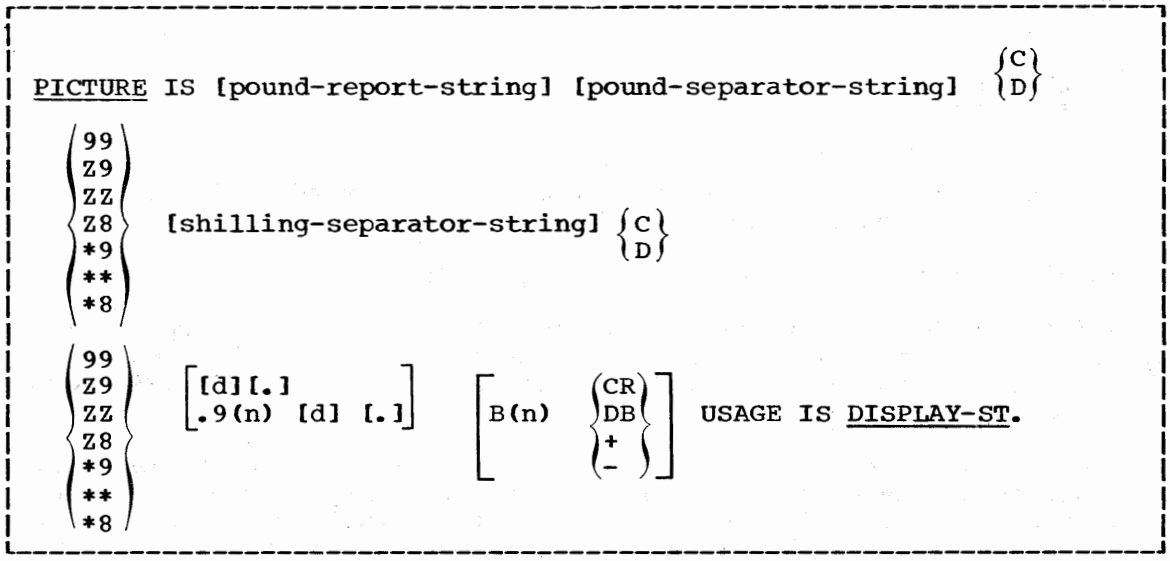


Figure 27. Format of Sterling Report PICTURE Clause

Picture	Numeric Value (in pence)	Sterling Equivalent £	s	d	Result
£££ /D99s/D99d	3068	12	15	08	£12/15s/08d
£££ /D99s/D99d	0668	2	15	08	b£2/15s/08d
£££ /D99s/D99d	0188	0	15	08	bbb/15s/08d
£££ /C99s/D99d	0188	0	15	08	bbbb15s/08d
ZZZ/DZZs/DZZd	0000	0	00	00	bbb/bbs/bbd
ZZZ/CZZs/DZZd	0000	0	00	00	bbbbbbs/bbd
ZZZ/CZZs/CZZd	0000	0	00	00	bbbbbbbbbbd
***/C**D/C**.99d	1040.12	4	06	08.12	**4/*6s/*8.12d
***/C**s/C**.99d	080.12	0	06	08.12	*****6s/*8.12d
***/D**s/D**.99d	00001.23	0	00	01.23	***/**s/*1.23d
£££ /D*9s/D**.99d	00961.23	4	00	01.23	b£4/*0s/*1.23d
£**/D*9s/D**.99d	00961.23	4	00	01.23	£*4/*0s/*1.23d
£**/D*9s/D**.99d	00001.23	0	00	01.23	£**/*0s/*1.23d

Figure 28. Sterling Currency Editing Applications

The following statements are provided for program debugging. They may appear anywhere in a COBOL Disk or Tape Operating Systems program or in a compile-time debugging packet.

For the TRACE and EXHIBIT statements the output is written on the system logical printing device (SYSLST).

TRACE

The format of the TRACE statement is:

```
{READY}
{RESET}TRACE
```

After a READY TRACE statement is encountered, each time execution of a paragraph or section begins, the paragraph-name or section-name is written on SYSLST, thus providing a trace of the path followed during program execution.

The execution of a RESET TRACE statement terminates the functions of a previous READY TRACE statement.

EXHIBIT

The format of the EXHIBIT statement is:

```
                 {NAMED         }  {data-name        }
EXHIBIT          {CHANGED NAMED }  {non-numeric-literal} ...
                 {CHANGED       }
```

Data-name may refer to an elementary or group item. However, if data-name is a group item, subfields specified as other than USAGE IS DISPLAY are not converted to a printable format.

The execution of an EXHIBIT NAMED statement causes a formatted display of the data-names (or non-numeric literals) listed in the statement. The format of the output for each data-name listed in the NAMED or CHANGED NAMED form of an EXHIBIT statement is:

```
blank
original data-name (including qualifiers, if written)
blank
equal sign
blank
value of data-name
blank
```

Literals listed in the statement are preceded by a blank, when displayed.

The sum of the sizes of the operands of an EXHIBIT statement may not exceed the maximum logical record length for the system logical printing device (SYSLST).

The EXHIBIT NAMED option statement is exhibited with up to four data-names and their data per print line. The sum of the size of the operands of each group of data names cannot exceed the maximum logical record length for the system logical printing device (SYSLST).

Each EXHIBIT statement must be the last statement in a sentence.

The CHANGED form of the EXHIBIT statement provides for a display of items when they change value, compared to the value at the previous time the EXHIBIT CHANGED statement was executed. The initial time such a statement is executed, all values are considered changed; they are displayed and saved for purposes of comparison.

Note that, if two distinct EXHIBIT CHANGED data-name statements appear in a program, changes in data-name are associated with the two separate statements. Depending on the path of program flow, the values of data-name saved for comparison may differ for the two statements.

Only one data-name may be listed in an EXHIBIT CHANGED statement.

The CHANGED NAMED form of the EXHIBIT statement causes a printout of each changed value for items listed in the statement. Only those values representing changes and their identifying names are printed. A fixed columnar format for the data to be displayed cannot be created with EXHIBIT CHANGED NAMED.

ON (COUNT-CONDITIONAL STATEMENT)

The format of the ON statement is:

```
ON integer-1 [AND EVERY integer-2] [UNTIL integer-3]

    {imperative-statement...}
    {NEXT SENTENCE          }

      [{ELSE     } {statement ...  }]
      [{OTHERWISE} {NEXT SENTENCE}]
```

The ON statement is a conditional statement. It specifies when the statements it contains are to be executed. ELSE (OR OTHERWISE) NEXT SENTENCE may be omitted if it immediately precedes the period for the sentence.

The count-condition (integer-1 AND EVERY integer-2 UNTIL integer-3) is evaluated as follows:

Each ON statement has a compiler-generated counter associated with it. The counter is initialized in the object program with a value of zero.

Each time the path of program flow reaches the ON statement, the counter is advanced by 1. Where K is any positive integer, if the value of the counter is equal to integer-1 +(K*integer-2), but is less than integer-3 if specified, the imperative statements (or NEXT SENTENCE) are executed. Otherwise, the statements after ELSE (or NEXT SENTENCE) are executed. If the ELSE option does not appear, the next sentence is executed.

If integer-2 is not given, it is assumed that integer-2 has a value of 1. If integer-3 is not given, no upper limit is assumed for it.

If neither integer-2 nor integer-3 is specified, the imperative statements are executed only once.

Examples:

ON 2 AND EVERY 2 UNTIL 10 DISPLAY A ELSE DISPLAY B.

On the second, fourth, sixth, and eighth times, A is displayed. B is displayed at all other times.

ON 3 DISPLAY A.

On the third time through the count-conditional statement, A is displayed. No action is taken at any other time.

Note: An ON statement with an UNTIL or ELSE option may not be used in an IF statement.

COMPILE-TIME DEBUGGING PACKET

Debugging statements for a given paragraph or section in a program may be grouped together into a debugging packet. These statements will be compiled with the source language program, and will be executed at object time. Each packet refers to a specified paragraph-name or section-name in the Procedure Division. Compile-time debugging packets are grouped together and are placed immediately preceding the source program.

Each compile-time debug packet is headed by the control card *DEBUG. The general form of this card is

```
1       8
*DEBUG location
```

where the parameters are described as follows:

Location is the COBOL section-name or paragraph-name (qualified, if necessary) indicating the point in the program at which the packet is to be executed. The statements in the packet are executed as if they were physically placed in the source program following the section-name or paragraph-name, but preceding the text associated with the name. The same location must not be used in more than one *DEBUG control card. Location cannot be a paragraph-name within any debug packet.

Note: Location can start anywhere within Margin A.

A debug packet may consist of any procedural statement conforming to the requirements of COBOL Disk and Tape Operating Systems. A GO TO, PERFORM, or ALTER statement in a debug packet may refer to a procedure-name in any debug packet or in the main body of the Procedure Division.

APPENDIX A: DISK AND TAPE OPERATING SYSTEMS COBOL WORD LIST

The words listed below constitute the Disk and Tape Operating Systems COBOL vocabulary of reserved words. (Included in the list are reserved words used by other IBM COBOL compilers. These words are placed in the list to aid in conversion from either Disk or Tape Operating System/360 COBOL to another IBM COBOL compiler. These words are enclosed in parentheses to help identify them. They have no special status in DOS/TOS COBOL.)

The programmer is reminded that reserved words have preassigned meanings in the COBOL language and cannot legally be used for any other purpose. Use of a reserved word as a data item, although illegal, will not cause diagnostic messages or program failure when the reserved word is not also used in its main function within the program. The reserved word NOTE, however, may not be used as a data item under any circumstances.

ACCEPT	(CONTROL)	FOR
ACCESS	(CONTROLS)	FORM-OVERFLOW
ACTUAL	COPY	FROM
ADD	(CORRESPONDING)	
ADVANCING	COUNT	(GENERATE)
AFTER	CREATING	GIVING
ALL	(CYCLES)	GO
ALPHABETIC		GREATER
ALTER	DATA	(GROUP)
ALTERNATE	DATE-COMPILED	
AND	DATE-WRITTEN	(HEADING)
APPLY	(DE)	HIGH-VALUE
ARE	(DECIMAL POINT)	HIGH-VALUES
AREA	DECLARATIVES	(HOLD)
AREAS	DEPENDING	
(ASCENDING)	(DESCENDING)	IBM-360
ASSIGN	(DETAIL)	(ID)
AT	DIRECT	IDENTIFICATION
AT END	DIRECT-ACCESS	IF
AUTHOR	DISPLAY	IN
	DISPLAY-ST	INCLUDE
(BEFORE)	DIVIDE	INDEXED
BEGINNING	DIVISION	(INDICATE)
BLANK		(INITIATE)
BLOCK	ELSE	INPUT
BY	END	INPUT-OUTPUT
	ENDING	INSTALLATION
CALL	ENTER	INTO
(CF)	ENTRY	INVALID
(CH)	ENVIRONMENT	I-O
CHANGED	EQUAL	I-O-CONTROL
CHARACTER	ERROR	IS
CHECKING	EVERY	
(CLOCK-UNITS)	EXAMINE	JUSTIFIED
CLOSE	EXHIBIT	
COBOL	EXIT	KEY
(CODE)		
(COLUMN)	FD	LABEL
(COMMA)	FILE	LABELS
COMPUTATIONAL	FILE-CONTROL	(LAST)
COMPUTATIONAL-1	FILE-ID	LEADING
COMPUTATIONAL-2	(FILE-LIMIT)	LEFT
COMPUTATIONAL-3	FILES	LESS
COMPUTE	FILLER	LIBRARY
CONFIGURATION	(FINAL)	(LIMIT)
CONSOLE	FIRST	(LIMITS)
CONTAINS	(FOOTING)	(LINE-COUNTER)

(LINE)
LINES
LINKAGE
LOCK
LOW-VALUE
LOW-VALUES

MODE
MORE-LABELS
MOVE
MULTIPLY

NAMED
NEGATIVE
NEXT
NO
NOT
NOTE
NUMERIC

OBJECT-COMPUTER
OCCURS
OF
OMITTED
ON
OPEN
OR
ORGANIZATION
OTHERWISE
OUTPUT
(OVERFLOW)

(PAGE)
(PAGE-COUNTER)
PERFORM
(PF)
(PH)
PICTURE
(PLUS)
POSITIVE
(PRINT-SWITCH)
PROCEDURE
PROCEED
(PROCESS)
PROCESSING
PROGRAM-ID
PROTECTION

QUOTE
QUOTES

RANDOM
(RD)
READ
READY
RECORD
RECORDING
RECORDS
REDEFINES
REEL
(RELATIVE)
(RELEASE)
REMARKS
REPLACING
(REPORT)
(REPORTING)
(REPORTS)
RERUN
RESERVE
RESET
RESTRICTED
RETURN
REVERSED
REWIND
REWRITE
(RF)
(RH)
RIGHT
ROUNDED
RUN

(SA)
SAME
(SD)
SEARCH
SECTION
SECURITY
SELECT
SENTENCE
SEQUENTIAL
SIZE
(SORT)
(SOURCE)
SOURCE-COMPUTER
SPACE
SPACES

(SPECIAL-NAMES)
STANDARD
STOP
SUBTRACT
(SUM)
SYMBOLIC
(SYSIN)
(SYSOUT)
SYSPUNCH

TALLY
TALLYING
(TERMINATE)
THAN
THEN
THRU
TIMES
TO
TRACE
TRACK-AREA
TRACKS
TRANSFORM
(TRY)
(TYPE)

UNIT
UNIT-RECORD
(UNITS)
UNTIL
UPON
USAGE
USE
USING
UTILITY

VALUE
VARYING

WHEN
WITH
WITHOUT
WORKING-STORAGE
WRITE
WRITE-ONLY

ZERO
ZEROES
ZEROS

APPENDIX B: INTRARECORD SLACK BYTES AND RECORD ALIGNMENT IN BLOCK FILES

In IBM System/360, storage is organized into bytes. Four bytes comprise a word of storage. Two bytes comprise a halfword; eight bytes comprise a doubleword. Certain types of processing operations require that data be aligned on a certain type of boundary--halfword, fullword, or doubleword. In order to insure correct alignment in such cases, it is sometimes necessary to insert bytes containing no meaningful data between data-items or between records. These are called slack bytes. In certain cases, they are inserted by the compiler; in other cases, it is the responsibility of the user to insert them.

INTRARECORD SLACK BYTES

For ease of programing and efficient object code, the COBOL compilier:

- Provides automatic field alignment within Working-Storage section, and unblocked files.
- Provides the facility of working with input and output records directly in a buffer.
- Provides efficient use of file space by packing succeeding blocked records without regard to alignment.

Whenever the USAGE is defined as COMPUTATIONAL, COMPUTATIONAL-1, or COMPUTATIONAL-2 within an 01 record description, slack bytes, if required, are automatically added to the record by the compiler in order to ensure proper synchronization of these computational data items. These slack bytes are added on the assumption that all 01 levels are aligned on a double word boundary. It is the user's responsibility to ensure that the data item is aligned on a double word boundary when:

- The argument of a CALL statement corresponds to a data-name defined with an 01 level in the LINKAGE SECTION of the subprogram.
- The record names are associated with a file where logical records are blocked.

The user can ensure this double word boundary alignment by moving the data item to an 01 level defined in working storage, or by adding interrecord slack bytes to force proper alignment of succeeding records in the block. (See Record Alignment Within Block Files.)

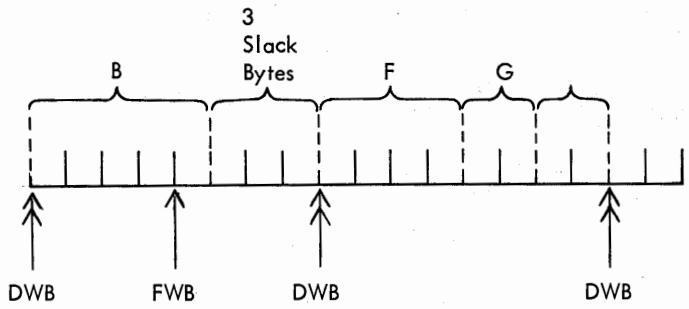
To determine the interrecord slack bytes required, the compiler:

- Sums the size of all elementary data items preceding a COMPUTATIONAL, COMPUTATIONAL-1 or COMPUTATIONAL-2 field including any slack bytes previously added.
- Divides this sum by K where:
  K = 8 for COMPUTATIONAL-2
  K = 4 for COMPUTATIONAL-1, or COMPUTATIONAL (5 digits or greater)
  K = 2 for COMPUTATIONAL (4 digits or smaller)
- If the remainder (R) = 0, no slack bytes are required.

If R ≠ 0, K-R slack bytes are added, these slack bytes are inserted after the last elementary data item (B in Figure 29) preceding the computational entry. Following the last elementary item (B) is a filler with a level number equivalent to the next entry (E).

Note: The filler is shown in the coding to illustrate the point. In reality, the filler is not listed as shown, but is generated by the compiler internally.

Figure 29 is an illustration of how slack bytes are inserted as a filler when USAGE is defined as COMPUTATIONAL, COMPUTATIONAL-1 or COMPUTATIONAL-2.



Bytes = 5
K = 4
Q = Quotient
R = Remainder
DWB = Double Word Boundary
FWB = Full Word Boundary

Bytes/K = Q + R
5/4 = 1 + 1 Therefore, Q=1, R=1 then
K-R = Slack Bytes Required

The filler implied would be:
02 FILLER PICTURE X(3);
as illustrated above

Figure 29. Use of Implied Filler as Slack Bytes

CODING FOR A USAGE CLAUSE

```
                    01  A.
                        02  B PICTURE X(5).
  Implied Filler        02  FILLER PICTURE X(3).
                        02  E COMPUTATIONAL.
                            03  F PICTURE 9(6).
                            03  G PICTURE 9(4).
```

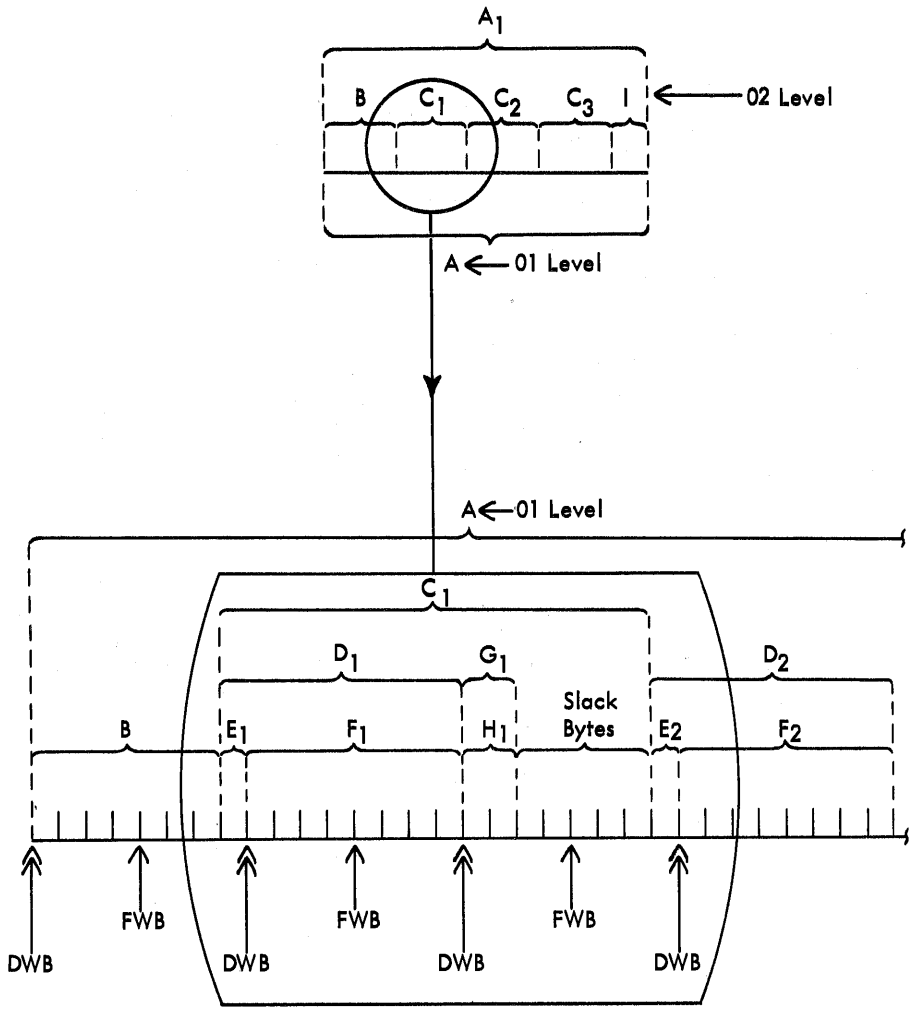
Slack bytes may also be added (automatically) whenever a group field is defined with an OCCURS clause and contains a data item whose usage is COMPUTATIONAL, COMPUTATIONAL-1, and COMPUTATIONAL-2.

To determine if slack bytes are required:

- Calculate the size of the group up to the point where adjustment is required including all necessary intrarecord slack bytes.
- Divide this sum by the largest K required by an elementary item within the group.
- If R=0, no slack bytes are required. If R≠0, K-R slack bytes are added.

The slack bytes are added at a level number equal to that of the group + 1 at the end of the group with the OCCURS.

See Figure 30 and the discussion that follows for an illustration of the use of slack bytes with an OCCURS clause.



DWB = Double Word Boundary
FWB = Full Word Boundary

Figure 30. Use of Slack Bytes as a Filler When a Group Field Is Defined

CODING OF AN OCCURS CLAUSE

```
                    01  A.
                        02  B PICTURE IS X(7).
                        02  C OCCURS 3 TIMES.
                            03  D.
                                04  E PICTURE IS X.
                                04  F USAGE COMPUTATIONAL-2.
                            03  G.
                                04  H PICTURE IS XX.
Implied Filler              03  FILLER PICTURE IS X(5).
                        02  I PICTURE IS X.
```

Fields A, B, and C can be represented as shown in Figure 30.

To compute the number of slack bytes, calculate the size of the group(C_1):

$$\text{BYTES} = 11 \qquad \frac{\text{BYTES}}{K} = Q + R$$

$$K = 8$$

$$\frac{11}{8} = 1 + 3, \qquad K - R = \text{NUMBER OF SLACK BYTES}$$

8 - 3 = 5 slack bytes; therefore, the filler is implied as:

```
03 FILLER PICTURE IS X(5).
```

RECORD ALIGNMENT WITHIN BLOCK FILES

Because the processing is done in a buffer, and not deblocked to a work area, the user must follow record alignment procedures within blocked files. When working with blocked files, slack bytes are not automatically added as when working with data. However, diagnostics will inform the user of the number of slack bytes required for fixed-length record alignment.

For purposes of adding intrarecord slack bytes to assure proper alignment of COMPUTATIONAL, COMPUTATIONAL-1, and COMPUTATIONAL-2 fields, all 01 levels are assumed to start on a double-word boundary.

Valid alignment of records can be accomplished by:

- Moving to an 01 in working-storage
- Adding the necessary slack bytes.

The compiler assures the user that all 01 levels in Working-Storage SectionS and all I/O buffers (not including any control bytes required by data management) will be aligned on a doubleword boundary.

When processing records in the buffer or on a file where the logical records are blocked and contain COMPUTATIONAL, COMPUTATIONAL-1 and COMPUTATIONAL-2 fields, the user must add the necessary slack bytes to ensure proper alignment of the logical records within the buffer.

To determine if interrecord slack bytes are required:

- Sum up the size of the record (include all intrarecord slack bytes).
- Divide this sum by maximum K required in any one of the elementary items.
- If R = O, no slack bytes are required.
  If R ≠, K-R slack bytes are required.

For alignment, the record should be expanded by the required number of slack bytes. Figure 31 (parts A and B) and the following text, illustrate invalidly aligned, and appropriately aligned, blocked files respectively.

Blocked V-type records containing COMPUTATIONAL-2 entries must be moved for proper alignment.

BLOCK FILES EXAMPLE CODING

```
FD A BLOCK CONTAINS 3 RECORDS LABEL RECORDS ARE OMITTED, DATA RECORDS
IS B.

01 B.

    02 C COMPUTATIONAL-1.

    02 D PICTURE X.
```

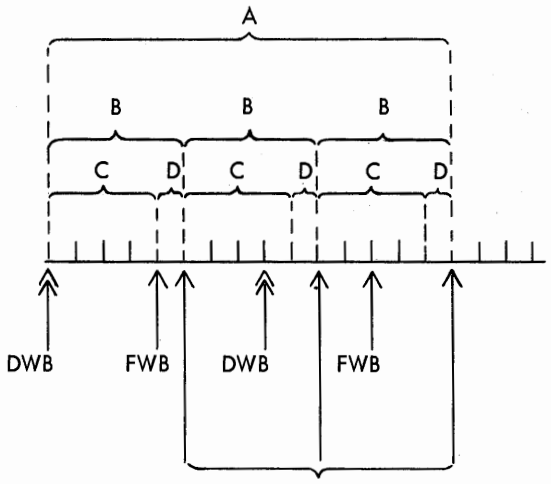
Note the invalid alignment for a COMPUTATIONAL-1 field in Figure 31, Part A.

To rectify this condition, (invalid alignment), move field B to an 01 in WORKING-STORAGE where automatic alignment will be provided, or compute and add the required filler as shown in the following.

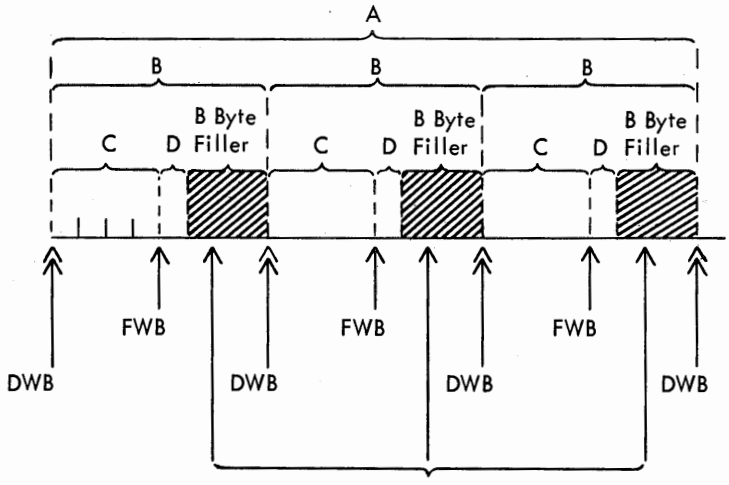
BLOCK FILE EXAMPLE CODING SHOWING THE FILLER FOR ALIGNMENT (REPEATED HERE FOR CLARITY).

```
FD A BLOCK CONTAINS 3 RECORDS LABEL RECORDS ARE OMITTED, DATA RECORDS IS B.
01 B.
  02 C COMPUTATIONAL-1.
  02 D PICTURE X.
  02 FILLER PICTURE X(3).
```

Note how fillers pad records to provide alignment of all 01's in the buffer, Figure 31, Part B.



Part A Invalid alignment for a COMPUTATIONAL-1 field



Part B Fillers pad records to provide alignment of 01's in the buffer.

DWB = Double Word Boundary FWB = Full Word Boundary

Figure 31. Invalidly Aligned and Appropriately Aligned File A Buffer

Linkage Section

In Linkage Section all 01's are assumed to be on a doubleword boundary. It is the user's responsibility to ensure proper alignment between an argument in CALL, and the corresponding data name in an ENTRY statement.

In File Section

INPUT FILES: It is the user's responsibility to ensure that the logical records contain the necessary intrarecord slack bytes. If the file is blocked, and processing is done in the buffer, he must have added the necessary interrecord slack bytes when the file was created.

OUTPUT FILES: The compiler adds the necessary intrarecord slack bytes. The user defines the necessary interrecord slack bytes as required by input.

APPENDIX C: INTERMEDIATE RESULTS IN ARITHMETIC OPERATIONS

In the case of an arithmetic statement containing only a single pair of operands, no intermediate results are generated. Intermediate results are possible in the following cases:

1. In an ADD or SUBTRACT statement containing multiple operands immediately following the verb

2. In a COMPUTE statement specifying a series of arithmetic operations

3. In arithmetic expressions contained in IF or PERFORM statements

In concept the compiler treats a statement as a succession of operations. For example, the following statement:

```
COMPUTE Y = A + B * C - D / E + F ** G is replaced by
MULTIPLY B      BY C       GIVING ir1
ADD A           TO ir1     GIVING ir2
DIVIDE E        INTO D     GIVING ir3
SUBTRACT ir3    FROM ir2   GIVING ir4
** F            BY G       GIVING ir5
ADD ir4         TO ir5     GIVING Y
```

This appendix contains a discussion of the compiler algorithms for determining the number of integer and decimal places reserved for intermediate results.

The following abbreviations will be used in this discussion and in Figure 32.

i--number of integer places carried for an intermediate result

d--number of decimal places carried for an intermediate result

d1,d2--number of decimal places defined for op1 or op2, respectively.

df--number of decimal places in final result field

ir--intermediate result field obtained from the execution of a generated arithmetic statement or operation. ir1, ir2, etc., represent successive intermediate results. These intermediate results are generated either in registers or in storage locations. Successive intermediate results may have the same location.

fr--number of integer and decimal places in final result field.

INTERMEDIATE RESULTS

The number of integer and decimal places contained in an ir is calculated as shown in Figure 32.

Operation	Statement Type	Decimal Places	Integer Places
+ or - (internal decimal) [1]	Arithmetic	d1 or d2, whichever is greater	i1 + 1 or i2 + 1, whichever is greater
+ or - (binary) [1]		d1 or d2, whichever is greater	i1 + 1 or i2 + 1 whichever is greater
*		d1 + d2	i1 + i2
/ if (i2+max(df+1,d2) +d1)≤30		df+1 or d2, whichever is greater	i2+d1
/ if (i2+max(df+1,d2) +d1)>30		d2-d1	i2+d1
**		df	fr - df
+ or -	IF or PERFORM	d1 or d2, whichever is greater	30 - d
*		d1+d2	30-d
/		d2	30-d
**		12	18

[1] The user should assume that i will increase by one in all + or - operations if either field is binary or packed.

Figure 32. Calculating Intermediate Results

COMPILER TREATMENT OF INTERMEDIATE RESULTS

The following indicates the action of the compiler when handling intermediate results.

If Value of i + d is	The Action Taken is
<30	i integer and d
=30	decimal places are carried for ir. (If operation is / or **, i + d never exceeds 30)
>30	30 - df integer and df decimal places are carried

Note: If ROUNDED is specified, the value of df is df + 1.

This appendix contains two sample COBOL programs, Figures 33 and 34. One is a calling program, the other is a subprogram which is linked by the calling program. The individual statements comprising the programs were extracted and interspersed throughout the main body of the manual for illustrative purposes. The linkage subprogram illustrated need not be a COBOL program. However, COBOL assumes option 2 of the standard CALL, SAVE, and RETURN macros.

IBM COBOL PROGRAM SHEET

Form No. X28-1464 Printed in U.S.A.

System: IBM BOS/360 | Punching Instructions | Sheet 1 of 2

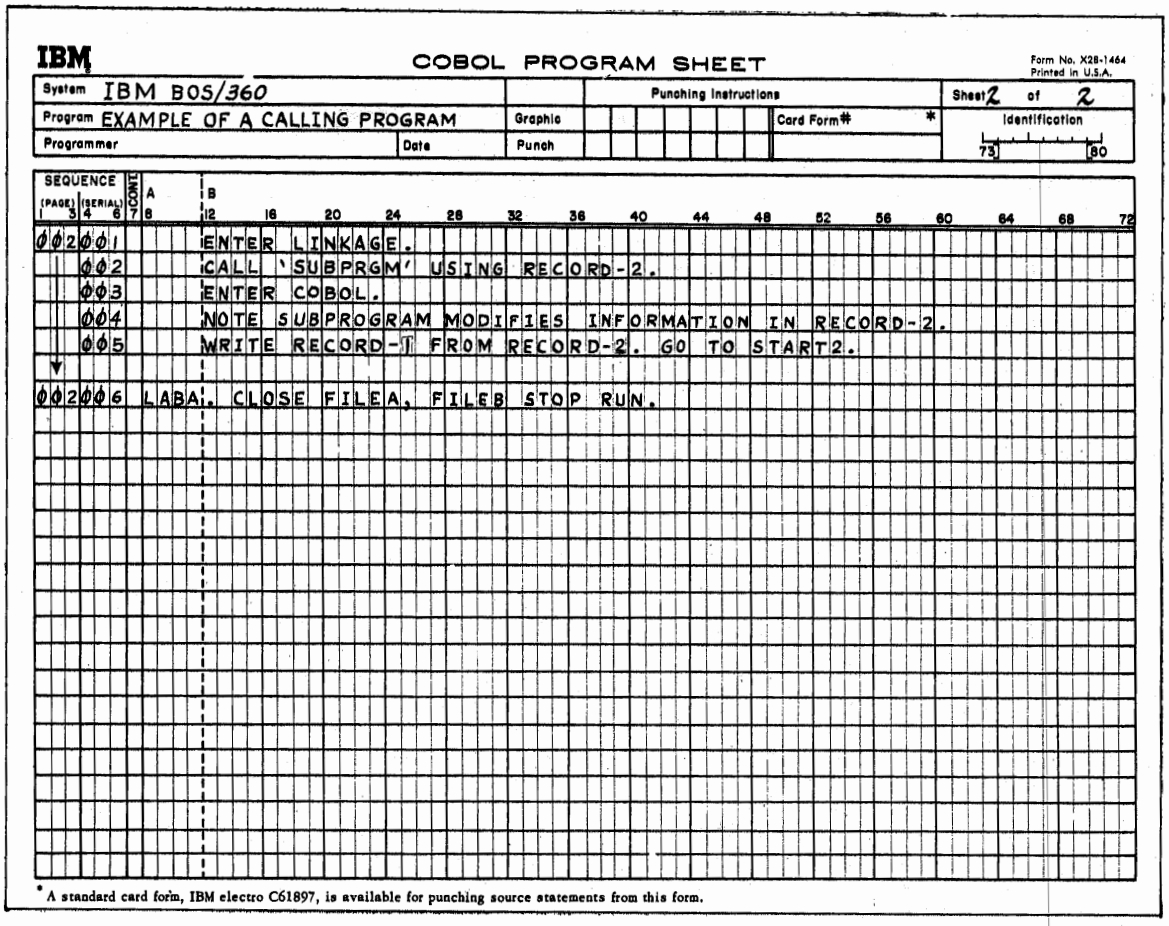
Program: EXAMPLE OF A CALLING PROGRAM | Graphic | Card Form# * | Identification 73–80

Programmer | Date | Punch

SEQUENCE (PAGE) 1–3	SEQUENCE (SERIAL) 4–6	CONT 7	A 8–11 / B 12–72
001	001		IDENTIFICATION DIVISION.
	002		PROGRAM-ID. 'CALLPRGM'.
	003		REMARKS. EXAMPLE OF A CALLING PROGRAM.
	004		ENVIRONMENT DIVISION.
	005		CONFIGURATION SECTION.
	006		SOURCE-COMPUTER. IBM-360 D30.
	007		OBJECT-COMPUTER. IBM-360 D30.
	008		INPUT-OUTPUT SECTION.
	009		FILE-CONTROL.
	010		SELECT FILEA ASSIGN TO 'SYS004' UTILITY 2400 UNITS.
	011		SELECT FILEB ASSIGN TO 'SYS005' UNIT-RECORD 2540R RESERVE NO
			ALTERNATE AREA.
	012		DATA DIVISION.
	013		FILE SECTION.
	014		FD FILEA, DATA RECORD IS RECORD-1, LABEL RECORDS ARE STANDARD,
			BLOCK CONTAINS 5 RECORDS, RECORDING MODE IS F.
	015		01 RECORD-1.
	016		02 SUB-FIELDA PICTURE IS X(68).
	017		02 SUB-FIELDB PICTURE IS X(12).
	018		FD FILEB DATA RECORD IS RECORD-2, LABEL RECORDS ARE OMITTED.
	019		01 RECORD-2 PICTURE X(80).
	020		PROCEDURE DIVISION.
	021		START. OPEN INPUT FILEB OUTPUT FILEA.
001	022		START2. READ FILEB AT END GO TO LABA.

* A standard card form, IBM electro C61897, is available for punching source statements from this form.

Figure 33. Example of a Calling Program (Part 1 of 2)



IBM COBOL PROGRAM SHEET

Form No. X28-1464 Printed in U.S.A.

System: IBM BOS/360 | Punching Instructions | Sheet 2 of 2

Program: EXAMPLE OF A CALLING PROGRAM | Graphic | Card Form# * | Identification (73–80)

Programmer | Date | Punch

SEQUENCE (PAGE)	SEQUENCE (SERIAL)	CONT	A / B
00	001		ENTER LINKAGE.
	002		CALL 'SUBPRGM' USING RECORD-2.
	003		ENTER COBOL.
	004		NOTE SUBPROGRAM MODIFIES INFORMATION IN RECORD-2.
	005		WRITE RECORD-T FROM RECORD-2. GO TO START2.
00	006		LABA. CLOSE FILEA, FILEB STOP RUN.

* A standard card form, IBM electro C61897, is available for punching source statements from this form.

Figure 33. Example of a Calling Program (Part 2 of 2)

IBM COBOL PROGRAM SHEET

Form No. X28-1464 Printed in U.S.A.

System: IBM BOS/360 | Punching Instructions | Sheet 1 of 2

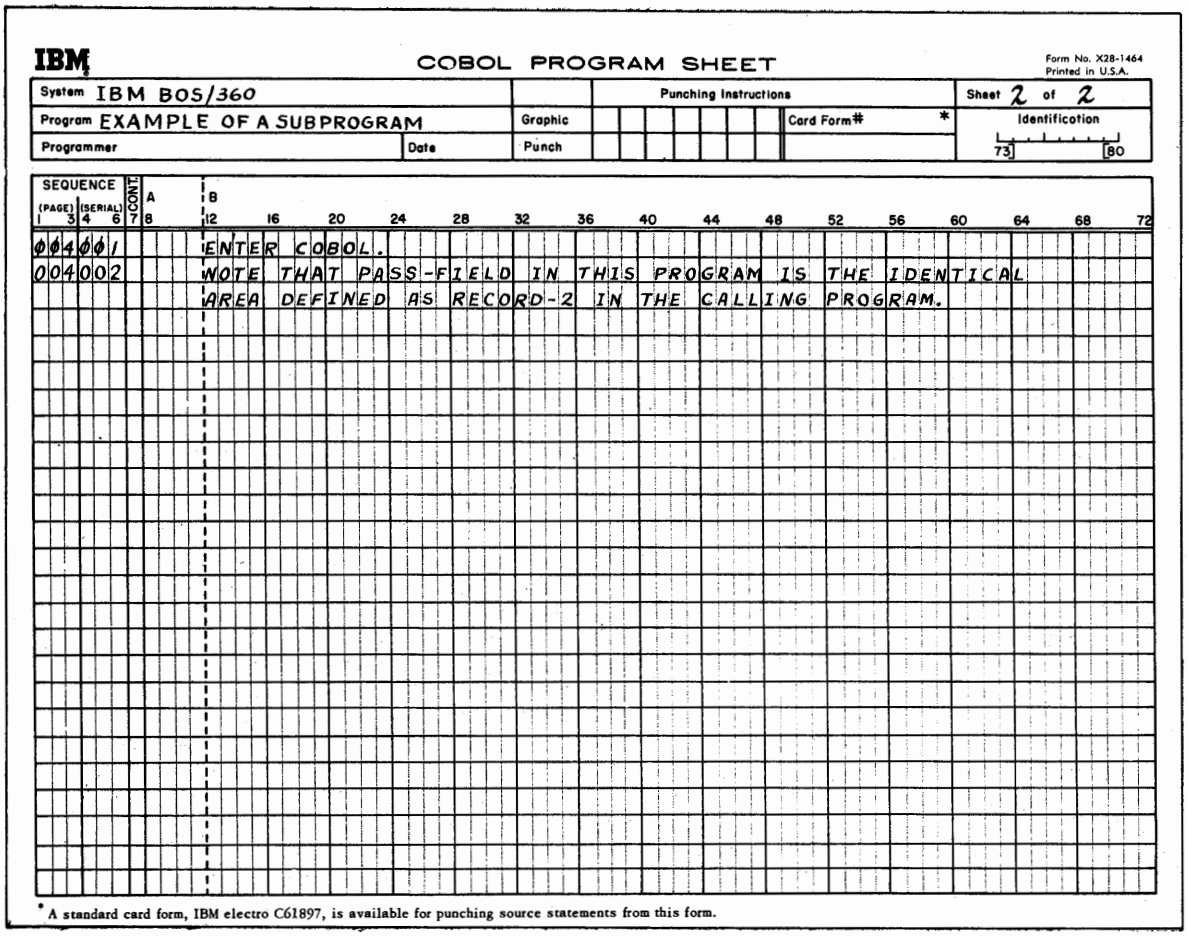
Program: EXAMPLE OF A SUBPROGRAM | Graphic | Card Form* | Identification (73–80)

Programmer | Date | Punch

```
SEQUENCE (PAGE) (SERIAL) CONT   A   B
 1  3  4  6  7  8   12   16   20   24   28   32   36   40   44   48   52   56   60   64   68   72
00300 01  IDENTIFICATION DIVISION.
      02  PROGRAM-ID. 'SUBPROG'.
      03  REMARKS. EXAMPLE OF A SUBPROGRAM.
      04  ENVIRONMENT DIVISION.
      05  CONFIGURATION SECTION.
      06  SOURCE-COMPUTER. IBM-360 D30.
      07  OBJECT-COMPUTER. IBM-360 D30.

      08  DATA DIVISION.
      09  WORKING-STORAGE SECTION.

      10  77  MODIFICATION PICTURE X(12), VALUE IS 'PUT ANY DATA'.
      11  LINKAGE SECTION.
      12  01  PASS-FIELD.
      13      02  A PICTURE X(68).
      14      02  B PICTURE X(12).

      15  PROCEDURE DIVISION.
      16  START. ENTER LINKAGE.
      17         'ENTRY 'SUBPRGM' USING PASS-FIELD.
      18         'ENTER COBOL.
      19  MODIFY. MOVE MODIFICATION TO B.
      20         'ENTER LINKAGE.
00302 21         'RETURN.
```

* A standard card form, IBM electro C61897, is available for punching source statements from this form.

Figure 34. Example of a Subprogram (Part 1 of 2)



IBM COBOL PROGRAM SHEET

Form No. X28-1464 Printed in U.S.A.

System IBM BOS/360 | Punching Instructions | Sheet 2 of 2

Program EXAMPLE OF A SUBPROGRAM | Graphic | Card Form# * | Identification 73 80

Programmer | Date | Punch

SEQUENCE (PAGE) 1 3 (SERIAL) 4 6 | CONT. 7 | A 8 | B 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72

```
000001     ENTER COBOL.
000002     NOTE THAT PASS-FIELD IN THIS PROGRAM IS THE IDENTICAL
           AREA DEFINED AS RECORD-2 IN THE CALLING PROGRAM.
```

* A standard card form, IBM electro C61897, is available for punching source statements from this form.

Figure 34. Example of a Subprogram (Part 2 of 2)

S/360 COBOL Lang. Spec. Printed in U.S.A. GC24-3433-6

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Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
[U.S.A. only]

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
[International]