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DOS

Systems Reference Library

IBM System/360 DOS

Full American National Standard COBOL

Programmer's Guide

Program Number 360N-CB-482

This publication describes how to compile an American National Standard COBOL X3.23-1968 program using the IBM System/360 Disk Operating System Full American National Standard COBOL Compiler Version 2. It also describes how to link edit the resulting object module, and execute the program. Included is a description of the output from each of these three steps: compile, link edit, and execute. In addition, this publication explains features of the compiler and available options of the operating system. American National Standard COBOL was formerly known as USA Standard COBOL.

PREFACE

This publication is logically and functionally divided into two parts. Part I contains information useful to programmers who are running IBM Full American National Standard COBOL programs, i.e., programs compiled on the Version 2 Compiler, under the control of the IBM System/360 Disk Operating System. Part I covers such topics as job control language, library usage, interpreting output, and program debugging. Part I is intended solely as object-time reference material.

Part II contains supplemental information on the use of the language as specified in the publication IBM System/360 Disk Operating System: Full American National Standard COBOL, Order No. GC28-6394, and should be used in conjunction with this publication for coding IBM American National Standard COBOL programs. Part II covers in detail such topics as file organization, file label handling, and record formats. Part II is intended as source-time reference material for language features that are primarily system-dependent.

Wider ranging and more detailed discussions of the Disk Operating System are given in the following publications:

DOS System Control and Service, Order No. GC24-5036

DOS Supervisor and I/O Macros, Order No. GC24-5037

DOS Data Management Concepts, Order No. GC24-3427

DOS System Generation, Order No. GC24-5033

IBM System/360 Principles of Operation, Order No. GA24-6821

The titles and abstracts of related publications are listed in the publication IBM System/360 Bibliography, Order No. GA22-6822.

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GN28-0458 (December 15, 1971) (DOS Release 26)
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Changes are periodically made to the specifications herein, any such changes will be reported in subsequent revisions or Technical Newsletters.

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

A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be addressed to IBM Corporation, Programming Publications, 1271 Avenue of the Americas, New York, New York 10020.

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COBOL has undergone considerable refinement and standardization since 1959. A standard COBOL has been approved by the American National Standards Institute, an industry-wide association of computer manufacturers and users. This standard is called American National Standard COBOL. IBM Full American National Standard COBOL is compatible with American National Standard COBOL and includes a number of extensions to it as well.

An IBM Full American National Standard COBOL program may be processed by the IBM System/360 Disk Operating System. Under control of the operating system, a set of IBM Full American National Standard COBOL source statements is translated to form a module. In order to be executed, the module in turn must be processed to form a phase. The reasons for this will become clear later. For now it is sufficient to note that the flow of an IBM Full American National Standard COBOL (herein, simply termed COBOL) program through the operating system is from source statements to module to phase.

The Disk Operating System consists essentially of a control program and a number of processing programs.

CONTROL PROGRAM

The components of the control program are: the Supervisor, Job Control Processor, and the Initial Program Loader.

SUPERVISOR

The main function of the Supervisor is to provide an orderly and efficient flow of jobs through the operating system. (A job is some specified unit of work, such as the processing of a COBOL program.) The Supervisor loads into the computer the phases that are to be executed. During execution of the program, control usually alternates between the Supervisor and the processing program. The Supervisor, for example, handles all requests for input/output operations.

JOB CONTROL PROCESSOR

The primary function of the Job Control Processor is the processing of job control statements. Job control statements describe the jobs to be performed and specify the programmer's requirements for each job. Job control statements are written by the programmer using the job control language. The use of job control statements and the rules for specifying them are discussed later.

INITIAL PROGRAM LOADER

The Initial Program Loader (IPL) routine loads the Supervisor into main storage when system operation is initiated. Detailed information about the Initial Program Loader need not concern the COBOL programmer. Anyone interested in this material, however, can find it in the publication DOS System Control and Service.

PROCESSING PROGRAMS

The processing programs include the COBOL compiler, service programs, and application programs.

SYSTEM SERVICE PROGRAMS

The system service programs provide the functions of generating the system, creating and maintaining the library sections, and editing programs into disk residence before execution. The system service programs are:

1. Linkage Editor. The Linkage Editor processes modules and incorporates them into phases. A single module can be edited to form a single phase, or several modules can be edited or linked together to form one executable phase. Moreover, a module to be processed by the Linkage Editor may be one that was just created (during the same job) or one that was created in a previous job and saved.

The programmer instructs the Linkage Editor to perform these functions through job control statements. In addition, there are several linkage editor control statements. Information on their use is given later.

2. Librarian. The Librarian consists of a group of programs used for generating the system, maintaining and reorganizing the disk library areas, and providing printed and punched output from the libraries. The three system libraries are: the core image library, the relocatable library, and the source statement library. In addition, the Librarian supports private core image, relocatable, and source statement libraries. Detailed information on the Librarian is given later.

APPLICATION PROGRAMS

Application programs are usually programs written in a higher-level programming language (e.g., COBOL). All application programs within the Disk Operating System are executed under the supervision of the control program.

IBM-SUPPLIED PROCESSING PROGRAMS

The following are examples of IBM-supplied processing programs:

1. Language translators, e.g., COBOL compiler
2. Sort/Merge
3. Utilities
4. Autotest

MULTIPROGRAMMING

For those systems with main storage equal to or in excess of 24K bytes, the Disk Operating System offers multiprogramming support. In addition to at least 24K bytes of main storage, multiprogramming support requires the storage protection feature.

Multiprogramming refers to the ability of the system to control more than one program concurrently by interleaving their execution. This support is referred to as fixed partitioned multiprogramming, since programs are assigned to fixed locations when they are cataloged to the system. Each program occupies a contiguous area of main storage. The amount of main storage allocated to programs to be executed may be determined when the system is generated, or it may be determined by the operator when the program is loaded into main storage for execution.

BACKGROUND VS. FOREGROUND PROGRAMS

There are two types of problem programs in multiprogramming: background and foreground. Background programs are initiated by the Job Control Processor from batched-job input streams. Foreground programs may operate in either the batched-job mode or in the single-program mode. Single-program foreground programs are initiated by the operator from the printer-keyboard. When one program is completed, the operator must explicitly initiate the next program.

Background and foreground programs initiate and terminate independently of one another. Neither is aware of the other's status or existence.

The system is capable of concurrently operating one background program and one or two foreground programs. Priority for CPU processing is controlled by the Supervisor with foreground programs having priority over background programs. Control is taken away from a high priority program when that program encounters a condition that prevents continuation of processing, until a specified event has occurred. Control is taken away from a lower priority program when an event for which a higher priority program was waiting has been completed. Interruptions are received and processed by the Supervisor.

In a multiprogramming environment, the COBOL compiler can execute either in the background or the foreground. In systems that support the batched-job foreground and private core image library options, the Linkage Editor can execute in either foreground partition as well as in the background partition. Additional information on executing the compiler and Linkage Editor in the foreground is contained in "Appendix F: System Configuration." COBOL program phases can be executed as either background or foreground programs.

A *job* is a specified unit of work to be performed under control of the operating system. A typical job might be the processing of a COBOL program -- compiling source statements, editing the module produced to form a phase, and then executing the phase. Job definition -- the process of specifying the work to be done during a single job -- allows the programmer considerable flexibility. A job can include as many or as few *job steps* as the programmer desires.

JOB STEPS

A job step is exactly what the name implies -- one step in the processing of a job. Thus, in the job mentioned above, one job step is the compilation of source statements; another is the link editing of a module; another is the execution of a phase. In contrast to a job definition, the definition of a job step is fixed. Each job step involves the execution of a program, whether it be a program that is part of the Disk Operating System or a program that is written by the programmer. A compilation requires the execution of the COBOL compiler. Similarly, an editing implies the execution of the Linkage Editor Finally, the execution of a phase is the execution of the problem program itself.

Compilation Job Steps

The compilation of a COBOL program may necessitate more than one job step (more than one execution of the COBOL compiler). In some cases, a COBOL program consists of a main program and one or more subprograms. To compile such a program, a separate job step must be specified for the main program and for each of the subprograms. Thus, the COBOL compiler is executed once for the main program and once for each subprogram. Each execution of the compiler produces a module. The separate modules can then be combined into one phase by a single job step -- the execution of the Linkage Editor.

For a COBOL program that consists of a main program and two subprograms, compilation and execution require five steps: (1) compile (main program), (2) compile (first subprogram), (3) compile (second subprogram), (4) link edit (three modules combined into one phase), and (5) execute (phase). Figure 1 shows a sample structure of the job deck for these five job steps. Compilation and execution in three job steps -- compile, link edit, and execute -- is applicable only when the COBOL source program is a single main program.

```
// JOB PROG1
.
.
.
// EXEC FCOBOL
   {source deck - main program}
/*
.
.
.
// EXEC FCOBOL
   {source deck - first subprogram}
/*
.
.
.
// EXEC FCOBOL
   {source deck - second subprogram}
/*
.
.
.
// EXEC LNKEDT
.
.
.
// EXEC
```

Figure 1. Sample Structure of Job Deck for Compiling, Link Editing, and Executing a Main Program and Two Subprograms

Multiphase Program Execution

The execution of a COBOL program has thus far been referred to as the execution of a phase. It is possible, however, to organize a COBOL program so that it is executed as two or more phases. Such a program is known as a *multiphase program*.

By definition, a *phase* is that portion of a program that is loaded into main storage by a single operation of the Supervisor. A COBOL program can be executed as a single phase only if there is an area of main storage available to accommodate all of it. A program that is too large to be executed as a single phase must be structured as a multiphase program. The technique that enables the programmer to use subprograms that do not fit into main storage (along with the main program) is called overlay.

The number of phases in a COBOL program has no effect on the number of job steps required to process that program. As will be seen, the Linkage Editor can produce one or more phases in a single job step. Similarly, both single-phase and multiphase programs require only one execution job step. Phase execution is the execution of all phases that constitute one COBOL program.

Detailed information on overlay structures, as well as information on using the facilities of the operating system to create multiple phases and to execute them, can be found in the chapter "Calling and Called Programs."

TYPES OF JOBS

A typical job falls into one of several categories. A brief description of these categories follows; a complete discussion is found in the chapter "Preparing COBOL Programs for Processing."

Compile-Only: This type of job involves only the execution of the COBOL compiler. It is useful when checking for errors in COBOL source statements. A compile-only job is also used to produce a module that is to be further processed in a subsequent job.

A compile-only job can consist of one job step or several successive job steps.

Edit-Only: This type of job involves only the execution of the Linkage Editor. It is used primarily to combine modules produced in previous compile-only jobs, and to check that all cross references between modules have been resolved. The programmer can specify that all modules be combined to form one phase; or he can specify that some modules form one phase and that others form additional phases. The phase output produced as the result of an edit-only job can be retained for execution in a subsequent job.

Compile and Edit: This type of job combines the functions of the compile-only and the edit-only jobs. It requires the execution of both the COBOL compiler and the Linkage Editor. The job can include one or more compilations, resulting in one or more modules. The programmer can specify that the Linkage Editor process any or all of the modules just produced; in addition, he can specify that one or more previously produced modules be included in the linkage editor processing.

Execute-Only: This type of job involves the execution of a phase (or multiple phases) produced in a previous job. Once a COBOL program has been compiled and edited successfully, it can be retained as one or more phases and executed whenever needed. This eliminates the need for recompiling and re-editing every time a COBOL program is to be executed.

Edit and Execute: This type of job combines the functions of the edit-only and the execute-only jobs. It requires the execution of both the Linkage Editor and the resulting phase(s).

Compile, Edit, and Execute: This type of job combines the functions of the compile and edit and the execute-only jobs. It calls for the execution of the COBOL compiler, the Linkage Editor, and the problem program; that is, the COBOL program is to be completely processed.

When considering the definition of his job, the programmer should be aware of the following: if a job step is cancelled during execution, the entire job is terminated; any remaining job steps are skipped. Thus, in a compile-edit-and execute job, a failure in compilation precludes the editing of the module(s) and phase execution. Similarly, a failure in editing precludes phase execution.

For this reason, a job usually should (but need not) consist of related job steps only. For example, if two independent single-phase executions are included in one job, the failure of the first phase execution precludes the execution of the second phase. Defining each phase execution as a separate job would prevent this from happening. If successful execution of both phases can be guaranteed before the job is run, however, the programmer may prefer to include both executions in a single job.

JOB DEFINITION STATEMENTS

Once the programmer has decided the work to be done within his job and how many job steps are required to perform the job, he can then define his job by writing job control statements. Since these statements are usually punched in cards, the set of job control statements is referred to as a job deck. In addition to job control statements, the job deck can include input data for a program that is executed during a job step. For example, input data for the COBOL compiler -- the COBOL program to be compiled -- can be placed in the job deck.

The inclusion of input data in the job deck depends upon the manner in which the installation has assigned input/output devices. Job control statements are read from the unit named SYSRDR (system reader), which can be either a card reader, a magnetic tape unit, or a disk extent. Input to the processing programs is read from the unit named SYSIPT (system input), which also can be either a card reader, a magnetic tape unit, or a disk extent. The installation has the option of assigning either two separate devices for these units (one device for SYSRDR, a second device for SYSIPT) or one device to serve as both SYSRDR and SYSIPT. If two devices have been assigned, the job deck must consist of only job control statements; input data must be kept separate. If only one device has been assigned, input data must be included within the job deck.

There are four job control statements that are used for job definition: the JOB statement, the EXEC statement, the end-of-data statement (/*), and the end-of-job statement (/&). In this chapter, the discussion of these job control statements is limited to the function and use of each statement. The rules for writing each statement are given in the chapter "Preparing COBOL Programs for Processing."

The JOB statement defines the start of a job. One JOB statement is required for every job; it must be the first statement in the job deck. The programmer must name his job on the JOB statement.

The EXEC statement requests the execution of a program. Therefore, one EXEC statement is required for each job step within a job. The EXEC statement indicates the program that is to be executed (for example, the COBOL compiler, the Linkage Editor). As soon as the EXEC statement has been processed, the program indicated by the statement begins execution.

The end-of-data statement, also referred to as the /* (slash asterisk) statement, defines the end of a program's input data. When the data is included within the job deck (that is, SYSIPT and SYSRDR are the same device), the /* statement immediately follows the input data. For example, COBOL source statements would be placed immediately after the EXEC statement for the COBOL compiler; a /* statement would follow the last COBOL source statement.

When input data is kept separate (that is, SYSIPT and SYSRDR are separate devices), the /* statement immediately follows each set of input data on SYSIPT. For example, if a job consists of two compilation job steps, an editing job step, and an execution job step, SYSIPT would contain the source statements for the first compilation followed by a /* statement, the source statements for the second compilation followed by a /* statement, any input data for the Linkage Editor followed by a /* statement, and perhaps some input data for the problem program followed by a /* statement.

The end-of-job statement, also referred to as the /& (slash ampersand) statement, defines the end of the job. A /& statement must appear as the last statement in the job deck.

OTHER JOB CONTROL STATEMENTS

The four job definition statements form the framework of the job deck. There are a number of other job control statements in the job control language; however, not all of them must appear in the job deck. The job control statements are summarized briefly in Table 1.

The double slash preceding each statement name identifies the statement as a job control statement. Most of the statements are used for data management -- creating, manipulating, and keeping track of data files. (Data files are externally stored collections of data from which data is read and onto which data is written.)

Table 1. Job Control Statements

Statement	Function
// ASSGN	Input/output assignments.
// CLOSE	Closes a logical unit assigned to magnetic tape.
// DATE	Provides a date for the Communication Region.
// DLAB	Disk file label information.
// DLBL	Disk file label information.
// EXEC	Execute program.
// EXTENT	Disk file extent.
// JOB	Beginning of control information for a job.
// LBLTYP	Reserves storage for label information.
// LISTIO	Lists input/output assignments.
// MTC	Controls operations on magnetic tape.
// OPTION	Specifies one or more job control options.
// PAUSE	Creates a pause for operator intervention.
// RESET	Resets input/output assignments to standard assignments.
// RSTRT	Restarts a checkpointed program.
// TLBL	Tape label information.
// TPLAB	Tape label information.
// UPSI	Sets user-program switches.
// VOL	Disk/tape label information.
// XTENT	Disk file extent.
/*	End-of-data-file or end-of-job-step.
/&	End-of-job.
*	Comments.

This chapter describes in greater detail the three types of job steps involved in processing a COBOL program. Once the reader becomes familiar with the information presented here, he should be able to write control statements by referring only to the next chapter, "Preparing COBOL Programs for Processing."

COMPILATION

Compilation is the execution of the COBOL compiler. The programmer requests compilation by placing in the job deck an EXEC statement that contains the program name FCOBOL, the name of the COBOL compiler. This is the EXEC FCOBOL statement.

Input to the compiler is a set of COBOL source statements, consisting of either a main program or a subprogram. Source statements must be punched in Extended Binary-Coded-Decimal Interchange Code (EBCDIC). The COBOL source statements are read from SYSIPT. The job deck is read from SYSRDR. If SYSRDR and SYSIPT are assigned to the same unit, the COBOL source statements should be placed after the EXEC FCOBOL statement in the job deck.

Output from the COBOL compiler is dependent upon the options specified when the system is generated. This output may include a listing of source statements exactly as they appear in the input deck. The source listing is produced on SYSLST. In addition, the module produced by the compiler may be written on SYSLNK, the linkage editor input unit, and punched on SYSPCH. Separate Data and/or Procedure Division maps, a symbolic cross-reference list, and diagnostic messages can also be produced. The format of compiler output is discussed and illustrated in the chapter "Interpreting Output."

The programmer can override any of the compiler options specified when the system was generated, or include some not previously specified, by using the OPTION control statement in the compile job step. Compiler options are discussed in detail in the chapter "Preparing COBOL Programs for Processing."

EDITING

Editing is the execution of the Linkage Editor. The programmer requests editing by placing in the job deck an EXEC statement that contains the program name LNKEDT, the name of the Linkage Editor. This is the EXEC LNKEDT statement.

Input to the Linkage Editor consists of a set of linkage editor control statements and one or more modules to be edited. These modules include any of the following:

1. Modules that were compiled previously in the job and placed at that time on the linkage editor input unit, SYSLNK.
2. Modules that were compiled in a previous job and saved as module decks. The module decks must be placed on SYSIPT. Linkage editor control statements are read from SYSRDR.
3. Modules that were compiled in a previous job step and cataloged in the relocatable library. The relocatable library is a collection of frequently used routines in the form of modules, that can be included in a program phase via the INCLUDE control statement in the linkage editor job step.

Output from the Linkage Editor consists of one or more phases. A phase may be an entire program or it may be part of an overlay structure (multiple phases).

A phase produced by the Linkage Editor can be executed immediately after it is produced (that is, in the job step immediately following the linkage editor job step), or it can be executed later, either in a subsequent job step of the same job or in a subsequent job. In either of the latter cases, the phase to be executed must be cataloged in the core image libary. Such a phase can be retrieved in the execute job step by specifying the phase name in the EXEC statement, where phase name is the name under which it was cataloged. Otherwise, the phase output is retained only for the duration of one job step following the linkage editor job step That is, if the module that was just link edited is to be executed in the next job step, it need not have been cataloged. An EXEC statement will cause the phase to be brought in from the temporary part of the core image library and will begin execution. However, the next time such a module is to be executed, the linkage editor job step is required since the phase was not cataloged in the core image library.

If a private core image library is assigned, output from the Linkage Editor is placed in the private core image library (either permanently or temporarily) rather than in the resident system core image library. When execution of a program is requested and a private core image library is assigned, this library is searched first for the requested phase name and then the system core image library is searched.

In addition to the phase, the Linkage Editor produces a phase map on SYSLST. Linkage editor diagnostic messages are also printed on SYSLST. If the NOMAP option of the linkage editor ACTION control statement is specified, no phase map is produced and linkage editor diagnostic messages are listed on SYSLST, if assigned. Otherwise, the diagnostic messages are listed on SYSLOG. The contents of the phase map are discussed and illustrated in the chapter "Interpreting Output."

Linkage editor control statements direct the execution of the Linkage Editor. Together with any module decks to be processed, they form the linkage editor input deck, which is read by the Job Control Processor from SYSIPT and written on SYSLNK.

There are four linkage editor control statements: the ACTION statement, the PHASE statement, the ENTRY statement, and the INCLUDE statement. These statements are discussed in the next chapter.

PHASE EXECUTION

Phase execution is the execution of the problem program, for example, the program written by the COBOL programmer. If the program is an overlay structure (multiple phase), the execution job step actually involves the execution of all the phases in the program.

The phase(s) to be executed must be contained in the core image library. The core image library is a collection of executable phases from which programs are loaded by the Supervisor. A phase is written in the temporary part of the core image library by the Linkage Editor at the time the phase is produced. It is permanently retained (cataloged) in the core image library, if the programmer has so requested, via the CATAL option in the OPTION control statement.

The programmer requests the execution of a phase by placing in the job deck an EXEC statement that specifies the name of the phase. However, if the phase to be executed was produced in the immediately preceding job step, it is not necessary to specify its name in the EXEC statement.

MULTIPHASE PROGRAMS

A COBOL program can be executed as a single phase as long as there is an area of main storage available to accommodate it. This area, known as the problem program area, must be large enough to contain the main program and all called subprograms. When a program is too large to be executed as a single phase, it must be structured as a multiphase program.

The overlay structure available to the COBOL programmer for multiphase programs is known as root phase overlay, and is used primarily for programs of three or more phases. One phase of the program is designated as the root phase (main program) and, as such, remains in the problem program area throughout the execution of the entire program. The other phases in the program -- subordinate phases -- are loaded into the problem program area as they are needed. A subordinate phase may overlay any previously loaded subordinate phase, but no subordinate phase may overlay the root phase. One or more subordinate phases can reside simultaneously in main storage with the root phase.

Use of the linkage editor control statements needed to effect overlay are discussed in the chapter "Calling and Called Programs."

This chapter provides information about preparing COBOL source programs for compilation, link editing, and execution.

ASSIGNMENT OF INPUT/OUTPUT DEVICES

Almost all COBOL programs include input/output statements calling for data to be read from or written into data files stored on external devices. COBOL programs do not reference input/output devices by their actual physical address, but rather by their symbolic names. Thus, a COBOL program is dependent on the device type and not on the actual device address. The COBOL programmer need only select the symbolic name of a device from a fixed set of symbolic names. At execution time, as a job control function, the symbolic name is associated with an actual physical device. The standard assignment of physical addresses to symbolic names may be made at system generation time. However, job control statements and operator commands can alter the standard device assignment before program execution. This is discussed later in this chapter.

To simulate an installation environment all the examples in this publication assume that the symbolic units and their physical and logical assignments are as shown in Figure 2.

The symbolic names are divided into two classes: system logical units and programmer logical units.

The system logical units (SYSIPT, SYSLNK, SYSLOG, SYSLST, SYSPCH, SYSRES, SYSCLB, SYSSLB, SYSRLB, and SYSRDR) are used by the control program and by IBM-supplied processing programs. SYSIPT, SYSLST, SYSPCH, and SYSLOG can be implicitly referenced by certain COBOL procedural statements. Two additional names, SYSIN and SYSOUT, are defined for background program assignments. The names are valid only to the Job Control Processor, and cannot be referenced in the COBOL program. SYSIN can be used when SYSRDR and SYSIPT are the same device; SYSOUT must be used when SYSLST and SYSPCH are assigned to the same magnetic tape unit. A complete discussion of the assignment of the logical unit SYSCLB can be found in the publication DOS System Control and Service.

Logical Unit	Physical Unit	Device Type
SYSRES	X'190'	2311 Disk unit
SYSLNK	X'191'	2311 Disk unit
SYSRDR, SYSIPT	X'00C'	2540 Card reader
SYSLST	X'00E'	1403 Printer
SYSPCH	X'00D'	2540 Card punch
SYSLOG	X'01F'	1052 Printer keyboard
SYSCLB	X'191'	2311 Disk unit
SYSSLB	X'191'	2311 Disk unit
SYSRLB	X'191'	2311 Disk unit
SYS001	X'191'	2311 Disk system work file
SYS002	X'191'	2311 Disk system work file
SYS003	X'190'	2311 Disk system work file
SYS004	X'281'	2400 Tape work file
SYS005	X'00E'	1403 Printer
SYS006	X'191'	2311 Disk unit
SYS007	X'191'	2311 Disk unit
SYS008	X'282'	2400 Tape unit
SYS009	X'283'	2400 Tape unit
SYS010	X'284'	2400 Tape unit
SYS011	X'285'	2400 Tape unit
SYS012	X'00E'	1403 Printer
SYS013	X'00C'	2540 Card reader
SYS014	X'01F'	1052 Printer keyboard
SYS015	X'192'	2314 Disk unit
SYS016 through SYS221	Unassigned	

Figure 2. Sample Logical Unit Assignments

Programmer logical units are those in the range SYS000 through SYS221 and may be referenced in the COBOL source language ASSIGN clause.

A COBOL programmer uses the source language ASSIGN clause to assign a file used by his problem program to the appropriate symbolic name. Although symbolic names may be assigned to physical devices at system generation time, the programmer may alter these assignments at execution time by means of the ASSGN control statement. However, if the programmer wishes to use the assignments made at system generation time for his own data files in the COBOL program, ASSGN control statements are unnecessary.

Table 2 is a complete list of symbolic names and their usage.

Table 2. Symbolic Names, Functions, and Permissible Device Types

Symbolic Name	Function	Permissible Device Types
SYSRDR	Input unit for control statements.	Card reader Magnetic tape unit Disk extent
SYSIPT	Input unit for programs.	Card reader Magnetic tape unit Disk extent
SYSPCH	Main unit for punched output.	Card punch Magnetic tape unit Disk extent
SYSLST	Main unit for printed output.	Printer Magnetic tape unit Disk extent
SYSLOG	Receives operator messages and logs in job control statements.	Printer keyboard Printer
SYSLNK	Input to the Linkage Editor.	Disk extent
SYSRES	Contains the operating system, the core image library, relocatable library, and source statement library.	Disk extent (2311,2314,3330[1])
SYSCLB	A private core image library.	Disk extent
SYSSLB	A private source statement library.	Disk extent
SYSRLB	A private relocatable library.	Disk extent
SYSIN	Must be used when SYSRDR and SYSIPT are assigned to the same disk extent. May be used when they are assigned to the same card reader or magnetic tape.	Disk Magnetic tape unit Card reader
SYSOUT	This name must be used when SYSPCH and SYSLST are assigned to the same magnetic tape unit. It must be assigned by the operator ASSGN command.	Magnetic tape unit
SYSmax	These units are available to the programmer as work files or for storing data files. They are called programmer logical units as opposed to the above-mentioned names which are always referred to as system logical units. The largest number of programmer logical units available in the system is 222 (SYS000 through SYS221). The value of SYSmax is determined by the distribution of the programmer logical units among the partitions.	Any unit

[1]Compiler work files must not be assigned to 3330.

JOB CONTROL

The Job Control Processor for the Disk Operating System prepares the system for execution of programs in a batched job environment. Input to the Job Control Processor is in the form of job control statements and job control commands.

JOB CONTROL STATEMENTS

Job control statements are designed for an 80-column punched card format. Although certain restrictions must be observed, the statements are essentially free form. Job control statements conform to these rules:

1. Name. Two slashes (//) identify the statement as a job control statement. They must be in columns 1 and 2. At least one blank immediately follows the second slash.

   Exceptions: The end-of-job statement contains /& in columns 1 and 2; the end-of-data-file statement contains /* in columns 1 and 2; the comment statement contains * in column 1 and a blank in column 2.

2. Operation. This identifies the operation to be performed. It can be up to eight characters long. At least one blank follows its last character.

3. Operand. This may be blank or may contain one or more entries separated by commas. The last term must be followed by a blank, unless its last character is in column 71.

4. Comments. Optional programmer comments must be separated from the operand by at least one space.

Continuation cards are not recognized by the Job Control Processor. For the exception to this rule, see the descriptions of the DLAB and TPLAB statements.

All job control statements are read from the device identified by the symbolic name SYSRDR.

Comments in Job Control Statements

Comment statements (i.e., statements preceded by an asterisk in column 1 followed by a blank) may be placed anywhere in the job deck. The remainder of the card may contain any character from the EBCDIC set. Comment statements are designed for communication with the operator; accordingly, they are written on the console printer-keyboard, SYSLOG, in addition to being written on SYSLST. If followed by a PAUSE control statement, the comment statement can be used to request operator action.

Statement Formats

The following notation is used in the statement formats:

1. All upper-case letters represent specifications that are to appear in the actual statement exactly as shown in the statement format. For example, JOB in the operation field of the JOB statement should be punched exactly as shown.

2. All lower-case letters represent generic terms that are to be replaced in the actual statement. For example, jobname is a generic term that should be replaced by the name that the programmer is giving his job.

3. Hyphens are used to join two or more words in order to form a single generic term. For example, device-address is one generic term.

4. Brackets are used to indicate that a specification is optional and is not always required in the statement. For example, [type] indicates that the programmer's replacement for the generic term, type, may or may not appear in the statement, depending on the programmer's requirements.

5. Braces enclosing stacked items indicate that a choice of one item must be made by the programmer. For example:

   SYS
PROG
ALL
SYSxxx

   indicates that either SYS, PROG, ALL, or SYSxxx must appear in the actual statement.

6. Brackets enclosing stacked items indicate that a choice of one item may, but need not, be made by the programmer. For example:

   ,X'ss'
   ,ALT

   indicates that either ,X'ss' or ,ALT but not both, may appear in the actual statement, or the specification can be omitted entirely.

7. All punctuation marks shown in the statement formats other than hyphens, brackets, and braces must be punched as shown. This includes periods, commas, and parentheses. For example, ,[date] means that the specification, if present in the statement, should consist of the programmer's replacement for the generic term date preceded by the comma with no intervening space. Even if the date is omitted, the comma must be punched as shown.

8. The ellipsis (...) indicates where repetition may occur at the programmer's option. The portion of the format that may be repeated is determined as follows:

   a. Scanning right to left, determine the bracket or brace delimiter immediately to the left of the ellipsis.

   b. Continue scanning right to left and determine the logically matching bracket or brace delimiter.

   c. The ellipsis applies to the words and punctuation between the pair of delimiters.

Sequence of Job Control Statements

The job deck for a specific job always begins with a JOB statement and ends with a /& (end-of-job) statement. A specific job consists of one or more job steps. The beginning of a job step is indicated by the appearance of an EXEC statement. When an EXEC statement is encountered, it initiates the execution of the job step, which includes all preceding control statements up to, but not including, a previous EXEC statement.

The only limitation on the sequence of statements within a job step is that which is discussed here for the label information statements.

The label statements must be in the order:

VOL
TPLAB

or

VOL
DLAB
XTENT (one for each area or file in the volume)

or

DLBL
EXTENT (one for each area or file in the volume)

or

TLBL

and must immediately precede the EXEC statement to which they apply.

DESCRIPTION AND FORMATS OF JOB CONTROL STATEMENTS

This section contains descriptions and formats of job control statements.

Job control statements, with the exception of /*, /&, and *, contain two slashes in columns 1 and 2 to identify them.

ASSGN Statement

The ASSGN control statement assigns a logical input/output unit to a physical device. An ASSGN control statement must be present in the job deck for each data file assigned to an external storage device in the COBOL program where these assignments differ from those established at system generation time. Data files are assigned to programmer logical units in COBOL by means of the source language ASSIGN clause. The ASSGN control statement may also be used to change a system standard assignment for the duration of the job. The format of the ASSGN control statement is as follows:

```
                                    ,X'ss'
 // ASSGN SYSxxx,device-address
                                    ,ALT
```

SYSxxx
is one of the logical devices listed in Table 2.

Exception: SYSOUT must be assigned using the ASSGN job control command. Job control commands are described in detail in the publication DOS System Control and Service.

device-address
allows three different formats:

X'cuu'
where c is the channel number and uu the unit number in hexadecimal notation. The values of 'cuu' are determined by each installation.

c = 0 for multiplexor channel, 1 through 6 for selector channels 1 through 6.

uu = 00 to FE (0 to 254) in hexadecimal.

UA
indicates that the logical unit is to be unassigned. Any source language input/output operation attempted on this device causes cancellation of the job.

IGN
indicates that the logical unit is to be assigned. Each time a READ statement for the file assigned to IGN is encountered, control will be transferred to the imperative-statement following the AT END option. The IGN option is not valid for SYSRDR, SYSIPT, and SYSIN. This option is useful in program debugging since source language input references to files residing on symbolic units for which IGN has been specified are ignored. Any file for which the IGN option is used must be a sequential input file. Output files assigned with the IGN option are not supported by American National Standard COBOL object programs.

X'ss'
is the device specification. It is used for specifying mode settings for 7-track and dual density 9-track tapes. If X'ss' is not specified, the system assumes X'90' for 7-track tapes and X'C0' for 9-track tapes. The possible specifications for X'ss' are shown in Figure 3.

ALT
must be specified in the control statement that assigns an alternate magnetic tape unit which is used when the capacity of the original assignment is reached. The specifications for the alternate unit must be the same as those of the orginal unit, since X'ss' cannot be specified. The characteristics of the alternate unit must be the same as those of the original unit. Multiple alternates can be assigned to a symbolic unit.

Device assignments made by the ASSGN control statement are considered temporary. They are in effect until another ASSGN control statement or a RESET statement for that logical unit, or the next /& or JOB statement is read, whichever occurs first. If a RESET, /&, or JOB statement is encountered, the assignment reverts to the standard assignment established at system generation time plus any modification by an ASSGN command.

The COBOL programmer may assign only the programmer logical units (SYS000 through SYS221) to data files used in his program. For example, if the following ASSIGN clause is used,

```
SELECT IN-FILE ASSIGN TO SYS004-UR-2540R-S
```

an ASSGN control statement must appear in the job deck which assigns SYS004 to a physical device if the physical device differs from the permanent assignment. In this case, the physical device must be a 2540 card reader. An example of such a control statement is:

```
// ASSGN SYS004,X'00C'
```

Physical unit X'00C' was permanently assigned to a 2540 Card Reader at system generation time.

Note: The ASSGN control statement is necessary only when the symbolic unit assignment is being made to a physical device address which differs from that established at system generation time.

"Appendix H: Sample Job Decks" contains illustrations of ASSGN statement usage.

ss	Bytes per Inch	7-Track Tape Parity	Translate Feature	Convert Feature
10	200	odd	off	on
20	200	even	off	off
28	200	even	on	off
30	200	odd	off	off
38	200	odd	on	off
50	556	odd	off	on
60	556	even	off	off
68	556	even	on	off
70	556	odd	off	off
78	556	odd	on	off
90	800	odd	off	on
A0	800	even	off	off
A8	800	even	on	off
B0	800	odd	off	off
B8	800	odd	on	off
		9-Track Tape		
C0	800	single density 9-track		
C0	1600	single density 9-track		
C0	1600	dual density 9-track		
C8	800	dual density 9-track		

Figure 3. Possible Specifications for X'ss' in the ASSGN Control Statement

CLOSE Statement

The CLOSE control statement is used to close either a system or programmer logical unit assigned to tape. As a result of the CLOSE control statement, a standard end-of-volume label set is written and the tape is rewound and unloaded. The CLOSE statement applies only to a temporarily assigned logical unit, that is, a logical unit for which an ASSGN control statement has been specified within the same job. The format of the CLOSE control statement is as follows:

```
                   ┌                  ┐
                   │,X'cuu'  [,X'ss'] │
                   │,UA               │
// CLOSE SYSxxx    │,IGN              │
                   │,ALT              │
                   └                  ┘
```

The logical unit can optionally be reassigned to another device, unassigned, or switched to an alternate unit.

Note that when SYSxxx is a system logical unit, one of the optional parameters must be specified. When closing a programmer logical unit, no optional parameter need be specified.

SYSxxx
: may only be used for magnetic tape and may be specified as SYSPCH, SYSLST, SYSOUT, or SYS000 through SYS221.

X'cuu'
: specifies that after the logical unit is closed, it will be assigned to the channel and unit specified. (See "ASSGN Control Statement" for an explanation of 'cuu'.) When reassigning a system logical unit, the new unit will be opened if it is either a mass storage device or a magnetic tape at load point.

X'ss'
: represents device specification for mode settings on 7-track and 9-track tape. (See "ASSGN Control Statement" for an explanation of 'ss'.) If X'ss is not specified, the mode settings remain unchanged.

UA
: specifies that the logical unit is to be closed and unassigned.

IGN
: specifies that the logical unit is to be closed and unassigned with the ignore option. This operand is invalid for SYSRDR, SYSIPT, or SYSIN.

ALT
: specifies that the logical unit is to be closed and an alternate unit is to be opened and used. This operand is valid only for system logical output units (SYSPCH, SYSLST, or SYSOUT) currently assigned to a magnetic tape unit.

DATE Statement

The DATE control statement contains a date that is put in the Communication Region of the Supervisor. A complete description of the fields of the Communication Region is given in "Appendix G: Communication Region." The DATE statement is in one of the following formats:

```
// DATE mm/dd/yy
----------------
// DATE dd/mm/yy
```

where:
- mm = month (01 to 12)
- dd = day (01 to 31)
- yy = year (00 to 99)

The format to be used is the format selected when the system was generated.

When the DATE statement is used, it applies only to the current job being executed. The Job Control Processor does not check the operand except to ensure that its length is eight characters. If no DATE statement is specified in the current job, the Job Control Processor supplies the date given in the last SET command. The SET command is discussed in detail in the publication DOS System Control and Service.

A DATE statement should be included in every job deck that has as one of its job steps the execution of a COBOL program that utilizes the special register CURRENT-DATE, if the date desired is other than that designated in the previous SET command.

TLBL Statement

The TLBL control statement replaces the VOL and TPLAB combination used in previous versions of the system. However, the current system will continue to support these statements. The TLBL control statement contains file label information for tape label checking and writing. Its format follows:

```
// TLBL filename,
     ['file-identifier'],[date],
     [file-serial-number],
     [volume-sequence-number],
     [file-sequence-number],
     [generation-number],
     [version-number]
```

filename
: identifies the file to the control program. It can be from one to seven characters in length. If the following SELECT sentence appears in a COBOL program:

SELECT NEWFILE ASSIGN TO
SYS003-UT-2400-S-OUTFILE

the filename operand on control statements for this file must be OUTFILE. If the SELECT clause were coded:

SELECT NEWFILE ASSIGN TO
SYS003-UT-2400-S

the filename operand on the control statement for the file must be SYS003.

'file-identifier'
: consists of from 1 to 17 characters, contained within apostrophes, indicating the name associated with the file on the volume. This operand may contain embedded blanks. If this operand is omitted on output files, the filename will be used. If this operand is omitted on input files, no checking will be done.

date
: consists of from one to six characters, in the format yy/ddd, indicating the expiration date of the file for output or the creation date for input. (The day of the year may consist of from one to three characters.) For output files, a one to four character retention period (d-dddd) may be specified. If this operand is omitted, a 0-day retention period will be assumed for output files. For input files, no checking will be done if this operand is omitted or if a retention period is specified.

file-serial-number
: consists of from one to six characters indicating the volume serial number of the first (or only) reel of the file. If fewer than six characters are specified, the field will be right-justified and padded with zeros. If this operand is omitted on output files, the volume serial number of the first (or only) reel of the file will be used. If the operand is omitted on input files, no checking will be done.

volume-sequence-number
: consists of from one to four characters in ascending order for each volume of a multivolume file. This number is incremented automatically by OPEN and CLOSE routines as required. If this operand is omitted on output files, BCD 0001 will be used. If omitted on input files, no checking is done.

file-sequence-number
: consists of from one to four characters in ascending order for each file of a multifile volume. This number is incremented automatically by OPEN and CLOSE routines as required. If this operand is omitted on output files, BCD 0001 will be used. If it is omitted on input files, no checking will be done.

generation-number
: consists of from one to four numeric characters that modify the file-identifier. If this operand is omitted on output files, BCD 0001 is used. If it is omitted on input files, no checking will be done.

version-number
consists of from one to two numeric characters that modify the generation number. If this operand is omitted on output files, BCD 01 will be used. If it is omitted on input files, no checking will be done.

Note: If a tape file with standard labels is opened two different ways in the same COBOL program, and that file resides on a multifile volume, the programmer should use two separate TLBL cards with different filenames specified on each.

DLBL Statement

The DLBL control statement, in conjunction with the EXTENT statement, replaces the VOL, DLAB, and XTENT combination used in previous versions of the Disk Operating System. However, the current system will continue to support the VOL, DLAB, and XTENT statements. The DLBL statement has the following format:

```
// DLBL filename
     ,['file-identifer'],[date],[codes]
```

filename
identifies the file to the control program. It can be from one to seven characters in length. If the following SELECT sentence appears in a COBOL program:

SELECT INFILE ASSIGN TO
SYS005-DA-2311-A-INPUTA

the filename operand on control statements for this file must be INPUTA. If the SELECT sentence is coded:

SELECT INFILE ASSIGN TO
SYS005-DA-2311-A

the filename operand on control statements for the file must be SYS005.

'file-identifier'
is the name associated with the file on the volume. This can consist of from 1 to 44 alphanumeric characters contained within apostrophes, including the file-identifier and, if used, generation-number and version-number of generation. If fewer than 44 characters are used, the field is left-justified and padded with blanks. If this operand is omitted, filename will be used.

date
consists of from one to six characters indicating either the retention period of the file in the format d through dddd (1-9999), or the absolute expiration date of the file in the format yy/ddd. When the d through dddd format is used, the file is retained for the number of days specified as dddd. For example, if date is specified as 31, the file will be retained a month from the day of creation. When the yy/ddd format is used, the file is retained until the day (ddd) in the year (yy) specified. For example, if date is specified as 69/200, the file will be retained through the 200th day of the year 1969.

If date is omitted when the file is created, a 7-day retention period is assumed. If this operand is present for a file opened as INPUT or I-O, it is ignored.

codes
is a 2- or 3-character field indicating the type of file label, as follows:

SD = Sequential Disk
DA = Direct Access
ISC = Indexed Sequential using Load Create
ISE = Indexed Sequential using Load Extension, Add, or Retrieve

If code is omitted, SD is assumed.

"Appendix H: Sample Job Decks" contains illustrations of DLBL statement usage.

EXTENT Statement

The EXTENT control statement defines each area (or extent) of a DASD file -- a file assigned to a mass storage device. One or more EXTENT control statements must follow each DLBL statement.

The EXTENT control statement replaces the XTENT statement used in previous versions of the Disk Operating System. However, XTENT will continue to be supported in the current system.

The format of the EXTENT control statement is:

```
// EXTENT [symbolic-unit],[serial-number]
     ,[type],[sequence-number]
     ,[relative-track],[number-of-tracks]
     ,[split-cylinder-track],[B=bins]
```

symbolic-unit
: is a 6-character field indicating the symbolic unit (SYSxxx) of the volume for which this extent is effective. If this operand is omitted, the symbolic unit of the preceding EXTENT statement will be used. When specified, symbolic-unit may be any SYSxxx assigned to the device type indicated in the SELECT sentence for the file. For example, if the following coding appears in a COBOL program:

```
SELECT OUTFILE ASSIGN TO
SYS004-DA-2311-A
```

the symbolic unit in the EXTENT control statement can by any SYSxxx assigned to a 2311 disk pack. The symbolic unit operand is not required for an IJSYSxx filename, where xx is IN, PH, LS, RS, SL, or RL. If SYSRDR or SYSIPT is assigned, this operand must be included.

serial-number
: consists of from one to six characters indicating the volume serial number of the volume for which this extent is effective. If fewer than six characters are used, the field will be right-justified and padded with zeros. If this operand is omitted, the volume serial number of the preceding EXTENT control statement will be used. If no serial number was provided in the EXTENT control statement, the serial number will not be checked and it will be the programmer's responsibility if files are destroyed as a result of mounting the incorrect volume.

type
: consists of one character indicating the type of the extent, as follows:

1 -- Data area (no split cylinder)
2 -- Overflow area (for an indexed file)
4 -- Index area (for an indexed file)
8 -- Data area (split cylinder)

If this operand is omitted, 1 is assumed.

sequence-number
: consists of from one to three characters containing a decimal number from 0 to 255 indicating the sequence number of this extent within a multi-extent file. Extent sequence 0 is used for the master index of an indexed file. If the master index is not used, the first extent of an indexed file has the sequence number 1. The extent sequence number for all other types of files begins with 0. If this operand is omitted for the first extent of ISFMS files, the extent will not be accepted. For SD or DA files, this operand is not required. Direct files can have up to five extents. Indexed files can have up to eleven data extents (nine prime, one cylinder index, one separate overflow).

relative-track
: consists of from one to five characters indicating the sequential number of the track, relative to zero, where the data extent is to begin. If this field is omitted on an ISFMS file, the extent will not be accepted. This field is not required for DA input or for SD input files (the extents from the file labels will be used).

Formulas for converting actual to relative track addresses (RT) and relative track to actual for the DASD devices follow.

Actual to Relative:

2311 10 x cylinder number + track number = RT

2314 20 x cylinder number + track number = RT

2321 1000 x subcell number + 100 x strip number + 20 x block number + track number = RT

Relative to Actual:

2311 $\frac{RT}{10}$ = quotient is cylinder, remainder is track

2314 $\frac{RT}{20}$ = quotient is cylinder, remainder is track

2321 $\frac{RT}{1000}$ = quotient is subcell, remainder1

$\frac{\text{remainder1}}{100}$ = quotient is strip, remainder2

$\frac{\text{remainder2}}{20}$ = quotient is block, remainder is track

Example: Track 5, cylinder 150 on a 2311 = 1505 in relative track.

number-of-tracks
consists of from one to five characters indicating the number of tracks to be allocated to the file. For SD input files, this field may be omitted. The number of tracks for a split cylinder file must be a multiple of the number of cylinders specified for the file and the number of tracks specified for each cylinder.

split-cylinder-track
consists of from one to two characters, with a value of 0 through 19, indicating the upper track number for the split cylinder in SD files.

bins
consists of from one to two characters identifying the 2321 bin that the extent was created for, or on which the extent is currently located. If the field is one character, the creating bin is assumed to be zero. There is no need to specify a creating bin for SD or ISFMS files. If this operand is omitted, bin 0 is assumed for both bins. If the operand is included and positional operands are omitted, only one comma is required preceding the keyword operand. If any operands preceding the bin specification are omitted, one comma for each operand is acceptable, but unnecessary.

Figure 4 shows examples of using the DLBL statement in conjunction with the EXTENT statement. "Applendix H: Sample Job Decks" contains illustrations of EXTENT statement usage.

VOL Statement

The VOL control statement is used when standard labels for a DASD or tape file are checked. It is used in conjunction with TPLAB or DLAB and XTENT statements. The VOL and TPLAB or VOL, DLAB and XTENT statements must appear in that order and must immediately precede the EXEC statement to which they apply. The format of the VOL control statement is:

```
// VOL SYSxxx,filename
```

SYSxxx
is the symbolic unit name. The symbolic unit name is the same name that appears in the XTENT statement for the file.

filename
identifies the file to the control program. It can consist of from one to seven characters. The appearance of two identical operands is characteristic of COBOL object modules, since filename might be the logical unit which is assigned to a device.

Note that filename, as used in this context, does not refer to the COBOL file-name, but to filename as it is used by the system.

For example, if the following COBOL coding appeared as part of a complete program, MASTERX is the name by which the file is known to the control program.

Direct file:

The following DLBL and EXTENT statements describe a direct file occupying 840 tracks, beginning on relative track 10.

```
// DLBL MASTER,,75/001,DA
// EXTENT SYS015,111111,1,0,10,840
```

Indexed file:

The following DLBL and EXTENT statements describe an indexed file occupying 90 tracks, beginning on relative track 1106. The first EXTENT allocates a 14-track cylinder index. The second EXTENT allocates a 76-track data area.

```
// DLBL MASTER,,75/001,ISC
// EXTENT SYS015,111111,4,1,1106,14
// EXTENT SYS015,111111,1,2,1120,76
```

Figure 4. Sample Label and File Extent Information for Mass Storage Files

```
ENVIRONMENT DIVISION.
FILE-CONTROL.
     SELECT MASTER-FILE ASSIGN TO
     SYS004-UT-2400-S-MASTERX
     .
     .
     .
DATA DIVISION.
FILE SECTION.
FD MASTER-FILE
     .
     .
     .
```

The VOL control statement for the file could be coded as follows:

```
// VOL SYS004,MASTERX
```

If the COBOL SELECT sentence had been coded as:

```
     SELECT MASTER-FILE ASSIGN TO
     SYS004-UT-2400-S
```

SYS004 would be the name by which the file is known to the control program and the VOL statement could be coded as follows:

```
// VOL SYS004,SYS004
```

The filename, as used in the VOL control statement format, is identical to the symbolic name of the program DTF that identifies the file. Although, in COBOL, displacement is from the symbolic name MASTER-FILE when referencing the DTF, the system interprets this to be MASTERX in the first case, and SYS004 in the second case.

When coding the VOL control statement for files assigned to mass storage devices, there is an additional consideration. If the following SELECT sentence appears in a COBOL program:

```
     SELECT INFILE ASSIGN TO
     SYS001-DA-2311-A-INPUTA
```

the symbolic unit name on the control statements for the file can be any SYSxxx assigned to a 2311 disk pack. The filename on control statements for the file must be INPUTA.

For example, the VOL control statement might be:

```
// VOL SYS021,INPUTA
```

If the SELECT sentence were coded:

```
     SELECT INFILE ASSIGN TO
     SYS004-DA-2311-A
```

the symbolic unit name on control statements for the file can be any SYSxxx assigned to a 2311 disk pack. The filename on control statements for the file must be SYS004. Both of the following VOL control statements are acceptable:

```
// VOL SYS004,SYS004
// VOL SYS005,SYS004
```

DLAB Statement

The DLAB control statement contains information for label checking and creation of files assigned to mass storage devices. This statement must immediately follow a VOL control statement. (Disk label formats are given in "Appendix C: Standard Mass Storage Device Labels.") The format of the DLAB control statement is:

```
// DLAB 'label fields 1-3',
    xxxx,yyddd,yyddd,'systemcode'[,type]
```

'label fields 1-3'
: The first three fields of the disk-file label are contained just as they appear in the label. This is a 51-character string contained within apostrophes and followed by a comma.

  The DLAB statement requires two cards for completion; therefore, column 72 of the first card requires a character punch other than a blank. The columns between the comma and the continuation character must be blank.

xxxx
: is the volume-sequence-number in field 4 of the Format 1 label and must begin in card column 16 of the second card.

yyddd,yyddd
: is the file creation date followed by the file expiration date. It is recommended that this field be left blank.

'systemcode'
: is ignored by the Disk Operating System. The dummy field specified must be 13 characters long.

type
: indicates the type of file label:

  SD = Sequential Disk
  DA = Direct Access
  ISC = Indexed Sequential (used when creating the file)
  ISE = Indexed Sequential (used when updating or retrieving the file)

  SD is assumed if this entry is omitted.

TPLAB Statement

The TPLAB control statement contains file label information for tape label checking and creation. It must immediately follow a VOL control statement. The TPLAB control statement contains an image of a portion of the standard tape file label. The format and contents of a standard tape label are given in "Appendix B: Standard Tape File Labels." The format of the TPLAB control statement is as follows:

```
// TPLAB   {'label fields 3-10'}
           {'label fields 3-13'}
```

'label fields 3-10'
: is a 49-byte character string contained within apostrophes, identical to positions 5 through 53 of the tape file label. These fields can be included in one line and are the only ones used for label checking.

'label fields 3-13'
: is a 69-byte character string contained within apostrophes, identical to positions 5 through 73 of the tape file label. These fields are too long to be included on a single line. The character string must extend into column 71, a continuation character (any character) must be placed in column 72, and the character string is completed on the next line. The continuation line starts in column 16. Fields 3 through 13 are written in the corresponding fields when the output label is created. When specified for an input file, fields 11 through 13 are ignored. However, even for output files, fields 11 through 13 are never used by the Disk Operating System label processing routines.

XTENT Statement

The XTENT control statement is used to define an area of a file on a mass storage device. Each DASD file (file assigned to a mass storage device) requires one or more XTENT control statements. The format of the XTENT control statement is:

```
// XTENT type,sequence,lower,upper
        'serial no',SYSxxx[,B2]
```

type
: Each XTENT type identifies the funtion of the defined area.

Extent Type -- occupies one or three columns containing:

1 = Data area (no split cylinder)
2 = Overflow area (for an indexed file)
4 = Index area (for an indexed file)
128 = Data area (split cylinder). If type 128 is specified, the lower head is assumed to be $H^1 H^2 H^2$ in lower, and the upper head is assumed to be $H_1 H_2 H_2$ in upper (See the discussion of the lower and upper fields.)

sequence
: Extent Sequence Number -- indicates the sequence number of this extent within a multi-extent file. The sequence number occupies one to three columns and contains a decimal number from 0 to 255. Extent sequence 0 is used for the master index of an indexed file. If the master index is not used, the first extent of an indexed file contains sequence number 1. The extent sequence for all other types of files begins with 0. Direct files can have up to five extents. Indexed files can have up to eleven data extents (nine prime, one cylinder index, one separate overflow).

lower
: Lower Limit of Extent -- occupies nine columns and contains the lowest address of the extent in the form $B_1C_1C_1C_2C_2C_2H_1H_2H_2$

where:

B_1 is the initially assigned cell number. It is equal to:

0 for 2311 and 2314
0 to 9 for 2321

C_1C_1 is the subcell number. It is equal to:

00 for 2311 and 2314
00 to 19 for 2321

$C_2C_2C_2$ is the cylinder number. It can be:

000 to 199 for 2311 and 2314

or strip number:

000 to 009 for 2321

H_1 is the head block position. It is equal to:

0 for 2311 and 2314
0 to 4 for 2321

H_2H_2 is the head number. It can be:

00 to 09 for 2311
00 to 19 for 2321 and 2314

A lower extent of all zeros is invalid.

Note: For 2321, the last five strips of subcell 19 are reserved for alternate tracks.

upper Upper Limit of Extent -- occupies nine columns containing the highest address of the extent in the same form as the lower limit.

serial no' Volume Serial Number -- This is a 6-byte alphanumeric character string, contained within apostrophes. The number is the same as in the volume label (volume serial number) and the Format 1 label (file serial number).

SYSxxx This is the symbolic address of the DASD drive. If more than one symbolic address is to be specified on separate XTENT cards for the same file, the symbolic addresses must be in consecutive order. See "EXTENT Statement" for details on SYSxxx assignments.

B_2 Currently assigned cell number. Its value is:

0 for 2311 or 2314
0 to 9 for 2321

This field is optional. If missing, the Job Control Processor assigns $B_2 = B_1$.

JOB Statement

The JOB control statement indicates the beginning of control information for a job. The JOB control statement is in the following format:

```
// JOB jobname
```

jobname
is a programmer-defined name consisting of from one to eight alphanumeric characters. Comments can appear on the JOB control statement following the jobname (through column 72). If the timer feature is present, the time of day appears in columns 73 to 80 when the JOB statement is printed on SYSLST. The time of day is also printed in columns 1 through 8 on the next line of SYSLOG.

If a job is restarted, the jobname must be identical to that used when the checkpoint was taken.

Note: The JOB statement resets the effect of all previously issued OPTION and ASSGN control statements.

LBLTYP Statement

The LBLTYP control statement defines the amount of storage to be reserved at linkage edit time in the problem program area of main storage in order to process tape and nonsequential DASD file labels. It applies to both background and foreground object programs, and is required if the file contains standard labels.

The LBLTYP control statement immediately precedes the // EXEC LNKEDT statement in the job deck, with the exception of self-relocating programs for which it is instead submitted immediately preceding the // EXEC statement for the program. The format of the LBLTYP control statement is:

```
           { TAPE[(nn)] }
// LBLTYP  {            }
           { NSD(nn)    }
```

TAPE[(nn)]
is used only if tape files requiring label information are to be processed and if no nonsequential DASD files are to be processed. nn is optional and is present only for future expansion. It is ignored by the Job Control Processor.

NSD(nn)
is used if any nonsequential DASD files are to be processed, regardless of other type files that are used. nn specifies the largest number of extents to be used for a single file.

LISTIO Statement

The LISTIO control statement causes the system to print a list of input/output assignments on SYSLST. The format of the LISTIO control statement is:

```
            ⎧ SYS    ⎫
            ⎪ PROG   ⎪
            ⎪ F1     ⎪
            ⎪ F2     ⎪
// LISTIO   ⎨ ALL    ⎬
            ⎪ SYSxxx ⎪
            ⎪ UNITS  ⎪
            ⎪ DOWN   ⎪
            ⎪ UA     ⎪
            ⎩ X'cuu' ⎭
```

SYS
: causes the physical units assigned to all system logical units to be listed.

PROG
: causes the physical units assigned to all background programmer logical units to be listed.

F1
: causes the physical units assigned to all foreground-one logical units to be listed.

F2
: causes the physical units assigned to all foreground-two logical units to be listed.

ALL
: causes the physical units assigned to all logical units to be listed.

SYSxxx
: causes the physical units assigned to the logical unit specified to be listed.

UNITS
: causes the logical units assigned to all physical units to be listed.

DOWN
: causes all physical units specified as inoperative to be listed.

UA
: causes all physical units not currently assigned to a logical unit to be listed.

X'cuu'
: causes the logical units assigned to the physical unit specified to be listed.

MTC Statement

The MTC control statement controls 2400 series magnetic tape operations. The format is as follows:

```
// MTC opcode,SYSxxx[,nn]
```

opcode
: specifies the operation to be performed. opcode can be chosen from the following:

BSF -- Backspace to tapemark

BSR -- Backspace to interrecord gap

ERG -- Erase gap (write blank tape)

FSF -- Forward space to tapemark

FSR -- Forward space to interrecord gap

RUN -- Rewind and unload

REW -- Rewind

WTM -- Write tapemark

SYSxxx
: represents any logical unit assigned to magnetic tape upon which the MTC control statement is to operate.

[,nn]
: is the decimal number (01 through 99) which, if specified, represents the number of times the operation is to be performed. If nn is omitted, the operation is performed once.

OPTION Statement

The OPTION control statement is used to specify one or more of the options of the Job Control Processor. The format of the OPTION statement is:

```
// OPTION option1[,option2]...
```

The order in which the selected options appear in the operand field is arbitrary. Options are reset to the standard established at system generation time upon encountering the next JOB statement or the /& statement.

The options are:

LOG
: causes the listing of columns 1 through 80 of all control statements on SYSLST. If LOG is not the standard established at system generation time, control statements are not listed until a LOG option is encountered. Once a LOG option statement is read, logging continues from job step to job step until a NOLOG option is encountered or until either the JOB or /& control statement is encountered.

NOLOG
: suppresses the listing of all control statements on SYSLST until a LOG option is encountered, or until either the JOB or /& control statement is encountered.

DUMP
: causes a dump of the registers and main storage to be printed on SYSLST in the case of an abnormal program termination (such as a program check).

NODUMP
: suppresses the DUMP option.

LINK
: indicates that the object module is to be link edited. When the LINK option is used, the output of the COBOL compiler is written on SYSLNK. The LINK option must always precede an EXEC LNKEDT statement in the job deck. (CATAL also causes the LINK option to be set.) LINK is not acceptable to the Job Control Processor operating in the foreground unless the private core image library option is supported and a private core image library is assigned.

NOLINK
: suppresses the LINK option. The COBOL compiler can also suppress the LINK option if the program contains an error that would preclude the successful execution of the program.

DECK
: causes the COBOL compiler to punch an object module on SYSPCH. If both DECK and LINK are specified, the output of the compiler is written on both SYSPCH and SYSLNK.

NODECK
: suppresses the DECK option.

LIST
: causes the compiler to write the COBOL source statements on SYSLST.

NOLIST
: suppresses the LIST option.

LISTX
: causes the COBOL compiler to write a Procedure Division map on SYSLST. In addition, global tables, literal pools, and register assignments will be provided.

NOLISTX
: suppresses the LISTX option.

XREF
: causes the COBOL compiler to write a symbolic cross-reference list on SYSLST.

NOXREF
: suppresses the XREF option.

SYM
: causes the COBOL compiler to write a Data Division map on SYSLST.

NOSYM
: suppresses the SYM option.

ERRS
: causes the COBOL compiler to write the diagnostic messages related to the source program on SYSLST.

NOERRS
: suppresses the ERRS option.

CATAL
: causes the cataloging of a phase or program in the core image library upon completion of a linkage editor job step. CATAL also causes the LINK option to be set. CATAL is not accepted by the Job Control Processor operating in a batched-job foreground environment unless the private core image library option is supported and a private core image library is assigned.

STDLABEL
: causes the standard label track to be cleared and all DASD or tape labels submitted after this point to be written on the standard label track. This option is reset to the USRLABEL option at end-of-job or end-of-job step. All file definition statements submitted after the STDLABEL option are available to any program in any area until another set of standard

file definition statements is submitted. STDLABEL is not accepted by the Job Control Processor operating in a batched-job foreground environment. All file definition statements following OPTION STDLABEL are included in the standard file definition set until one of the following occurs:

- End-of-job step
- End-of-job
- OPTION USRLABEL is specified
- OPTION PARSTD is specified

USRLABEL
: causes all DASD or tape labels submitted after this point to be written at the beginning of the user label track.

PARSTD
: causes all DASD or tape labels submitted after this point to be written at the beginning of the partition standard label track. The PARSTD option is reset to the USRLABEL option at end-of-job or end-of-job step. All file definition statements submitted after the PARSTD option will be available to any program in the current partition until another set of partition standard file definition statements is submitted. All file definition statements submitted after OPTION PARSTD will be included in the standard file definition set until one of the following occurs:

- End-of-job step
- End-of-job
- OPTION USRLABEL is specified
- OPTION STDLABEL is specified

For a given filename, the sequence of search for label information during an OPEN is the USRLABEL area, followed by the PARSTD area, followed by the STDLABEL area.

The options specified in the OPTION statement remain in effect until a contradictory option is encountered or until a JOB control statement is read. In the latter case, the options are reset to the standard that was established at system generation time.

Any assignment for SYSLNK, after the occurrence of the OPTION statement, cancels the LINK and CATAL options. These two options are also canceled after each occurrence of an EXEC statement with a blank operand.

PAUSE Statement

The PAUSE control statement allows for operator intervention between job steps. The format of the PAUSE control statement is:

```
// PAUSE [comments]
```

The PAUSE control statement is effective just before the next input control statement in the job deck is read. The PAUSE control statement always prints on SYSLOG and SYSLST.

An example of this statement is:

```
// PAUSE SAVE SYS004, SYS005, MOUNT
     NEW TAPES
```

This sample statement instructs the operator to save the output tapes and mount two new tapes.

When the PAUSE statement is encountered by the Job Control Processor, the printer keyboard (IBM 1052) is unlocked for operator-message input. The end-of-communication indicator, B, causes processing to continue. If an IBM 1052 Printer is not available, the PAUSE control statement is ignored.

RESET Statement

The RESET control statement resets input/output assignments to the standard assignments. The standard assignments are those specified at system generation time plus any modifications made by the operator by means of the ASSGN command without the TEMP option. The RESET command is discussed in detail in the publication DOS System Control and Service. The format of the RESET statement is:

```
          { SYS    }
// RESET  { PROG   }
          { ALL    }
          { SYSxxx }
```

SYS
: resets all system logical units to their standard assignments.

PROG
: resets all programmer logical units to their standard assignments.

ALL
: resets all system and programmer logical units to their standard assignments.

SYSxxx
: resets the logical unit specified to its standard assignment.

RSTRT Statement

A restart facility is available for checkpoint programs. A programmer can use the source language RERUN clause in his program to cause checkpoint records to be written. This allows sufficient information to be stored so that program execution can be restarted at a specified point. The checkpoint information includes the registers, tape positioning information, a dump of main storage, and a restart address.

The restart facility allows the programmer to continue execution of an interrupted job at a point other than the beginning. The procedure is to submit a group of job control statements including a RSTRT control statement. The format is as follows:

```
// RSTRT SYSxxx,nnnn,filename
```

SYSxxx
: is the symbolic unit name of the 2400, 2311, or 2314 checkpoint file used for restarting. This unit must have been assigned previously.

nnnn
: is the identification of the checkpoint record to be used for restarting. This serial number consists of four characters. It corresponds to the checkpoint identification used when the checkpoint was taken. The serial number is supplied by the checkpoint routine.

filename
: is the symbolic name of the 2311 or 2314 disk checkpoint file used for restarting. It must be identical to the SYSxxx of the system-name specified in the RERUN clause.

When a checkpoint is taken, the completed checkpoint is noted on SYSLOG. Restarting can be done from any checkpoint record, not just the last. The jobname specified in the JOB statement must be identical to the jobname used when the checkpoint was taken. The proper input/output device assignments must precede the RSTRT control statement.

Assignment of input/output devices to symbolic unit names may vary from the initial assignment. Assignments are made for restarting jobs in the same manner as assignments are made for normal jobs.

See the chapter "Program Checkout" for further details on taking checkpoints and restarting a program for which checkpoints have been taken.

UPSI Statement

The UPSI control statement allows the programmer to set program switches that can be tested by problem programs at execution time. The UPSI control statement has the following format:

```
// UPSI nnnnnnnn
```

nnnnnnnn
: consists of from one to eight characters of 0, 1, or X. Positions containing 1 are set to 1; positions containing X are unchanged. Unspecified rightmost positions are assumed to be X.

The UPSI byte is the 24th byte in the Communication Region of the Supervisor. A complete description of the fields of the Communication Region is given in "Appendix G: Communication Region." The Job Control Processor clears the UPSI byte to binary zeros before reading control statements for each job. When the UPSI control statement is read, the Job Control Processor sets these bits to the programmer's specifications. Any combination of the eight bits can be tested in the COBOL source program at execution time by means of the source language switches UPSI-0 through UPSI-7.

CBL STATEMENT -- COBOL OPTION CONTROL CARD

Although most options for compilation are specified either at system generation time or in the OPTION control statement, the COBOL compiler provides an additional statement, the CBL statement, for the specification of compile-time options unique to COBOL.

The CBL card must be placed between the EXEC FCOBOL statement and the first statement in the COBOL program. The CBL card cannot be continued. However, if specification of options will continue past column 71, multiple CBL cards may be used.

The options shown in the following format may appear in any order. No blanks may appear in the operand field. Underscoring indicates the default case.

```
CBL [BUF=nnnnn] [,SEQ  ] [,FLAGW]
                [,NOSEQ] [,FLAGE]

  [,SUPMAP] [,SPACEn] [,CLIST]

  [,STXIT] [,QUOTE] [,TRUNC  ] [,ZWB  ]
           [,APOST] [,NOTRUNC] [,NOZWB]

[,CATALR  ]  [,LIB  ]
[,NOCATALR]  [,NOLIB]
```

CBL
: must begin in column 2 and be preceded and followed by at least one blank.

BUF=nnnnn
: the BUF option specifies the amount of storage to be assigned to each compiler work file buffer. nnnnn is a decimal number from 256 to 32,767. If this option is not specified, 256 is assumed.

SEQ
NOSEQ
: indicates whether or not the compiler is to check the sequence of source statements. If SEQ is specified and a statement is not in sequence, it is flagged.

FLAGW
FLAGE
: determines which diagnostics the compiler will list. FLAGW indicates that all diagnostics will be listed (severity levels W, C, E, and D). FLAGE indicates that only those diagnostics with severity levels C, E, and D will be listed.

SUPMAP
: causes the CLIST and LISTX options to be suppressed if an E-level diagnostic message is produced by the compiler. SUPMAP also causes the DECK option to be suppressed, and no object module is produced.

SPACEn
: indicates the type of spacing to be used on the output listing. n can be specified as either 1 (single spacing), 2 (double spacing), or 3 (triple spacing). If the SPACEn option is omitted, single spacing is provided.

CLIST
: indicates that a condensed listing is to be produced. The condensed listing will contain only the address of the first generated instruction for each verb in the Procedure Division. The CLIST option overrides the LISTX or NOLISTX options. The LISTX or NOLISTX options are either established at system generation time or specified in the OPTION control statement.

STXIT
: enables a USE AFTER STANDARD ERROR declarative to get control when an input/output error occurs on a unit record device.

QUOTE
APOST
: QUOTE indicates to the compiler that the double quotation marks (") should be accepted as the character to delineate literals; APOST indicates that the apostrophe (') should be accepted. The compiler will generate the specified character for the figurative constant QUOTE(S).

NOTRUNC
TRUNC
: is an option that applies only to COMPUTATIONAL receiving fields in MOVE statements and arithmetic expressions. If TRUNC is specified, extra code is generated to truncate the final intermediate result of the arithmetic expression, or the sending field in the MOVE statement, to the number of digits specified in the PICTURE clause of the COMPUTATIONAL receiving field. If TRUNC is specified, the compiler assumes that the data being manipulated conforms to PICTURE and USAGE specifications. The compiler then generates code to manipulate the data based on the size of the field in core (halfword, etc.). TRUNC conforms to the American National Standard, while NOTRUNC leads to more efficient

processing. This will occasionally cause dissimilar results for various sending fields because of the different code generated to perform the operation.

ZWB
NOZWB
indicates whether or not the compiler will generate code to strip the sign when comparing a signed external decimal field with an alphanumeric field. If ZWB is in effect, the signed external decimal field is moved to an intermediate field and has its sign stripped before being compared with the alphanumeric field.

LIB
NOLIB
indicates that BASIS and/or COPY statements are in the source program. If either COPY or BASIS is present, LIB must be in effect. If COPY and/or BASIS statements are not present, use of the NOLIB option yields more efficient compiler processing.

CATALR
NOCATALR
causes the compiler to generate CATALR card images on the SYSPCH file if OPTION DECK is in effect during compilation. This will allow cataloging of the compiler-produced object modules into the relocatable library. The default is NOCATALR for which no CATALR cards are produced by the compiler. The module names in the CATALR cards adhere to the same rules as the phase names in the compiler-produced PHASE cards according to the segmentation and sort phase naming conventions.

JOB CONTROL COMMANDS

Job control commands are distinguished from job control statements by the absence of // blank in positions 1 through 3 of each command. They permit the operator to adjust the system according to day-to-day operating conditions. This is particularly true in the area of device assignment, where the operator may need to (1) communicate to the system that a device is unavailable, or (2) designate a different device as the standard for a given symbolic unit. Therefore, these commands normally are not a part of the regular job deck for a job. Job control commands tend to be effective across jobs, whereas job control statements are confined within a job.

Job control commands are discussed in detail in the publication DOS System Control and Service.

LINKAGE EDITOR CONTROL STATEMENTS

Object modules used as input to the Linkage Editor must include linkage editor control statements. There are four linkage editor control statements: PHASE, INCLUDE, ENTRY, and ACTION.

Linkage editor control statements initially enter the system through the device assigned to SYSRDR as part of the input job stream. PHASE and INCLUDE statements may also be present on SYSIPT or in the relocatable library. All four statements are verified for operation (INCLUDE, ACTION, ENTRY, or PHASE) and are copied to SYSLNK to become input when the Linkage Editor is executed.

Linkage editor control statements must be blank in position 1 of the statement. The operand field is terminated by the first blank position. It cannot extend beyond column 72.

The Linkage Editor is executed as a distinct job step. Figure 5 shows how the linkage editor function is performed as a job step in three kinds of operations.

1. Catalog Programs in Core Image Library. The linkage editor function is performed immediately preceding the operation that catalogs programs into the core image library. When the CATAL option is specified, programs edited by the Linkage Editor are cataloged in the core image library by the Librarian after the editing function is performed. The sequence of this operation is shown in Part A of Figure 5. Note that the input for the LNKEDT function could contain modules from the relocatable library instead of, or in addition to, those modules from the card reader, tape unit, or mass storage unit extent assigned to SYSIPT. This is accomplished by naming the module(s) to be copied from the relocatable library in an INCLUDE statement.

Load-and-Execute. The sequence of this operation is shown in Part B of Figure 5. Specifying OPTION LINK causes the Job Control Processor to open SYSLNK, and allows the Job Control Processor to place the object module(s) and linkage editor control statements on SYSLNK. As with the catalog operation, the input can consist of object modules from the relocatable library instead of, or in addition to, those modules from the card reader, tape unit, or disk extent assigned to SYSIPT. This is accomplished by specifying the name of the module to be included in the operand of an INCLUDE statement. After the object modules have been edited and placed in the core image library, the program is executed. The blank operand in the EXEC control statement indicates that the program that has just been link edited and temporarily stored in the core image library is to be executed.

3. Compile-and-Execute. Source modules can be compiled and then executed in a single sequence of job steps. In order to do this, the COBOL compiler is directed to write the object module directly on SYSLNK. This is done by using the LINK option in the OPTION control statement. Upon completion of this output operation, the linkage editor function is performed. The program is link edited and temporarily stored in the core image library. The sequence of this operation is shown in Part C of Figure 5.

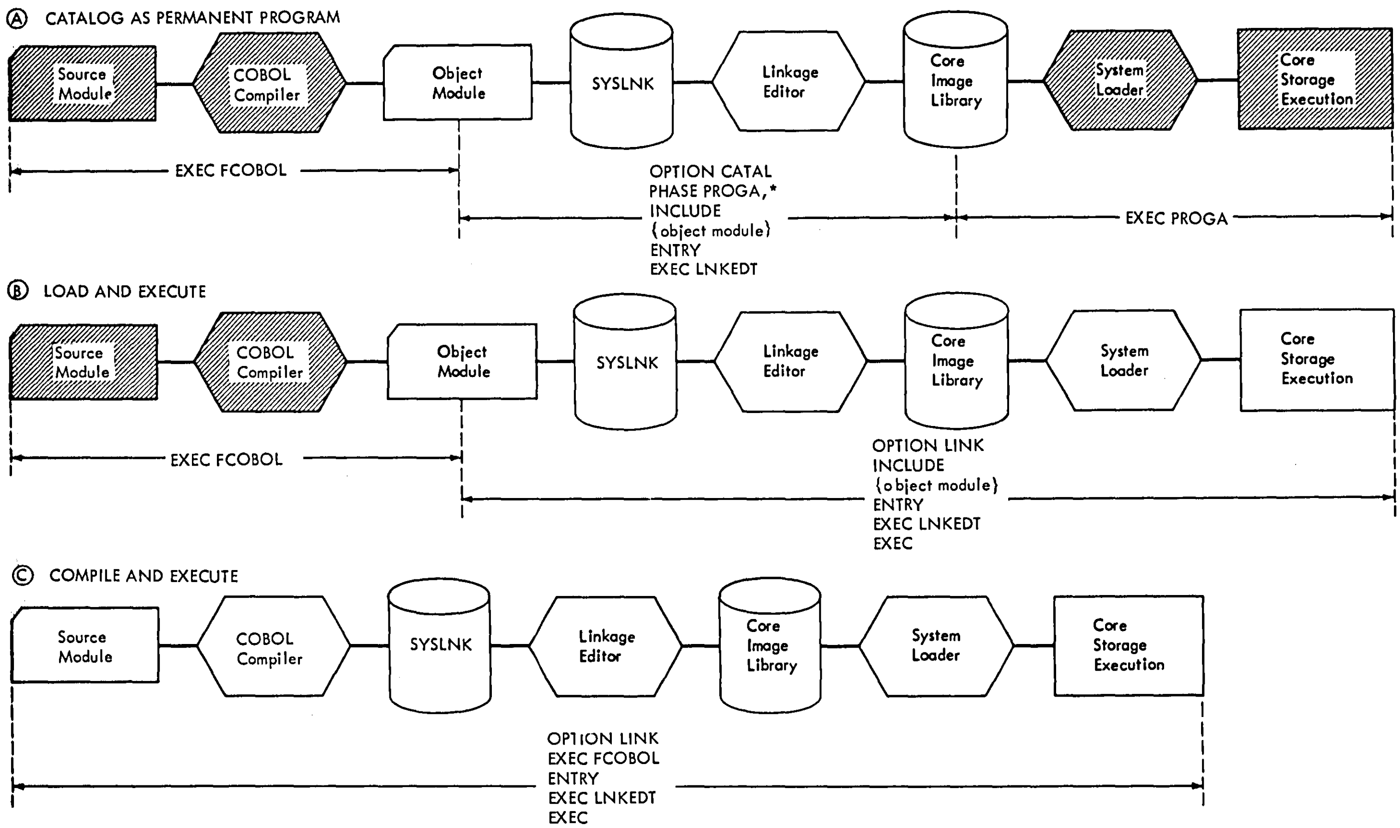

Figure 5. Job Definition -- Use of the Librarian

In each of the operations described in Figure 5, if a private core image library is assigned, output from the Linkage Editor will be placed (either permanently or temporarily) in the private core image library rather than in the system core image library. If the Linkage Editor is executed in a batched-job foreground partition, a private core image library must be assigned. Private core image libraries are a system generation option.

Control Statement Placement

The placement of linkage editor control statements is subject to the following rules:

1. The ACTION statement must be the first linkage editor control statement encountered in the input stream; otherwise, it is ignored.
2. The PHASE statement must precede each object module that is to begin a phase.
3. The INCLUDE statement must be specified for each object module that is to be included in a program phase.
4. A single ENTRY statement should follow the last object module when multiple object modules are processed in a single linkage editor run.

ACTION and ENTRY statements, when present, must be on SYSRDR. PHASE and INCLUDE statements may be present on SYSRDR, SYSIPT, or in the relocatable library.

PHASE Statement

The PHASE statement must be specified if the output of the Linkage Editor is to consist of more than one phase or if the program phase is to be cataloged in the core image library. Each object module that begins a phase must be preceded by a PHASE statement. Any object module not preceded by a PHASE statement will be included in the current phase.

The statement provides the Linkage Editor with a phase name and an origin point for the phase. The PHASE statement is in the following format:

```
PHASE name,origin[,NOAUTO]
```

name
: is the symbolic name of the phase. It is the name under which the program phase is to be cataloged. This name does not have to be the name specified in the PROGRAM-ID paragraph in the Identification Division of the source program and, in the case of overlay and sort, it should not be the same. It must consist of from one to eight alphanumeric characters. Phases that are to be executed in an overlay structure should have phase names of from five to eight alphanumeric characters, the first four of which should be the same. An asterisk cannot be used as the first character of a phase name.

origin
: indicates to the Linkage Editor the starting address of this specific phase. An asterisk may be used as an origin specification to indicate that this phase is to follow the previous phase. This origin specification format of the PHASE statement covers all applications that do not include setting up overlay structures. See the chapter "Calling and Called Programs" for information on the PHASE statement for overlay applications.

NOAUTO
: indicates that the Automatic Library Look-Up (AUTOLINK) feature is suppressed for both the private relocatable library and the system relocatable library. (The use of NOAUTO causes the AUTOLINK process to be suppressed for that phase only.) The AUTOLINK feature is discussed later in this chapter.

INCLUDE Statement

The INCLUDE statement must be specified for each object module deck or object module in the relocatable library that is to be included in a program phase. The format of the INCLUDE statement is as follows:

```
INCLUDE [module-name][,(namelist)]
```

The INCLUDE statement has two optional operands. When both operands are used, they must be in the prescribed order. When the first operand is omitted and the second operand is used, a comma must precede the second operand.

module-name
: must be specified when the object module is in the relocatable library. It is not specified when the module to be included is in the form of a card deck being entered from SYSIPT. module-name is the name under which the module was cataloged in the library, and must consist of from one to eight alphanumeric characters.

(namelist)
: causes the Linkage Editor to construct a phase from the control sections specified in the list. Since control sections are of no interest to the COBOL programmer, users interested in this option should refer to the description of the INCLUDE statement in the publication DOS System Control and Service.

ENTRY Statement

The ENTRY statement is required only if the programmer wishes to provide a specific entry point in the first phase produced by the Linkage Editor. When no ENTRY statement is provided, the Job Control Processor writes an ENTRY statement with a blank operand on SYSLNK to ensure that an ENTRY statement will be present to halt link editing. The transfer address will be the load address of the first phase. The ENTRY statement is described further in the publication DOS System Control and Service.

ACTION Statement

The ACTION statement is used to indicate linkage editor options. When used, the statement must be the first linkage editor statement in the input stream. The format of the ACTION statement is as follows:

```
        ⎧CLEAR ⎫
        ⎪MAP   ⎪
        ⎪NOMAP ⎪
ACTION  ⎨NOAUTO⎬
        ⎪CANCEL⎪
        ⎪BG    ⎪
        ⎪F1    ⎪
        ⎩F2    ⎭
```

CLEAR
indicates that the entire temporary portion of the core image library will be set to binary zero before the beginning of the linkage editor function. CLEAR is a time-consuming function and should be used only when necessary.

MAP
indicates that SYSLST is available for diagnostic messages. In addition, a main storage map is output on SYSLST.

NOMAP
indicates that SYSLST is unavailable when performing the link edit function. The mapping of main storage is not performed, and all linkage editor diagnostic messages are listed on the printer-keyboard (SYSLOG).

NOAUTO
suppresses the AUTOLINK function for both the private and system relocatable libraries during the link editing of the entire program. AUTOLINK is discussed later in this chapter.

CANCEL
causes an automatic cancellation of the job if any of the linkage editor errors 2100I through 2170I occur.

These diagnostic messages can be found in the publication <u>DOS System Control and Service</u>.

BG, F1, and F2
are options used to link edit a program for execution in a partition other than that in which the link edit function is taking place. See the publication <u>DOS System Control and Service</u>.

AUTOLINK FEATURE

If any references to external-names are still unresolved after all modules have been read from SYSLNK, SYSIPT, and/or the relocatable library, AUTOLINK collects each unresolved external reference from the phase. It then searches the private relocatable library (if SYSRLB has been assigned) and the system relocatable library for module names identical to the unresolved names and includes these modules in the program phase. This feature should not be suppressed (via PHASE or ACTION statements) in linkage editor job steps which include COBOL subroutines cataloged in the relocatable library. See the chapter "Calling and Called Programs" for additional details.

The system residence device (SYSRES) for the Disk Operating System can contain three libraries: the core image library, the relocatable library, and the source statement library. Executable programs (core image format) are stored in the core image library; relocatable object modules are stored in the relocatable library; and source language routines are stored in the source statement library.

The core image library is required for each disk resident system. The relocatable library and the source statement library are not required.

In addition to the three system libraries located on SYSRES, the programmer may also request creation of private core image, source statement, and relocatable libraries. These libraries are discussed under "Private Libraries" in this chapter.

LIBRARIAN

The Librarian is a group of programs that perform three major functions:

1. Maintenance
2. Service
3. Copy

Maintenance functions are used to catalog (that is, add), delete, or rename components of the three libraries, condense libraries and directories, set a condense limit for an automatic condense function, reallocate directory and library extents, and update the source statement library.

The copy function is used either to completely or selectively copy the disk on which the system resides. Service functions are used to translate information from a particular library to printed (displayed) or punched output.

Only the catalog maintenance function of the Librarian is discussed in this publication for the three system libraries. In addition, the update function of the source statement library is discussed. A complete description of librarian functions can be found in the publication DOS System Control and Service.

CORE IMAGE LIBRARY

The core image library may contain any number of programs. Each program consists of one or more separate phases. Associated with the core image library is a core image directory which contains a unique descriptive entry for each phase in the core image library. These entries in the core image directory are used to locate and retrieve phases from the core image library.

Cataloging and Retieving Program Phases -- Core Image Library

If a program is to be cataloged in the core image library, the job control statement // OPTION with the CATAL option must be specified prior to the first linkage editor control card, and must precede the first PHASE card of the program to be cataloged. Upon successful completion of the linkage editor job step, output from the Linkage Editor is placed in the core image library as a permanent member. The program phase is cataloged under the name specified in the PHASE statement.

If a phase in the core image library is to be replaced by a new phase having the same name, only the catalog function need be used. The previously cataloged phase of the same name is implicitly deleted from the core image directory by the catalog function, and the space it occupies in the library can later be released by the condense function.

Note: The necessary ASSGN control statements must follow the // JOB control statement if the current assignments are not the following:

1. SYSRDR -- Card reader, tape unit, or disk extent
2. SYSIPT -- Card reader, tape unit, or disk extent
3. SYSLST -- Printer, tape unit, or disk extent
4. SYSLOG -- Printer keyboard
5. SYSLNK -- Disk extent

The following is an example of cataloging a single phase, FOURA, into the core image library. (The program phase FOURA can be executed in the next job step by specifying the // EXEC statement with a blank name field.)

```
// JOB CATALOG
// OPTION CATAL
   PHASE FOURA,*
   INCLUDE

      {object deck}
/*
// LBLTYP TAPE
// EXEC LNKEDT
// EXEC
/&
```

To compile, link edit, and catalog the phase FOURA into the core image library in the same job, the following job deck could be used:

```
// JOB CATALOG
// OPTION CATAL
   PHASE FOURA,*
// EXEC FCOBOL

      {source deck}
/*
// EXEC LNKEDT
/*
/&
```

When the phase is executed in a subsequent job, the EXEC statement that calls for execution must specify FOURA, i.e., the name by which the phase has been cataloged.

```
// JOB EXJOB
// EXEC FOURA
/&
```

RELOCATABLE LIBRARY

The relocatable library contains any number of modules. Each module is a complete object deck in relocatable format. The purpose of the relocatable library is to allow the programmer to maintain frequently used routines in residence and combine them with other modules without recompiling.

Associated with the relocatable library is the relocatable directory. The directory contains a unique, descriptive entry for each module in the relocatable library. The entries in the relocatable directory are used to locate and retrieve modules in the relocatable library.

MAINTENANCE FUNCTIONS

To request a maintenance function for the relocatable library, the following control statement is used:

```
// EXEC MAINT
```

Cataloging a Module -- Relocatable Library

The catalog function adds a module to the relocatable library. A module in the relocatable library is the output of a complete COBOL compilation.

The catalog function implies a delete function. Thus, if a module exists in the relocatable library with the same name as a module to be cataloged, the module in the library is deleted by deleting reference to it in the relocatable directory.

The CATALR control statement is required to add a module to the relocatable library. The format of the CATALR control statement is:

```
CATALR module-name [,v.m]
```

module-name
: is the name by which the module is known to the control program. The module-name consists of from one to eight characters the first of which must not be an asterisk.

v.m
: specifies the change level at which the module is to be cataloged. v may be any decimal number from 0 through 127. m may be any decimal number from 0 through 255. If this operand is omitted, a change level of 0.0 is assumed. A change level can be assigned only when a module is cataloged.

All control statements required to catalog an object module must be read from SYSIPT. For the catalog function, device assignments must be as follows:

1. SYSRDR -- Card reader, tape unit, or disk extent
2. SYSIPT -- Card reader, tape unit, or disk extent
3. SYSLST -- Printer, tape unit, or disk extent
4. SYSLOG -- Printer keyboard

Note: If SYSRDR and/or SYSIPT are assigned to a tape unit, the MAINT program assumes that the tape is positioned to the first input record. The tape is not rewound at the end of the job.

The following is an example of compiling a source program and cataloging the resultant module in the relocatable library. The job deck is read from SYSIPT.

```
// JOB NINE
// OPTION DECK
// EXEC FCOBOL

    {source deck}
/*
// PAUSE PLACE DECK AFTER CATALR CARD
// EXEC MAINT
   CATALR MOD9

    (punched deck goes here)
/*
/&
```

In the above example, as a result of the compile step, the object module is written on SYSPCH. The next job step catalogs the object module (MOD9) into the relocatable library. Since the object module must be cataloged from SYSIPT, a message to the operator instructs him to place the object module on SYSIPT behind the CATALR statement.

The following is an example of cataloging two previously created object modules in the relocatable library:

```
// JOB EIGHT
// EXEC MAINT
   CATALR MOD8A

    {object deck}
   CATALR MOD8B

    {object deck}
/*
/&
```

An additional capability of the system permits a programmer to compile a program and to catalog it to the system relocatable, or private relocatable, library in one continuous run. The programmer inserts a CATALR statement in his job control input stream preceding the compiler execute statement. The CATALR statement will be written on the SYSPCH file (tape or mass storage device) ahead of the compiler output. The programmer then reassigns the SYSPCH file as SYSIPT and executes the MAINT program to perform the catalog function. The output of the compilation (on tape or mass storage device) may be cataloged immediately or it may be cataloged at some later time. It can also be held after cataloging as backup of the compilation.

Note: This facility is not available for IBM 2314, 2319, and 3330 applications because of the restriction in the MAINT program limiting input to only 80 character records. Records produced for 2314, 2319, and 3330 applications exceed this limit.

SOURCE STATEMENT LIBRARY

The source statement library contains any number of books. Each book in the source statement library is composed of a sequence of source language statements. The purpose of the source statement library is to allow the COBOL programmer to initiate the compilation of a book into the source program by using the COPY statement or the BASIS card.

Each book in the source statement library is classified as belonging to a specific sublibrary. Sublibraries are defined for two programming languages: Assembler and COBOL. Individual books are classified by sublibrary names. Therefore, books written in each of these languages may have the same name.

Associated with the source statement library is a source statement directory. The directory contains a unique descriptive entry for each book in the source statement library. The entries in the source statement directory are used to locate and retrieve books in the source statement library.

MAINTENANCE FUNCTIONS

To request a maintenance function for the source statement library, the following control statement must be used:

```
// EXEC MAINT
```

Cataloging a Book -- Source Statement Library

The CATALS control statement is required to add a book to a sublibrary of the source statement library.

A book added to a sublibrary of the source statement library is removed by using the delete function. When a book exists in a sublibrary with the same name as a book to be cataloged in that sublibrary, the existing book in the sublibrary is deleted. The following is the format of the CATALS control statement:

```
CATALS sublib.library-name[,v.m[,C]]
```

The operation field contains CATALS.

sublib
: represents the sublibrary to which a book is to be cataloged and can be:

  Any alphanumeric character (0-9, A-Z, #, $, and @) representing source statement libraries. The characters A and C have special uses:

  A is used for the Assembler sublibrary

  C is used for the COBOL sublibrary

The sublib qualifier is required. If omitted, the operand will be flagged as invalid and no processing will be done on the book.

library-name
: represents the name of the book to be cataloged. The library-name consists of from one to eight alphanumeric characters, the first of which must be alphabetic. It is the name the programmer uses to retrieve the book when using the source language COPY statement or BASIS card.

v.m
: specifies the change level at which the book is to be cataloged. v may be any decimal number from 0 through 127; m may be any decimal number from 0 through 255. If this operand is omitted, a change level of 0.0 is assumed. The v.m operand becomes part of the entry in the directory for the specified book. Its value is incremented each time an update is performed on the book.

C
: indicates that change level verification is required before updates are accepted for this book.

See the UPDATE control statement, discussed later in this chapter, for its relationship to the v.m and C operands of the CATALS control statement.

In addition to the CATALS control statement, a control statement of the following form must precede and follow the book to be cataloged:

```
BKEND [sublib.library-name],[SEQNCE],
   [count],[CMPRSD]
```

All operand entries are optional. When used, the entries must be in the prescribed order and need appear only in the BKEND statement preceding the book to be cataloged.

The first entry in the operand field is identical to the operand of the CATALS control statement.

SEQNCE
: specifies that columns 76 to 80 of the card images constituting the book are to be checked for ascending sequence numbers. If an error is detected in the sequence checking, an error message is printed. The error can be corrected, and the book can be recataloged.

count
: specifies the number of card images in the book. When the count operand is used, the card input is counted, beginning with the preceding BKEND statement and including the subsequent BKEND statement. If an error is detected in the card count, an error message is printed. The error can be corrected, and the book can be recataloged.

CMPRSD
: indicates that the book to be cataloged in the library is in compressed format as a result of CMPRSD having been specified when performing a PUNCH or DSPCH service function. These functions are described in the publication DOS System Control and Service.

Card input for the catalog function is from the device assigned to SYSIPT. The CATALS control statement is also read from the device assigned to SYSIPT. For the catalog function, device assignments must be as follows:

1. SYSRDR -- Card reader, tape unit, or disk extent
2. SYSIPT -- Card reader, tape unit, or disk extent
3. SYSLST -- Printer, tape unit, or disk extent
4. SYSLOG -- Printer keyboard

Frequently used Environment Division, Data Division, and Procedure Division entries can be cataloged in the COBOL sublibrary of the source statement library. A book in the source statement library might consist, for example, of a file description of the Data Division or a paragraph of the Procedure Division.

The following is an example of cataloging a file description in the COBOL sublibrary of the source statement library.

```
// JOB ANYNAME
// EXEC MAINT
   CATALS C.FILEA
   BKEND C.FILEA
          BLOCK CONTAINS 13 RECORDS
          RECORD CONTAINS 120 CHARACTERS
          LABEL RECORDS ARE STANDARD
          DATA RECORD IS RECA.
   BKEND
/*
/&
```

Retrieving a Cataloged Book -- COBOL COPY Statement: The preceding file description can be included in a COBOL source program by writing the following statement:

```
     FD FILEB COPY FILEA.
```

Note that the library entry does not include FD or the file-name. It begins with the first clause that is actually to follow the file-name. This is true for all options of the COPY statement. However, data entries in the library may have a level number (01 or 77) identical to the level number of the data-name that precedes the COPY statement. In this case, all information about the library data-name is copied from the library and all references to the library data-name are replaced by the data-name in the program if the REPLACING option is specified. The change is made only for this program. The entry as it appears in the library remains unchanged. For example, assume the following data entry is cataloged under the library-name DATAR,

```
   01  PAYFILE USAGE IS DISPLAY.
       02  CALC PICTURE 99.
       02  GRADE PICTURE 9
           OCCURS 1 DEPENDING ON CALC OF
           PAYFILE.
```

and the following statement is written in a COBOL source module:

```
   01  GROSS COPY DATAR REPLACING PAYFILE
         BY GROSS.
```

The compiler interprets this as:

```
   01  GROSS USAGE IS DISPLAY.
       02  CALC PICTURE 99.
       02  GRADE PICTURE 9
           OCCURS 1 DEPENDING ON CALC OF
           GROSS.
```

Note also that the library-name is used to identify the book in the library. It has no other use in the COBOL program.

Text cataloged in the source statement library must conform to COBOL margin restrictions.

The COBOL COPY statement is discussed in detail in the section "Extended Source Program Library Facility."

Updating Books -- Source Statement Library

The update function is used to make changes to properly identified statements within a book in the source statement library. Statements are identified in the identification field, columns 73 through 80, which is fixed in format as follows:

Columns 73-76 Program identification which must be constant throughout the book.

Columns 77-80 Sequence number of the statement within the book.

One or more source statements may be added to, deleted from, or replaced in a book in the library without the necessity of replacing the entire book. The update function also provides these facilities:

1. Resequencing statements within a book in the source statement library
2. Changing the change level (v.m) of the book
3. Adding or removing the change level requirement
4. Copying a book with optional retention of the old book with a new name (for backup purposes)

The UPDATE control statement is used for the update function and has the following format:

```
    UPDATE sublib.library-name,[s.book1],
       [v.m],[nn]
```

The operation field contains UPDATE.

sublib
: represents the sublibrary that contains the book to be updated. It may be any of the characters 0 through 9, A through Z, #, $, or @.

s.book1
: provides a temporary update option. The old book is renamed s.book1 and the updated book is named sublib.library-name. s indicates the sublibrary that contains the old, renamed book. It may be one of the characters 0 through 9, A through Z, #, $, or @. If this operand is not specified, the old book is deleted.

v.m
: represents the change level of the book to be updated. v may be any decimal number from 0 through 127; m may be any decimal number from 0 through 255. This operand must be present if change level verification is to be performed. Use of the optional entry C in the CATALS control statement at the time the book is cataloged in the library determines whether change level verification is required before updating. If the directory entry specifies that change level verification is not required before updating, the change level operand in the UPDATE control statement is ignored.

  If the change level is verified, the change level in the book's directory entry is increased by 1 by the system for verification of the next update. If m is at its maximum value and an update is processed, m is reset to 0 and the value of v is increased by 1. If both v and m are at their maximum values and an update is processed, both v and m are reset to 0.

nn
: represents the resequencing status required for the update. nn may be a 1- or 2-character decimal number from 1 through 10, or it may be the word NO. If nn is a decimal number, it represents the increment that will be used in resequencing the statements in the book. If nn is NO, the statements will not be resequenced. If nn is not specified, the statements will be resequenced with an increment of 1. When a book is resequenced, the sequence number of thefirst statement is 0000. For example, if a book is cataloged in the source statement library with sequence numbers ranging from 0010 through 1000 with increments of 5 for each statement:

  and nn is not specified when the update function is performed, the book is resequenced with numbers 0000, 0001, 0002, ... etc.

  and NO is specified, insertions, deletions, and/or replacements are made with no effect on the original sequence numbers.

  and nn is specified as 2, the book is resequenced with numbers 0000, 0002, 0004, ... etc., regardless of the original sequencing of the book in the library or the sequence numbers of the added or replacement cards.

The UPDATE control statement is followed by ADD, DEL (delete), and/or REP (replace) control statements as required, followed by the terminating END statement. The ADD, DEL, REP, and END statements are identified as update control statements by a right parenthesis in the first position (column 1 in card format). This is a variation from the general librarian control statement format; thus, it clearly identifies these control statements as part of the update function.

ADD Statement: The ADD statement is used for the addition of source statements to a book. The format is:

```
) ADD seq-no
```

ADD indicates that source statements following this statement are to be added to the book.

seq-no
: represents the sequence number of the statement in the book after which the new statements are to be added. It may be any decimal number consisting of from one to four characters.

DEL Statement: The DEL statement causes the deletion of source statements from the book. The format is:

```
) DEL first-seq-no[,last-seq-no]
```

DEL indicates that statements are to be deleted from the book.

first-seq-no
last-seq-no
: represent the sequence numbers of the first and last statements of a section to be deleted. Each number may be a decimal number consisting of from one to four characters. If last-seq-no is not specified, the statement represented by first-seq-no is the only statement deleted.

REP Statement: The REP statement is used when replacement of source statements is required in a book. The format is:

```
) REP first-seq-no[,last-seq-no]
```

REP indicates that source statements following this statement are to replace existing statements in a book.

first-seq-no
last-seq-no
: represent the sequence numbers of the first and last statements of a section to be replaced. Each number may be a decimal number consisting of from one to four characters. Any number of new statements can be added to a book when a section is replaced. (The number of statements added need not equal the number of statements being replaced.)

Sequence number 9999 is the highest number acceptable for a statement to be updated. If the book is so large that statement sequence numbers have "wrapped around" (progressed from 9998, 9999, to 0000,0001), it will not be possible to update statements 0000 and 0001.

END Statement: This statement indicates the end of updates for a given book. The format is:

```
) END [v.m[,C]]
```

v.m
: represents the change level to be assigned to the book after it is updated; v may be any decimal number from 0 through 127. m may be any decimal number from 0 through 255. This operand provides an additional means of specifying the change level of a book in the library. (The other method is through the use of the v.m operand in the CATALS statement.)

C
: indicates that change level verification is required before any subsequent updates for a given book.

If v.m is specified and C is omitted, the book does not require change level verification before a subsequent update. This feature removes a previously specified verification requirement for a particular book.

If both optional operands are omitted, the change level in the book's directory entry is increased as a result of the update, and the verification requirement remains unchanged.

Logical Unit Assignment and Control Statement Placement:

For the update function, SYSIN must be assigned to a card reader, a tape unit, or a disk unit. SYSLST must be assigned to a printer, a tape unit, or a disk extent; SYSLOG must be assigned to the printer keyboard.

Control statement input for the update function, read from the device assigned to SYSIN, must be in the following order:

1. The JOB control statement.
2. The ASSGN control statements, if the current assignments are not those required. The ASSGN control statements that can be used are SYSIN, SYSLST, and SYSLOG.
3. The EXEC MAINT control statement.
4. The UPDATE control statement.
5.) ADD,) DEL, or) REP statements with appropriate source statements.
6.) END statement.
7. The /* control statement.
8. The /& control statement, which is the last control statement of the job.

The source statement library can also be updated by using the DELETE and INSERT cards. These are discussed in "Extended Source Program Library Facility" in this chapter, and in the publication IBM System/360 Disk Operating System: Full American National Standard COBOL.

UPDATE Function -- Invalid Operand Defaults

UPDATE Statement:

1. If the first or second operand is invalid, the statement is flagged, the book is not updated, and the remaining control statements are checked to determine their validity.

2. If change level verification is required and the incorrect change level is specified, the statement is flagged, the book is not updated, and the remaining control statements are checked to determine their validity.

3. If the resequencing operand is invalid, resequencing is done in increments of 1.

ADD, DEL, or REP Statements:

1. If there is an invalid operation or operand in an ADD, DEL, or REP statement, the statement is flagged, the book is not updated, and the remaining control statements are checked to determine their validity. All options of the UPDATE and END statements are ignored.

2. The second operand must be greater than the first operand in a DEL or REP statement. If not, the statement is considered invalid and is flagged, the book is not updated, and the remaining control statements are checked to determine their validity. All options of the UPDATE and END statements are ignored.

3. All updates to a book between an UPDATE statement and an END statement must be in ascending sequential order of statement sequence numbers. The first operand of a DEL or REP statement must be greater than the last operand of the preceding control statement. The operand of an ADD statement must be equal to or greater than the last operand of the preceding control statement. Consecutive ADD statements must not have the same operand. If these conditions are not met, the default is the same as for items 1 and 2.

END Statement: If the first operand of the END statement is invalid, the statement is flagged, both operands are ignored, and the book is updated as though no operands were specified. If the second operand is invalid, the statement is flagged, the operand is ignored, and the book is updated as though the second operand were not specified.

Out-of-Sequence Updates: If the source statements to be added to a book are not in sequence or do not contain sequence numbers, the book is updated, and a message indicating the error appears following the END statement. If the resequencing option has been specified in the UPDATE statement, the book is sequenced by the specified value, and subsequent updating is possible. If the resequencing option is not specified, the book is resequenced in increments of 1, and subsequent updating will be possible. If the resequencing option NO is specified, the book will be out of sequence, and subsequent updating may not be possible.

PRIVATE LIBRARIES

Private libraries are desirable in the system to permit some libraries to be located on a disk pack other than the one used by SYSRES.

Private libraries are supported for the core image library, the relocatable library, and the source statement library, on both the 2311, 2314, and 3330 mass storage devices. However, the following restrictions apply:

1. The private library must be on the same type of disk device as SYSRES.

2. Reference may be made to a private core image library only if SYSCLB is assigned. If SYSCLB is assigned, the system core image library cannot be changed.

3. Reference may be made to a private relocatable library only if SYSRLB is assigned. If SYSRLB is assigned, the system relocatable library cannot be changed.

4. Reference may be made to a private source statement library only if SYSSLB is assigned. If SYSSLB is assigned, the system source statement library cannot be changed.

5. Private libraries cannot be reallocated.

6. The COPY function is not effective for private libraries except when they are being created.

An unlimited number of private libraries is possible. However, each must be distinguished by a unique file identification in the DLBL statement for the library. No more than one private relocatable library and one private source statement library may be assigned in a given job.

The creation and maintenance of private libraries is discussed in the publication DOS System Control and Service.

SOURCE LANGUAGE CONSIDERATIONS

To use the private source statement library for COPY, BASIS, INSERT, and DELETE (see "Extended Source Program Library Facility" for further details), the ASSGN, DLBL, and EXTENT control statements that define this private library must be present in the job deck for compilation. When present, a search for the book is made in the private library. If it is not there, the system library is searched. If the statements for the private library are not present, the system library is searched. A programmer may create several private libraries, but only one private library can be used in a given job.

EXTENDED SOURCE PROGRAM LIBRARY FACILITY

A complete program may be included as an entry in the source statement library by using the catalog function. This program can then be retrieved by a BASIS card and compiled in a subsequent job.

The following control statements would be used to catalog the program SAMPLE as a book in the COBOL sublibrary of the source statement library:

```
// JOB CATALOG
// EXEC MAINT
   CATALS C.SAMPLE
   BKEND C.SAMPLE

     {source program}

   BKEND
/*
/&
```

When compiling a program that has been cataloged in the COBOL sublibrary of the source statement library, a BASIS card brings in an entire source program. The following control statements could be used to compile the cataloged program SAMPLE:

```
// JOB PGM1
// OPTION LOG,DECK,LIST,LISTX,ERRS
// EXEC FCOBOL
 CBL LIB
       BASIS SAMPLE
/*
/&
```

INSERT or DELETE cards may follow the BASIS card if the user wishes to modify the book SAMPLE before it is processed by the compiler. The original source program must have been coded with sequence numbers in columns 1 through 6 of each source card.

The INSERT statement will add new source statements after the specified sequence numbers. The DELETE statement will delete the statements indicated by the sequence numbers, or will delete more than one statement when the first and last sequence numbers to be deleted are specified, separated by a hyphen. Source program cards may follow a DELETE card for insertion before the card following the last one deleted. The sequence numbers in columns 1 through 6 are used to update COBOL source statements at compilation time, and are in effect for the one run only.

Assume that a company runs its payroll program each week as a source program taken from the source statement library. The name of the program is PAYROLL. During the year, an old age insurance tax (FICA) is deducted at the rate of 4-2/5% each week for all personnel until earnings exceed $7800. The coding to accomplish this is shown in Figure 6.

At the beginning of the year, the test for earnings over $7800 is taken out of the program until a more appropriate time later in the year. In addition, at the beginning of the year, management dictates that all draftsmen receive a 5% pay increase. Assume that records for all personnel contain an occupation code. The code identifying draftsmen is DR. The programmer can program these changes as shown in Figure 7.

The altered program will contain the coding shown in Figure 8.

```
000730                   IF ANNUAL-PAY GREATER THAN 7800 GO TO PAY-WRITE.
000735                   IF ANNUAL-PAY GREATER THAN 7800 - BASE-PAY GO TO LAST-FICA.
000740   FICA-PAYR.      COMPUTE FICA-PAY = BASE-PAY * .044
000745                         MOVE FICA-PAY TO OUTPUT-FICA.
000750   PAY-WRITE.            MOVE BASE-PAY TO OUTPUT-BASE.
000755                         ADD BASE-PAY TO ANNUAL-PAY.
   .                     .
   .                     .
   .                     .
000850                   STOP RUN.
```

Figure 6. Sample Coding to Calculate FICA

```
// JOB PGM2
// OPTION LOG,DECK,LIST,LISTX,ERRS
// EXEC FCOBOL
 CBL LIB,QUOTE
       BASIS PAYROLL
       DELETE 000730, 000735
                  IF OCCUPATION-CODE = "DR" PERFORM PAY-INCREASE THRU EX1.
       INSERT 000850
              PAY-INCREASE.  MULTIPLY 1.05 BY BASE-PAY.
              EX1.   EXIT.
/&
```

Figure 7. Altering a Program from the Source Statement Library Using INSERT and DELETE Cards

```
             IF OCCUPATION-CODE = "DR" PERFORM PAY-INCREASE THRU EX1.
000740 FICA-PAYR. COMPUTE FICA-PAY = BASE-PAY * .044
000745                MOVE FICA-PAY TO OUTPUT-FICA.
000750 PAY-WRITE. MOVE BASE-PAY TO OUTPUT-BASE.
000755                ADD BASE-PAY TO ANNUAL-PAY.
.                     .
.                     .
.                     .
000850                STOP RUN.
       PAY-INCREASE. MULTIPLY 1.05 BY BASE-PAY.
       EX1.           EXIT.
```

Figure 8. Effect of INSERT and DELETE Cards

A programmer using the American National Standard COBOL compiler under the IBM System/360 Disk Operating System has several methods available to him for testing and debugging his programs for increased operating efficiency.

The COBOL debugging language can be used by itself or in conjunction with other COBOL statements. A dump can also be used for program checkout.

DEBUG LANGUAGE

The COBOL debugging language is designed to assist the COBOL programmer in producing an error-free program in the shortest possible time. The following sections discuss the use of the debug language and other methods of program checkout.

The three debug language statements are TRACE, EXHIBIT, and ON. Any one of these statements can be used as often as necessary. They can be interspersed throughout a COBOL source program, or they can be contained in a packet in the input stream to the compiler.

Program checkout may not be desired after testing is completed. A debug packet can be removed after testing to eliminate the extra object program coding generated for the debug statements.

The output produced by the TRACE and EXHIBIT statements is listed on the system logical output device (SYSLST).

The following discussions describe methods of using the debug language.

FLOW OF CONTROL

The READY TRACE statement causes the compiler-generated card numbers for each section-name and paragraph-name to be displayed. These card numbers are listed on SYSLST at execution time when control passes to these sections and paragraphs. Hence, the output of the READY TRACE statement appears as a list of card numbers.

To reduce the length of the list and the time taken to generate it, a trace can be stopped with a RESET TRACE statement. The READY TRACE/RESET TRACE combination is helpful in examining a particular area of the program where the flow of control is difficult to determine, e.g., code consists of a series of PERFORM statements or nested conditional statements. The READY TRACE statement can be coded so that the trace begins before control passes to that area. The RESET TRACE statement can be coded so that the trace stops when the program has passed beyond the area.

Use of the ON statement with the TRACE statement allows conditional control of the tracing. When the COBOL compiler encounters an ON statement, it creates a counter which is incremented during execution, whenever control passes through that ON statement. For example, if an error occurs when a specific record is processed, the ON statement can be used to isolate the problem record. The statement should be placed where control passes through it only once for each record that is read. When the contents of the counter equal the number of the record (as specified in the ON statement), a trace can be taken on that record. The following example shows a method in which the 200th record could be selected for a TRACE statement.

```
Col.
1      Area A
-------------------------------------------
       RD-REC.
       .
       .
       .
DEBUG  RD-REC
       PARA-NM-1.    ON 200 READY TRACE.
                     ON 201 RESET TRACE.
```

If the TRACE statement were used without the ON statement, every record would be traced.

An example of a common program error is failing to break a loop or unintentionally creating a loop in the program. If many iterations of the loop are required before it can be determined that a program error exists, the ON statement can be used to initiate a trace after the expected number of iterations has been completed.

Note: If an error occurs during compilation of an ON statement, the diagnostic message may refer to the previous statement number.

DISPLAYING DATA VALUES DURING EXECUTION

A programmer can display the value of a data item during program execution by using the EXHIBIT statement. The EXHIBIT statement has three options:

1. EXHIBIT NAMED -- Displays the names and values of the data-names listed in the statement.
2. EXHIBIT CHANGED -- Displays the value of the data-names listed in the statement only if the value has changed since the last execution of the statement.
3. EXHIBIT CHANGED NAMED -- Displays the names and the values of the data-names only if the values have changed since the last execution of the statement.

Data values can be used to check the accuracy of the program. For example, using EXHIBIT NAMED, the programmer can display specified fields from records, compute the calculations himself, and compare his calculations with the output from his program. The coding for a payroll problem might be:

```
Col.
1       Area A
-------------------------------------------
           .
           .
           .
        GROSS-PAY-CALC.
            COMPUTE GROSS-PAY =
            RATE-PER-HOUR * (HRSWKD
            + 1.5 * OVERTIMEHRS).
        NET-PAY-CALC.
           .
           .
DEBUG   NET-PAY-CALC
        SAMPLE-1. ON 10 AND
            EVERY 10 EXHIBIT NAMED
            RATE-PER-HOUR, HRSWKD,
            OVERTIMEHRS, GROSS-PAY.
```

This coding will cause the values of the four fields to be listed for every tenth data record before net pay calculations are made. The output could appear as:

```
RATE-PER-HOUR = 4.00 HRSWKD = 40.0
     OVERTIMEHRS = 0.0 GROSS-PAY = 160.00

RATE-PER-HOUR = 4.10 HRSWKD = 40.0
     OVERTIMEHRS = 1.5 GROSS-PAY = 173.23

RATE-PER-HOUR = 3.35 HRSWKD = 40.0
     OVERTIMEHRS = 0.0 GROSS-PAY = 134.00
```

Note: Decimal points are included in this example for clarity, but actual printouts depend on the data description in the program.

The preceding was an example of checking at regular intervals (every tenth record). A check of any unusual conditions can be made by using various combinations of COBOL statements in the debug packet. For example:

```
IF OVERTIMEHRS GREATER THAN 2.0
  EXHIBIT NAMED PAYRCDHRS...
```

In connection with the previous example, this statement could cause the entire pay record to be displayed whenever an unusual condition (overtime exceeding two hours) is encountered.

The EXHIBIT statement with the CHANGED option also can be used to monitor conditions that do not occur at regular intervals. The values of data-names are listed only if the value has changed since the last execution of the statement. For example, suppose the program calculates postage rates to various cities. The flow of the program might be:

```
          .
          .
          .
  ┌────────────┐
  │READ INPUT  │
  │ DATA FOR   │<----- B
  │   CITY     │
  └─────┬──────┘
        |
        |
        V
  ┌────────────┐
  │ CALCULATE  │
  │ RATE FOR   │
  │   CITY     │
  └─────┬──────┘
        |
        |
        V
  ┌────────────┐
  │  EXHIBIT   │
  │  CHANGED   │
  └─────┬──────┘
        |
        |
        V
      LAST          NO
      CITY         -----> B
        YES
        |
        |
        |
        V
        .
        .
        .
```

The EXHIBIT statement with the CHANGED option in the program might be:

```
EXHIBIT CHANGED STATE CITY RATE
```

The output from the EXHIBIT statement with the CHANGED option could appear as:

```
01  01  10
    02  15
    03
    04  10
02  01
    02  20
    03  15
    04
03  01  10
    .
    .
    .
```

The first column contains the code for a state, the second column contains the code for a city, and the third column contains the code for the postage rate. The value of a data-name is listed only if it has changed since the previous execution. For example, since the postage rate to city 02 and city 03 in state 01 are the same, the rate is not printed for city 03.

The EXHIBIT statement with the CHANGED NAMED option lists the data-name if the value has changed. For example, the program might calculate the cost of various methods of shipping to different cities. After the calculations are made, the following statement could appear in the program:

```
EXHIBIT CHANGED NAMED STATE CITY RAIL
  BUS TRUCK AIR
```

The output from this statement could appear as shown in Figure 9. Note that a data-name and its value are listed only if the value has changed since the previous execution.

```
STATE = 01 CITY = 01 RAIL = 10 BUS = 14 TRUCK = 12 AIR = 20

CITY = 02

CITY = 03 BUS = 06 AIR = 15

CITY = 04 RAIL = 30 BUS = 25 TRUCK = 28 AIR = 34

STATE = 02 CITY = 01 TRUCK = 25

CITY = 02 TRUCK = 20 AIR = 30

     .
     .
     .
```

Figure 9. Sample Output of EXHIBIT Statement with the CHANGED NAMED Option

TESTING A PROGRAM SELECTIVELY

A debug packet allows the programmer to select a portion of the program for testing. The packet can include test data and can specify operations the programmer wants to be performed. When the testing is completed, the packet can be removed. The flow of control can be selectively altered by the inclusion of debug packets, as illustrated in the following example of selective testing of B:

```
┌──────────┐
│          │
│  START   │
│          │
└────┬─────┘
     │
     └─────────────────┐
                       │
                       V
┌──────────┐      ┌──────────┐
│          │      │  DEBUG   │
│    A     │      │  PACKET  │
│          │      │  FOR A   │
└──────────┘      └────┬─────┘
                       │
     ┌─────────────────┘
     │
     V
┌──────────┐
│          │
│    B     │
│          │
└────┬─────┘
     │
     └─────────────────┐
                       │
                       V
┌──────────┐      ┌──────────┐
│          │      │  DEBUG   │
│    C     │      │  PACKET  │
│          │      │  FOR C   │
└──────────┘      └────┬─────┘
                       │
                       │
     ┌─────────────────┘
     │
     V
┌──────────┐
│          │
│  STOP    │
│  RUN     │
└──────────┘
```

In this program, A creates data, B processes it, and C prints it. The debug packet for A simulates test data. It is first in the program to be executed. In the packet, the last statement is GO TO B, which permits A to be bypassed. After B is executed with the test data, control passes to the debug packet for C, which contains a GO TO statement that transfers control to the end of the program, bypassing C.

TESTING CHANGES AND ADDITIONS TO PROGRAMS

If a program runs correctly, and changes or additions might improve its efficiency, a debug packet can be used to test changes without modifying the original source program.

If the changes to be incorporated are in the middle of a paragraph, the entire paragraph with the changes included must be written in the debug packet. The last statement in the packet should be a GO TO statement that transfers control to the next procedure to be executed.

There are usually several ways to perform an operation. Alternative methods can be tested by putting them in debug packets.

The source program library facility can be used for program checkout by placing a source program in a library (see the chapter "Librarian Functions"). Changes or additions to the program can be tested by using the BASIS card and any number of INSERT and DELETE cards. Such changes or additions remain in effect only for the duration of the run.

A debug packet can also be used in conjunction with the BASIS card to debug a program or to test deletions or additions to it. The debug packet is inserted in the input stream immediately following the BASIS card and any INSERT or DELETE cards.

DUMPS

If a serious error occurs during execution of the problem program, the job is abnormally terminated; any remaining steps are bypassed; and a program phase dump is generated. The programmer can use the dump for program checkout. (However, any pending transfers to an external device may not be completed. For example, if a READY TRACE statement is in effect when the job is abnormally terminated, the last card number may not appear on the external device.) In cases where a serious error occurs in other than the problem program (e.g., Supervisor), a dump is not produced. Note that program phase dumps can be suppressed if the NODUMP option of the OPTION control statement has been specified for the job, or if NODUMP was specified at system generation time and is not overridden by the DUMP option for the current job.

HOW TO USE A DUMP

When a job is abnormally terminated due to a serious error in the problem program, a message is written on SYSLST which indicates the:

1. Type of interrupt (e.g., program check)

2. Hexadecimal address of the instruction that caused the interrupt

3. Condition code

4. Reason for the interrupt (e.g., data exception)

The instruction address can be compared to the Procedure Division map. The contents of LISTX provide a relative address for each statement. The load address of the module (which can be obtained from the map of main storage generated by the Linkage Editor) must be subtracted from the instruction address to obtain the relative instruction address as shown in the Procedure Division map. If the interrupt occurred within the COBOL program, the programmer can use the error address and LISTX to locate the specific statement in the program which caused a dump to be taken. Examination of the statement and the fields associated with it may produce information as to the specific nature of the error.

Figure 10 is a sample dump which was caused by a data exception. Invalid data (i.e., data which did not correspond to its usage) was placed in the numeric field B as a result of redefinition. The following discussion illustrates the method of finding the specific statement in the program which caused the dump. Letters identifying the text correspond to letters in the program listing.

(A) The program interrupt occurred at HEX LOCATION 0039BC. This is indicated in the SYSLST message printed just before the dump.

(B) The linkage editor map indicates that the program was loaded into address 0032A0. This is determined by examining the load point of the control section TESTRUN. TESTRUN is the name assigned to the program module by the source coding:

```
PROGRAM-ID.  TESTRUN.
```

(C) The specific instruction which caused the dump is located by subtracting the load address from the interrupt address (i.e., subtracting 32A0 from 39BC). The result, 71C, is the relative interrupt address and can be found in the object code listing. In this case the instruction in question is an AP (add decimal).

(D) The left-hand column of the object code listing gives the compiler-generated card number associated with the instruction. It is card 69. As seen in the source listing, card 69 contains the COMPUTE statement.

Additional details about reading a dump are found in the chapter "Interpreting Output."

ERRORS THAT CAN CAUSE A DUMP

A dump can be caused by one of many errors. Several of these errors may occur at the COBOL language level while others can occur at the job control level.

The following are examples of COBOL language errors that can cause a dump:

1. A GO TO statement with no procedure-name following it may have been improperly initialized with an ALTER statement. The execution of this statement will cause an invalid branch to be taken and results will be unpredictable.

2. Moves of or arithmetic calculations using numeric fields that have not been properly initialized.

   For example, neglecting to initialize the object of an OCCURS clause with the DEPENDING ON option, or referencing data fields prior to the first READ statement may cause a program interrupt and a dump.

3. Invalid data placed in a numeric field as a result of redefinition.

4. Input/output errors that are nonrecoverable.

5. Items with subscripts whose values exceed the defined maximum value can destroy machine instructions when moved.

6. Attempting to execute an invalid operation code through a system or program error.

7. Generating an invalid address for an area that has address protection.

8. Subprogram linkage declarations that are not defined exactly as they are stated in the calling program.

9. Data or instructions can be modified by entering a subprogram and manipulating data incorrectly. A COBOL subprogram can acquire invalid information from the main program, e.g., a CALL statement using a procedure-name and an ENTRY statement using a data-name.

10. An input file contains invalid data such as a blank numeric field or data incorrectly specified by its data description.

    The compiler does not generate a test to check the sign position for a valid configuration before the item is used as an operand. The programmer can test for valid data by means of the numeric class test and, by using the TRANSFORM statement, convert it to valid data under certain conditions.

    For example, if the units position of a numeric data item described as USAGE IS DISPLAY contained a blank, the blank could be transformed to a zero, thus forcing a valid sign.

LOCATING A DTF

One or more DTF's are generated by the compiler for each file opened in the COBOL program. All information about that file is found within the DTF or in the fields preceding the DTF. See the chapter "Advanced Processing Capabilities" for the type of information available and its location.

A particular DTF may be located in an execution-time dump as follows:

1. Determine the order of the DTF address cells in the TGT from the DTF numbers shown for each file-name in the glossary.

   Note: Since the order is the same as the FD's in the Data Division, the order can be determined from the source program if the SYM option was not used (i.e., no glossary was printed).

2. Find the relative starting address of the block of DTF cells from the TGT listing in the Memory Map.

3. Calculate the absolute starting address of the block by adding the hexadecimal relocation factor for the beginning of the object module as given in the linkage editor MAP.

4. Allowing one fullword per DTF cell, count off the cells from the starting address found in step 3, using the order determined in step 1 to locate the desired DTF cell.

5. If more than one DTF is generated for a file, the above procedure should be followed using the PGT and the SUBDTF cells rather than the TGT and the DTFADR cells. The order of multiple DTF's in core is dependent on the OPEN option as follows:

   a. INPUT

   b. OUTPUT

   c. I-O or INPUT REVERSED

The following discussion illustrates the method of finding the DTF's in the sample program in Figure 10. Letters identifying the text refer to letters in the program listing.

E The DTF for FILE-1 precedes the DTF for FILE-2.

F DTFADR CELLS begin at relative location 5B0.

G Since the relocation factor is 32A0, the DTFADR CELLS begin at location 3850 in the dump.

H The DTF for FILE-1 begins at location 33F8, and the DTF for FILE-2 begins at location 3470.

LOCATING DATA

The location assigned to a given data-name may similarly be found by using the BL number and displacement given for that entry in the glossary, and then locating the appropriate one fullword BL cell in the TGT. The hexadecimal sum of the glossary displacement and the contents of the cell should give the relative address of the desired area. This can then be converted to an absolute address as described above.

Since the problem program in Figure 10 interrupted because of a data exception, the programmer should locate the contents of field B at the time of the interrupt. This can be done as follows:

J Locate data-name B in the glossary. It appears under the column headed SOURCE-NAME. Source-name B has been assigned to base locator 3 (i.e., BL =3) with a displacement of 050. The sum of the value of base locator 3 and the displacement value 50 is the address of data-name B.

K The Register Assignment table lists the registers assigned to each base locator. Register 6 has been assigned to BL =3.

L The contents of the 16 general registers at the time of the interrupt are displayed at the beginning of the dump. Register 6 contains the address 00003388.

M The location of data-name B can now be determined by adding the contents of register 6 and the displacement value 50. The result, 33D8, is the address of the leftmost byte of the 4-byte field B.

Note: Field B contains F1F2F3C4. This is external decimal representation and does not correspond to the USAGE COMPUTATIONAL-3 defined in the source listing.

N The location assigned to a given data-name may also be found by using the BL CELLS pointer in the TGT Memory Map. Figure 10 indicates that the BL cells begin at location 3844 (add 5A4 to the load point address, 32A0, of the object module). The first four bytes are the first BL cell, the second four bytes are the second BL cell, etc. Note that the third BL cell contains the value 3388. This is the same value as that contained in register 6.

Note: Some program errors may destroy the contents of the general registers or the BL cells. In such cases, alternate methods of locating the DTF's are useful.

```
// JOB DTACHK                                                                05.00.19
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL



 CBL QUOTE,SEQ
000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. TESTRUN.
000030     AUTHOR. PROGRAMMER NAME.
000040     INSTALLATION. NEW YORK PROGRAMMING CENTER.
000050     DATE-WRITTEN.  FEBRUARY 4, 1971
000060 DATE-COMPILED. 04/24/71
000070    REMARKS. THIS PROGRAM HAS BEEN WRITTEN AS A SAMPLE PROGRAM FOR
000080     COBOL USERS. IT CREATES AN OUTPUT FILE AND READS IT BACK AS
000090     INPUT.
000100
000110 ENVIRONMENT DIVISION.
000120 CONFIGURATION SECTION.
000130 SOURCE-COMPUTER. IBM-360-H50.
000140 OBJECT-COMPUTER. IBM-360-H50.
000150 INPUT-OUTPUT SECTION.
000160 FILE-CONTROL.
000170     SELECT FILE-1 ASSIGN TO SYS008-UT-2400-S.
000180     SELECT FILE-2 ASSIGN TO SYS008-UT-2400-S.
000190
000200 DATA DIVISION.
000210 FILE SECTION.
000220 FD  FILE-1
000230     LABEL RECORDS ARE OMITTED
000240     BLOCK CONTAINS 5 RECORDS
000250     RECORDING MODE IS F
000255     RECORD CONTAINS 20 CHARACTERS
000260     DATA RECORD IS RECORD-1.
000270 01  RECORD-1.
000280     05 FIELD-A PIC X(20).                          E
000290 FD  FILE-2
000300     LABEL RECORDS ARE OMITTED
000310     BLOCK CONTAINS 5 RECORDS
000320     RECORD CONTAINS 20 CHARACTERS
000330     RECORDING MODE IS F
000340     DATA RECORD IS RECORD-2.
000350 01  RECORD-2.
000360     05 FIELD-A PIC X(20).
```

Figure 10. Sample Dump Resulting from Abnormal Termination (Part 1 of 6)

```
000370 WORKING-STORAGE SECTION.
000380 01  FILLER.
000390     02 COUNT PIC S99 COMP SYNC.
000400     02 ALPHABET PIC X(26) VALUE IS "ABCDEFGHIJKLMNOPQRSTUVWXYZ".
000410     02 ALPHA REDEFINES ALPHABET PIC X OCCURS 26 TIMES.
000420     02 NUMBR PIC S99 COMP SYNC.
000430     02 DEPENDENTS PIC X(26) VALUE "01234012340123401234012340".
000440     02 DEPEND REDEFINES DEPENDENTS PIC X OCCURS 26 TIMES.
000450 01  WORK-RECORD.
000460     05 NAME-FIELD PIC X.
000470     05 FILLER PIC X.
000480     05 RECORD-NO PIC 9999.
000490     05 FILLER PIC X VALUE IS SPACE.
000500     05 LOCATION PIC AAA VALUE IS "NYC".
000510     05 FILLER PIC X VALUE IS SPACE.
000520     05 NO-OF-DEPENDENTS PIC XX.
000530     05 FILLER PIC X(7) VALUE IS SPACES.
000534 01  RECORDA.
000535     02 A PICTURE S9(4) VALUE 1234.
000536     02 B REDEFINES A PICTURE S9(7) COMPUTATIONAL-3.
000540
000550 PROCEDURE DIVISION.
000560 BEGIN. READY TRACE.
000570     NOTE THAT THE FOLLOWING OPENS THE OUTPUT FILE TO BE CREATED
000580     AND INITIALIZES COUNTERS.
000590 STEP-1. OPEN OUTPUT FILE-1. MOVE ZERO TO COUNT, NUMBR.
000600     NOTE THAT THE FOLLOWING CREATES INTERNALLY THE RECORDS TO BE
000610     CONTAINED IN THE FILE, WRITES THEM ON TAPE, AND DISPLAYS
000620     THEM ON THE CONSOLE.
000630 STEP-2. ADD 1 TO COUNT, NUMBR. MOVE ALPHA (COUNT) TO
000640     NAME-FIELD.
000645         COMPUTE B = B + 1.   D
000650     MOVE DEPEND (COUNT) TO NO-OF-DEPENDENTS.
000660     MOVE NUMBR TO RECORD-NO.
000670 STEP-3. DISPLAY WORK-RECORD UPON CONSOLE. WRITE RECORD-1 FROM
000680     WORK-RECORD.
000690 STEP-4. PERFORM STEP-2 THRU STEP-3 UNTIL COUNT IS EQUAL TO 26.
000700     NOTE THAT THE FOLLOWING CLOSES THE OUTPUT FILE AND REOPENS
000710     IT AS INPUT.
000720 STEP-5. CLOSE FILE-1. OPEN INPUT FILE-2.
000730     NOTE THAT THE FOLLOWING READS BACK THE FILE AND SINGLES
000740     OUT EMPLOYEES WITH NO DEPENDENTS.
000750 STEP-6. READ FILE-2 RECORD INTO WORK-RECORD AT END GO TO STEP-8.
000760 STEP-7. IF NO-OF-DEPENDENTS IS EQUAL TO "0" MOVE "Z" TO
000770     NO-OF-DEPENDENTS. EXHIBIT NAMED WORK-RECORD. GO TO STEP-6.
000780 STEP-8. CLOSE FILE-2.
000790     STOP RUN.
```

Figure 10. Sample Dump Resulting from Abnormal Termination (Part 2 of 6)

INTRNL NAME	LVL	SOURCE NAME	BASE	DISPL	INTRNL NAME	DEFINITION	USAGE	R	O	Q	M
DNM=1-148	FD	FILE-1	DTF=01		DNM=1-148		DTFMT				F
DNM=1-178	01	RECORD-1	BL=1	000	DNM=1-178	DS OCL20	GROUP				
DNM=1-199	02	FIELD-A	BL=1	000	DNM=1-199	DS 20C	DISP				
DNM=1-216	FD	FILE-2	DTF=02		DNM=1-216		DTFMT				F
DNM=1-246	01	RECORD-2	BL=2	000	DNM=1-246	DS OCL20	GROUP				
DNM=1-267	02	FIELD-A	BL=2	000	DNM=1-267	DS 20C	DISP				
DNM=1-287	01	FILLER	BL=3	000	DNM=1-287	DS OCL56	GROUP				
DNM=1-306	02	COUNT	BL=3	000	DNM=1-306	DS 1H	COMP				
DNM=1-321	02	ALPHABET	BL=3	002	DNM=1-321	DS 26C	DISP				
DNM=1-339	02	ALPHA	BL=3	002	DNM=1-339	DS 1C	DISP	R	O		
DNM=1-357	02	NUMBR	BL=3	01C	DNM=1-357	DS 1H	COMP				
DNM=1-372	02	DEPENDENTS	BL=3	01E	DNM=1-372	DS 26C	DISP				
DNM=1-392	02	DEPEND	BL=3	01E	DNM=1-392	DS 1C	DISP	R	O		
DNM=1-408	01	WORK-RECORD	BL=3	038	DNM=1-408	DS OCL20	GROUP				
DNM=1-432	02	NAME-FIELD	BL=3	038	DNM=1-432	DS 1C	DISP				
DNM=1-452	02	FILLER	BL=3	039	DNM=1-452	DS 1C	DISP				
DNM=1-471	02	RECORD-NO	BL=3	03A	DNM=1-471	DS 4C	DISP-NM				
DNM=1-490	02	FILLER	BL=3	03E	DNM=1-490	DS 1C	DISP				
DNM=2-000	02	LOCATION	BL=3	03F	DNM=2-000	DS 3C	DISP				
DNM=2-018	02	FILLER	BL=3	042	DNM=2-018	DS 1C	DISP				
DNM=2-037	02	NO-OF-DEPENDENTS	BL=3	043	DNM=2-037	DS 2C	DISP				
DNM=2-063	02	FILLER	BL=3	045	DNM=2-063	DS 7C	DISP				
DNM=2-082	01	RECORDA	BL=3	050	DNM=2-082	DS OCL4	GROUP				
DNM=2-102	02	A	BL=3	050	DNM=2-102	DS 4C	DISP-NM				
DNM=2-113	02	B ← J	BL=3	050	DNM=2-113	DS 4P	COMP-3	R			

MEMORY MAP

TGT	003E8
SAVE AREA	003E8
SWITCH	00430
TALLY	00434
SORT SAVE	00438
ENTRY-SAVE	0043C
SORT CORE SIZE	00440
NSTD-REELS	00444
SORT RET	00446
WORKING CELLS	00448
SORT FILE SIZE	00578
SORT MODE SIZE	0057C
PGT-VN TBL	00580
TGT-VN TBL	00584
SORTAB ADDRESS	00588
LENGTH OF VN TBL	0058C
LNGTH OF SORTAB	0058E
PGM ID	00590
A(INIT1)	00598
UPSI SWITCHES	0059C
OVERFLOW CELLS	005A4
BL CELLS ← N	005A4
DTFADR CELLS	005B0 ← F
TEMP STORAGE	005B8
TEMP STORAGE-2	005C0
TEMP STORAGE-3	005C0
TEMP STORAGE-4	005C0
BLL CELLS	005C0
VLC CELLS	005C4
SBL CELLS	005C4
INDEX CELLS	005C4
SUBADR CELLS	005C4
ONCTL CELLS	005CC
PFMCTL CELLS	005CC
PFMSAV CELLS	005CC
VN CELLS	005D0
SAVE AREA =2	005D4
XSASW CELLS	005D4
XSA CELLS	005D4
PARAM CELLS	005D4
RPTSAV AREA	005D8
CHECKPT CTR	005D8
IOPTR CELLS	005D8

Figure 10. Sample Dump Resulting from Abnormal Termination (Part 3 of 6)

```
REGISTER ASSIGNMENT

 REG 6    BL =3 ←(K)
 REG 7    BL =1
 REG 8    BL =2


67                    0006FC  41 40 6 002               LA    4,002(0,6)          DNM=1-339
                      000700  48 20 6 000               LH    2,000(0,6)          DNM=1-306
                      000704  4C 20 C 03A               MH    2,03A(0,12)         LIT+2
                      000708  1A 42                     AR    4,2
                      00070A  5B 40 C 038               S     4,038(0,12)         LIT+0
                      00070E  50 40 D 1DC               ST    4,1DC(0,13)         SBS=1
                      000712  58 E0 D 1DC               L     14,1DC(0,13)        SBS=1
                      000716  D2 00 6 038 E 000         MVC   038(1,6),000(14)    DNM=1-432      DNM=1-339
69                    00071C  FA 30 6 050 C 03C  (C)→   AP    050(4,6),03C(1,12)  DNM=2-113      LIT+4
70                    000722  41 40 6 01E               LA    4,01E(0,6)          DNM=1-392
                      000726  48 20 6 000               LH    2,000(0,6)          DNM=1-306
                      00072A  4C 20 C 03A               MH    2,03A(0,12)         LIT+2
                      00072E  1A 42                     AR    4,2
                      000730  5B 40 C 038               S     4,038(0,12)         LIT+0
                      000734  50 40 D 1E0               ST    4,1E0(0,13)         SBS=2
                      000738  58 E0 D 1E0               L     14,1E0(0,13)        SBS=2
                      00073C  D2 00 6 043 E 000         MVC   043(1,6),000(14)    DNM=2-37       DNM=1-392
                      000742  92 40 6 044               MVI   044(6),X'40'        DNM=2-37+1


// EXEC LNKEDT


   PHASE    XFR-AD  LOCORE  HICORE  DSK-AD    ESD TYPE   LABEL     LOADED  REL-FR

 PHASE***   0032A0  0032A0  004ADB  53 01 2   CSECT      TESTRUN   0032A0  0032A0  ←(B)

                                              CSECT      IJFFBZZN  003C50  003C50
                                              *  ENTRY   IJFFZZZN  003C50
                                              *  ENTRY   IJFFBZZZ  003C50
                                              *  ENTRY   IJFFZZZZ  003C50

                                              CSECT      ILBDSAE0  0049F0  0049F0
                                                 ENTRY   ILBDSAE1  004A06

                                              CSECT      ILBDMNS0  0049E8  0049E8

                                              CSECT      ILBDDSP0  0041B8  0041B8
                                              *  ENTRY   ILBDDSP1  004708
                                              *  ENTRY   ILBDDSP2  0047A0
                                              *  ENTRY   ILBDDSP3  004958

                                              CSECT      ILBDIML0  004990  004990

                                              CSECT      IJJCPD1   003FC0  003FC0
                                                 ENTRY   IJJCPD1N  003FC0
                                              *  ENTRY   IJJCPD3   003FC0


// ASSGN SYS008,X'182'
// EXEC
```

Figure 10. Sample Dump Resulting from Abnormal Termination (Part 4 of 6)

```
0S03I PROGRAM CHECK INTERRUPTION - HEX LOCATION 0039BC - CONDITION CODE 0 - DATA EXCEPTION    A
0S00I JOB DTACHK   CANCELED


         DTACHK                                                                    L

GR 0-7   00003850 00003960 00000001 00000001   0000338A 50003C12 00003388 00003550
GR 8-F   000035B8 00003BE2 000032A0 000032A0   00003880 00003688 0000338A 000041B8
FP REG   00000000 00000000 00000000 00000000   00000000 00000000 00000000 00000000
COMREG   BG ÅDDR IS 000208


000000   00000000 00000000 00000000 00000000   00000000 00000208 FF050000 00000000
000020   FF050007 40002E06 FF150007 C00039C2   5B5BC2C5 D6D1F440 FF05000E 80002E00
000040   00002F28 08000000 00002F18 00000000   FCBF1CB3 015005E8 00040000 0F0014BA
000060   00040000 00000336 00040000 0000147A   00000000 00000BBC 00040000 000002D4
000080   00000000 00000000 00000000 00000003   00050003 06B006B0 06B041BB 00734570
0000A0   0146940F B47B41A0 C0544570 0B8418A8   41900156 4180B2CE 47F000DA 06B006B0
0000C0   06B006B0 06B006B0 06B041BB 001741BB   00504570 01464180 01569640 A0019120
0000E0   A00C4710 00EA9260 A00195E2 A0024780   0DC695C1 A0024780 0DC69561 A0024780
000100   010E9104 A0004780 010E9203 008F9281   A0004BA0 0262487A C00049A0 027641AA
000120   C0440778 94F9703B D7017058 70589283   A0009680 A0014400 04080788 947FA001
000140   4570B218 07F842B0 00E748B0 02C847F0   BC704570 BC70D205 BEEEBEF5 DC05BEEE
000160   C0441BAA DD06BEEE 000C43A1 000742A0   023741AA C0444400 A0045890 A0044220
000180   A0009140 A0014710 BB64D207 01F09008   68009058 68209060 68409068 68609070
0001A0   4BA00262 41AAC000 D2010016 A0009898   90108200 01F04400 A0045890 A0049818
0001C0   9030989D 01F08200 00389284 C0A4D207   01F0BF50 9890BF58 820001F0 9680A000
0001E0   41100030 47F0B166 96030039 82000038   FF050007 40002E06 00001000 00002000
000200   00003000 80001048 F0F461F2 F461F7F1   32A03000 00000000 00000000 00000000
000220   C4E3C1C3 C8D24040 0007AFFF 00004ADB   00004ADB 00000010 0007FFFF F875ECD1
000240   A8A07CD0 00C62171 21782269 226A0000   25102514 25183CF0 F4F2F4F7 F1F1F1F4
000260   00002044 0000000C 22E21E4E 1EF41F04   1F140020 214C0010 5B5BC2D6 00130001
000280   01001F98 20000000 00000000 02080000   00000294 00000000 000025AC 00000044
0002A0   00001F2C 00000000 00000000 00000000   00000000 00000000 00000000 00000000
0002C0   0000289C 00003228 100020CE 00001DC8   00002A9C 923801C9 909D01F0 4190086C
0002E0   48A00236 4AA00262 9180A000 47100306   58B0A004 9018B030 48B002C8 41CBB000
000300   41DCB000 07F99601 A00048B0 02C841CB   B00041DC B00095FF A00F0789 90E0BF6C
000320   48E001C8 D207BF50 E00094FD BF51D213   BF5801F0 07F9909D 01F09220 01C94590
000340   02E04190 01B69500 00234780 03F49526   002347B0 00BE4860 00221A66 487002CA
000360   48667000 07F6181F 1B664121 000F4570   BCAC4860 BE5C1B22 43201007 4130001F
000380   1B234740 03904130 00151B23 47B00392   1A234220 04D94320 100747F0 04584720
0003A0   00CA4230 04D94820 02364322 C0031A23   950B1007 47F00454 472000C8 96801002
0003C0   960C1004 07F91858 41430002 43540000   41455000 1A444A40 BE5495FF 40004770
0003E0   03CC4284 000007F9 95FF04B1 07891B00   5000BF74 95FF04B1 4780B238 48600236
000400   95600237 47800366 D502A005 02814770   04204111 00004910 BE3A47B0 04201B66
000420   4121000F 4570BCAC D5021009 023947B0   00C61B33 43301007 95011006 4770039E
000440   92FF04D9 D200044D A00D4123 000BD500   1007A00E 47B000CA D4031002 C0B04182
000460   20004870 02544338 70004930 BE3847B0   03B88930 00034A30 024891F0 30044780
000480   B60ED501 0022BB2C 4780B8E4 D501BE4C   BE5A4720 04AE4930 BE744770 04AE950F
0004A0   00234780 04AE9110 30064780 B2384180   00014148 80001A44 4A40BE54 18584A50
0004C0   0274D200 04B14000 50104000 92FF4000   42205000 4260500C 92035018 91F03004
0004E0   4780B62E 47F004EC 5880BF8C 44000CB8   9560C09C 47700566 D20202CD 10095860
000500   02CC9507 60004770 0566D202 02CD6001   587002CC 1B444340 30054C40 BE485A40
000520   02D04144 0000D503 70014000 47800566   9120100C 47100560 91051002 47700560
000540   91406004 47800560 94BF6004 91101002   47800558 96401002 96141002 9601100C
000560   D2034000 700195FF 30024770 03C64280   30029198 30060779 43203000 4322C09D
000580   48603000 95003000 47800592 9F006000   07694060 05E29550 30044780 080C9504
0005A0   50184780 08409101 100C4710 05D0940F   06FF91F0 500C4780 05D0D300 C09C3004
0005C0   95035018 47D00634 9560C09C 4780067C   D2020049 1009940F 0703D300 0048500C
0005E0   9C00000E 477005F2 4032C0B4 96803006   07F94730 0BC69106 00454770 0E9C913F
000600   00454770 060C91AF 00440789 D201003A   05E29550 30044770 0620D202 00491009
000620   58600048 4A60BDDC 50600040 4032C0B4   47F0089A 95015018 4720065C 9560C09C
000640   47700654 45700B84 9120800F 47100094   47F0065C 91203006 47100094 9560C09C
000660   477005D0 45700B84 4B800262 4878C000   91407038 471005D0 96F006FF 95003003
```

Figure 10. Sample Dump Resulting from Abnormal Termination (Part 5 of 6)

```
          DTACHK

0032E0   00005218 00000208 00000000 00000000     00000000 00000000 00000000 00000000
003300   00000000 --SAME--
003320   00000000 58C0F0C6 58E0C000 58D0F0CA     9500E000 4770F0A2 9610D048 92FFE000
003340   47F0F0AC 98CEF03A 90ECD00C 185D989F     F0BA9110 D0480719 07FF0700 00003BE2
003360   000032A0 000032A0 00003880 00003688     000038EC 00003BC8 C3D6C2C6 F0F0F0F1
003380   E3C5E2E3 D9E4D540 0001C1C2 C3C4C5C6     C7C8C9D1 D2D3D4D5 D6D7D8D9 E2E3E4E5
0033A0   E6E7E8E9 0001F0F1 F2F3F4F0 F1F2F3F4     F0F1F2F3 F4F0F1F2 F3F4F0F1 F2F3F4F0   M
0033C0   C1000000 000040D5 E8C34000 00404040  H  40404040 00000000 F1F2F3C4 00004C40
0033E0   01010014 00000000 00000000 00000000     0E000000 04000000 00009200 00000108
003400   00003430 00000000 10003C50 1160E2E8     E2F0F0F8 40400162 10000000 04000000
003420   00000000 86BCF018 41E0E001 58201044     010034E8 20000064 00003550 00003550
003440   00000014 000035B3 00640063 00000000     00000000 000049F0 01010014 00000000
003460   00000000 00000000 00000000 04000000     00008200 00000108 000034A8 00000000
003480   10003C50 1168E2E8 E2F0F0F8 40400272     00000000 20000000 00000000 86BCF018
0034A0   41E0E001 58201044 020035B8 00000064     00003620 00000000 00000014 00000000
0034C0   00640063 00000000 00004A06 000049F0     00000000 00000000 00000000 00000000
0034E0   00000000 00000000 00004770 30129261     10004110 100107F3 D20467CE 6017D201
003500   67D56274 C6C3D6C2 D6D3F8F0 F8F0F1F0     F1F2F1F1 F2F0F2F2 F2F1F3F0 F4F0F5F0
003520   F5F1F6F0 F6F1F7F0 0100DDA8 10006670     20006148 40005DC8 70004C40 41110004
003540   41110004 41110004 58110000 58F10010     45EF0018 41105342 07FB0000 000032B0
003560   000035A4 000035F8 00003DB4 000039B0     00003944 00004096 00003D0A 000032B0
003580   000062B8 00004478 00004C94 00005704     00005A4C 00005B68 0000373E 000035E4
0035A0   000036A6 060C40FF C4B2DE09 D2106276     D207601C D212F363 603B6276 96F06041
0035C0   4110601C 5840C65C 41200008 05301B24     47403018 95401000 47703012 92611000
0035E0   41101001 00000000 6276C494 58F0C340     077F9240 6820D206 00004218 000042B0
003600   00004348 000043E0 000062B8 00004478     00004510 000045F8 D500627C 00000000
003620   000001FF 00003800 00003982 00003968     00003F2C 00003BAA 00003BAA 00003C40
003640   000037DA 00003BAA 00003E6C 00003D60     00004090 00003DBE 00003B20 00003BC6
003660   00003BC6 00000203 02030001 04050104     00000203 00000105 00000404 00000104
003680   04040202 01030000 00202020 20210000     1C404040 40404000 00200000 00006148
0036A0   00180014 0F0F0000 000C1C0C 00000000     58F0C010 000036F4 10000006 0C000822
0036C0   00000000 00040D00 01E40267 00000003     7000004B 00000000 00000000 000038EC
0036E0   00000000 00000000 000033F8 00003550     000032A0 000033F8 50003C12 02AA1000
003700   00100C00 09EE0000 FFFFD201 6030C49A     4810C4A6 06104C10 C48C5010 D24C4810
003720   C4A60610 4C10C48C 5010D264 414062AE     5A40D24C F871D208 4000D205 00000000
003740   50D05362 41D053F6 5430536A 98675366     18809506 800041E0 568E58F0 52BA078F
003760   43680000 8C600004 89600002 8870001B     58B6536E 91508000 477054D0 91A08000
003780   47E054D0 00003958 00003550 01005366     70003934 000041B8 00003850 00003960
0037A0   00003550 000032A0 000033F8 50003C12     00003388 00003550 000035B8 00003BE2
0037C0   000032A0 000032A0 00003880 00003960     000041B8 00003850 00004708 00003550
0037E0   00015540 00003958 58F10010 45EF0008  G  180747F0 568ED703 532E532E 47F0568E
003800   49A053E2 58C053E6 078C91FF 53D14780     566845B0 55F445B0 00000000 00000000
003820   E000590C 478056AC 91FF53D0 47105686     41B05686 47F055F4 000032A0 91FF53D1
N 003840 47105598 00003550 000035B8 00003388     000033F8 00003470 00000000 0000001C
003860   00000000 0000338A 42F90000 88F00008     00003A3E 17671776 1767D201 60045366
003880   000049E8 000041B8 00004990 00003950     00003A3E 00003AE0 00003B2C 00003B88
0038A0   00003A5E 00003A72 00003B26 00003B58     00003A3E 504088AE 00000001 1C00001A
0038C0   5B5BC2D6 D7C5D540 5B5BC2C3 D3D6E2C5     5B5BC2C6 C3D4E4D3 F0E90000 C0000000
0038E0   E6D6D9D2 60D9C5C3 D6D9C420 58F0C004     051F0001 4004F6F0 404040AA 9640D048
003900   58F0C004 051F0001 4004F6F3 40404010     4110C040 5800D1C8 184005F0 5000F008
003920   4500F00C 000033F8 0A024100 D1C858F0     C00805EF 5810D1C8 96101020 5020D1BC
003940   5870D1BC D2016000 C038D201 601CC038     58F0C004 051F0001 4004F6F7 404040F1
003960   4830C03A 4A306000 4E30D1D0 D705D1D0     D1D0940F D1D64F30 D1D04030 60004830
003980   C03A4A30 601C4E30 D1D0D705 D1D0D1D0     940FD1D6 4F30D1D0 4030601C 41406002
0039A0   48206000 4C20C03A 1A425B40 C0385040     D1DC58E0 D1DCD200 6038E000 FA306050
0039C0   C03C4140 601E4820 60004C20 C03A1A42     5B40C038 5040D1E0 58E0D1E0 D2006043
0039E0   E0009240 60444830 601C4E30 D1D0F331     603AD1D6 96F0603D 58F0C004 051F0001
003A00   4004F7F2 4040404F 58F0C004 051F0002     00000014 0D0001C4 0038FFFF D2137000
```

Figure 10. Sample Dump Resulting from Abnormal Termination (Part 6 of 6)

COMPILER DIAGNOSTICS

Diagnostic messages are generated by the compiler and listed on SYSLST when errors are found in the source program. A complete list of compiler diagnostics is contained in "Appendix I: Diagnostic Messages."

Note: Diagnostic messages are suppressed when the NOERRS option is in effect.

WORKING WITH DIAGNOSTIC MESSAGES

1. Approach the diagnostic messages in the order in which they appear on the source listing. It is possible to get compound diagnostic messages. Frequently, an earlier diagnostic message indicates the reason for a later diagnostic message. For example, a missing quotation mark for a nonnumeric literal could involve the inclusion of some clauses not intended for that particular literal. This could cause an apparently valid clause to be diagnosed as invalid because it is not complete, or because it is in conflict with something that preceded it.

2. Check for missing or superfluous punctuation, or other errors of this type.

3. Frequently, a seemingly meaningless message is clarified when the valid syntax or format of the clause or statement in question is referenced.

GENERATION OF DIAGNOSTIC MESSAGES

The compiler scans the statement, element by element, to determine whether the words are combined in a meaningful manner. Based upon the elements that have already been scanned, there are only certain words or elements that can be correctly encountered.

If the anticipated elements are not encountered, a diagnostic message is produced. Some errors may not be uncovered until information from various sections of the program is combined and the inconsistency is noted. Errors uncovered in this manner can produce a slightly different message format than those uncovered when the actual source text is still available. The message that is made unique through that particular error may not contain, for example, the actual source statement that produced the error.

Errors that appear to be identical are diagnosed in a slightly different manner, depending on where they were encountered by the compiler and how they fit within the context of valid syntax. For example, a period missing from the end of the Working-Storage section header is diagnosed specifically as a period required. There is no other information that can appear at that point. However, if at the end of a data item description entry, an element is encountered that is not valid at that point, such as the digits 02, it is diagnosed as invalid. Any clauses associated with the 02 entry which conflict with the clauses in the previous entry (the one that contained the missing period), are diagnosed. Thus, a missing period produces a different type of diagnostic message in one situation than in the other.

If an error occurs during compilation of an ON statement, the diagnostic message may refer to the previous statement number.

Note: If an E-level diagnostic is generated, the LINK option is cancelled, and any linkage editor control statements in the job stream are invalid. For this reason, the following message is issued by the Job Control Processor following the first linkage editor control statement encountered:

$$\text{1S1n} \begin{Bmatrix} \text{D} \\ \text{I} \end{Bmatrix} \text{ STATEMENT OUT OF SEQUENCE.}$$

LINKAGE EDITOR OUTPUT

The Linkage Editor produces diagnostic messages, console messages, and a storage map. For a complete description of output and error messages from the Linkage Editor, see the publication DOS System Control and Service. Output resulting from the link editing of a COBOL program is discussed in the chapter "Interpreting Output."

EXECUTION-TIME MESSAGES

When an error condition that is recognized by compiler-generated code occurs during execution, an error message is written on SYSLST and SYSLOG. No message is written on SYSLST when an error occurs in the foreground and SYSLST is assigned to a disk.

Messages that normally appear on SYSLOG are provided with a code indicating whether the message originated in a foreground or background program. These messages are listed in "Appendix I: Diagnostic Messages."

RECORDING PROGRAM STATUS

When a program is expected to run for an extended period of time, provision should be made for taking checkpoint information periodically during the run. A checkpoint is the recording of the status of a problem program and main storage (including input/output status and the contents of the general registers). Thus, it provides a means of restarting the job at an intermediate checkpoint position rather than at the beginning, if for any reason processing is terminated before the normal end of the program. For example, a job of higher priority may require immediate processing, or some malfunction (such as a power failure) may occur and cause an interruption. Checkpoints are taken using the COBOL RERUN clause.

Restart is a means of resuming the execution of the program from one of the checkpoints rather than from the beginning. The ability to restart is provided through the RSTRT job control statement.

RERUN CLAUSE

The presence of the RERUN clause in the source program causes the CHKPT macro instruction to be issued at the specified interval. When the CHKPT macro instruction is issued, the following information is saved:

1. Information for the Restart and other supervisor or job control routines.
2. The general registers.
3. Bytes 8 through 10, and 12 through 45 of the Communication Region.
4. The problem program area.
5. All file protection extents for files assigned to mass storage devices if the extents are attached to logical units contained in the program for which checkpoints are taken.

Since the COBOL RERUN clause provides a linkage to the system CHKPT macro instruction, any warnings and restrictions on the use of this macro instruction also apply to the use of the RERUN clause. See the publication DOS Supervisor and I/O Macros for a complete description of the CHKPT macro instruction.

TAKING A CHECKPOINT

In order to take a checkpoint, the programmer must specify the source language RERUN clause and must define the file upon which checkpoint records are to be written (e.g., ASSGN, EXTENT, etc.) Checkpoint information must be written on a 2311 or 2314 mass storage device or on a magnetic tape -- either 7- or 9-track. Checkpoint records cannot be imbedded in one of the problem program's output files, i.e., the program must establish a separate file exclusively for checkpoint records.

In designing a program for which checkpoints are to be taken, the programmer should consider the fact that, upon restarting, the program must be able to continue as though it had just reached that point in the program at which termination occurred. Hence, the programmer should ensure that:

1. File handling is such as to permit easy reconstruction of the status of the system as it existed at the time of checkpoint was taken. For example, when multifile reels are used, the operator should be informed (by message) as to which file is in use at the time a checkpoint is to be taken. He requires this information at restart time.
2. The contents of files are not altered between the time of the checkpoint and the time of the restart. For sequential files, all records written on the file at the time the checkpoint is taken should be unaltered at restart time. For nonsequential files, care must be taken to design the program so that a restart will not duplicate work that has been completed between checkpoint time and restart time. For example, suppose that checkpoint 5 is taken. By adding an amount representing the interest due, account XYZ is updated on a direct-access file that was opened with the I-O option. If the program is restarted from checkpoint 5 and if the interest is recalculated and again added to account XYZ, incorrect results will be produced.

If the program is modular in design, RERUN statements must be included in all modules that handle files for which checkpoints are to be taken. (When an entry point of a module containing a RERUN statement is encountered, a COBOL subroutine, ILBDCKP0, is called. ILBDCKP0 enters the files of the module into the list of files to be repositioned.) Repositioning to the proper record will not occur for any files that were defined in modules other than those containing RERUN statements. Moreover, a restart from any given checkpoint may not reposition other tapes on which checkpoints are stored. Note, too, that only one disk checkpoint file can be used.

RESTARTING A PROGRAM

If the programmer requests checkpoints in his job by means of the COBOL RERUN clause, the following message is given each time a checkpoint is taken:

```
0C001 CHKPT nnnn HAS BEEN TAKEN ON
     SYSxxx
```

nnnn
: is the 4-character identification of the checkpoint record.

To restart a job from a checkpoint, the following steps are required:

1. Replace the // EXEC statement with a // RSTRT statement. The format of the RSTRT statement is discussed in the chapter "Preparing COBOL Programs For Processing." All other job control statements applicable to the job step should be the same as when the job was originally run. If necessary, the channel and unit addresses for the // ASSGN control statements may be changed.

2. Rewind all tapes used by the program being restarted, and mount them on devices assigned to the symbolic units required by the program. If multivolume files are used, mount (on the primary unit) the reel being used at the time that the checkpoint was taken, and rewind it. If multifile volumes are used, position the reel to the start of the file referenced at the time the checkpoint is being taken.

3. Reposition any card file so that only cards not yet read when the checkpoint was taken are in the card reader.

4. Execute the job.

The Full American National Standard COBOL compiler, COBOL object module, Linkage Editor, and other system components can produce output in the form of printed listings, punched card decks, diagnostic or informative messages, and data files directed to tape or to mass storage devices. This chapter gives the format of and describes this output. The same COBOL program is used for each example. "Appendix A: Sample Program Output" shows the output formats in the context of a complete listing generated by the sample program.

COMPILER OUTPUT

The output of the compilation job step may include:

- A printed listing of the job control statements
- A printed listing of the statements contained in the source program
- A glossary of compiler-generated information about data
- Global tables, register assignments, and literal pools
- A printed listing of the object code
- A condensed listing containing only the relative address of the first generated instruction for each verb
- Compiler diagnostic messages
- A cross-reference listing
- System messages
- An object module

The presence or absence of the above-mentioned types of compiler output is determined by options specified at system generation time. These options can be overridden or additional options specified at compilation time by using the OPTION control statement and the CBL card.

The level of diagnostic message printed depends upon the FLAGW or FLAGE option of the CBL card.

All output to be listed is written on the device assigned to SYSLST. If SYSLST is assigned to a magnetic tape, COBOL will treat the file as an unlabeled tape. Line spacing of the source listing is controlled by the SPACEn option of the CBL card and by SKIP 1/2/3 and EJECT in the COBOL source program. The number of lines per page can be specified in the SET command. In addition, a listing of input/output assignments can be printed on SYSLST by using the LISTIO control statement.

Figure 11 contains the compiler output listing shown in "Appendix A: Sample Program Output." Each type of output is numbered, and each format within each type is lettered. The text below and that following the figure is an explanation of the figure.

1. The listing of the job control statements associated with this job step. These statements are listed because the LOG option was specified at system generation time.

2. Compiler options. The CBL card, if specified, is printed on SYSLST unless the LIST option is suppressed.

3. The source module listing. The statements in the source program are listed exactly as submitted except that a compiler-generated card number is listed to the left of each line. This is the number referenced in diagnostic messages and in the object code listing. It is also the number printed on SYSLST as a result of the source language TRACE statement. The source module is not listed when the NOLIST option is specified.

The following notations may appear on the listing:

C Denotes that the statement was inserted with a COPY statement.

** Denotes that the card is out of sequence. NOSEQ should be specified on the CBL card if the sequence check is to be suppressed.

I Denotes that the card was inserted with an INSERT or BASIS card.

```
// JOB SAMPLE
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
```

1

2

```
 CBL QUOTE,SEQ
00001    000010 IDENTIFICATION DIVISION.
00002    000020 PROGRAM-ID. TESTRUN.
00003    000030     AUTHOR. PROGRAMMER NAME.
00004    000040     INSTALLATION. NEW YORK PROGRAMMING CENTER.
00005    000050     DATE-WRITTEN.  FEBRUARY 2,1971
00006    000060 DATE-COMPILED. 04/24/71
00007    000070    REMARKS. THIS PROGRAM HAS BEEN WRITTEN AS A SAMPLE PROGRAM FOR
00008    000080     COBOL USERS. IT CREATES AN OUTPUT FILE AND READS IT BACK AS
00009    000090     INPUT.
00010    000100
00011    000110 ENVIRONMENT DIVISION.
00012    000120 CONFIGURATION SECTION.
00013    000130 SOURCE-COMPUTER. IBM-360-H50.
00014    000140 OBJECT-COMPUTER. IBM-360-H50.
00015    000150 INPUT-OUTPUT SECTION.
00016    000160 FILE-CONTROL.
00017    000170     SELECT FILE-1 ASSIGN TO SYS008-UT-2400-S.
00018    000180     SELECT FILE-2 ASSIGN TO SYS008-UT-2400-S.
00019    000190
  .
  .
  .
00056    000550 PROCEDURE DIVISION.
00057    000560 BEGIN. READY TRACE.
00058    000570     NOTE THAT THE FOLLOWING OPENS THE OUTPUT FILE TO BE CREATED
00059    000580     AND INITIALIZES COUNTERS.
00060    000590 STEP-1. OPEN OUTPUT FILE-1. MOVE ZERO TO COUNT, NUMBR.
  .
  .
  .
00073    000720 STEP-5. CLOSE FILE-1. OPEN INPUT FILE-2.
00074    000730     NOTE THAT THE FOLLOWING READS BACK THE FILE AND SINGLES
00075    000740     OUT EMPLOYEES WITH NO DEPENDENTS.
00076    000750 STEP-6. READ FILE-2 RECORD INTO WORK-RECORD AT END GO TO STEP-8.
00077    000760 STEP-7. IF NO-OF-DEPENDENTS IS EQUAL TO "0" MOVE "Z" TO
00078    000770     NO-OF-DEPENDENTS. EXHIBIT NAMED WORK-RECORD. GO TO STEP-6.
00079    000780 STEP-8. CLOSE FILE-2.
00080    000790     STOP RUN.
```

3

Figure 11. Examples of Compiler Output (Part 1 of 4)

A INTRNL NAME	B LVL	C SOURCE NAME	D BASE	E DISPL	F INTRNL NAME	G DEFINITION	H USAGE	J R	O	Q	M
DNM=1-148	FD	FILE-1	DTF=01		DNM=1-148		DTFMT				F
DNM=1-178	01	RECORD-1	BL=1	000	DNM=1-178	DS 0CL20	GROUP				
DNM=1-199	02	FIELD-A	BL=1	000	DNM=1-199	DS 20C	DISP				
DNM=1-216	FD	FILE-2	DTF=02		DNM=1-216		DTFMT				F
DNM=1-246	01	RECORD-2	BL=2	000	DNM=1-246	DS 0CL20	GROUP				
DNM=1-267	02	FIELD-A	BL=2	000	DNM=1-267	DS 20C	DISP				
DNM=1-287	01	FILLER	BL=3	000	DNM=1-287	DS 0CL56	GROUP				
DNM=1-306	02	COUNT	BL=3	000	DNM=1-306	DS 1H	COMP				
DNM=1-321	02	ALPHABET	BL=3	002	DNM=1-321	DS 26C	DISP				
DNM=1-339	02	ALPHA	BL=3	002	DNM=1-339	DS 1C	DISP	R	O		
DNM=1-357	02	NUMBR	BL=3	01C	DNM=1-357	DS 1H	COMP				
DNM=1-372	02	DEPENDENTS	BL=3	01E	DNM=1-372	DS 26C	DISP				
DNM=1-392	02	DEPEND	BL=3	01E	DNM=1-392	DS 1C	DISP	R	O		
DNM=1-408	01	WORK-RECORD	BL=3	038	DNM=1-408	DS 0CL20	GROUP				
DNM=1-432	02	NAME-FIELD	BL=3	038	DNM=1-432	DS 1C	DISP				
DNM=1-452	02	FILLER	BL=3	039	DNM=1-452	DS 1C	DISP				
DNM=1-471	02	RECORD-NO	BL=3	03A	DNM=1-471	DS 4C	DISP-NM				
DNM=1-490	02	FILLER	BL=3	03E	DNM=1-490	DS 1C	DISP				
DNM=2-000	02	LOCATION	BL=3	03F	DNM=2-000	DS 3C	DISP				
DNM=2-018	02	FILLER	BL=3	042	DNM=2-018	DS 1C	DISP				
DNM=2-037	02	NO-OF-DEPENDENTS	BL=3	043	DNM=2-037	DS 2C	DISP				
DNM=2-063	02	FILLER	BL=3	045	DNM=2-063	DS 7C	DISP				

4

```
                 MEMORY MAP

            TGT A                  003E0

        SAVE AREA                  003E0
        SWITCH                     00428
        TALLY                      0042C
        SORT SAVE                  00430
        ENTRY-SAVE                 00434
        SORT CORE SIZE             00438
        NSTD-REELS                 0043C
        SORT RET                   0043E
        WORKING CELLS              00440
        SORT FILE SIZE             00570
        SORT MODE SIZE             00574
        PGT-VN TBL                 00578
        TGT-VN TBL                 0057C
        SORTAB ADDRESS             00580
        LENGTH OF VN TBL           00584
        LNGTH OF SORTAB            00586
        PGM ID                     00588
        A(INIT1)                   00590
        UPSI SWITCHES              00594
        OVERFLOW CELLS             0059C
        BL CELLS                   0059C
        DTFADR CELLS               005A8
        TEMP STORAGE               005B0
        TEMP STORAGE-2             005B8
        TEMP STORAGE-3             005B8
        TEMP STORAGE-4             005B8
        BLL CELLS                  005B8
        VLC CELLS                  005BC
        SBL CELLS                  005BC
        INDEX CELLS                005BC
        SUBADR CELLS               005BC
        ONCTL CELLS                005C4
        PFMCTL CELLS               005C4
        PFMSAV CELLS               005C4
        VN CELLS                   005C8
        SAVE AREA =2               005CC
        XSASW CELLS                005CC
        XSA CELLS                  005CC
        PARAM CELLS                005CC
        RPTSAV AREA                005D0
        CHECKPT CTR                005D0
        IOPTR CELLS                005D0

LITERAL POOL (HEX) B

00610 (LIT+0)      00000001  001A5B5B  C2D6D7C5  D5405B5B  C2C3D3D6  E2C55B5B
00628 (LIT+24)     C2C6C3D4  E4D3F0E9  C0000000

     DISPLAY LITERALS (BCD)

00634 (LTL+36)    'WORK-RECORD'

            PGT C                  005D8

        OVERFLOW CELLS             005D8
        VIRTUAL CELLS              005D8
        PROCEDURE NAME CELLS       005E4
        GENERATED NAME CELLS       005F8
        SUBDTF ADDRESS CELLS       00608
        VNI CELLS                  00608
        LITERALS                   00610
        DISPLAY LITERALS           00634
```

5

Figure 11. Examples of Compiler Output (Part 2 of 4)

```
REGISTER ASSIGNMENT
                        6
REG 6    BL =3
REG 7    BL =1
REG 8    BL =2

 A              B         C                          E                 F

 57           000640                       START   EQU   *
              000640  58 F0 C 004                  L     15,004(0,12)       V(ILBDDSP0)
              000644  05 1F                        BALR  1,15
              000646  000140                       DC    X'000140'
              000649  04F5F7404040                 DC    X'04F5F7404040'
 57           000650  96 40 D 048                  OI    048(13),X'40'      SWT+0
 60           000654  58 F0 C 004                  L     15,004(0,12)       V(ILBDDSP0)
              000658  05 1F                        BALR  1,15
              00065A  000140                       DC    X'000140'
              00065D  04F6F0404040                 DC    X'04F6F0404040'
 60           000664  41 10 C 03E                  LA    1,03E(0,12)        LIT+6
              000668  58 00 D 1C8                  L     0,1C8(0,13)        DTF=1
              00066C  18 40                        LR    4,0
              00066E  05 F0                        BALR  15,0
              000670  50 00 F 008                  ST    0,008(0,15)
              000674  45 00 F 00C                  BAL   0,00C(0,15)
              000678  00000000                     DC    X'00000000'
              00067C  0A 02                        SVC   2
              00067E  41 00 D 1C8                  LA    0,1C8(0,13)        DTF=1
              000682  58 F0 C 008                  L     15,008(0,12)       V(ILBDIML0)
              000686  05 EF                        BALR  14,15
              000688  58 10 D 1C8                  L     1,1C8(0,13)        DTF=1
              00068C  96 10 1 020                  OI    020(1),X'10'
              000690  50 20 D 1BC                  ST    2,1BC(0,13)        BL =1
              000694  58 70 D 1BC                  L     7,1BC(0,13)        BL =1
 60           000698  D2 01 6 000 C 038    D       MVC   000(2,6),038(12)   DNM=1-306      LIT+0
              00069E  D2 01 6 01C C 038            MVC   01C(2,6),038(12)   DNM=1-357      LIT+0     7
 64           0006A4                       PN=01   EQU   *
              0006A4  58 F0 C 004                  L     15,004(0,12)       V(ILBDDSP0)
              0006A8  05 1F                        BALR  1,15
              0006AA  000140                       DC    X'000140'
              0006AD  04F6F4404040                 DC    X'04F6F4404040'
 64           0006B4  48 30 C 03A                  LH    3,03A(0,12)        LIT+2
              0006B8  4A 30 6 000                  AH    3,000(0,6)         DNM=1-306
              0006BC  4E 30 D 1D0                  CVD   3,1D0(0,13)        TS=01
              0006C0  D7 05 D 1D0 D 1D0            XC    1D0(6,13),1D0(13)  TS=01          TS=01
              0006C6  94 0F D 1D6                  NI    1D6(13),X'0F'      TS=01+6
              0006CA  4F 30 D 1D0                  CVB   3,1D0(0,13)        TS=01
              0006CE  40 30 6 000                  STH   3,000(0,6)         DNM=1-306
              0006D2  48 30 C 03A                  LH    3,03A(0,12)        LIT+2
              0006D6  4A 30 6 01C                  AH    3,01C(0,6)         DNM=1-357
              0006DA  4E 30 D 1D0                  CVD   3,1D0(0,13)        TS=01
              0006DE  D7 05 D 1D0 D 1D0            XC    1D0(6,13),1D0(13)  TS=01          TS=01
              0006E4  94 0F D 1D6                  NI    1D6(13),X'0F'      TS=01+6
              0006E8  4F 30 D 1D0                  CVB   3,1D0(0,13)        TS=01
              0006EC  40 30 6 01C                  STH   3,01C(0,6)         DNM=1-357
 64           0006F0  41 40 6 002                  LA    4,002(0,6)         DNM=1-339
              0006F4  48 20 6 000                  LH    2,000(0,6)         DNM=1-306
              0006F8  4C 20 C 03A                  MH    2,03A(0,12)        LIT+2
              0006FC  1A 42                        AR    4,2
              0006FE  5B 40 C 038                  S     4,038(0,12)        LIT+0
              000702  50 40 D 1DC                  ST    4,1DC(0,13)        SBS=1
              000706  58 E0 D 1DC                  L     14,1DC(0,13)       SBS=1
              00070A  D2 00 6 038 E 000            MVC   038(1,6),000(14)   DNM=1-432      DNM=1-339
```

Figure 11. Examples of Compiler Output (Part 3 of 4)

```
                                        CROSS-REFERENCE DICTIONARY
   A

DATA NAMES                       DEFN      REFERENCE

FILE-1                           00017     00060  00060  00068  00073
RECORD-1                         00028     00068  00068
FILE-2                           00018     00073  00073  00076  00076  00079
RECORD-2                         00036     00076
COUNT                            00040     00060  00064  00064  00064  00066  00070
ALPHA                            00042     00064  00064
NUMBR                            00043     00060  00064  00064  00067
DEPEND                           00045     00066  00066                                8
WORK-RECORD                      00046     00068  00068  00068  00076  00078
NAME-FIELD                       00047     00064
RECORD-NO                        00049     00067  00067
NO-OF-DEPENDENTS                 00053     00066  00066  00077  00077  00077  00077
    B
PROCEDURE NAMES                  DEFN      REFERENCE

STEP-2                           00064     00070
STEP-3                           00068     00070
STEP-6                           00076     00078
STEP-8                           00079     00076
```

```
CARD    ERROR MESSAGE                D
A  64   B  ILA5011I-W   C  HIGH ORDER TRUNCATION MIGHT OCCUR.         9
   64      ILA5011I-W      HIGH ORDER TRUNCATION MIGHT OCCUR.
```

Figure 11. Examples of Compiler Output (Part 4 of 4)

If DATE-COMPILED is specified in the Identification Division, any sentences in that paragraph are replaced in the listing by the date of compilation. It is printed in one of the following formats depending upon the format chosen at system generation time.

DATE-COMPILED. month/day/year or

DATE-COMPILED. day/month/year

(4) Glossary. The glossary is listed when the SYM option is specified. The glossary contains information about names in the COBOL source program.

(A) and (F) The internal-name generated by the compiler. This name is used in the compiler object code listing to represent the name used in the source program. It is repeated in column F for readability.

(B) A normalized level number. This level number is determined by the compiler as follows: the first level number of any hierarchy is always 01, and increments for other levels are always by one. Only level numbers 03 through 49 are affected; level numbers 66, 77, and 88, and FD, SD, and RD indicators are not changed.

(C) The data-name that is used in the source module.

Note: The following Report Writer internally-generated data-names can appear under the SOURCE NAME column:

CTL.LVL	Used to coordinate control break activities.
GRP.IND	Used by coding for GROUP INDICATE clause.
TER.COD	Used by coding for TERMINATE clause.
FRS.GEN	Used by coding for GENERATE clause.
-nnnn	Generated report record associated with the file on which the report is to be printed.
RPT.RCD	Build area for print record.
CTL.CHR	First or second position of RPT.RCD. Used for carriage control character.
RPT.LIN	Beginning of actual information which will be displayed. Second or third position of RPT.RCD.
CODE-CELL	Used to hold code specified.
E.nnnn	Name generated from COLUMN clause in 02-level statement.
S.nnnn	Used for elementary level with SUM clause, but not with data-name.
N.nnnn	Used to save the total number of lines used by a report group when relative line numbering is specified.

(D) and (E) For data-names, these columns contain information about the address in the form of a base and displacement. For file-names, the column contains information about the associated DTF, if any.

(G) This column defines storage for each data item. It is represented in assembler-like terminology. Table 3 refers to information in this column.

(H) Usage of the data-name. For FD entries, the DTF type is identified (e.g., DTFDA). For group items containing a USAGE clause, the usage type is printed For group items that do not contain a USAGE clause, GROUP is printed. For elementary items, the information in the USAGE clause is printed.

Table 3. Glossary Definition and Usage

Type	Definition	Usage
Group Fixed-Length	DS OCLN	GROUP
Alphabetic	DS NC	DISP
Alphanumeric	DS NC	DISP
Alphanumeric Edited	DS NC	AN-EDIT
Numeric Edited	DS NC	NM-EDIT
Index-Name	DS 1H	INDEX-NM
Group Variable-Length	DS VLI=N	GROUP
Sterling Report	DS NC	RPT-ST
External Decimal	DS NC	DISP-NM
External Floating-Point	DS NC	DISP-FP
Internal Floating-Point	DS 1F	COMP-1
	DS 1D	COMP-2
Binary	DS 1H, 1F, OR 2F	COMP
Internal Decimal	DS NP	COMP-3
Sterling Non-Report	DS NC	DISP-ST
Index-Name	BLANK	INDEX-NAME
File (FD)	BLANK	DTF TYPE
Condition (88)	BLANK	BLANK
Report Definition (RD)	BLANK	BLANK
Sort Definition (SD)	BLANK	BLANK

Note: Under the definition column, N = size in bytes, except in group variable-length where it is a variable cell number.

J A letter under column:

R - Indicates that the data-name redefines another data-name.

O - Indicates that an OCCURS clause has been specified for that data-name.

Q - Indicates that the data-name is or contains the DEPENDING ON object of the OCCURS clause.

M - Indicates the record format. The letters which may appear under column M are:

F - fixed-length records

U - undefined records

V - variable-length records

S - spanned records

5 Global tables and literal pool: Global tables and the literal pool are listed when the LISTX option is specified, unless SUPMAP is also specified and an E-level error is encountered. A global table contains easily addressable information needed by the object program for execution. For example, in the Procedure Division output coding (3), the address of the first instruction under STEP-1 (OPEN OUTPUT FILE-1) is found in the PROCEDURE NAME CELLS portion of the Program Global Table (PGT).

A The Task Global Table (TGT). This table is used to record and save information needed during the execution of the object program. This information includes switches, addresses, and work areas.

B The Literal Pool. This lists all literals used in the program, with duplications removed. These literals include those specified by the programmer (e.g., MOVE "ABC" TO DATA-NAME) and those generated by the compiler (e.g., to align decimal points in arithmetic computations). The literals are divided into two groups: those that are referenced by instructions (marked "LITERAL POOL") and those that are parameters to the display object time subroutine (marked "DISPLAY LITERALS").

C The Program Global Table (PGT). This table contains literals and the addresses of procedure-names and generated procedure-names referenced by Procedure Division instructions.

6 Register assignment: This lists the permanent register assigned to each base locator in the object program.

The remaining base locators are given temporary register assignments but are not listed. Register assignments are listed when LISTX is specified.

(7) Object code listing. The object code listing is produced when the LISTX option is specified, unless SUPMAP is also specified and an E-level error is encountered. The actual object code listing contains:

(A) The compiler-generated card number. This number identifies the COBOL statement in the source deck which contains the verb that generates the object code found in column C. For Report Writer generated routines, each routine references the compiler-generated card number of its respective RD.

(B) The relative location, in hexadecimal notation, of the object code instruction in the module.

(C) The actual object code instruction in hexadecimal notation.

(D) The procedure-name number. A number is assigned only to procedure-names referred to in other Procedure Division statements.

(E) The object code instruction in the form that closely resembles assembler language. (Displacements are in hexadecimal notation.)

(F) Compiler-generated information about the operands of the generated instruction. This includes names and relative locations of literals. Table 4 refers to information in this column.

(8) Cross-reference Dictionary: The cross reference dictionary is produced when the XREF option is specified. It consists of two parts:

(A) The XREF dictionary for data-names consists of data-names followed by the generated card number of the statement which defines each data-name, and the generated card number of statements where each data-name is referenced. Report Writer data-names, with the exception of data-names in the form "-nnn", are defined with the generated card number of their respective RD's.

(B) The XREF dictionary for procedure-names consists of the procedure-names followed by the generated card number of the statement where each procedure-name is used as a section-name or paragraph-name, and the generated card number of statements where each procedure-name is referenced.

The names appear in the order in which they appear in the source program. The number of references appearing in the cross-reference dictionary for a given name is based upon the number of times the name is referenced in the code generated by the compiler.

Table 4. Symbols Used in the Listing and Glossary to Define Compiler-Generated Information

Symbol	Meaning
DNM	SOURCE DATA NAME
SAV	SAVE AREA CELL
SWT	SWITCH CELL
TLY	TALLY CELL
WC	WORKING CELL
TS	TEMPORARY STORAGE CELL
VLC	VARIABLE LENGTH CELL
SBL	SECONDARY BASE LOCATOR
BL	BASE LOCATOR
BLL	BASE LOCATOR FOR LINKAGE SECTION
ON	ON COUNTER
PFM	PERFORM COUNTER
PSV	PERFORM SAVE
VN	VARIABLE PROCEDURE NAME
SBS	SUBSCRIPT ADDRESS
XSW	EXHIBIT SWITCH
XSA	EXHIBIT SAVE AREA
PRM	PARAMETER
PN	SOURCE PROCEDURE NAME
GN	GENERATED PROCEDURE NAME
DTF	DTF ADDRESS
VN	VARIABLE NAME INITIALIZATION
LIT	LITERAL
TS2	TEMPORARY STORAGE (NON-ARITHMETIC)
RSV	REPORT SAVE AREA
SDF	SECONDARY DTF POINTER
TS3	TEMPORARY STORAGE (SYNCHRONIZATION)
TS4	TEMPORARY STORAGE (SYNCHRONIZATION)
INX	INDEX CELL
V(BCDNAME)	VIRTUAL
VIR	VIRTUAL

Diagnostic messages: The diagnostic messages associated with the compilation are always listed. The format of the diagnostic message is:

(A) Compiler-generated card number. This is the number of a line in the source program related to the error.

(B) Message identification. The message identification for the Disk Operating System Full American National Standard COBOL compiler always begins with the symbols ILA.

(C) The severity level. There are four severity levels as follows:

(W) Warning
This level indicates that an error was made in the source program. However, it is not serious enough to interfere with the execution of the program. These warning messages are listed only if the FLAGW option is specified in the CBL card or chosen at system generation time.

(C) Conditional
This level indicates that an error was made but the compiler usually makes a corrective assumption. The statement containing the error is retained. Execution can be attempted.

(E) Error
This level indicates that a serious error was made. Usually the compiler makes no corrective assumption. The statement or operand containing the error is dropped. Compilation is completed, but execution of the program should not be attempted.

(D) Disaster
This error indicates that a serious error was made. Compilation is not completed. Results are unpredictable.

(D) The message text. The text identifies the condition that caused the error and indicates the action taken by the compiler.

Since Report Writer generates a number of internal data items and procedural statements, some error messages may reflect internal names. In cases where the error occurs mainly in these generated routines, the error messages may indicate the card number of the RD entry for the report under consideration. In addition, there are errors that may indicate the number of the card upon which the statement containing the error ends rather than the card upon which the error occurs. Internal name formats for Report Writer are discussed under "Glossary" (heading 4, item C).

"Appendix I: Diagnostic Messages" gives a complete list of compiler diagnostic messages.

OBJECT MODULE

The object module contains the external symbol dictionary, the text of the program, and the relocation dictionary. It is followed by an END statement that marks the end of the module. For additional information about the external symbol dictionary and the relocation dictionary, see the publication DOS System Control and Service.

An object deck is punched if the DECK option is specified, unless an E-level diagnostic message is generated. The object module is written on SYSLNK if the LINK option is specified, unless an E-level diagnostic message is generated.

LINKAGE EDITOR OUTPUT

The output of the link edit step may include:

- A printed listing of the job control statements
- A map of the phase after it has been processed by the Linkage Editor
- Diagnostic messages
- A listing of the linkage editor control statements
- A phase which may be assigned to the core image library

Any diagnostic messages associated with the Linkage Editor are automatically generated as output. The other forms of output may be requested by the OPTION control statement. All output to be listed is printed on the device assigned to SYSLST.

Figure 12 is an example of a linkage editor output listing. It shows the job control statements and the phase map. The different types of output are numbered and each type to be explained is lettered. The text following the figure is an explanation of the figure.

```
// EXEC LNKEDT        (1)
```

```
JOB  SAMPLE               DISK LINKAGE EDITOR DIAGNOSTIC OF INPUT   (2)

ACTION TAKEN    MAP
LIST   AUTOLINK   IJFFBZZN
LIST   AUTOLINK   ILBDDSP0
LIST   INCLUDE IJJCPD1
LIST   AUTOLINK   ILBDIML0
LIST   AUTOLINK   ILBDMNS0
LIST   AUTOLINK   ILBDSAE0
LIST   ENTRY
```

```
   (A)       (B)      (C)      (D)       (E)        (F)        (G)        (H)      (J)
  PHASE    XFR-AD   LOCORE   HICORE   DSK-AD    ESD TYPE   LABEL      LOADED   REL-FR

PHASE***   0032A0   0032A0   004ACB   53 01 2   CSECT      TESTRUN    0032A0   0032A0

                                                CSECT      IJFFBZZN   003C40   003C40
                                                *  ENTRY   IJFFZZZN   003C40
                                                *  ENTRY   IJFFBZZZ   003C40
                                                *  ENTRY   IJFFZZZZ   003C40

                                                CSECT      ILBDSAE0   0049E0   0049E0
                                                   ENTRY   ILBDSAE1   0049F6

                                                CSECT      ILBDMNS0   0049D8   0049D8         (3)

                                                CSECT      ILBDDSP0   0041A8   0041A8
                                                *  ENTRY   ILBDDSP1   0046F8
                                                *  ENTRY   ILBDDSP2   004790
                                                *  ENTRY   ILBDDSP3   004948

                                                CSECT      ILBDIML0   004980   004980

                                                CSECT      IJJCPD1    003FB0   003FB0
                                                   ENTRY   IJJCPD1N   003FB0
                                                *  ENTRY   IJJCPD3    003FB0
```

Figure 12. Linkage Editor Output

(1) The job control statements. These statements are listed since the LOG option is specified.

(2) Disk linkage editor diagnostic message of input. The ACTION statement is not required. If the MAP option is specified, SYSLST must be assigned. If the statement is not used and SYSLST is assigned, MAP is assumed and a map of main storage and any error diagnostic messages are considered output on SYSLST.

(3) Map of main storage. A phase map is printed when MAP is specified (or assumed) during linkage editor processing. The following information is contained in the map of main storage:

(A) The name of each phase. This is the name specified in the phase statement.

(B) The transfer address of each phase.

C The lowest main storage location of each phase.

D The highest main storage location of each phase.

E The hexadecimal disk address where the phase begins in the core image library.

F The names of all CSECT's belonging to a phase.

G All defined entry points within a CSECT. If an entry point is not referenced, it is flagged with an asterisk (*).

H The address where each CSECT is loaded.

J The relocation factor of each CSECT.

Comments on the Phase Map

The severity of linkage editor diagnostic messages may affect the production of the phase map. Since various processing options affect the structure of the phase, the text of the phase map will sometimes provide additional information. For example, the phase may contain an overlay structure. In this case, a map will be listed for each segment in the overlay structure.

Linkage Editor Messages

The Linkage Editor may generate informative or diagnostic messages. A complete list of these messages is included in the publication DOS Operator Communications and Messages.

DOS ANS COBOL UNRESOLVED EXTERNAL REFERENCES

When the linkage editor encounters a weak external reference (WXTRN), autolinking is suppressed and the V-type address constant is either resolved from those modules included into the load module or it remains unresolved. Unresolved WXTRNs will not cause the linkage editor to cancel the link step if ACTION CANCEL is in effect.

The object time subroutine library of the ANS Full COBOL compiler utilizes WXTRNs not only as address constants but also as switches to determine at object time whether certain options are in effect. It is a very convenient feature which can lead to tight and efficient code.

Unresolved WXTRNs are normally intentional but unresolved EXTRNs are normally unintentional and an error.

Any of the following unresolved WXTRNs may appear when link editing an object module produced by an ANS COBOL compiler:

ILBDCKP2
ILBDDSPO
ILBDRELO
ILBDDSP1
ILBDDSP3

COBOL PHASE EXECUTION OUTPUT

The output generated by program execution (in addition to data written on output files) may include:

- Data displayed on the console or on the printer
- Messages to the operator
- System informative messages
- System diagnostic messages
- A system dump

A dump and system diagnostic messages are generated automatically during program execution only if the program contains errors that cause abnormal termination.

Figure 13 is an example of output from the execution job step. The following text is an explanation of the illustration.

1. Job control statements. These statements are listed because the LOG option is specified.

2. Program output on printer. The results of execution of the TRACE and EXHIBIT NAMED statements appear on the program listing.

3. Console output. Data is printed on the console as a result of the execution of DISPLAY UPON CONSOLE.

```
// ASSGN SYS008,X'183'
// EXEC

64
68
73
76
77
WORK-RECORD = A 0001 NYC Z
76
77
WORK-RECORD = B 0002 NYC 1
76
77
WORK-RECORD = C 0003 NYC 2
76
77
WORK-RECORD = D 0004 NYC 3
76
77
WORK-RECORD = E 0005 NYC 4
76
77
WORK-RECORD = F 0006 NYC Z
```

```
BG // JOB SAMPLE
   00.07.09
BG A 0001 NYC 0
BG B 0002 NYC 1
BG C 0003 NYC 2
BG D 0004 NYC 3
BG E 0005 NYC 4
BG F 0006 NYC 0
BG G 0007 NYC 1
BG H 0008 NYC 2
BG I 0009 NYC 3
BG J 0010 NYC 4
BG K 0011 NYC 0
BG L 0012 NYC 1
BG M 0013 NYC 2
BG N 0014 NYC 3
BG O 0015 NYC 4
BG P 0016 NYC 0
BG Q 0017 NYC 1
BG R 0018 NYC 2
BG S 0019 NYC 3
BG T 0020 NYC 4
BG U 0021 NYC 0
BG V 0022 NYC 1
BG W 0023 NYC 2
BG X 0024 NYC 3
BG Y 0025 NYC 4
BG Z 0026 NYC 0
BG EOJ SAMPLE
   00.09.20,DURATION 00.02.11
```

Figure 13. Output from Execution Job Steps

OPERATOR MESSAGES

The COBOL phase may issue operator messages. In the message, XX denotes a system-generated 2-character numeric field that is used to identify the program issuing the message.

STOP Statement

The following message is generated by the STOP statement with the literal option:

XX C110A STOP 'literal'

Explanation: This message is issued at the programmer's discretion to indicate possible alternative action to be taken by the operator.

Operator Response: Follows the instructions given both by the message and on the job request form supplied by the programmer. If the job is to be resumed, hit end-of-block.

ACCEPT Statement

The following message is generated by an ACCEPT statement with the FROM CONSOLE option:

XX C111A "AWAITING REPLY"

Explanation: This message is issued by the object program when operator intervention is required.

Operator Response: Enter the reply and hit end-of-block to send message. (The contents of the text field should be supplied by the programmer on the job request form.)

SYSTEM OUTPUT

Informative and diagnostic messages may appear in the listing during the execution of the object program.

Each of these messages contains an identification code in the first column of the message to indicate the portion of the operating system that generated the message. Table 5 lists these codes, together with identification for each.

Table 5. System Message Identification Codes

Code	Identification
0	An on-line console message from the Supervisor
1	A message from the Job Control Processor
2	A message from the Linkage Editor
3	A message from the Librarian
4	A message from LIOCS
7	A message from the Sort program
C	A message from COBOL object-time subroutines

This chapter describes the accepted linkage conventions for calling and called programs and discusses linkage methods when using an assembler language program. In addition, this chapter contains a description of the overlay facility which enables different called programs to occupy the same area in main storage at different times. It also contains a suggested assembler language program to be used in conjunction with the overlay feature.

A COBOL source program that passes control to another program is a calling program. The program that receives control from the calling program is referred to as a called program. Both programs must be compiled (or assembled) in separate job steps, but the resulting object modules must be link edited together in the same phase.

A called program can also be a calling program; that is, a called program can, in turn, call another program. In Figure 14 for instance, program A calls program B; program B calls program C. Therefore:

1. A is considered a calling program by B
2. B is considered a called program by A
3. B is considered a calling program by C
4. C is considered a called program by B

```
        A               B               C
  ┌────────┐      ┌────────┐      ┌────────┐
  |Calling |      |Called  |      |Called  |
  |program |      |program |      |program |
  |of B    |      |of A    |      |of B    |
  |        |--->  |        |---->|        |
  |        |      |Calling |      |        |
  |        |      |program |      |        |
  |        |      |of C    |      |        |
  └────────┘      └────────┘      └────────┘
```
Figure 14. Calling and Called Programs

By convention, a called program may call to an entry point in any other program, except one on a higher level in the "path" of that program. That is, A may call to an entry point in B or C, and B may call C; however, C should not call A or B. Instead, C transfers control only to B by issuing the EXIT PROGRAM or GOBACK statements in COBOL (or its equivalent in another language). B then returns to A.

Compiler generated switches, e.g., ON and ALTER, are not reinitialized upon each entrance to the called program, that is, the program is in its last executed state.

Note: It is necessary for an American National Standard COBOL program to know whether it is the main or the called program. For this reason, any non-American National Standard COBOL program calling an American National Standard program must first call the subroutine ILBDSET0. The function of this subroutine is to set a switch to X'FF' in subroutine ILBDMNS0, which is the indication to the American National Standard COBOL program that it is a called program. Standard linkage conventions should be observed when calling ILBDSET0; there are no parameters to be passed.

LINKAGE

Whenever a program calls another program, linkage must be established between the two. The calling program must state the entry point of the called program and must specify any arguments to be passed. The called program must have an entry point and must be able to accept the arguments. Further, the called program must establish the linkage for the return of control to the calling program.

LINKAGE IN A CALLING PROGRAM

A calling COBOL program must contain the following statement at the point where another program is to be called:

```
CALL literal-1 [USING identifier-1
             [identifier-2]...]
```

literal-1
: is the name specified as the program-name in the PROGRAM-ID paragraph of the called program, or the name of the entry point in the called program. When the called program is to be entered at the beginning of the Procedure Division, literal-1 is the name of the program being called. When the called program is to be entered at some point other

than the beginning of the Procedure Division, literal-1 should not be the same as the name specified in the PROGRAM-ID paragraph of the called program. Since the program-name in the PROGRAM-ID paragraph produces an external reference defining an entry point, this entry point name would not be uniquely defined as an external reference.

identifier-1 [identifier-2]...
: are the arguments being passed to the called program. Each identifier represents a data item defined in the File, Working-Storage, or Linkage Sections of the calling program and should contain a level number 01 or 77. When passing identifiers from the File Section, the file should be open before the CALL statement is executed. If the called program is an assembler language program, the arguments may represent file-names and procedure-names. If no arguments are to be passed, the USING option is omitted.

LINKAGE IN A CALLED PROGRAM

A called COBOL program must contain two sets of statements:

1. One of the following statements must appear at the point where the program is entered.

   If the called program is entered at the first instruction in the Procedure Division and arguments are passed by the calling program:

   ```
   PROCEDURE DIVISION [USING
     identifier-1 [identifier-2]...].
   ```

   If the entry point of the called program is not the first statement of the Procedure Division:

   ```
   ENTRY literal-1 [USING identifier-1
     [identifier-2]...]
   ```

   literal-1
   : is the name of the entry point in the called program. It is the same name that appears in the CALL statement of the program that calls this program. literal-1 must not be the name of any other entry point or program-name in the run unit.

   identifier-1 [identifier-2]...]
   : are the data items representing parameters. They correspond to the arguments of the CALL statement of the calling program. Each data item in this parameter list must be defined in the Linkage Section of the called program and must contain a level number of 01 or 77.

2. Either of the following statements must be inserted where control is to be returned to the calling program:

   ```
   EXIT PROGRAM.
   ---
   GOBACK.
   ```

   Both the EXIT PROGRAM and GOBACK statements cause the restoration of the necessary registers, and return control to the point in the calling program immediately following the calling sequence.

ENTRY POINTS

Each time an entry point is specified in a called program, an external-name is defined. An external-name is a name that can be referenced by another program that has been separately compiled or assembled. Each time an entry name is specified in a calling program, an external reference is defined. An external reference is a symbol that is defined as an external-name in another separately compiled or assembled program. The Linkage Editor resolves external-names and external references, and combines calling and called programs into a format suitable for execution together, i.e., as a single phase.

Note: Several different entry points may be defined in one COBOL source module. Different CALL statements in any module of the phase may specify the same entry point, but each definition of an entry point must be unique in the same phase.

CORRESPONDENCE OF ARGUMENTS AND PARAMETERS

The number of identifiers in the argument list of the calling program should be the same as the number of identifiers in the parameter list of the called program. If the number of identifiers in the argument list of the calling program is greater than the number of identifiers in the parameter list of the called program, only those specified in the parameter list of the called program may be referred to by the called program. There is a one-for-one correspondence. The correspondence is positional and not by name. An identifier must not appear more than once in the same USING clause.

Only the address of an argument is passed. Consequently, both the identifier that is an argument and the identifier that is the corresponding parameter refer to the same location in main storage. The pair of identifiers need not be identical, but the data descriptions must be equivalent. For example, if an argument is a level-77 data-name representing a 30-character string, its corresponding parameter could also be a level-77 data-name representing a character string of length 30, or the parameter could be a level-01 data item with subordinate items representing character strings whose combined length is 30.

Although all parameters in the ENTRY statement must be described with level numbers 01 or 77, there is no such restriction made for arguments in the CALL statement. An argument may be a qualified name or a subscripted name. When a group item with a level number other than 01 is specified as an argument, proper boundary word alignment is required if subordinate items are described as COMPUTATIONAL, COMPUTATIONAL-1, or COMPUTATIONAL-2. If the argument corresponds to an 01-level parameter, doubleword alignment is required.

LINK EDITING WITHOUT OVERLAY

Assume that a COBOL main program (COBMAIN), at one or more points in its logic executes CALL statements to COBOL programs SUBPRGA, SUBPRGB, SUBPRGC, and SUBPRGD. Also assume that the module sizes for the main program and subprograms are:

Program	Module Size (in bytes)
COBMAIN	20,000
SUBPRGA	4,000
SUBPRGB	5,000
SUBPRGC	6,000
SUBPRGD	3,000

Through the linkage mechanism, all called programs plus COBMAIN must be link edited together to form one module of 38,000 bytes. Therefore, COBMAIN would require 38,000 bytes of storage in order to be executed. No overlay structure need be specified at link edit time if 38,000 bytes of core storage are available.

The following is an example of the job control statements needed to link edit these calling and called programs without specifying an overlay structure. The source decks for COBMAIN and SUBPRGA are included in the job deck, whereas SUBPRGB, SUBPRGC, and SUBPRGD are in the relocatable library.

```
// JOB NOVERLAY
// OPTION LINK,LIST,DUMP
   ACTION MAP
   PHASE EXAMP1,*
   INCLUDE

   {object module COBMAIN}
/*
   INCLUDE SUBPRGB
   INCLUDE SUBPRGC
   INCLUDE SUBPRGD
   INCLUDE

   {object module SUBPRGA}
/*
   ENTRY
// EXEC LNKEDT
// EXEC

   {data for program}
/*
/&
```

Figure 15 is an example of the data flow logic of this call structure where all the programs fit into main storage.

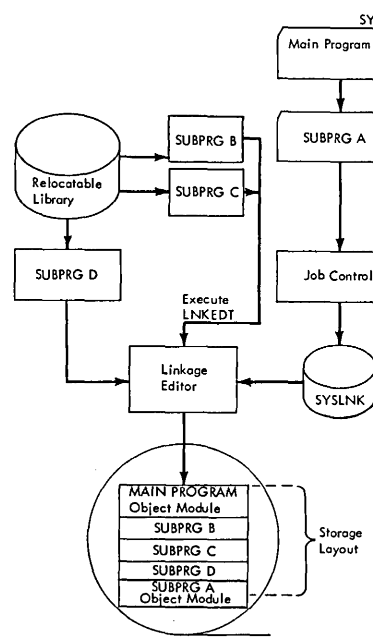

Figure 15. Example of Data Flow Logic in a Call Structure

Note: For the example given, it is assumed that SYSLNK is a standard assignment. The flow diagram illustrates how the various program segments are link edited into storage in a sequential arrangement.

ASSEMBLER LANGUAGE SUBPROGRAMS

A main program written in COBOL can call programs written in other languages that use the same linkage conventions. Whenever a COBOL program calls an assembler language program, certain conventions and techniques must be used.

There are three basic ways to use assembler-written called programs with a main program written in COBOL:

1. A COBOL main program or called program calling an assembler-writtem program.

2. An assembler-written program calling a COBOL program.

3. An assembler-written program calling another assembler-written program.

From these combinations, more complicated structures can be formed.

In a COBOL program, the expansions of the CALL and GOBACK or EXIT PROGRAM statements provide the save and return coding that is necessary to establish linkage between the calling and called programs in accordance with the linkage conventions of the system. Assembler language programs must be prepared in accordance with the same linkage conventions. These conventions include:

1. Using the proper registers to establish linkage.

2. Reserving, in the calling program, a storage area for items contained in the argument list. This storage area can be referenced by the called program.

3. Reserving, in the calling program, a save area in which the contents of the registers can be saved.

REGISTER USE

The Disk Operating System has assigned functions to certain registers used in linkages. Table 6 shows the conventions for using general registers as linkage registers. The calling program must load the address of the return point into register 14, and it must load the address of the entry point of the called program into register 15.

Table 6. Conventional Use of Linkage Registers

Reg. No.	Reg. Name	Function
1	Argument list register	Address of the argument list passed to the called program.
13	Save area register	Address of the area reserved by the calling program in which the contents of certain registers are stored by the called program.
14	Return register	Address of the location in the calling program to which control is returned after execution of the called program.
15	Entry point register	Address of the entry point in the called program.

SAVE AREA

A calling assembler language program must reserve a save area of 18 words, beginning on a fullword boundary, to be used by the called program for saving registers; it must load the address of this area into register 13. Table 7 shows the layout of the save area and the contents of each word.

A called COBOL program does not save floating-point registers. The programmer is responsible for saving and restoring the contents of these registers in the calling program.

ARGUMENT LIST

The argument list is a group of contiguous fullwords, beginning on a fullword boundary, each of which is an address of a data item to be passed to the called program. If the program is to pass arguments, an argument list must be prepared and its address loaded into register 1. The high-order bit of the last argument, by convention, is set to 1 to indicate the end of the list.

Table 7. Save Area Layout and Word Contents

AREA (word 1)	This word is a part of the standard linkage convention established under the Disk Operating System. The word must be reserved for proper addressing of the subsequent entries. However, an assembler subprogram may use the word for any desired purpose.
AREA+4 (word 2)	The address of the previous save area, that is, the save area of the subprogram that called this one.
AREA+8 (word 3)	The address of the next save area, that is, the save area of the subprogram to which this subprogram refers.
AREA+12 (word 4)	The contents of register 14, that is, the return address.
AREA+16 (word 15)	The contents of register 15, that is, the entry address.
AREA+20 (word 6)	The contents of register 0.
AREA+24 (word 7)	The contents of register 1.
.	.
.	.
.	.
AREA+68 (word 18)	The contents of register 12.

Any assembler-written program must be coded with a detailed knowledge of the data formats of the arguments being passed. Most coding errors occur because of the data format discrepancies of the arguments.

If one programmer writes both the calling program and the called program, the data format of the arguments should not present a problem when passed as parameters. However, when the programs are written by different programmers, the data format specifications for the arguments must be clearly defined for the programmer.

The linkage conventions used by an assembler program that calls another program are illustrated in Figure 16. The linkage should include:

1. The calling sequence.
2. The save and return routines.
3. The out-of-line parameter list. (An in-line parameter list may be used.)
4. A save area on a fullword boundary.

In-Line Parameter List

The assembler programmer may establish an in-line parameter list instead of an out-of-line list. In this case, he may substitute the calling sequence and parameter list illustrated in Figure 17 for that shown in Figure 16.

```
deckname  START  0                INITIATES PROGRAM ASSEMBLAGE AT FIRST
*                                 AVAILABLE LOCATION.  ENTRY POINT TO THE
*                                 PROGRAM.
          ENTRY  name1
          EXTRN  name2
          USING  name1,15
*  SAVE ROUTINE
name1     STM    14,r1,12(13)     THE CONTENTS OF REGISTERS 14, 15, AND
*                                 0 THROUGH r1 ARE STORED IN THE SAVE
*                                 AREA OF THE CALLING PROGRAM (PREVIOUS
*                                 SAVE AREA). r1 IS ANY NUMBER FROM 0 THROUGH 12.
          LR     r3,15
          DROP   15
          USING  name1,r3         WHERE r3 AND r2 HAVE BEEN SAVED
          LR     r2,13            LOADS REGISTER 13, WHICH POINTS TO THE
*                                 SAVE AREA OF THE CALLING PROGRAM, INTO
*                                 ANY GENERAL REGISTER, r2, EXCEPT 0 AND 13.
          LA     13,AREA          LOADS THE ADDRESS OF THIS PROGRAM'S
*                                 SAVE AREA INTO REGISTER 13.
          ST     13,8(r2)         STORES THE ADDRESS OF THIS PROGRAM'S SAVE
*                                 AREA INTO WORD 3 OF THE SAVE AREA OF THE
*                                 CALLING PROGRAM.
          ST     r2,4(13)         STORES THE ADDRESS OF THE PREVIOUS SAVE
*                                 AREA (I.E., THE SAME AREA OF THE CALLING
*                                 PROGRAM) INTO WORD 2 OF THIS PROGRAM'S
*                                 SAVE AREA.
          BC     15,prob1
AREA      DS     18F              RESERVES 18 WORDS FOR THE SAVE AREA
*                                 THIS IS LAST STATEMENT OF SAVE ROUTINE.
prob1     {User-written program statements}
*  CALLING SEQUENCE
          LA     1,ARGLST
          L      15,ADCON
          BALR   14,15
          {Remainder of user-written program statements}
*  RETURN ROUTINE
          L      13,4(13)         LOADS THE ADDRESS OF THE PREVIOUS SAVE
*                                 AREA BACK INTO REGISTER 13.
          LM     2,r1,28(13)      THE CONTENTS OF REGISTER 2 THROUGH r1 ARE
*                                 RESTORED FROM THE PREVIOUS SAVE AREA.
          L      14,12(13)        LOADS THE RETURN ADDRESS, WHICH IS IN
*                                 WORD 4 OF THE CALLING PROGRAM'S SAVE AREA,
*                                 INTO REGISTER 14.
          MVI    12(13),X'FF'     SETS FLAG FF IN THE SAVE AREA OF THE
*                                 CALLING PROGRAM TO INDICATE THAT CONTROL
*                                 HAS RETURNED TO THE CALLING PROGRAM.
          BCR    15,14            LAST STATEMENT IN RETURN ROUTINE
ADCON     DC     A(name2)         CONTAINS THE ADDRESS OF SUBPROGRAM name2.
*  PARAMETER LIST
ARGLST    DC     AL4(arg1)        FIRST STATEMENT IN PARAMETER AREA SETUP
          DC     AL4(arg2)
           .
           .
           .
          DC     X'80'            FIRST BYTE OF LAST ARGUMENT SETS BIT 0 TO 1
          DC     AL3(argn)        LAST STATEMENT IN PARAMETER AREA SETUP
```

Figure 16. Sample Linkage Routines Used with a Calling Subprogram

```
ADCON    DC      A(prob1)
          .
          .
          .
         LA      14,RETURN
         L       15,ADCON
         CNOP    2,4
         BALR    1,15
         DC      AL4(arg1)
         DC      AL4(arg2)
          .
          .
          .
         DC      X'80'
         DC      AL3(argn)
RETURN   EQU     *
```

Figure 17. Sample In-line Parameter List

LOWEST LEVEL PROGRAM

If an assembler called program does not call any other program (i.e., if it is at the lowest level), the programmer should omit the save routine, calling sequence, and parameter list shown in Figure 16. If the assembler called program uses any registers, it must save them. Figure 18 illustrates the appropriate linkage conventions used by an assembler program at the lowest level.

```
deckname START  0
         ENTRY  name

         USING  *,15
name     STM    14,r1,12(13)
          .
          .
          .
User-written program statements
          .
          .
          .
         LM     2,r1,28(13)
         MVI    12(13),X'FF'
         BCR    15,14
```

Note: If registers 13 and/or 14 are used in the called subprogram, their contents should be saved and restored by the called subprogram.

Figure 18. Sample Linkage Routines Used with a Lowest Level Subprogram

OVERLAYS

If a program is too large to be contained in the number of bytes available in main storage, it can still be executed by means of an overlay structure. An overlay structure permits the re-use of storage locations previously occupied by another program. In order to use an overlay structure, the programmer must plan his program so that one or more called programs need not be in main storage at the same time as the rest of the program phase.

The following is a diagram of the basic form of a program to be overlaid:

```
               |
               |
               |ROOT PHASE
               |
               |
               |
       ________|________
      |                 |
      |                 |
      |                 |
      |                 |
      |                 |
      |SUBA             |SUBB
```

The root phase consists of the COBOL main program and an assembler language subroutine which handles the overlay structures. SUBA and SUBB are the called programs that are to be overlaid in core storage.

In using the overlay technique, the programmer specifies to the Linkage Editor which programs are to overlay each other. These programs are processed by the Linkage Editor so they can be placed automatically in main storage for execution when called by the main program. The resulting output of the Linkage Editor is called an overlay structure.

SPECIAL CONSIDERATIONS WHEN USING OVERLAY STRUCTURES

There are three areas of special concern to the programmer who decides to use the overlay feature. These problems concern the use of the assembler language subroutine, proper link editing, and job control statements.

ASSEMBLER LANGUAGE SUBROUTINE FOR ACCOMPLISHING OVERLAY

The CALL statement is used for "direct" linkage; that is, the assistance of the Supervisor is not required (as it is when loading or fetching a phase). There are no COBOL statements that will generate the equivalent of the LOAD or FETCH assembler macro instructions. For this reason, one must call an assembler program to effect an overlay of a COBOL program. This routine must be link edited as part of either a root phase or permanently resident phase.

The sample overlay subroutine shown in Figure 19 is governed by the following restrictions:

1. The example is a suggested technique, and is not the only technique.
2. It can be used for assembler overlays if the programmer has a desired entry point in his END card and the first statement at that entry point is 'STM 14,12,12(13)'.
3. This subroutine can be used for a COBOL program which contains an ENTRY statement immediately following the Procedure Division header. It will not work with a COBOL subprogram compiled with a Procedure Division USING statement, or for entry points in a COBOL subprogram which appear anywhere other than as the first instruction of the Procedure Division. A suggested technique for diverse entry points is a table look-up using V-type constants.

```
STMNT       SOURCE STATEMENT

0001  OVERLAY   START 0
0002            ENTRY OVRLAY
0003  * AT ENTRY TIME
0004  *     R1=POINTER TO ADCON LIST OF USING ARGUMENTS
0005  *     FIRST ARGUMENT IS PHASE OR SUBROUTINE NAME
0006  *     MUST BE 8 BYTES
0007  *     R13=ADDRESS OF SAVE AREA
0008  *     R14=RETURN POINT OF CALLING PROGRAM
0009  *     R15=ENTRY POINT OF OVERLAY PROGRAM
0010  * AT EXIT
0011  *     R1=POINTER TO SECOND ARGUMENT OF ADCON LIST
0012  *         OF USING ARGUMENTS
0013  *     R14=RETURN POINT OF CALLING PROGRAM--NOT THIS PROG
0014  *     R15=ENTRY POINT OF PHASE OR SUBPROGRAM
0015  *
0016            USING *,15
0017  OVRLAY    STM  0,1,SAVE           SAVE WORK REGS
0018            L    1,0(1)             POINT R1 TO PHASE NAME
0019            CLC  CORSUB,0(1)        IN CORE?
0020            BE   SUBIN              YES,BR
0021            MVC  CORSUB(8),0(1)     SET CURRENT PHASE
0022            SR   0,0
0023            SVC  4                  LOAD PHASE
0024  SEARCH1   LA   1,4(1)             STEP SEARCH POINT
0025            CLC  0(4,1),=C'COBF'    END OF INIT1?
0026            BNE  SEARCH1            NO, LOOP
0027            S    1,=F'8'            POINT TO "START" ADCON
0028            L    1,0(1)             LOAD "START"
0029            LA   1,8(1)             INCREMENT TO "ENTRY"
0030            ST   1,ASUB             SAVE ENTRY ADDR.
0031  SUBIN     LM   0,1,SAVE           RELOAD WORK REGS
0032            LA   1,4(1)             POINT TO PARAMETERS
0033            L    15,ASUB
0034            BR   15                 BRANCH TO ENTRY POINT
0035  CORSUB    DS   0CL8
0036            DC   8X'FF'
0037  ASUB      DS   F
0038  SAVE      DS   2F
0039            END
```

Figure 19. Example of an Assembler Language Subroutine for Accomplishing Overlay

Note: Care should be taken with the techniques used in statements 0019 and 0020. Only when the COBOL program is loaded are altered GO TO statements reinitialized. A better technique would be to load the called programs each time they are required.

LINK EDITING WITH OVERLAY

In a linkage editor job step, the programmer specifies the overlay points in a program by using PHASE statements. In the Working-Storage Section, a level-01 or level-77 constant must be created for each phase to be called at execution time. These constants have a PICTURE of X(8) and a VALUE clause containing the same name as that appearing on the PHASE card for that segment in the link edit run.

In addition, each argument to be passed to the called program must have an entry in the Linkage Section. Remember, also, that the ENTRY statement should not refer to the program-name. (Use of the program-name will result in incorrect execution.)

When more than one subprogram in the overlay structure requires the same COBOL subroutine, the // EXEC LNKEDT statement must be preceded by INCLUDE cards for each of these subroutines. The names of these subroutines can be determined by requesting LISTX at compile time.

When preparing the control cards for the Linkage Editor, the programmer should be certain to include the assembler language subroutine with the main (root) phase. Also, to achieve maximum overlay, the phase names for the called programs should be different from the names of the called programs specified in the PROGRAM-ID paragraphs. Maximum overlay causes loading of the next phases to start at the same point where the first overlay phase started.

Figure 20 is a flow diagram of the overlay logic. The PHASE cards indicate the beginning address of each phase. The phases OVERLAYC and OVERLAYD will have the same beginning address as OVERLAYB. The sequence of events is:

1. The main program calls the overlay routine.

2. The overlay routine fetches the particular COBOL subprogram and places it in the overlay area.

3. The overlay routine transfers control to the first instruction of the called program.

4. The called program returns to the COBOL calling program (not to the assembler language overlay routine).

If OVERLAYB were known to be in storage, the CALL statement would be:

```
CALL "OVERLAYB" USING PARAM-1, PARAM-2.
```

But when using the assembler language overlay routine (OVRLAY), it becomes:

```
   CALL "OVRLAY" USING PROCESS-LABEL,
     PARM-1, PARM-2.
```

where PROCESS-LABEL contains the external-name OVERLAYB of the called program.

However, the ENTRY statement of the called program is the same for both cases, i.e., ENTRY "OVRLAY1" USING PARAM-1, PARAM-2, whether it is called indirectly by the main program through the overlay program or called directly by the main program.

Note: An ENTRY which is to be called by OVRLAY must precede the first executable statement in the called program.

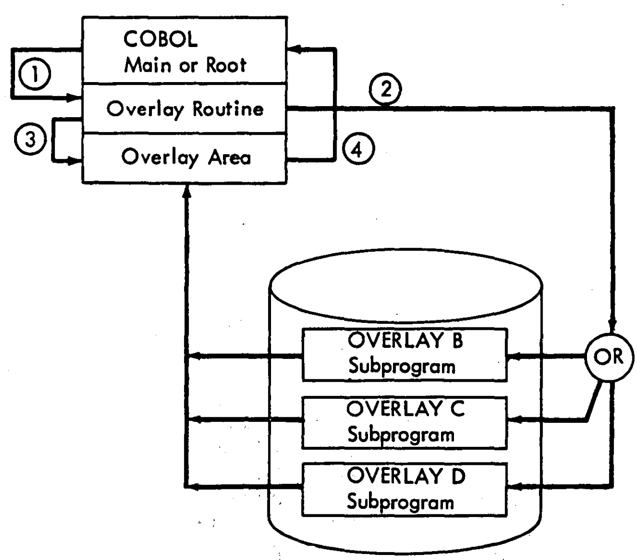

Figure 20. Flow Diagram of Overlay Logic

JOB CONTROL FOR ACCOMPLISHING OVERLAY

The job control statements required to accomplish the overlay illustrated in Figure 20 are shown in Figure 21. The PHASE statements specify to the Linkage Editor that the overlay structure to be established is one in which the called programs OVERLAYB, OVERLAYC, and OVERLAYD overlay each other when called during execution.

Note: The phase name specified in the PHASE card must be the same as the value contained in the first argument for CALL "OVRLAY", i.e., PROCESS-LABEL, COMPUTE-TAX, etc., contain OVERLAYB, OVERLAYC, respectively, which are the names given in the PHASE card.

It is the programmer's responsibility to write the entire overlay, i.e., the COBOL main (or calling) program and an assembler language subroutine (for which a sample program is given in this chapter) that fetches and overlays the called programs. A calling sequence to obtain an overlay structure between three COBOL subprograms is illustrated in Figure 22.

```
// JOB OVERLAYS
// OPTION LINK
   PHASE OVERLAY,ROOT
// EXEC FCOBOL
   {COBOL Source for Main Program MAINLINE}
/*
// EXEC ASSEMBLY
     {Source deck for Assembler Language Routine OVERLAY}
/*
   PHASE OVERLAYB,*
// EXEC FCOBOL
     {COBOL Source for Called Program OVERLAYB}
/*
   PHASE OVERLAYC,OVERLAYB
// EXEC FCOBOL
     {COBOL Source for Called Program OVERLAYC}
/*
   PHASE OVERLAYD,OVERLAYC
// EXEC FCOBOL
     {COBOL Source for Called Program OVERLAYD}
/*
// EXEC LNKEDT
// EXEC
/*
/&
```

Figure 21. Job Control for Accomplishing Overlay

```
COBOL Program Main (Root or Main Program)

IDENTIFICATION DIVISION.
PROGRAM-ID. MAINLINE.
.
.
.
ENVIRONMENT DIVISION.
.
.
.
DATA DIVISION.
.
.
.
WORKING-STORAGE SECTION.
77  PROCESS-LABEL PICTURE IS X(8) VALUE IS "OVERLAYB".
77  PARAM-1 PICTURE IS X.
77  PARAM-2 PICTURE IS XX.
77  COMPUTE-TAX PICTURE IS X(8) VALUE IS "OVERLAYC".

01  NAMET.
    02 EMPLY-NUMB PICTURE IS 9(5).
    02 SALARY PICTURE IS 9(4)V99.
    02 RATE PICTURE IS 9(3)V99.
    02 HOURS-REG PICTURE IS 9(3)V99.
    02 HOURS-OT PICTURE IS 9(2)V99.
01  COMPUTE-SALARY PICTURE IS X(8) VALUE IS "OVERLAYD".
01  NAMES.
    02 RATES PICTURE IS 9(6).
    02 HOURS PICTURE IS 9(3)V99.
    02 SALARYX PICTURE IS 9(2)V99.
.
.
.
PROCEDURE DIVISION.
.
.
.
    CALL "OVRLAY" USING PROCESS-LABEL, PARAM-1, PARAM-2.
.
.
.
    CALL "OVRLAY" USING COMPUTE-TAX, NAMET.
.
.
.
    CALL "OVRLAY" USING COMPUTE-SALARY, NAMES.
.
.
.
```

Figure 22. Calling Sequence to Obtain Overlay Between Three COBOL Subprograms (Part 1 of 3)

```
COBOL Subprogram B

IDENTIFICATION DIVISION.
PROGRAM-ID. OVERLAY1.
.
.
.
ENVIRONMENT DIVISION.
.
.
.
DATA DIVISION.
.
.
LINKAGE SECTION.

01   PARAM-10 PICTURE X.
01   PARAM-20 PICTURE XX.
.
.
.
PROCEDURE DIVISION.
PARA-NAME.   ENTRY "OVRLAY1" USING PARAM-10, PARAM-20.
.
.
.
             GOBACK.


COBOL Subprogram C

IDENTIFICATION DIVISION.
PROGRAM-ID. OVERLAY2.
.
.
.
 ENVIRONMENT DIVISION.
.
.
.
.
DATA DIVISION.
.
.
LINKAGE SECTION.

01   NAMEX.
     02 EMPLY-NUMBX PICTURE IS 9(5).
     02 SALARYX PICTURE IS 9(4) V99.
     02 RATEX PICTURE IS 9(3)V99.
     02 HOURS-REGX   PICTURE IS 9(3)V99.
     02 HOURS-OTX PICTURE IS 9(2)V99.

PROCEDURE DIVISION.
PARA-NAME. ENTRY "OVRLAY2" USING NAMEX.
.
.
.
             GOBACK.
```

Figure 22. Calling Sequence to Obtain Overlay Between Three COBOL Subprograms (Part 2 of 3)

```
COBOL Subprogram D

IDENTIFICATION DIVISION.
PROGRAM-ID. OVERLAY3.
.
.
.
ENVIRONMENT DIVISION.
.
.
.
DATA DIVISION.
.
.
LINKAGE SECTION
01   NAMES.
     02 RATES PICTURE IS 9(6).
     02 HOURS PICTURE IS 9(3)V99.
     02 SALARYX PICTURE IS 9(2)V99.
.
PROCEDURE DIVISION.
PARA-NAME. ENTRY "OVRLAY3" USING NAMES.
.
.
.
           GOBACK.
```

Figure 22. Calling Sequence to Obtain Overlay Between Three COBOL Subprograms (Part 3 of 3)

In order to use the System/360 Disk Operating System Sort/Merge program, Sort Feature statements are written in the COBOL source program. These statements are described in the publication IBM System/360 Disk Operating System: Full American National Standard COBOL. The Sort/Merge program itself is described in the publication IBM System/360 Disk Operating System: Tape and Disk Sort/Merge, Order No. GC28-6676. "Appendix F: System Configuration" in this publication contains information about system requirements when the Sort Feature is used.

Additional job control statements must be included in the execution step of the job to describe the files used by the sort program. These statements are described below in "Sort Job Control Requirements."

Note: The Checkpoint/Restart Feature can be activated during a sorting operation by specifying the RERUN statement.

SORT JOB CONTROL REQUIREMENTS

Three types of files can be defined for the Sort program in the execution job step: input, output, and work.

SORT INPUT AND OUTPUT CONTROL STATEMENTS

When the USING and/or GIVING options are specified, the compiler generates dummy Input and/or Output Procedures. Hence, the job control requirements for files named as operands of USING and GIVING are the same as those for files used as input to or output from the sorting operation in these procedures.

The following job control statements are required for files used as input to or output from the sorting operation:

ASSGN

followed by

VOL
TPLAB

or

VOL
DLAB
XTENT

or

DLBL
EXTENT

or

TLBL

The symbolic unit to which each sort input or output file is assigned in the source language ASSIGN clause is specified in an ASSGN control statement.

Note: ASSGN control statements are required only if the input/output devices used in an application have not been previously assigned the appropriate symbolic names.

If an input file contains standard labels, a TLBL or DLBL (or VOL and TPLAB or VOL and DLAB) statement(s) is required. The symbolic name of the device from which the input file is to be read must also be included on this statement.

One EXTENT (XTENT) control statement is required to define the limits of each area of a mass storage device from which an input file will be read. EXTENT (XTENT) statements must include the symbolic unit name of the device containing the extent.

If the output file is to use standard labels, a TLBL or DLBL (or VOL and TPLAB or VOL and DLAB) statement(s) is required.

One EXTENT (XTENT) control statement must be used to define the limits of each area of a mass storage device onto which the output file is written. The symbolic name of the output unit must appear on this card.

SORT WORK FILE CONTROL STATEMENTS

The Sort program requires at least one mass storage unit or three tape units as an intermediate sort work file. The symbolic units to which this file is assigned must be consecutively numbered beginning with SYS001. Intermediate storage may be assigned on the following devices:

- IBM 2400 Magnetic Tape Units
- IBM 2311 Disk Storage Drive
- IBM 2314 Direct-Access Storage Device

Note: When variable-length or redefined-length records are being sorted, sort work files must not be assigned to 7-track tapes. 7-track tape work files can only be used to sort records whose keys are packed decimal or binary.

Device types may not be mixed; i.e., work units for a particular sort operation must all be of the same type.

If spanned records are being sorted and mass storage devices are being used as sort work files, it is the programmer's responsibility to assign these work files to devices whose track sizes are larger than the logical record sizes of the records being sorted. A spanned record that is larger than the available track size can be sorted by assigning the work files to magnetic tape.

If a work unit is to use standard labels, a TLBL or DLBL (or VOL and TPLAB or VOL and DLAB) control statement(s) is required. The filename entry on these statements must be SORTWK1 through SORTWKn. The symbolic unit names assigned to the work areas to be allocated (SYS001, SYS002, etc.) must appear on these cards.

One EXTENT (XTENT) control statement must be included to define each work area on a mass storage device. The total work area required may be divided into as many as eight extents, which would require eight EXTENT (XTENT) control statements. Symbolic unit names on these statements must be in consecutive order, (SYS001, SYS002, etc.).

Amount of Intermediate Storage Required

When intermediate storage is assigned on a mass storage unit, at least twice the amount required to hold all input records should be assigned. This area may consist of from one to eight extents, and the extents may be assigned on no more than eight devices.

If tape intermediate storage is used, at least the minumum number of units (three) must be assigned. The input file can be as large as the number of records that can be written on one full reel of tape. Assigning more than three intermediate storage tape drives does not increase the maximum input file size, but does improve performance.

Improving Performance

Performance increases significantly if 50K is available for execution of the Sort program. At the 100K level, the performance is very high. If no core is available, the Sort/Merge program will issue a message:

7054A "INSUFFICIENT CORE"

SORT DIAGNOSTIC MESSAGES

The messages generated by the Sort Feature are listed in the publication IBM System/360 Disk Operating System: Tape and Disk Sort/Merge, Order No. GC28-6676.

LINKAGE WITH THE SORT FEATURE

To initiate a sort operation, the COBOL object program includes the object time subroutine ILBDSRT0 and transfers control to it.

If the INPUT PROCEDURE option of the SORT statement is specified in the source program, exit E15 of the Sort/Merge program is used. At this exit, the record released by the programmer is passed to the Sort/Merge program. Since a dummy Input Procedure will be generated by the compiler when the USING option is specified, records in the USING file are also passed to the Sort/Merge program at exit E15.

If the OUTPUT PROCEDURE option of the SORT statement is specified, exit E35 of the Sort/Merge program is used. At this exit, the record returned by the Sort/Merge program is passed to the programmer. Since a dummy Output Procedure is generated by the compiler when the GIVING option is specified, records are also returned at exit E35 and written on this file.

Completion Codes

The Sort/Merge program returns a completion code upon termination and this code is stored in the COBOL special register SORT-RETURN. The codes are:

0 -- Successful completion of Sort/Merge

16 -- Unsuccessful completion of Sort/Merge

Successful Completion: When a Sort/Merge application has been successfully executed, a completion code of zero is returned and the sort operation terminates.

Unsuccessful Completion: If the Sort program encounters an error during execution that will not allow it to complete successfully, it returns a completion code of 16 and terminates. (A possible error is an uncorrectable input/output error.) The publication IBM System/360 Disk Operating System: Tape and Disk Sort/Merge, Order No. GC28-6676 contains a detailed description of the conditions under which this termination will occur.

The programmer may test the SORT-RETURN register for successful termination of the sort operation, as shown in the following example:

```
SORT SALES-RECORDS ON ASCENDING KEY,
CUSTOMER-NUMBER, DESCENDING KEY DATE,
USING FN-1, GIVING FN-2.  IF
SORT-RETURN NOT EQUAL TO ZERO, DISPLAY
"SORT UNSUCCESSFUL" UPON CONSOLE, STOP
RUN.
```

Cataloging a Sort Program

When the CATAL option is used to catalog a sort program, the following should be observed:

- To avoid duplicate names when selecting a catalog name for his program, the programmer must be aware of the naming convention used by the compiler to generate the name of the dummy phase into which the phases of the Sort/Merge program will subsequently be loaded.

Naming Convention: The compiler generates the phase card for the dummy phase using the following convention:

- If the PROGRAM-ID name is 6, 7, or 8 characters in length, the dummy phase name consists of the first 6 characters plus 2 zero characters.
- If the PROGRAM-ID name is less than 6 characters in length, the name is padded with zeros to 8 characters.
- Since the system expects the first character of PROGRAM-ID to be alphabetic, the first character, if numeric, is converted as follows:

  0 -> J
  1-9 -> A-I

  The hyphen is converted to zero if it appears as the second through eighth character.

CHECKPOINT/RESTART DURING A SORT

The Checkpoint/Restart Feature is available to the programmer using the COBOL SORT statement. The programmer uses the RERUN clause to specify that checkpoints should be taken during program execution. The control statement requirements for taking a checkpoint are discussed in the chapter "Program Checkout."

The system-name specified in the RERUN clause as the sort checkpoint device must not be the same as any system-name used in the source language ASSIGN clause, but follows the same rules of formation.

The RERUN clause is fully described in the publication IBM System/360 Disk Operating System: Full American National Standard COBOL.

USING SORT IN A MULTIPHASE ENVIRONMENT

When the Sort program is invoked in a multiphase environment, the following should be noted:

1. It is the programmer's responsibility to ensure that the COBOL program containing the SORT statement is the highest phase in core.

2. If two programs are compiled, link edited, and executed together, only one program may use the Sort feature. If both programs require Sort, the programs can be compiled separately and then the decks must be organized so that the dummy phase cards for Sort are both together at the end of the deck before they are link edited and executed.

Note: A technique for effective utilization of core storage when the SORT verb is used in a segmented program can be found in the chapter "Programming Techniques."

COBOL segmentation is a facility that provides a means of accomplishing object time overlay as a result of specifications made at the source language level. Segmentation will allow the programmer to divide the Procedure Division of a source program into sections. Through the use of a system of priority numbers, certain sections are designated as permanently resident in core storage and other sections as overlayable fixed segments and/or independent segments. Thus, a large program can be executed in a defined area of core storage by limiting the number of segments in the program that are permanently resident in core.

If there is a limit on the amount of core available, the program SAVECORE could be segmented as illustrated in Figure 23.

```
IDENTIFICATION DIVISION.

PROGRAM-ID. SAVECORE.
.
.
ENVIRONMENT DIVISION.

OBJECT-COMPUTER. IBM-360-50
     SEGMENT-LIMIT IS 15.
.
.
DATA DIVISION.
.
.
PROCEDURE DIVISION.
SECTION-1  SECTION 8.
.
.
SECTION-2  SECTION 8.
.
.
SECTION-3  SECTION 16.
.
.
SECTION-4  SECTION 8.
.
.
SECTION-5  SECTION 50.
.
.
SECTION-6  SECTION 16.
.
.
SECTION-7  SECTION 50.
.
.
```

Figure 23. Segmenting the Program SAVECORE

Assuming that 12K is available for the program SAVECORE, Figure 24 shows the manner in which core storage would be utilized. It is apparent from the illustration that SECTION-3, SECTION-6, and SECTION-7 cannot be in core at the same time, nor can SECTION-3, SECTION-5 and SECTION-7 be in core simultaneously.

Sections in the permanent segment (SECTION-1, SECTION-2, and SECTION-4) are those which must be available for reference at all times, or which are referenced frequently. They are distinguished here by the fact that they have been assigned priority numbers less than the segment limit.

Sections in the overlayable fixed segment are sections which are less frequently used. They are always made available in the state they were in when last used. They are distinguishable here by the fact that they have been assigned priority numbers greater than the segment limit but less than 49.

Sections in the independent segment can overlay, and be overlaid by, either an overlayable fixed segment or another independent segment. Independent segments are those assigned priority numbers greater than 49 and less than 100, and they are always given control in their initial state.

OPERATION

Execution of the object program begins in the root segment. The first segment in the permanent segment is considered the root segment. If the program does not contain a permanent segment, the compiler generates a dummy segment which will initiate the execution of the first overlayable or independent segment. All global tables, literals, and data areas are part of the root segment. Called object time subroutines are also part of the root segment. When CALL statements appear in a segmented program, subprograms are loaded with the fixed portion of the main program as if they had a priority of zero.

Segmented programs must not be called by another program (segmented or not segmented). If a segmented program calls a subprogram, the CALL statement may appear in any segment. However, the object module associated with the subprogram must be included in the root segment prior to the execution of the main program. This can be accomplished in several ways. Following are two examples:

1. Produce object decks for both programs and place the one for the subprogram in the root segment:

   PHASE,ROOT

   {object deck for the root segment}

   {object deck for the subprogram}

   PHASE,*

   {object deck for the overlay segment}
   .
   .
   .
   followed by a // EXEC LNKEDT and a // EXEC.

2. Catalog the object module for the subprogram in the relocatable library prior to link editing the main program. Insert an INCLUDE card for the subprogram and an ENTRY card for the root phase into the linkage editor control cards for the root phase of the main program. The Linkage Editor will search the relocatable library for the subprogram and include it with the root phase. The ENTRY card will cause the Linkage Editor to pass control to the main program at execution time.

OUTPUT FROM A SEGMENTED PROGRAM

COMPILER OUTPUT

The output produced by the compiler is an overlay structure consisting of multiple object modules preceded by linkage editor control statements. Segments whose priority is greater than the segment limit (or 49, if no SEGMENT-LIMIT clause is specified) consist of executable instructions only.

The compiler generates each segment as a separate object module preceded by a PHASE card. The names appearing on these PHASE cards (segment-names) conform to the following naming conventions:

1. The name of the root segment is the same as the program-name specified in the PROGRAM-ID clause.

2. The name of each overlayable and independent segment is a combination of the program-name and the priority

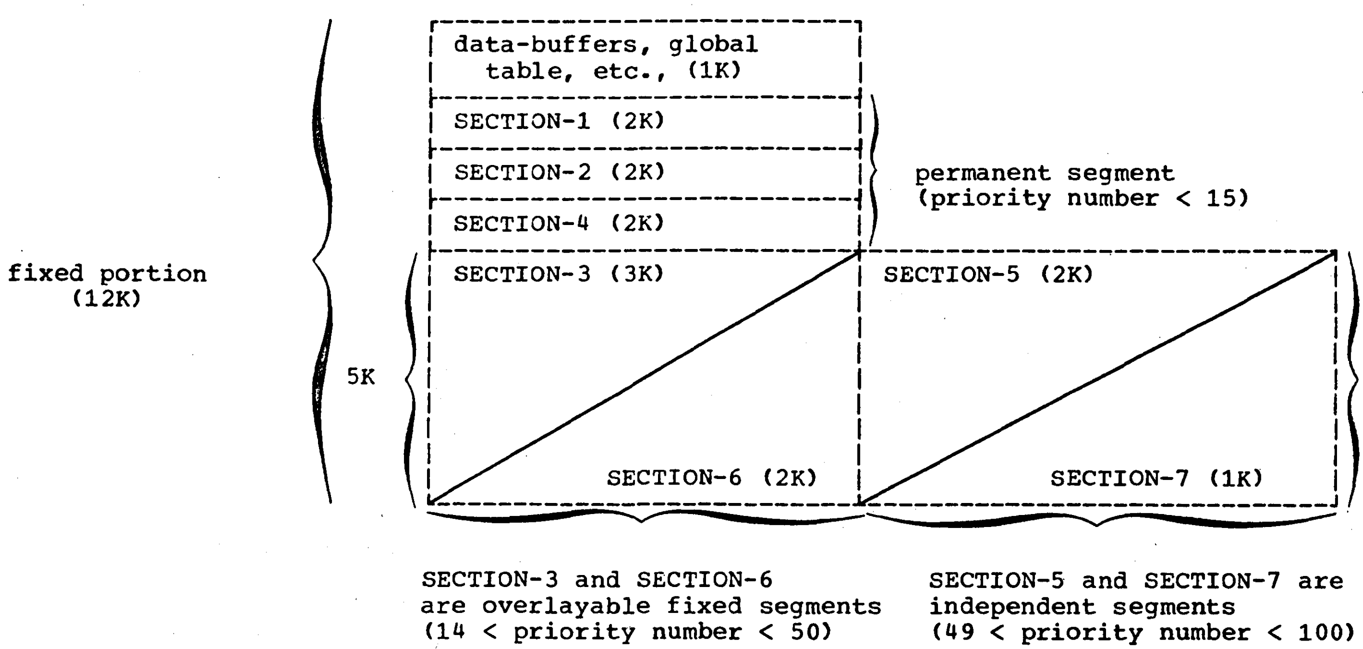

Figure 24. Storage Layout for SAVECORE

number of the segment. These names are formed according to the following rules:

a. If the program-name is 6, 7, or 8 characters in length, the segment-name consists of the first 6 characters of program-name plus the 2-character priority number.

b. If the program-name is less than 6 characters in length, the priority number is appended after the program-name.

c. Since the system expects the first character of PROGRAM-ID to be alphabetic, the first character, if numeric, is converted as follows:

```
0   -> J
1-9 -> A-I
```

The hyphen is converted to zero if it appears as the second through eighth character.

Note: Single-digit priority numbers are preceded by a zero.

Warning: In order to avoid duplicate names, the programmer must be aware of the above naming conventions. If the last two characters of an 8-character PROGRAM-ID are numeric, these same two characters may not appear in the source program as a segment number.

Figure 25 is an illustration of the compiler output for the skeleton program shown in Figure 23.

```
PHASE SAVECORE,ROOT

 {object module for the root segment
  (sections with priority-numbers less
  than the segment limit) including any
  programs called by SAVECORE}


PHASE SAVECO16,*

 {object module for segments with a
  priority of 16 (two sections)}


PHASE SAVECO50,SAVECO16

 {object module for segments with a
  priority of 50 (two sections)}
```

Figure 25. Compiler Output for SAVECORE

LINKAGE EDITOR OUTPUT

Figure 26 is an illustration of the input to the Linkage Editor and the phase map produced by the Linkage Editor resulting from the compilation and editing of the segmented program BIGJOB. The following text is an explanation of the figure.

1 PHASE card generated by the compiler for the root segment BIGJOB.

2 AUTOLINK card for the Segmentation subroutine.

3 PHASE cards generated by the compiler for segments of priority 10, 47-50, 60, 62, and 63.

4 Control cards generated for the Sort Feature. These cards are explained in "Sort in a Segmented Program".

5 Location of the entry point CURSEGM. Item 6 is explained in "Determining the Priority of the Last Segment Loaded into the Transient Area".

6 Load address of phase BIGJOB00. Item 6 is explained in "Sort in a Segmented Program."

Note: If the CATALR option of the CBL card is specified, the compiler generates CATALR cards in front of PHASE cards.

Cataloging a Segmented Program

When the CATAL option is used to catalog a segmented program, the following points should be observed:

1. To avoid duplicate names, the programmer must be aware of the naming conventions used by the compiler (see "Compiler Output") because a segment-name may be at the same as a phase-name already existing in the core image library.

2. Since the PHASE card is generated by the compiler, the user must not specify a PHASE card for the program.

To invoke a previously cataloged segmented program, the programmer must use the following control statement:

```
// EXEC name
```

where name is the program-name specified in the PROGRAM-ID clause.

Determining the Priority of the Last Segment Loaded into the Transient Area

If a segmented program is abnormally terminated during execution, the priority of the last segment loaded into the transient area can be determined as follows:

1. In the map of main storage generated by the Linkage Editor, under the column LABEL, look for the name 'CURSEGM' (see item 5 in Figure 26).

2. Associated with this label, in the column LOADED, is an address.

3. At this location is stored the priority (one byte) of the segment current in the transient area. If this byte is X'00', no segment has been loaded into the transient area. This indicates that the error causing the dump occurred in the root segment.

USING THE PERFORM STATEMENT IN A SEGMENTED PROGRAM

When the PERFORM statement is used in a segmented program, the programmer should be aware of the following:

- A PERFORM statement that appears in a section whose priority-number is less than the segment limit can have within its range only (1) sections with priority-numbers less than 50, and (2) sections wholly contained in a single segment whose priority-number is greater than 49.

  Note: As an extension to American National Standard COBOL, the DOS Full American National Standard COBOL Compiler allows sections with any priority-number to fall within the range of a PERFORM statement.

- A PERFORM statement that appears in a section whose priority-number is equal to or greater than the segment limit can have within its range only (1) sections with the same priority-number as the section containing the PERFORM statement, and (2) sections with priority-numbers that are less than the segment limit.

  Note: As an extension to American National Standard COBOL, the DOS Full American National Standard COBOL Compiler allows sections with any priority-number to fall within the range of a PERFORM statement.

- When a procedure-name in a segment with a priority-number less than the segment limit is referred to by a PERFORM statement in a segment with a priority-number greater than the segment limit, the independent segment will be reinitialized upon exit from the PERFORM statement.

SORT IN A SEGMENTED PROGRAM

If a segmented program contains a SORT statement, the sort program will be loaded above the largest overlayable or independent segment as shown in Figure 27.

The compiler accomplishes this by providing the following two control statements at the end of the overlay structure:

```
PHASE BIGJOB00,transient area + L

INCLUDE ILBDDUM0
```

These cards are illustrated in Figure 26, item 4. The value of "L" in the figure is X'002F2' which is the length of the longest segment, BIGJOB47, rounded to the next halfword boundary. Note that Linkage Editor relocates the phase BIGJOB00 to the next doubleword boundary (see Figure 26, item 6).

Note: A technique for effective utilization of core storage when a segmented program uses the Sort Feature can be found in the chapter "Programming Techniques."

```
JOB  BIGJ                    DISK LINKAGE EDITOR DIAGNOSTIC OF INPUT

ACTION TAKEN       MAP

LIST    PHASE   BIGJOB,ROOT  <-- 1
.
.
.
LIST    AUTOLINK      ILBDSEM0  <-- 2
LIST    AUTOLINK      ILBDSRT0
.
.
LIST    PHASE BIGJOB10,*
LIST    PHASE BIGJOB47,BIGJOB10 )
LIST    PHASE BIGJOB48,BIGJOB47 )
LIST    PHASE BIGJOB49,BIGJOB48 )
LIST    PHASE BIGJOB50,BIGJOB49 )  <-- 3
LIST    PHASE BIGJOB60,BIGJOB50 )
LIST    PHASE BIGJOB62,BIGJOB60 )
LIST    PHASE BIGJOB63,BIGJOB62 )
LIST    PHASE BIGJOB00,BIGJOB63+X'002F2' }
LIST    INCLUDE ILBDDUM0                 }  <-- 4

        PHASE     XFR-AD  LOCORE  HICORE  DSK-AD    ESD TYPE  LABEL     LOADED  REL-FR

ROOT  BIGJOB      003000  003000  0075A3  64 04 1   CSECT     BIGJOB    003000  003000
                                                      .
                                                      .
                                                      .
                                                    CSECT     ILBDSEM0  006268  006268
                                                    *  ENTRY  CURSEGM   00637D  <-- 5
                                                    CSECT     ILBDSRT0  006B38  006B38
                                                      .
                                                      .
                                                      .
      BIGJOB10    0075A8  0075A8  0075E9  64 09 2   CSECT     BIGJOB10  0075A8  0075A8
      BIGJOB47    0075A8  0075A8  007899  65 00 1   CSECT     BIGJOB47  0075A8  0075A8
      BIGJOB48    0075A8  0075A8  0075DB  65 00 2   CSECT     BIGJOB48  0075A8  0075A8
      BIGJOB49    0075A8  0075A8  0075D3  65 01 1   CSECT     BIGJOB49  0075A8  0075A8
      BIGJOB50    0075A8  0075A8  0075F1  65 01 2   CSECT     BIGJOB50  0075A8  0075A8
      BIGJOB60    0075A8  0075A8  0076ED  65 02 1   CSECT     BIGJOB60  0075A8  0075A8
      BIGJOB62    0075A8  0075A8  0075D1  65 02 2   CSECT     BIGJOB62  0075A8  0075A8
      BIGJOB63    0075A8  0075A8  007621  65 03 1   CSECT     BIGJOB63  0075A8  0075A8
      BIGJOB00    0078A0  0078A0  0078A1  65 03 2   CSECT     ILBDDUM0  0078A0  0078A0  6
```

Figure 26. Link Editing a Segmented Program

```
          +--------------+
          |     ROOT     |  Including COBOL subroutines and called programs
          +--------------+
        { |  TRANSIENT   |
      L { |    AREA      |  Overlayable and independent segments
        { |              |
          +--------------+
          | SORT PROGRAM |
          +--------------+

  L = length of the largest segment in bytes.
```

Figure 27. Location of Sort Program in a Segmentation Structure

PART II

- PROCESSING COBOL FILES ON MASS STORAGE DEVICES
- ADVANCED PROCESSING CAPABILITIES
- RECORD FORMATS
- PROGRAMMING TECHNIQUES

A mass storage device is one on which records can be stored in such a way that the location of any one record can be determined without extensive searching. Records can be accessed directly rather than serially.

The recording surface of a mass storage device is divided into many tracks. A track is defined as a circumference of the recording surface. The number of tracks per recording surface and the capacity of a track for each device are shown in Table 8.

Table 8. Recording Capacities of Mass Storage Devices

Device	Capacity
2311	200 tracks per surface; 3625 bytes per track.
2314	200 tracks per surface; 7294 bytes per track.
2321	100 tracks per strip; 2000 bytes per track.

Each device has some type of access mechanism through which data is transferred to and from the device. The mechanisms are different for each device, but each mechanism contains a number of read/write heads that transfer data as the recording surfaces rotate past them. Only one head can transfer data (either reading or writing) at a time.

FILE ORGANIZATION

Records in a file must be logically organized so that they can be retrieved efficiently for processing. Three methods of organization for mass storage devices are supported by the Disk Operating System Full American National Standard COBOL compiler: sequential, direct, and indexed.

SEQUENTIAL ORGANIZATION

In a sequential file, records are organized solely on the basis of their successive physical location in the file. The records are read or updated in the same order in which they appear. Individual records cannot be located quickly. Records usually cannot be deleted or added unless the entire file is rewritten. This organization is used when most of the records in the file are processed each time the file is used.

DIRECT ORGANIZATION

A file with direct organization is characterized by some predictable relationship between the key of a record and the address of that record on a mass storage device. This relationship is established by the programmer.

Direct organization is generally used for files where the time required to locate individual records must be kept to an absolute minimum, or for files whose characteristics do not permit the use of sequential or indexed organization.

This organization method has considerable flexibility. The accompanying disadvantage is that although the Disk Operating System provides the routines to read or write a file of this type, the programmer is largely responsible for the logic and programming required to locate the key of a record and its address on a mass storage device.

INDEXED ORGANIZATION

An indexed file is similar to a sequential file in that rapid sequential processing is possible. The indexes associated with an indexed file also allow quick retrieval of individual records through random access. Moreover, a separate area of the file is set aside for additions; this eliminates the need to rewrite the entire file when adding records, a process that would usually be necessary with a sequentially organized file. Although the added records are not physically in key sequence, the indexes are constructed in such a way that the added records can be quickly retrieved in key sequence, thus making rapid sequential access possible.

In this method of organization, the Disk Operating System has control over the location of the individual records. Since the characteristics of the file are known, most of the mechanics of locating a particular record are handled by the system.

DATA MANAGEMENT CONCEPTS

The data management facilities of the Disk Operating System are provided by a group of routines that are collectively referred to as the Input/Output Control System (IOCS). A distinction is made between two types of routines:

1. Physical IOCS (PIOCS) -- the physical input/output routines included in the Supervisor. PIOCS is used by all programs run within the system. It includes facilities for scheduling input/output operations, checking for and handling error conditions related to input/output devices, and handling input/output interruptions to maintain maximum input/output speeds without burdening the programmer's problem program.

2. Logical IOCS (LIOCS) -- the logical input/output routines linked with the programmer's problem program. These routines provide an interface between the programmer's file processing routines and the PIOCS routines.

   LIOCS performs those functions that a programmer needs to locate and access a logical record for processing. A logical record is one unit of information in a file of similar units, for example, one employee's record in a master payroll file, one part-number record in an inventory file, or one customer account record in an account file. One or more logical records may be included in one physical record. LIOCS refers to the routines that perform the following functions:

   a. Blocking and deblocking records

   b. Switching between input/output areas when two areas are specified for a file

   c. Handling end-of-file and end-of-volume conditions

   d. Checking and writing labels

A brief description of functions performed by LIOCS and their relationship to a COBOL program follows.

Whenever COBOL imperative-statements (READ, WRITE, REWRITE, etc.) are used in a program to control the input/output of records in a file, that file must be defined by a DTF (Define The File). A DTF is created for each file opened in a COBOL program from information specified in the Environment Division, FD entry, and input/output statements in the source program. The DTF for each file is part of the object module that is generated by the compiler. It describes the characteristics of the logical file, indicates the type of processing to be used for the file, and specifies the main storage areas and routines used for the file.

One of the constants in the DTF table is the address of a logic module that is to be used at execution time to process that file. A logic module contains the coding necessary to perform data management functions required by the file such as blocking and deblocking, initiating label checking, etc.

Generally, these logic modules are assembled separately and cataloged in the relocatable library under a standard name. At link editing time, the Linkage Editor searches the relocatable library using the virtual reference to locate the logic module. The logic module is then included as part of the program phase. Note that since the Autolink feature of the Linkage Editor is responsible for including the logic modules, the COBOL programmer need not specify any INCLUDE statements.

The type of DTF table prepared by the compiler depends on the organization of the file and the device to which it is assigned. The DTF's used for processing files assigned to mass storage devices are as follows:

DTFSD -- Sequential organization, sequential access

DTFDA -- Direct organization, sequential or random access

DTFIS -- Indexed organization, sequential or random access

The remainder of this chapter provides information about preparing programs which process files assigned to mass storage devices. Included are general descriptions of the organization, the COBOL statements that must be specified in order to build the correct DTF tables, and coding examples.

SEQUENTIAL ORGANIZATION (DTFSD)

In a sequential file on a mass storage device, records are written one after another -- track by track, cylinder by cylinder -- at successively higher addresses.

Records may be fixed-length, spanned, or variable-length, blocked or unblocked, or undefined. Since the file is always accessed sequentially, it is not formatted with keys.

Processing a sequentially organized file for selected records is inefficient. If it is done infrequently, the time spent in locating the records is not significant. The slowest way is to read the records sequentially until the desired one is located. On the average, half of the file must be read to locate one record.

Additions and deletions require a complete rewrite of a sequentially organized file on a mass storage device. Sequential organization is used on mass storage devices primarily for tables and intermediate storage rather than for master files.

Sequentially organized files formatted with keys cannot be created using DTFSD. DTFDA may be used to create and access (sequentially or randomly) such files.

PROCESSING A SEQUENTIALLY ORGANIZED FILE

To create, retrieve, or update a DTFSD file, the following specifications should be made in the source program:

ENVIRONMENT DIVISION

Required clauses:

SELECT [OPTIONAL] file-name

$$\text{ASSIGN TO SYSnnn-}\left\{\begin{matrix}\text{UT}\\ \\ \text{DA}\end{matrix}\right\}\text{-}\left\{\begin{matrix}\text{2311}\\ \text{2314}\\ \text{2321}\end{matrix}\right\}\text{-S}$$

Optional clauses:

RESERVE Clause
FILE-LIMIT Clause
ACCESS MODE IS SEQUENTIAL
PROCESSING MODE IS SEQUENTIAL
RERUN Clause
SAME Clause
APPLY WRITE-ONLY Clause (create only)
APPLY WRITE-VERIFY Clause (create or update only)

Invalid clauses:

ACCESS MODE IS RANDOM
ACTUAL KEY Clause
NOMINAL KEY Clause
RECORD KEY Clause
TRACK-AREA Clause
MULTIPLE FILE TAPE Clause
APPLY EXTENDED-SEARCH Clause
APPLY CYL-OVERFLOW Clause

$$\text{APPLY}\left\{\begin{matrix}\text{MASTER-INDEX}\\ \\ \text{CYL-INDEX}\end{matrix}\right\}\text{ Clause}$$

APPLY CORE-INDEX Clause

DTFSD files may be opened as INPUT, OUTPUT, or I-O. When creating such a file, an INVALID KEY condition occurs when the file limit has been reached and an attempt is made to place another record on the mass storage device. The file limit is determined from the XTENT or EXTENT control statements.

When a DTFSD file is opened as OUTPUT, each WRITE statement signifies the creation of a new record. When opened as I-O, each WRITE statement signifies that the record just read is to be rewritten.

DIRECT ORGANIZATION (DTFDA)

With direct organization, there is a definite relationship beteween the key of a record and its address. This relationship permits rapid access to any record if the file is carefully organized. The programmer develops a record address that ranges from zero to some maximum by converting a particular field in each record to a track address. Each byte in the address is a binary number. To reference a particular record, the programmer must supply both the track address and the identifier that makes each record unique on its track. Both the track address and the identifier are supplied by the programmer in the ACTUAL KEY clause. This will be discussed in detail later in this chapter.

With direct organization, records may be fixed length, spanned or undefined. The records must be unblocked. R0 (record zero) of each track is used as a capacity record. It contains the address of the last record written on the track, and is used by the system to determine whether a new record will fit on the track. The capacity records are updated by the system as records are added to the file. The capacity records do not account for deletions: as far as the system is concerned, once a track is full it remains full (even if the programmer deletes records) until the file is reorganized.

Often, more records are converted to a given track address than will actually fit on the track. These surplus records are known as overflow records and are usually written into a separate area known as an overflow area.

As already noted, the programmer has an unlimited choice in deciding where records are to be located in a directly organized file. The logic and programming are his responsibility.

When creating or making additions to the file, the programmer must specify the location for a record (track address) and the identifier that makes each record on the track unique. If there is space on the track, the system writes the record and updates the capacity record. If the specified track is full, a standard error condition occurs, and the programmer may specify another track address in his USE AFTER STANDARD ERROR declarative routine.

In the case of one maximum size record per track (when spanned records are not specified), the data length plus the length of the symbolic key cannot exceed the following values:

2311 -- 3605 bytes
2314 -- 7249 bytes
2321 -- 1984 bytes

When reading or updating the file, the programmer must supply the track address and the unique identifier on the track for the specific record being sought. The system locates the track and searches that track for the record with the specified identifier. If the record is not found, COBOL indicates this to the programmer by raising an INVALID KEY condition. Only the track specified by the programmer is searched. If, however, the APPLY EXTENDED-SEARCH clause has been specified for the file, the entire cylinder is searched for the desired record. In this case, the INVALID KEY condition arises only if the record cannot be found on the cylinder. To ensure file integrity, the upper limit of each extent of a file using EXTENDED-SEARCH must be the last track of a cylinder.

Error recovery from a DTFDA file is described in detail in the chapter "Advanced Processing Capabilities."

ACCESSING A DIRECTLY ORGANIZED FILE

A directly organized file (DTFDA) may be accessed either sequentially or randomly.

ACCESSING A DIRECTLY ORGANIZED FILE SEQUENTIALLY: When reading a direct file sequentially, records are retrieved in logical sequence; this logical sequence corresponds exactly to the physical sequence of the records. To retrieve a DTFDA file sequentially, the following specifications are made in the source program:

ENVIRONMENT DIVISION

Required clauses:

SELECT [OPTIONAL] file-name

$$\text{ASSIGN TO SYSnnn-DA-}\left\{\begin{matrix}2311\\2321\\2314\end{matrix}\right\}\text{-}\left\{\begin{matrix}A\\D\end{matrix}\right\}$$

Optional clauses:

FILE-LIMIT Clause
ACCESS MODE IS SEQUENTIAL
PROCESSING MODE IS SEQUENTIAL
ACTUAL KEY Clause
RERUN Clause
SAME Clause

Invalid clauses:

RESERVE Clause
ACCESS MODE IS RANDOM
NOMINAL KEY Clause
RECORD KEY Clause
TRACK-AREA Clause
MULTIPLE FILE TAPE Clause
APPLY WRITE-ONLY Clause
APPLY CYL-OVERFLOW Clause
APPLY EXTENDED- SEARCH Clause
APPLY WRITE-VERIFY Clause

$$\text{APPLY}\left\{\begin{matrix}\text{MASTER-INDEX}\\\text{CYL-INDEX}\end{matrix}\right\}\text{Clause}$$

APPLY CORE-INDEX Clause

When DTFDA records are retrieved sequentially, the file may be opened only as INPUT. The AT END condition occurs when the last record has been read and execution of another READ is attempted.

Note that in the ASSIGN clause, an A must be specified for files with actual track addressing, and a D must be specified for files with relative track addressing.

ACCESSING A DIRECTLY ORGANIZED FILE RANDOMLY: To create a directly organized file randomly, the following specifications are made in the source program:

ENVIRONMENT DIVISION

Required clauses:

SELECT file-name

ASSIGN TO SYSnnn-DA- $\left\{\begin{matrix}2311\\2321\\2314\end{matrix}\right\}$ - $\left\{\begin{matrix}A\\D\end{matrix}\right\}$

ACCESS MODE IS RANDOM
ACTUAL KEY Clause

Optional clauses:

FILE-LIMIT Clause
PROCESSING MODE IS SEQUENTIAL
RERUN Clause
SAME Clause
APPLY WRITE-VERIFY Clause

Invalid clauses:

RESERVE Clause
ACCESS MODE IS SEQUENTIAL
NOMINAL KEY Clause
RECORD KEY Clause
TRACK-AREA Clause
MULTIPLE FILE TAPE Clause
APPLY WRITE-ONLY Clause
APPLY EXTENDED-SEARCH Clause
APPLY WRITE-VERIFY Clause
APPLY CYL-OVERFLOW Clause

APPLY $\left\{\begin{matrix}\text{MASTER-INDEX}\\\text{CYL-INDEX}\end{matrix}\right\}$ Clause

APPLY CORE-INDEX Clause

Note that in the ASSIGN clause, an A must be specified for files with actual track addressing, and a D must be specified for files with relative track addressing.

To retrieve or update a directly organized file randomly, the following specifications must be made in the source program.

ENVIRONMENT DIVISION

Required clauses:

SELECT file-name

ASSIGN TO SYSnnn-DA- $\left\{\begin{matrix}2311\\2314\\2321\end{matrix}\right\}$ - $\left\{\begin{matrix}A\\D\\U\\W\end{matrix}\right\}$

ACCESS MODE IS RANDOM
ACTUAL KEY Clause

Note that in the ASSIGN clause an A must be specified for files with actual track addressing, a D must be specified for files with relative track addressing, a U must be specified for files with actual track addressing when the REWRITE statement is used, and W must be specified for files with relative track addressing when the REWRITE statement is used.

The optional and invalid clauses are the same as those specified previously for creating a directly organized file.

Exception: APPLY EXTENDED-SEARCH is optional when retrieving or updating a directly organized file randomly.

ACTUAL KEY CLAUSE

Note that the ACTUAL KEY clause is required for DTFDA files when ACCESS IS RANDOM, is optional for DTFDA files when ACCESS IS SEQUENTIAL, and is not used for DTFSD files.

The actual key consists of two components. One component expresses the track address at which the record is to be placed for an output operation, or at which the search is to begin for an input operation. The track address can be expressed either as an actual address or as a relative address, depending upon the addressing scheme chosen when the file was created. The other component is associated with the record itself and serves as its unique identifier. The structures of both actual keys are shown in Figure 28.

	Actual Key	
	Actual Track Address	Record Identifier
Byte	1 8	9 263

	Actual Key	
	Relative Track Address	Record Identifier
Byte	1 4	5 258

Figure 28. Structures of the Actual Key

	Pack	Cell		Cylinder		Head		Record
	M	B	B	C	C	H	H	R
Byte / Device	0	1	2	3	4	5	6	7
2311	0-221	0	0	0	0-199	0	0-9	0-255
2314	0-221	0	0	0	0-199	0	0-19	0-255
2321	0-221	0	0-9	0-19	0-9	0-4	0-19	0-255

Figure 29. Permissible Specifications for the First Eight Bytes of the Actual Key

The format of the ACTUAL KEY clause is:

ACTUAL KEY IS data-name

When actual track addressing is used, data-name may be any fixed item from 9 through 263 bytes in length. It must be defined in the Working-Storage, File, or Linkage Section. The first eight bytes are used to specify the actual track address. The structure of these bytes and permissible specifications for the 2311, 2314, and 2321 mass storage devices are shown in Figure 29. The programmer may select from 1 to 255 bytes for the record identifier portion of the actual key field.

When relative track addressing is used, data-name may be any fixed item from 5 through 258 bytes in length. It must be defined in the File Section, the Working-Storage Section, or the Linkage Section. The first four bytes of data-name are the track identifier. The identifier is used to specify the relative track address for the record and must be defined as an 8-integer binary data item whose maximum value does not exceed 16,777,215. The remainder of data-name, which is 1 through 254 bytes in length, is the record identifier. It represents the symbolic portion of the key field used to identify a particular record on a track.

For a complete discussion of the ACTUAL KEY clause, see the publication IBM System/360 Disk Operating System: Full American National Standard COBOL.

Randomizing Techniques

One method of determining the value of the track address portion of the field defined in the ACTUAL KEY clause is referred to as indirect addressing. Indirect addressing generally is used when the range of keys for a file includes a high percentage of unused values. For example, employee numbers may range from 000001 to 009999, but only 3000 of the possible 9999 numbers are currently assigned. Indirect addressing is also used for nonnumeric keys. Key, in this discussion, refers to that field of the record being written that will be converted to the track address portion.

Indirect addressing signifies that the key is converted to a value for the actual track address by using some algorithm intended to limit the range of addresses. Such an algorithm is called a randomizing technique. Randomizing techniques need not produce a unique address for every record and, in fact, such techniques usually produce synonyms. Synonyms are records whose keys randomize to the same address.

Two objectives must be considered in selecting a randomizing technique:

1. Every possible key in the file must randomize to an address within the designated range.

2. The addresses should be distributed evenly across the range so that there are as few synonyms as possible.

Note that one way to minimize synonyms is to allocate more space for the file than is actually required to contain all the records. For example, the percentage of locations that are actually used might be 80% to 85% of the allocated space.

When actual track addressing is used, the first eight bytes of the ACTUAL KEY field can be thought of as a "discontinuous binary address." This is significant to the programmer because he must keep two considerations in mind. First, the cylinder and head number must be in binary notation, so the results of the randomizing formula must be in binary format. Second, the address is "discontinuous" since a mathematical overflow from one element (e.g., head number) does not increment the adjacent element (e.g., cylinder number).

DIVISION/REMAINDER METHOD: One of the simplest ways to indirectly address a directly organized file is by using the division/remainder method. (For a discussion of other randomizing techniques, see the publication Introduction to IBM System/360 Direct Access Storage Devices and Organization Methods, Order No. GC20-1649.)

1. Determine the amount of locations required to contain the data file. Include a packing factor for additional space to eliminate synonyms. The packing factor should be approximately 20% of the total space allocated to contain the data file.

2. Select, from the prime number table, the nearest prime number that is less than the total of step 1. A prime number is a number divisible only by itself and the integer 1. Table 9 is a partial list of prime numbers.

3. Clear any zones from the first eight bytes of the actual key field. This can be accomplished by moving the key to a field described as COMPUTATIONAL.

4. Divide the key by the prime number selected.

5. Ignore the quotient; utilize the remainder as the relative location within the data file.

6. (For actual track addressing only) Locate the beginning of the space available and manipulate the relative address, to the actual device address if necessary.

For example, assume that a company is planning to create an inventory file on a 2311 disk storage device. There are 8000 different inventory parts, each identified by an 8-character part number. Using a 20% packing factor, 10,000 record positions are allocated to store the data file.

Method A: The closest prime number to 10,000, but under 10,000, is 9973. Using one inventory part number as an example, in this case #25DF3514, and clearing the zones we have 25463514. Dividing by 9973 we get a quotient of 2553 and a remainder of 2445. 2445 is the relative location of the record within the data file corresponding to part number 25DF3514. The record address can be determined from the relative location as follows:

1. (For actual track addressing only) Determine the beginning point for the data file (e.g., cylinder 100, track 0).

2. Determine the number of records that can be stored on a track (e.g., twelve per track on a 2311 disk pack, assuming each inventory record is 200 bytes long).

   Because each data record contains non-data components, such as a count area and interrecord gaps, track capacity for data storage will vary with record length. As the number of separate records on a track increases, interrecord gaps occupy additional byte positions so that data capacity is reduced. Track capacity formulas provide the means to determine total byte requirements for records of various sizes on a track. These formulas can be found in the publications IBM System/360 Component Descriptions, Order Nos. GA26-5988 and GA26-3599.

3. Divide the relative number (2445) by the number of records to be stored on each track.

4. (For actual track addressing only) The result, quotient = 203, is now divided into cylinder and head designation. Since the 2311 disk pack has ten heads, the quotient of 203 is divided by 10 to show:

   Cylinder or CC = 20
   Head or HH = 03 (high-order zero added)

4B. (For relative track addressing only) The result, quotient = 203, now becomes the track identifier of the actual key.

Method B: Utilizing the same example, another approach will also provide the relative track address:

1. The number of records that may be contained on one track is twelve. Therefore, if 10,000 record locations are to be provided, 834 tracks must be reserved.

Table 9. Partial List of Prime Numbers (Part 1 of 2)

A (Number)	B (Nearest Prime Number Less Than A)
500	499
600	599
700	691
800	797
900	887
1000	997
1100	1097
1200	1193
1300	1297
1400	1399
1500	1499
1600	1597
1700	1699
1800	1789
1900	1889
2000	1999
2100	2099
2200	2179
2300	2297
2400	2399
2500	2477
2600	2593
2700	2699
2800	2797
2900	2897
3000	2999
3100	3089
3200	3191
3300	3299
3400	3391
3500	3499
3600	3593
3700	3697
3800	3797
3900	3889
4000	3989
4100	4099
4200	4177
4300	4297
4400	4397
4500	4493
4600	4597
4700	4691
4800	4799
4900	4889
5000	4999
5100	5099
5200	4197
5300	5297
5400	4399
5500	5483

Table 9. Partial List of Prime Numbers (Part 2 of 2)

A (Number)	B (Nearest Prime Number Less Than A)
5600	5591
5700	5693
5800	5791
5900	5897
6000	5987
6100	6091
6200	6199
6300	6299
6400	6397
6500	6491
6600	6599
6700	6691
6800	6793
6900	6899
7000	6997
7100	7079
7200	7193
7300	7297
7400	7393
7500	7499
7600	7591
7700	7699
7800	7793
7900	7883
8000	7993
8100	8093
8200	8191
8300	8297
8400	8389
8500	8467
8600	8599
8700	8699
8800	8793
8900	8899
9000	8899
9100	9091
9200	9199
9300	9293
9400	9397
9500	9497
9600	9587
9700	9697
9800	9791
9900	9887
10,000	9973
10,100	10,099
10,200	10,193
10,300	10,289
10,400	10,399
10,500	10,499
10,600	10,597

2. The prime number nearest, but less than 834, is 829.

3. Divide the zone-stripped key by the prime value. (In the example, 25463514 divided by 829 provides a quotient of 30715 and a remainder of 779. The remainder is the relative address.)

4. (For actual track addressing only) To convert the relative address to an actual device address, divide the relative address by the number of tracks in a cylinder. The quotient will provide the cylinder number and the remainder will be the track number. For example, the 2311 disk pack would utilize 779 as:

   Cylinder or CC = 77
   Track or HH = 9

Figure 30 is a sample COBOL program which creates a direct file with actual track addressing using Method B and provides for the possibility of synonym overflow. Synonym overflow will occur if a record randomizes to a track that is already full. The following description highlights the features of the example. Circled numbers on the program listing correspond to the numbers in the text.

1 The value 10 is added to TRACK-1 to ensure that the problem program does not write on cylinder 0. Cylinder 0 must be reserved for the Volume Table of Contents.

- Since the prime number used as a divisor is 829, the largest possible remainder will be 828. Adding 10 to TRACK-1 adjusts the largest possible remainder to 838.

2 If synonym overflow occurs, control is given to the error procedure declarative specified in the first section of the Procedure Division. The declarative provides that:

- Any record which cannot fit on a track (i.e., tracks 0 through 8 of any cylinder) will be written in the first available position on the following track(s).
- Any record which cannot fit within a single cylinder will be written on cylinder 84 (i.e., the cylinder overflow area).
- If a record cannot fit on either cylinders 1 through 83, or on cylinder 84, the job is terminated.

3 The standard error condition "no room found" is tested before control is given to the synonym routine. Other standard error conditions as well as invalid key conditions result in job termination.

ERROR-COND is the identifier which specifies the error condition that caused control to be given to the error declarative. ERROR-COND is printed on SYSLST whenever the error declarative section is entered. TRACK-ID and C-REC are also printed on SYSLST. They are printed before the execution of each WRITE statement. This output has been provided in order to facilitate an understanding of the logic involved in the creation of D-FILE.

4 The first twelve records which randomize to cylinder 002 track 8 are actually written on track 8.

5 The next twelve records which randomize to cylinder 002 track 8 are adjusted by the SYNONYM-ROUTINE and written on cylinder 002 track 9.

6 The next twelve records which randomize to cylinder 002 track 8 are adjusted by the SYNONYM-ROUTINE and written on cylinder 84 track 0 (i.e., the overflow cylinder).

7 The last two records which randomize to cylinder 002 track 8 are adjusted by the SYNONYM-ROUTINE and written on cylinder 84 track 1 (i.e., the overflow cylinder).

```
// JOB  METHODB
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
```

```
       IDENTIFICATION DIVISION.
       PROGRAM-ID. METHOD-B.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SOURCE-COMPUTER. IBM-360.
       OBJECT-COMPUTER. IBM-360.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           SELECT D-FILE ASSIGN SYS015-DA-2311-A-MASTER
           ACCESS IS RANDOM
           ACTUAL KEY IS ACT-KEY.
           SELECT C-FILE ASSIGN TO SYS007-UR-2540R-S.
       DATA DIVISION.
       FILE SECTION.
       FD  D-FILE
           LABEL RECORDS ARE STANDARD.
       01  D-REC.
           02  PART-NUM PIC X(8).
           02  NUM-ON-HAND PIC 9(4).
           02  PRICE PIC 9(5)V99.
           02  FILLER PIC X(181).
       FD  C-FILE
           LABEL RECORDS ARE OMITTED.
       01  C-REC.
           02  PART-NUM PIC X(8).
           02  NUM-ON-HAND  PIC 9(4).
           02  PRICE PIC 9(5)V99.
       WORKING-STORAGE SECTION.
       77  HD     PIC 9 VALUE ZERO.
       77  SAVE      PIC S9(8) COMP SYNC.
       77  QUOTIENT     PIC S9(5) COMP SYNC.
       01  ERROR-COND.
           02  FILLER PIC 99  VALUE ZERO.
           02  ERR     PIC 9  VALUE ZERO.
           02  FILLER PIC 9(5)   VALUE ZERO.
       01  TRACK-1      PIC 9999.
       01  TRACK-ID REDEFINES TRACK-1.
           02  CYL PIC 999.
           02  HEAD PIC 9.
       01  KEY-1.
           02  M    PIC S999 COMP SYNC VALUE ZEROES.
           02  BB   PIC S9   COMP SYNC VALUE ZERO.
           02  CC   PIC S999 COMP SYNC.
           02  HH   PIC S9   COMP SYNC.
           02  R    PIC X    VALUE LOW-VALUE.
           02  REC-ID   PIC X(8).
       01  KEY-2 REDEFINES KEY-1.
           02  FILLER PIC X.
           02  ACT-KEY PIC X(16).
```

Figure 30. Creating a Direct File Using Method B (Part 1 of 4)

```
PROCEDURE DIVISION.
DECLARATIVES.
ERROR-PROCEDURE SECTION. USE AFTER STANDARD ERROR PROCEDURE
    ON D-FILE GIVING ERROR-COND.
ERROR-ROUTINE.
    EXHIBIT NAMED ERROR-COND.
    IF ERR = 1 GO TO SYNONYM-ROUTINE    ELSE
        DISPLAY 'CTHER STANDARD ERROR  ' REC-ID                 } ③
        GO TO EOJ.
SYNONYM-ROUTINE.
    IF CC = 84 AND HD = 9  DISPLAY 'OVERFLCW AREA FULL'
        GO TO EOJ.
    IF CC = 84 ADD 1 TO HD  GO TO ADJUST-HD.                           ②
    IF HH = 9 GO TO END-CYLINDER.
    ADD 1 TO HH.
    GO TO WRITES.
ENC-CYLINDER.
    MOVE 84 TO CC.
ADJUST-HD.
    MOVE HD TO HH.
    GO TO WRITES.
END DECLARATIVES.
FILE-CREATICN SECTION.
    OPEN INPUT C-FILE
        OUTPUT D-FILE.
READS.
    READ C-FILE AT END GO TO EOJ.
    MOVE CORRESPONDING C-REC TO D-REC.
    MOVE PART-NUM OF C-REC TO REC-ID SAVE.
    DIVIDE SAVE BY 829 GIVING QUOTIENT REMAINDER TRACK-1.          } ①
    ADD 10 TO TRACK-1.
    MOVE CYL TO CC.
    MOVE HEAD TO HH.
WRITES.
    EXHIBIT NAMED TRACK-ID  C-REC  CC  HH.
    WRITE D-REC INVALID KEY GO TO INVALID-KEY.
    GO TO READS.
INVALID-KEY.
    CISPLAY 'INVALID KEY  '  REC-ID.
EOJ.
    CLOSE C-FILE D-FILE.
    STOP RUN.
```

```
// LBLTYP NSD(01)
// EXEC LNKEDT
```

Figure 30. Creating a Direct File Using Method B (Part 2 of 4)

```
// ASSGN SYS007,X'00C'
// ASSGN SYS015,X'192'
// DLBL MASTER,,50/001,DA
// EXTENT SYS015,111111,1,0,10,840
// EXEC
```

```
TRACK-ID = 0010 C-REC = 82900000          CC = 001 HH = 0
TRACK-ID = 0011 C-REC = 82900001          CC = 001 HH = 1
TRACK-ID = 0011 C-REC = 82900001X         CC = 001 HH = 1
TRACK-ID = 0028 C-REC = 8290001801        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001802        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001803        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001804        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001805        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001806        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001807        CC = 002 HH = 8    (4)
TRACK-ID = 0028 C-REC = 8290001808        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001809        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001810        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001811        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001812        CC = 002 HH = 8
TRACK-ID = 0028 C-REC = 8290001813        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001813        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001814        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001814        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001815        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001815        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001816        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001816        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001817        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001817        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001818        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001818        CC = 002 HH = 9    (5)
TRACK-ID = 0028 C-REC = 8290001819        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001819        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001820        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001820        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001821        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001821        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001822        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001822        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001823        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001823        CC = 002 HH = 9
TRACK-ID = 0028 C-REC = 8290001824        CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001824        CC = 002 HH = 9
```

Figure 30. Creating a Direct File Using Method B (Part 3 of 4)

```
TRACK-ID = 0028 C-REC = 8290001825     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001825     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001825     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001826     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001826     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001826     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001827     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001827     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001827     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001828     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001828     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001828     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001829     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001829     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001829     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001830     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001830     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001830     CC = 084 HH = 0      6
TRACK-ID = 0028 C-REC = 8290001831     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001831     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001831     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001832     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001832     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001832     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001833     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001833     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001833     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001834     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001834     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001834     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001835     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001835     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001835     CC = 084 HH = 0
TRACK-ID = 0028 C-REC = 8290001836     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001836     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001836     CC = 084 HH = 0

TRACK-ID = 0028 C-REC = 8290001837     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001837     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001837     CC = 084 HH = 0
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001837     CC = 084 HH = 1      7
TRACK-ID = 0028 C-REC = 8290001838     CC = 002 HH = 8
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001838     CC = 002 HH = 9
ERROR-COND = 00100000
TRACK-ID = 0028 C-REC = 8290001838     CC = 084 HH = 1
```

Figure 30. Creating a Direct File Using Method B (Part 4 of 4)

Figure 31 is a sample COBOL program which creates a direct file with relative track addressing using Method B. The sample program provides for the possibility of synonym overflow. Synonym overflow will occur if a record randomizes to a track which is already full. The following discussion highlights some basic features. Circled numbers on the program listing correspond to numbers in the text.

(1) Since the prime number used as a divisor is 829, the largest possible remainder will be 828.

(2) If synonym overflow occurs, control is given to the USE AFTER STANDARD ERROR declarative specified in the first section of the Procedure Division. The declarative provides that any record that cannot fit on the track to which it randomizes will be written on the first subsequent track available.

(3) The standard error condition "no room found" is tested before control is given to the SYNONYM-ROUTINE. Other standard error conditions as well as invalid key conditions result in job termination (EOJ).

ERROR-COND is the identifier which specifies the error condition that caused control to be given to the error declarative. ERROR-COND is printed on SYSLST whenever the error declarative section is entered. TRACK-ID and C-REC are also printed on SYSLST before execution of each WRITE statement. This output has been provided in order to facilitate an understanding of the logic involved in the creation of D-FILE.

(4) The first twelve records which randomize to relative track 18 are actually written on relative track 18.

(5) The next twelve records which randomize to relative track 18 are adjusted by the SYNONYM-ROUTINE and are actually written on relative track 19.

(6) The next twelve records which randomize to relative track 18 are adjusted by the SYNONYM-ROUTINE and are actually written on relative track 20.

(7) The last two records which randomize to relative track 18 are adjusted by the SYNONYM-ROUTINE and are actually written on relative track 21.

```
// JOB METHODB
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
```

```
 CBL QUOTE
               IDENTIFICATION DIVISION.
               PROGRAM-ID. METHODB.
               ENVIRONMENT DIVISION.
               CONFIGURATION SECTION.
               SOURCE-COMPUTER. IBM-360.
               OBJECT-COMPUTER. IBM-360.
               INPUT-OUTPUT SECTION.
               FILE-CONTROL.
                   SELECT D-FILE ASSIGN TO SYS015-DA-2311-D-MASTER
                   ACCESS IS RANDOM
                   ACTUAL KEY IS ACT-KEY.
                   SELECT C-FILE ASSIGN TO SYS007-UR-2540R-S.
               DATA DIVISION.
               FILE SECTION.
               FD  D-FILE .
                   LABEL RECORDS ARE STANDARD.
               01  D-REC.
                   05 PART-NUM PIC X(8).
                   05 NUM-ON-HAND PIC 9(4).
                   05 PRICE PIC 9(5)V99.
                   05 FILLER PIC X(181).
               FD  C-FILE
                   LABEL RECORDS ARE OMITTED.
               01  C-REC.
                   05 PART-NUM PIC X(8).
                   05 NUM-ON-HAND PIC 9(4).
                   05 PRICE PIC 9(5)V99.
                   05 FILLER PIC X(61).
               WORKING-STORAGE SECTION.
               77  SAVE PIC S9(8) COMP SYNC.
               77  QUOTIENT PIC S9(8) COMP SYNC.
               01  ACT-KEY.
                   02 TRACK-ID PIC S9(8) COMP SYNC.
                   02 REC-ID PIC X(8).
               01  ERROR-COND.
                   02 FILLER PIC 99 VALUE ZERO.
                   02 ERR PIC 9 VALUE ZERO.
                   02 FILLER PIC 9(5) VALUE ZERO.
```

Figure 31. Creating a Direct File with Relative Track Addressing Using Method B (Part 1 of 4)

```
PROCEDURE DIVISION.
DECLARATIVES.
ERROR-PROCEDURE SECTION. USE AFTER STANDARD ERROR PROCEDURE
    ON D-FILE GIVING ERROR-COND.
ERROR-ROUTINE.
    EXHIBIT NAMED ERROR-COND.
    IF ERR = 1 GO TO SYNONYM-ROUTINE ELSE                     3          2
        DISPLAY "OTHER STANDARD ERROR  " REC-ID
        GO TO EOJ.
SYNONYM-ROUTINE.
    IF TRACK-ID IS LESS THAN 834, ADD 1 TO TRACK-ID. GO TO
        WRITES.
END DECLARATIVES.
    OPEN INPUT C-FILE
         OUTPUT D-FILE.
READS.
    READ C-FILE AT END GO TO EOJ.
    MOVE CORRESPONDING C-REC TO D-REC.
    MOVE PART-NUM OF C-REC TO REC-ID, SAVE.
    DIVIDE SAVE BY 829 GIVING QUOTIENT REMAINDER TRACK-ID.   1
WRITES.
    EXHIBIT NAMED TRACK-ID C-REC.
    WRITE D-REC INVALID KEY GO TO INVALID-KEY.
    GO TO READS.
INVALID-KEY.
    DISPLAY "INVALID KEY  " REC-ID.
EOJ.
    CLOSE C-FILE D-FILE.
    STOP RUN.
```

```
// LBLTYP NSD(01)
// EXEC LNKEDT
```

Figure 31. Creating a Direct File with Relative Track Addressing Using Method B (Part 2 of 4)

```
// ASSGN SYS007,X'00C'
// ASSGN SYS015,X'192'
// DLBL MASTER,,70/365,DA
// EXTENT SYS025,111111,1,0,10,850
// EXEC

TRACK-ID = 00000000 C-REC = 82900000
TRACK-ID = 00000001 C-REC = 82900001
TRACK-ID = 00000018 C-REC = 8290001801
TRACK-ID = 00000018 C-REC = 8290001802
TRACK-ID = 00000018 C-REC = 8290001803
TRACK-ID = 00000018 C-REC = 8290001804
TRACK-ID = 00000018 C-REC = 8290001805
TRACK-ID = 00000018 C-REC = 8290001806     4
TRACK-ID = 00000018 C-REC = 8290001807
GRACK-ID = 00000018 C-REC = 8290001808
TRACK-ID = 00000018 C-REC = 8290001809
TRACK-ID = 00000018 C-REC = 8290001810
TRACK-ID = 00000018 C-REC = 8290001811
TRACK-ID = 00000018 C-REC = 8290001812
TRACK-ID = 00000018 C-REC = 8290001813
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001813
TRACK-ID = 00000018 C-REC = 8290001814
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001814
TRACK-ID = 00000018 C-REC = 8290001815
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001815
TRACK-ID = 00000018 C-REC = 8290001816
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001816
TRACK-ID = 00000018 C-REC = 8290001817
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001817
TRACK-ID = 00000018 C-REC = 8290001818
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001818
TRACK-ID = 00000018 C-REC = 8290001819
ERROR-COND = 00100000                      5
TRACK-ID = 00000019 C-REC = 8290001819
TRACK-ID = 00000018 C-REC = 8290001820
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001820
TRACK-ID = 00000018 C-REC = 8290001821
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001821
TRACK-ID = 00000018 C-REC = 8290001822
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001822
TRACK-ID = 00000018 C-REC = 8290001823
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001823
TRACK-ID = 00000018 C-REC = 8290001824
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001824
```

Figure 31. Creating a Direct File with Relative Track Addressing Using Method B (Part 3 of 4)

```
TRACK-ID = 00000018 C-REC = 8290001825
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001825
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001825
TRACK-ID = 00000018 C-REC = 8290001826
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001826
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001826
TRACK-ID = 00000018 C-REC = 8290001827
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001827
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001827
TRACK-ID = 00000018 C-REC = 8290001828
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001828
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001828
TRACK-ID = 00000018 C-REC = 8290001829
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001829
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001829
TRACK-ID = 00000018 C-REC = 8290001830
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001830
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001830
TRACK-ID = 00000018 C-REC = 8290001831
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001831
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001831
TRACK-ID = 00000018 C-REC = 8290001832
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001832
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001832
TRACK-ID = 00000018 C-REC = 8290001833
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001833
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001833
TRACK-ID = 00000018 C-REC = 8290001834
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001834
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001834
TRACK-ID = 00000018 C-REC = 8290001835
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001835
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001835
TRACK-ID = 00000018 C-REC = 8290001836
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001836
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001836
TRACK-ID = 00000018 C-REC = 8290001837
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001837
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001837
ERROR-COND = 00100000
TRACK-ID = 00000021 C-REC = 8290001837
TRACK-ID = 00000018 C-REC = 8290001838
ERROR-COND = 00100000
TRACK-ID = 00000019 C-REC = 8290001838
ERROR-COND = 00100000
TRACK-ID = 00000020 C-REC = 8290001838
ERROR-COND = 00100000
TRACK-ID = 00000021 C-REC = 8290001838
```

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Figure 31. Creating a Direct File with Relative Track Addressing Using Method B (Part 4 of 4)

ACTUAL TRACK ADDRESSING CONSIDERATIONS FOR SPECIFIC DEVICES

Randomizing for the 2311 Disk Drive

When randomizing for the 2311 Disk Drive, it is possible to circumvent the discontinous binary address by coding the randomizing formula in decimal arithmetic and then converting the results to binary. This can be done by setting aside a decimal field with the low-order byte reserved for the head number, and the high-order bytes reserved for the cylinder number. A mathematical overflow from the head number will now increment the cylinder number and produce a valid address. The low-order byte should then be converted to binary and stored in the HH field, and the high-order bytes converted to binary and stored in the CC field of the actual key field.

Randomizing to the 2311 Disk Drive should present no significant problems if the programmer using direct organization is completely aware that the cylinder and head number give him a unique track number. To illustrate, the 2311 could be thought of as consisting of tracks numbered as follows:

```
         Cylinder 0  Cylinder 1  Cylinder 2
             --┐        --┐        --┐
Track          | 0        |10        |20
Numbers      --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               | 9        |19        |29
```

If the randomizing formula resulted in an address of cylinder 001, head 9:

Cylinder Number	Head Number
001	9

this would be a reference to track 19. This fact allows the programmer to ignore the discontinuous cylinder and head number. If his formula resulted in an address of 0020, this would result in accessing cylinder 2, head 0, the location of track 20.

The programmer can make another use of this decimal track address. He may wisn to reserve the last track of each cylinder for synonyms. If this is the case, he is in effect redefining the cylinder to consist of nine tracks rather than ten tracks. The 2311 cylinder could then be thought of as consisting of track numbers, as follows:

```
         Cylinder 0  Cylinder 1  Cylinder 2
             --┐        --┐        --┐
Track          | 0        |9         |18
Numbers      --┤        --┤        --┤
               |          |          |19
             --┤        --┤        --┤
               |          |          |20
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               |          |          |
             --┤        --┤        --┤
               | 8        |17        |26
```

If the programmer randomizes to relative track number 20, he can access it by dividing the track address by the number of tracks (9) in a cylinder. The quotient now becomes the cylinder number, and the remainder becomes the head number.

```
       2 = cylinder number
    ----
 9/ 0020
      18
     ---
       2 = head number
```

To simplify randomizing, an algorithm must be developed to generate a decimal track address. This track address can then be converted to a binary cylinder number and head number. In addition, tracks can be reserved by dividing the track address by the number of tracks in a cylinder. The same concepts will hold true for devices such as the 2314. For example, an algorithm can be developed using 20 tracks per cylinder and dividing by the closest prime number less than 20.

Randomizing for the 2321 Data Cell

The track reference field for the 2321 Data Cell is composed of the following discontinuous binary address:

		cell	sub cell	strip	cyl.	head	record
M	B	B	C	C	H	H	R
		0-9	0-19	0-9	0-4	0-19	

At first glance, this presents an almost impossible randomizing task; but since each strip includes 100 tracks that are accessible through cylinder and head number, the 2321 Data Cell can be considered to consist of consecutively numbered tracks.

Tracks	Strip
0 → 99	0
100 → 199	1
900 → 999	9
1000 → 1099	10
1900 → 1999	19
10000 → 10099	100
19900 → 19999	199
199900 → 199999	1999

It can be seen that relative track 20 is located on cylinder 1, head 0 of some particular strip. Its address can be calculated by dividing by 20.

```
      1 = cylinder number
    ┌---
20 ) 20
     20
    ---
      0 = head number
```

Thus, relative track number 120 will be located on strip 1, cylinder 1, head 0 of some subcell. Note that the strip number is given by the hundreds digit, and the cylinder and head number are derived by dividing the two low-order digits by 20.

The same relationship holds true for relative track number 900. It is located on strip 9, cylinder 0, track 0. Again, the hundreds digit gives the strip number, and dividing the two low-order digits by 20 results in a quotient and remainder of zero.

This relationship holds true through a relative track number of 19999, which is the number of tracks that can be contained on one cell of a data cell array. By applying the foregoing rules, an address of subcell 19, strip 9, cylinder 4, head 19 is derived.

Thus, by randomizing to a 5-digit decimal track number, the programmer will be able to access the 20,000 tracks (40,000,000 characters) contained in a cell.

The thousands digits would represent the subcell number, the hundreds digit the strip number, and the quotient and remainder of the two low-order digits divided by 20 would represent the cylinder and head number. Each one of these resulting decimal digits would then be converted to binary and placed in the appropriate location in the track reference field.

There is a total of 200,000 tracks per data cell array. To derive valid addresses that cross cell boundaries, the programmer should randomize to a 6-digit decimal track address. The highest address possible should be 199,999. To convert this to a data cell address, similar rules apply. In this case, the programmer must divide the three high-order digits by 20:

```
       9 = cell
    ┌---
20 ) 199
     180
    ----
      19 = subcell
```

The quotient becomes the cell number and the remainder becomes the subcell number. The hundreds digit is still the strip number, and the cylinder and head number can be derived as previously illustrated. The resulting address is 0091994190 and would appear in the first eight bytes of the actual key field as follows:

		cell	sub cell	strip	cyl.	head	
M	B	B	C	C	H	H	R
0	0	9	19	9	4	19	0

Randomizing to the data cell can be accomplished by developing an algorithm to generate decimal track addresses. The use of the foregoing rules makes it possible to convert these generated track addresses to the appropriate discontinuous binary address.

INDEXED ORGANIZATION (DTFIS)

An indexed file is a sequential file with indexes that permit rapid access to individual records as well as rapid sequential processing. Error recovery from a DTFIS file is described in detail in the chapter "Advanced Processing Capabilities." An indexed file has three distinct areas: a prime area, indexes, and an overflow area. Each area is described in detail below.

PRIME AREA

When the file is first created, or when it is subsequently reorganized, records are written in the prime area. Until the prime area is full, additions to the file may also be written there. The prime area may span multiple volumes. Note that the last track of the prime area may not be used by the COBOL programmer.

The records in the prime area must be formatted with keys, and must be positioned in key sequence. The records may be blocked or unblocked. If records are blocked, each logical record within the block contains its key, and the key area for the block contains the key of the highest record in the block. The Disk Operating System permits fixed-length records only. Figure 32 shows the formats of blocked and unblocked records on a track.

```
Unblocked Records

|KEY NUMBER|     | COUNT | KEY | DATA |     | COUNT | KEY | DATA |          |
     ^                      ^     ^
     |                      |     |
     |                      |     |
     |                      |     └--Logical record (key embedded)
     |                      |
     |                      └--Key of logical record
     |
     └--Highest key on track

Blocked Records

|KEY NUMBER|  | COUNT      | KEY | DATA | DATA | DATA |   |               |
     ^                      ^      \__________________/
     |                      |              ^
     |                      |              |
     |                      |              └--Logical records with embedded keys
     |                      |
     |                      └--Key of last logical record in block
     |
     └--Highest key on track
```

Figure 32. Formats of Blocked and Unblocked Records

INDEXES

There are three possible levels of indexes for a file with indexed organization: a track index, a cylinder index, and a master index. They are created and written by the system when the file is created or reorganized.

Track Index

This is the lowest level of index and is always present. There is one track index for each cylinder in the prime area. It is always written on the first track of the cylinder that it indexes.

The track index contains a pair of entries for each prime data track in the cylinder: a normal entry and an overflow entry. The normal entry contains the home address of the prime track and the key of the highest record on the track. The overflow entry contains the highest key associated with that track and the address of the lowest record in the overflow area. If no overflow entry has yet been made, the address of the lowest record in the overflow area is the dummy entry X'FF'.

Cylinder Index

The cylinder index is a higher level of index and is always present. Its entries point to track indexes. There is one cylinder index for the file. It is written on the device specified in the APPLY CYL-INDEX clause. If this clause is not specified, the cylinder index is written on the same device as the prime area.

Master Index

The master index is the highest level index and is optional. It is used when the cylinder index is so long that searching it is very time consuming. It is suggested that a master index be requested when the cylinder index occupies more than four tracks. (A master index consists of one entry for each track of the cylinder index.)

The Disk Operating System permits one level of master index for the file and requires that it be written immediately before the cylinder index. If a master index is desired, the APPLY MASTER-INDEX clause must be specified in the source program. When this clause is specified, the cylinder index is placed on the same device as the master index.

OVERFLOW AREA

There are two types of overflow areas: a cylinder overflow area and an independent overflow area. Either or both may be specified for an indexed file. Records are written in the overflow area(s) as additions are made to the file.

Cylinder Overflow Area

A certain number of whole tracks are reserved in each cylinder for overflow records from the prime tracks in that cylinder. The programmer may specify the number of tracks to be reserved by means of the APPLY CYL-OVERFLOW clause. If he specifies 0 as the number of tracks in this clause, no cylinder overflow area is reserved. If the clause is omitted, 20% of each cylinder is reserved for overflow.

Independent Overflow Area

Overflow records from anywhere in the prime area are placed in a certain number of cylinders reserved soley for this purpose. The size and location of the independent overflow area can be specified if the programmer includes the proper job control XTENT (or EXTENT) cards. The area must, however, be on the same mass storage device type as the prime area.

A suggested approach is to have cylinder overflow areas large enough to contain the average number of overflow records caused by additions and an independent overflow area to be used as the cylinder overflow areas are filled.

Adding Records to an Indexed File

A new record added to an indexed file is placed into a location on a track in the prime area determined by the value of its key field. If records in the file were placed in precise physical sequence, the addition of a new record would require the shifting of all records with keys higher than that of the one inserted. However, indexed organization allows a record to be inserted into its proper position on a track, with the shifting of only the

```
PRIME DATA AREA

 Track No.

  0001      |00001|    |00003|    ....    |00009|    |00010|    |00011|
                                                        ^          ^
                                                        |          |
                                                        |          |
                                  New record------------           |
                                                                   |
                        Original record moved up--------------------

  0002      |00016|    |00017| .....................   |00025|    |00027|


OVERFLOW AREA

            |00014|    ........
             ^
             |
             ------Record removed from Track 0001
```

Figure 33. Adding a Record to a Prime Track

records on that track. Any records for which there is no space on that track are then placed in an overflow area, and become overflow records. Overflow records are always fixed-length, unblocked records, formatted with keys.

As records are added to the overflow area, they are no longer in key sequence. The system ensures, however, that they are always in logical sequence.

Figure 33 illustrates the addition of a record to a prime track.

The new record (00010) is written in its proper sequential location on the prime track. The rest of its prime records are moved up one location. The bumped record (00014) is written in the first available location in the overflow area. The record is placed in the cylinder overflow area for that cylinder, if a cylinder overflow area exists and if there is space in it; otherwise, the record is placed in the independent overflow area. The first addition to a track is always handled in this manner. Any record that is higher than the original highest record on the preceding track, but lower than the original highest record on this track, is written on the prime track. Record 00015, for example, would be written as the first record on track 0002, and record 00027 would be bumped into the overflow area.

Subsequent additions are written either on the prime track where they belong or as part of the overflow chain from that track. If the addition belongs between the last prime record on a track and a previous overflow from that track (as is the case with record 00013), it is written in the first available location in the overflow area on an empty track, or on a track whose first record has a numerically lower key.

If the addition belongs on a prime track (as would be the case with record 00005), it is written in its proper sequential location on the prime track. The bumped record (record 00011) is written in the overflow area.

A record with a key higher than the current highest key in the file is placed on the last prime track containing data records. If that track is full, the record is placed in the overflow area.

ACCESSING AN INDEXED FILE (DTFIS)

An indexed file may be accessed both sequentially and randomly.

<u>ACCESSING AN INDEXED FILE SEQUENTIALLY</u>: An indexed file may only be created sequentially. It can also be read and updated in the sequential access mode. The following specifications may be made in the source program.

<u>ENVIRONMENT DIVISION</u>

<u>Required clauses</u>:

SELECT [OPTIONAL] file-name

ASSIGN TO SYSnnn-DA-$\left\{\begin{matrix}2311\\2314\\2321\end{matrix}\right\}$- I

RECORD KEY Clause
NOMINAL KEY Clause (when reading, if the START statement is used)

<u>Optional clauses</u>:

FILE-LIMIT Clause
ACCESS MODE IS SEQUENTIAL
PROCESSING MODE IS SEQUENTIAL
RERUN Clause
SAME Clause
APPLY WRITE-VERIFY Clause (create and update)
APPLY CYL-OVERFLOW Clause (create)

APPLY $\left\{\begin{matrix}\text{MASTER-INDEX}\\\text{CYL-INDEX}\end{matrix}\right\}$ Clause

<u>Invalid clauses</u>:

ACCESS MODE IS RANDOM
ACTUAL KEY Clause
TRACK-AREA Clause
MULTIPLE FILE TAPE Clause
APPLY WRITE-ONLY Clause
APPLY EXTENDED-SEARCH Clause
APPLY CORE-INDEX Clause
RESERVE Clause

<u>ACCESSING AN INDEXED FILE RANDOMLY</u>: A randomly-accessed indexed file may be read, updated, or added to. The following specifications may be made in the source program:

<u>ENVIRONMENT DIVISION</u>

<u>Required clauses</u>:

SELECT [OPTIONAL] file-name

ASSIGN TO SYSnnn-DA- $\left\{\begin{matrix}2311\\2314\\2321\end{matrix}\right\}$ -I

ACCESS IS RANDOM
NOMINAL KEY Clause
RECORD KEY Clause

<u>Optional clauses</u>:

FILE LIMIT Clause
PROCESSING MODE IS SEQUENTIAL
TRACK-AREA Clause
RERUN Clause
SAME Clause
APPLY WRITE VERIFY Clause
APPLY CYL-OVERFLOW Clause
APPLY CORE-INDEX Clause

APPLY $\left\{\begin{matrix}\text{MASTER-INDEX}\\\text{CYL-INDEX}\end{matrix}\right\}$ Clause

<u>Invalid clauses</u>:

RESERVE Clause
ACCESS MODE IS SEQUENTIAL
ACTUAL KEY Clause
MULTIPLE FILE TAPE Clause
APPLY EXTENDED-SEARCH Clause

<u>Key Clauses</u>

When creating an indexed file, the only key clause required is the RECORD KEY clause. The data-name specified in this clause is the name of the field within the record that contains the key. Keys must be in ascending numerical order when creating an indexed file.

If a START statement is used when retrieving an indexed file sequentially, the NOMINAL KEY clause is required.

When accessing an indexed file randomly, both the NOMINAL KEY and RECORD KEY clauses are required. When reading the file, the data-name specified in the NOMINAL KEY clause is the key of the record which is being retrieved. The data-name specified in the RECORD KEY clause is the name of the field within the record that contains this key.

When adding records to an indexed file, the data-name specified in the NOMINAL KEY clause is the key for the record being written and is used to determine its physical location. The data-name specified in the RECORD KEY clause specifies the field in the record that contains the key.

Improving Efficiency

When processing an indexed file, the following source language Environment Division clauses may be used to improve efficiency:

TRACK-AREA Clause
APPLY CORE-INDEX Clause

For additional details, see the publication IBM System/360 Disk Operating System: Full American National Standard COBOL.

The following topics are discussed within this chapter:

DTF Tables

Error Recovery

Volume and File Label Handling

DTF TABLES

Whenever COBOL imperative-statements (READ, WRITE, REWRITE, etc.) are used in a program to control the input and/or output of records in a file, that file must be defined by a DTF. A DTF is created by the compiler for each file opened in a COBOL program from information specified in the Environment Division, FD entry, and input/output statements in the source program. The DTF for each file is part of the object module that is generated by the compiler. It describes the characteristics of the logical file, indicates the type of processing to be used for the file, and specifies the main storage areas and routines used for the file.

The DTF's generated for the permissible combinations of device type and COBOL file processing technique are as follows:

DTFCD	Card reader, punch -- organization and access sequential
DTFPR	Printer -- organization and access sequential
DTFMT	Tape -- organization and access sequential
DTFSD	Mass storage device -- organization and access sequential
DTFDA	Mass storage device -- organization direct, access sequential or random
DTFIS	Mass storage device -- organization indexed, access sequential or random

Because of their limited interest for the COBOL programmer, the contents and location of the fields of each of the DTF types are not discussed in this publication. However, there are certain fields which immediately precede the storage area allocated for the DTF which are pertinent and which are described below.

For magnetic tape files (DTFMT) or sequentially organized files on mass storage devices (DTFSD), a 26-byte Pre-DTF is reserved in front of the DTF. The fields of the Pre-DTF are shown in Table 10. If any option is not specified, the field will contain binary zeros.

When actual track addressing is used for files with direct organization and random access (DTFDA), a variable-length Pre-DTF is reserved. The fields of the Pre-DTF are shown in Table 11. If any option is not specified, the field will contain binary zeros.

When relative track addressing is used for files with direct organization and random access (DTFDA), a variable-length Pre-DTF is reserved. The fields of the Pre-DTF are shown in Table 12. If any option is not specified, the field will contain binary zeros.

Table 10. Fields Preceding DTFMT and DTFSD

2 bytes	Length of nonstandard label, if present
1 byte	Number of reels (as specified in the ASSIGN clause) when file is opened[1]
1 byte	Number of reels remaining (i.e., file not completely read)[1]
2 bytes	Maximum record length if records are variable, blocked and APPLY WRITE-ONLY is not specified.
4 bytes	Address of label declarative with BEGINNING [REEL / UNIT] option
4 bytes	Address of label declarative with ENDING [REEL / UNIT] option
4 bytes	Address of label declarative with ENDING FILE option
4 bytes	Address of label declarative with BEGINNING FILE option
1 byte	Switch -- FF if closed WITH LOCK; otherwise, the switch is used as shown in Table 16
3 bytes	Address of USE AFTER STANDARD ERROR declarative
DTFMT/DTFSD	

[1]For INPUT files with nonstandard labels only.

Table 11. Fields Preceding DTFDA -- ACCESS IS RANDOM -- Actual Track Addressing

9-263 bytes	ACTUAL KEY[1]
8 bytes	SEEK Address[2]
2 bytes	Error bytes[3]
4 bytes	Address of file extent information
4 bytes	Address of label declarative with ENDING FILE option
4 bytes	Address of label declarative with BEGINNING FILE option
1 byte	Switch -- FF if closed WITH LOCK; otherwise the switch is used as shown in Table 16
3 bytes	Address of USE AFTER STANDARD ERROR declarative
DTFDA	

[1]ACTUAL KEY specified in last executed WRITE statement
[2]In the form MBBCCHHR
[3]This area is reserved by the Supervisor and assigned the name ERRBYTE. For a complete discussion, refer to the publication DOS Supervisor and I/O Macros, Order No. GC24-5037.

Table 12. Fields Preceding DTFDA -- ACCESS IS RANDOM -- Relative Track Addressing

5-258 bytes	ACTUAL KEY[1]
4 bytes	SEEK address[2]
3 bytes	Last extent used[3]
1 byte	Not used
2 bytes	Error bytes[4]
1 byte	Index to last extent used in the Disk Extent Table
3 bytes	Address of Disk Extent Table in the DTF
4 bytes	Address of label declarative with ENDING FILE option
4 bytes	Address of label declarative with BEGINNING FILE option
1 byte	Switch -- FF if closed WITH LOCK; otherwise the switch is used as shown in Table 16
3 bytes	Address of USE AFTER STANDARD ERROR declarative
DTFDA	

[1]ACTUAL KEY specified in the last executed WRITE statement
[2]In the form TTTR
[3]In the form TTT
[4]This area is reserved by the DOS Supervisor and assigned the name ERRBYTE. For a complete discussion, refer to the publication DOS Supervisor and I/O Macros.

When actual track addressing is used for files with direct organization and sequential access (DTFDA), a 31-byte Pre-DTF is reserved. The fields of the Pre-DTF are shown in Table 13. If any option is not specified, the field will contain binary zeros.

When relative track addressing is used for files with direct organization and sequential access (DTFDA), a 31-byte Pre-DTF is reserved. The fields of the Pre-DTF are shown in Table 14. If any option is not specified, the field will contain binary zeros.

For files whose organization is indexed, eight bytes are reserved preceding the DTF, as shown in Table 15.

Table 13. Fields Preceding DTFDA -- ACCESS IS SEQUENTIAL -- Actual Track Addressing

8 bytes	SEEK address[1]
5 bytes	IDLOC[2]
2 bytes	Error bytes[3]
4 bytes	Address of file extent information
4 bytes	Address of label declarative with ENDING FILE option
4 bytes	Address of label declarative with BEGINNING FILE option
1 byte	Switch -- FF if closed WITH LOCK; otherwise the switch is used as shown in Table 16
3 bytes	Address of USE AFTER STANDARD ERROR declarative
DTFDA	

[1]In the form MBBCCHHR
[2]Address (returned by the system) of next record in the form CCHHR
[3]This area is reserved by the DOS Supervisor and assigned the name ERRBYTE. For a complete discussion, refer to the publication DOS Supervisor and I/O Macros.

Table 14. Fields Preceding DTFDA -- ACCESS IS SEQUENTIAL -- Relative Track Addressing

4 bytes	SEEK address[1]
3 bytes	Last extent used[2]
1 byte	Not used
4 bytes	IDLOC[3]
1 byte	Not used
2 bytes	Error bytes[4]
1 byte	Index to the last extent used in the Disk Extent Table
3 bytes	Address of Disk Extent Table in the DTF
4 bytes	Address of label declarative with ENDING FILE option
4 bytes	Address of label declarative with BEGINNING FILE option
1 byte	Switch -- FF if closed with LOCK; otherwise the switch is used as shown in Table 16
3 bytes	Address of USE AFTER STANDARD ERROR declarative
DTFDA	

[1]In the form TTTR
[2]In the form TTT
[3]Address (returned by the system) of the next record in the form TTTR
[4]This area is reserved by the DOS Supervisor and assigned the name ERRBYTE. For a complete discussion, refer to the publication DOS Supervisor and I/O Macros.

Table 15. Fields Preceding DTFIS

2 bytes	Unused
2 bytes	Displacement of record key within record
1 byte	Switch -- FF if closed WITH LOCK; otherwise the switch is used as shown in Table 16
3 bytes	Address of USE AFTER STANDARD ERROR declarative
DTFIS	

Some files can be opened several different ways in one COBOL program.

For DTFCD and DTFPR, only one DTF will be generated for each file.

For DTFMT, a maximum of three DTF's may be needed -- one each for OPEN INPUT, OPEN INPUT REVERSED, and OPEN OUTPUT.

For DTFSD, a maximum of three DTF's may be needed -- one each for OPEN INPUT, OPEN OUTPUT, and OPEN I-O statements.

For DTFIS and DTFDA, only one DTF is needed.

Pre-DTF Switch

When used, this switch provides communication between the executing program and its input/output subroutines at execution time. The entire byte may be set to X'FF' to indicate that the file was closed WITH LOCK and cannot be reopened. Otherwise the switch is used as shown in Table 16.

ERROR RECOVERY

COBOL allows the programmer to handle input/output errors through 1) the INVALID KEY clause for certain source language statements, and 2) the USE AFTER STANDARD ERROR declarative sentence.

Input/output errors caused by the program can be recovered from directly by the procedure specified in the INVALID KEY clause. That is, when the system determines that an invalid key condition exists, control is returned to the programmer at the imperative-statement specified in the INVALID KEY clause. An invalid key condition can occur on files with direct or indexed organization and on sequentially organized disk files. The errors that cause an invalid key condition are shown in Table 17.

Table 16. Meaning of Pre-DTF Switch

Bit	Meaning, if ON
0	Turned ON the first time a DTFSD output file is opened. The entire DTF is saved for subsequent OPEN OUTPUT statements.
1	Turned ON when DTFDA or DTFSD files are opened I-O.
2	This bit is ON to indicate beginning of volume user label processing. The bit is set OFF when a file is opened to indicate to the user label processing subroutine (ILBDUSL0) that beginning-of-file user labels are to be processed. That subroutine sets the bit ON after beginning-of-file processing to indicate that all subsequent calls for this subroutine are for beginning-of-volume user label processing.
3	For output files with variable-length blocked records, this bit is turned OFF when a file is opened and ON for all WRITE's after the first.
4	Turned ON for spanned record processing on a DTFDA file.
5-7	Not used.

Table 17. Errors Causing an Invalid Key Condition

Organization	ACCESS	OPEN	I-O Verb	Condition
Sequential	[SEQUENTIAL]	OUTPUT	WRITE	End of extents reached.
Direct	[SEQUENTIAL]	OUTPUT	WRITE	Track address outside file extents.
Direct	RANDOM	INPUT	READ	No record found.
		OUTPUT	WRITE	Track address outside file extents.
		I-O	READ REWRITE	Track address outside file extents.
Indexed	[SEQUENTIAL]	INPUT I-O	START	No record found.
		OUTPUT	WRITE	Duplicate record; sequence check.
	RANDOM	INPUT	READ	No record found.
		I-O	REWRITE	
		I-O	WRITE	Duplicate record.

Other input/output errors cause the job to be cancelled unless the programmer has specified a USE AFTER STANDARD ERROR declarative. Control is transferred to this declarative section if the system determines that a "standard" error has occurred during input/output processing. In this declarative section, the programmer may interrogate the COBOL error bytes if he has specified the GIVING option of the USE AFTER STANDARD ERROR declarative sentence. The meaning of these bytes for a specified combination of device type and file processing technique is shown in Table 18.

Table 18. Meaning of Error Bytes for GIVING Option of Error Declarative

Device	Organization	ACCESS	OPEN	I/O Verb	Condition	Byte	Result
Unit record	Sequential	[SEQUENTIAL]			Input/output error	1	File must be closed and job must be terminated.
Tape	Sequential	[SEQUENTIAL]	INPUT	READ	Wrong length record	2	Skip block if return is made to non-declarative portion.
					Parity error	1	Skip block if return is made to non-declarative portion.
			OUTPUT	WRITE	All exceptional conditions are handled by the system.		
DASD	Sequential	[SEQUENTIAL]	INPUT I-O	READ	Wrong length record	2	Skip block if return is made to non-declarative portion.
					Parity error	1	Skip block if return is made to non-declarative portion.
			OUTPUT I-O	WRITE	Parity error	1	Bad block written.
					Wrong length record	2	Bad block written.
DASD	Direct	[SEQUENTIAL]	INPUT	READ	Wrong length record	2	Return to statement after READ.
					Data check in count area	1	Return to statement after READ.
					Data check for key and/or data	4	Return to statement after READ.
DASD	Direct	RANDOM	INPUT I-O	READ	Same as ACCESS SEQUENTIAL (above).		
			OUTPUT	WRITE	Wrong length record	2	Return to next statement; bad block written.
					Data check in count area	1	Return to next statement; bad block written.
					Data check for key and/or data	4	Return to next statement; bad block written.
					No room found	3	Return to next statement.

Note: If no USE AFTER STANDARD ERROR routine is specified and one of the above conditions occurs, the programmer is notified of the condition and the job is cancelled.

Table 18. Meaning of Error Bytes for GIVING Option of Error Declarative (Part 2 of 2)

Device	Organization	ACCESS	OPEN	I/O Verb	Condition	Byte	Result
DASD	Direct	RANDOM	I/O	REWRITE	Wrong length record	2	Return to next statement; bad block written.
					Data check in count area	1	Return to next statement; bad block written.
					Data check in key and/or data	4	Return to next statement; bad block written.
DASD	Indexed	[SEQUENTIAL]	INPUT I-O	READ REWRITE	DASD error	1	Return to next statement; bad block read or written.
					Wrong length record	2	
				START	DASD error	1	Continued processing of file permitted.
			OUTPUT	WRITE	DASD error	1	Return to next statement; bad block written.
					Wrong length record	2	
					Prime data area full	3	File must be closed.
					Cylinder index full	4	File must be closed.
					Master index full	5	File must be closed.
DASD	Indexed	RANDOM	INPUT I-O	READ REWRITE	DASD error	1	Return to next statement; bad block read or written.
					Wrong length record	2	
			I-O	WRITE	DASD error	1	Return to next statement; bad block written.
					Wrong length record	2	
					Overflow area full	6	Files must be closed.

Note: If no USE AFTER STANDARD ERROR routine is specified and one of the above conditions occurs, the programmer is notified of the condition and the job is cancelled.

If the programmer includes a USE AFTER STANDARD ERROR routine without specifying the GIVING option, he must call an assembler language routine within the declarative if he wishes to interrogate the error bits -- set either in the DTF (DTFMT, DTFSD, or DTFIS) or in the fields preceding the DTF (DTFDA).

Interrogation of these error bits should be made to the locations shown in Tables 19, 20, 21, and 22.

Note: The byte and bit displacement in Tables 19, 20, 21, and 22 is relative to zero.

Table 19. Location and Meaning of Error Bits for DTFMT

OPEN	Verb	Condition	Byte*	Bit
INPUT	READ	Wrong length record	3	1
		Parity error	2	6
OUTPUT	WRITE	Wrong length record	3	1
		Parity error	2	6
*Within the DTF.				

Table 20. Location and Meaning of Error Bits for DTFSD

OPEN	Verb	Condition	Byte*	Bit
INPUT, I-O	READ	Wrong length record	3	1
		Parity error	2	6
OUTPUT, I-O	WRITE	Parity error	2	6
*Within the DTF.				

Table 21. Location and Meaning of Error Bits for DTFDA

ACCESS	OPEN	Verb	Condition	Byte*	Bit
[SEQUENTIAL]	INPUT	READ	Wrong length record	0	1
			Data check in count area	1	0
			Data check in key or data	1	3
			No record found	1	2 or 4
RANDOM	INPUT, I-O	READ	Same as sequential		
	OUTPUT	WRITE	Wrong length record	0	1
			No room found	0	4
			Data check in count area	1	0
			Data check in key or data	1	3
	I-O	REWRITE	Wrong length record	0	1
			Data check in count area	1	0
			Data check in key or data	1	3
			No record found	1	2 or 4
*Within error bytes preceding DTF. See the section "DTF Tables" for the location of these bytes.					

Table 22. Location and Meaning of Error Bits for DTFIS

ACCESS	OPEN	Verb	Condition	Byte*	Bit
[SEQUENTIAL]	INPUT, I-O	READ	DASD error	30	0
			Wrong length record	30	1
	OUTPUT	WRITE	DASD error	30	0
			Wrong length record	30	1
			Prime data area full	30	2
			Cylinder index full	30	3
			Master index full	30	4
RANDOM	INPUT, I-O	READ REWRITE	DASD error	30	0
			Wrong length record	30	1
	I-O	WRITE	DASD error	30	0
			Wrong length record	30	1
			Overflow area full	30	6
*Within the DTF.					

The following should be considered when processing tape input files:

1. Two types of errors are returned to the programmer: wrong length record and parity check. The COBOL error bytes, if requested, are set to reflect the error condition and control is transferred to the USE AFTER STANDARD ERROR declarative sentence. The error block is made available at data-name-2 of the GIVING option, if specified.

   If a parity error is detected when a block of records is read, the tape is backspaced and reread 100 times before control is returned to the programmer. If the error persists, the block is considered an error block and is added to the block count found in the DTF table.

2. Normal return (to the non-declarative portion) from a USE AFTER STANDARD ERROR declarative section is through the invoked IOCS subroutine. Thus, the next sequential block is brought into main storage permitting continued processing of the file. (The error block is bypassed.) A return through the use of a GO TO statement does not bring the next block into main storage; therefore, it is impossible to continue processing the file.

The processing of a sequential disk file opened as input is the same as the previous discussion of tape files, except that the disk block is reread ten times before being considered an error block.

COBOL cannot handle nested errors on sequential files. If errors occur within an error declarative, results are unpredictable.

VOLUME AND FILE LABEL HANDLING

TAPE LABELS

Among the several types of tape labels allowed under the Disk Operating System are: volume labels, standard file labels, user standard labels, and nonstandard labels. Unlabeled files are also permitted. The description of each type of label follows.

Volume Labels

A volume label is used whenever standard file labels are used. Logical IOCS requires a volume label with VOL1 as its first four characters on every standard or user standard labeled file. VOL2-VOL8 are also allowed, but must be written and checked by the programmer.

Standard File Labels

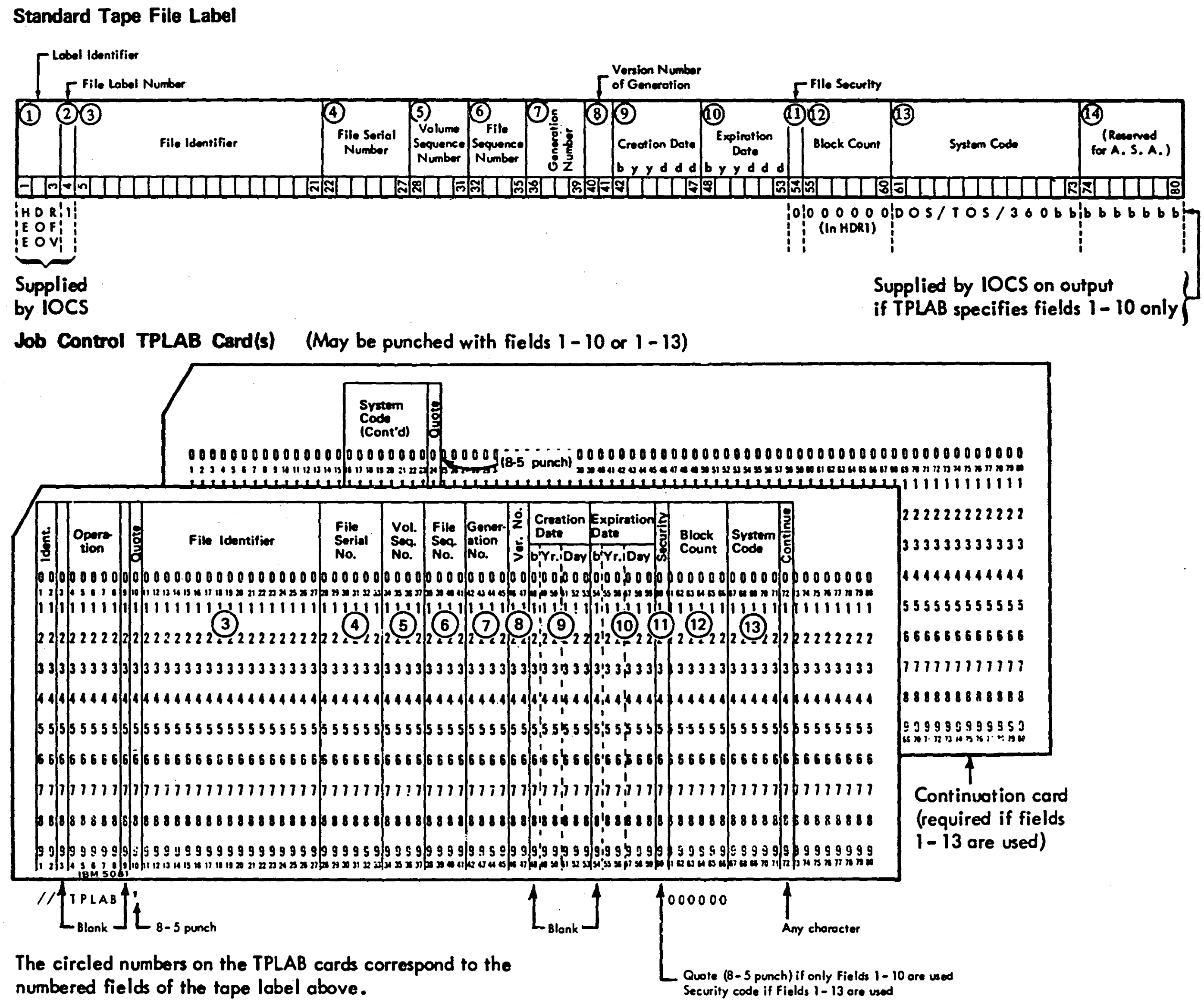
A standard file label is an 80-character label created when an output file is opened or closed, in part by IOCS using the VOL and TPLAB or TLBL control statements. The first three characters are HDR (header), EOV (end-of-volume), or EOF (end-of-file). The fourth character is a 1, indicating the first of a possible eight labels. The remainder of the label is formatted into fields describing the file. Labels 2 through 8 in this field are bypassed on input, and are not created on output under the Disk Operating System. The contents of the fields of a standard file label are described in "Appendix B: Standard Tape File Labels." The relationship between the TPLAB statement and a standard file label is shown in Figure 34. The relationship between the TLBL statement and a standard file label is shown in Figures 35 and 36.

User Standard Labels

A user standard label is an 80-character label having UHL (user header label) or UTL (user trailer label) in the first three positions. The fourth position contains a number 1 through 8 which represents the relative position of the user label within a group of user labels. The contents of the remaining 76 positions are entirely up to the programmer. User labels, if present, follow HDR, EOV, or EOF standard labels. On multivolume files, they may also appear at beginning-of-volume. User header labels are resequenced starting with one (UHL1) at the beginning of a new volume. Figure 37 shows the positioning of user labels on a file.

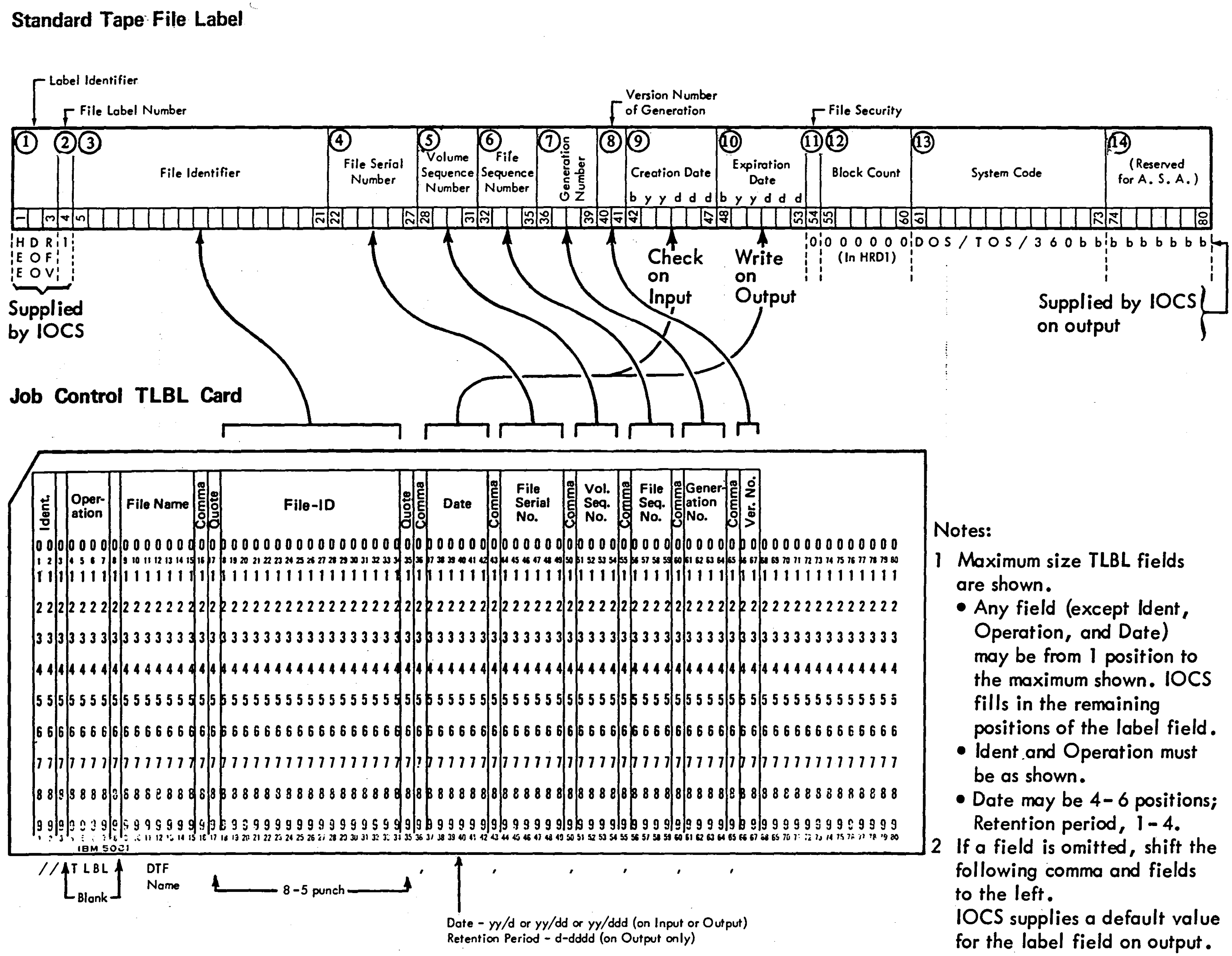
Nonstandard Labels

A nonstandard label may be any length. The contents of a nonstandard label is entirely programmer-dependent. It is the COBOL programmer's responsibility either to process or bypass nonstandard labels on input and to create them on output. Figure 38 shows the positioning of nonstandard labels on a file.



The circled numbers on the TPLAB cards correspond to the numbered fields of the tape label above.

Figure 34. Standard Tape File Label and TPLAB Cards



Notes:

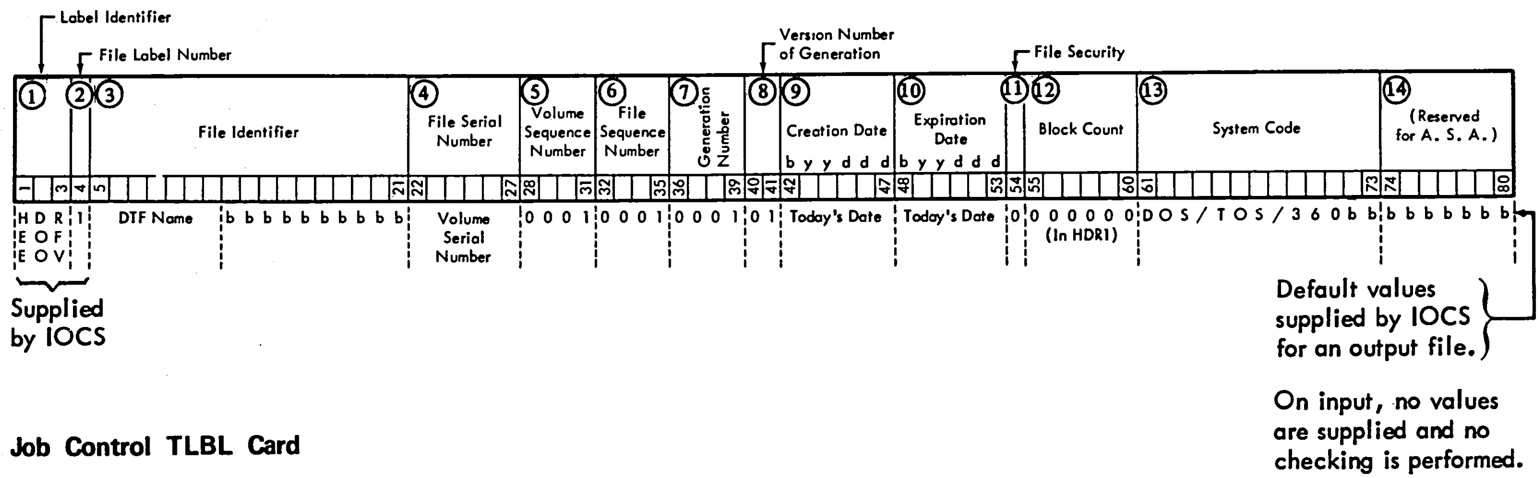
1 Maximum size TLBL fields are shown.
- Any field (except Ident, Operation, and Date) may be from 1 position to the maximum shown. IOCS fills in the remaining positions of the label field.
- Ident and Operation must be as shown.
- Date may be 4-6 positions; Retention period, 1-4.

2 If a field is omitted, shift the following comma and fields to the left. IOCS supplies a default value for the label field on output.

3 No comma follows the last field used.

Figure 35. Standard Tape File Label and TLBL Card (Showing Maximum Specifications)

Standard Tape File Label



Job Control TLBL Card

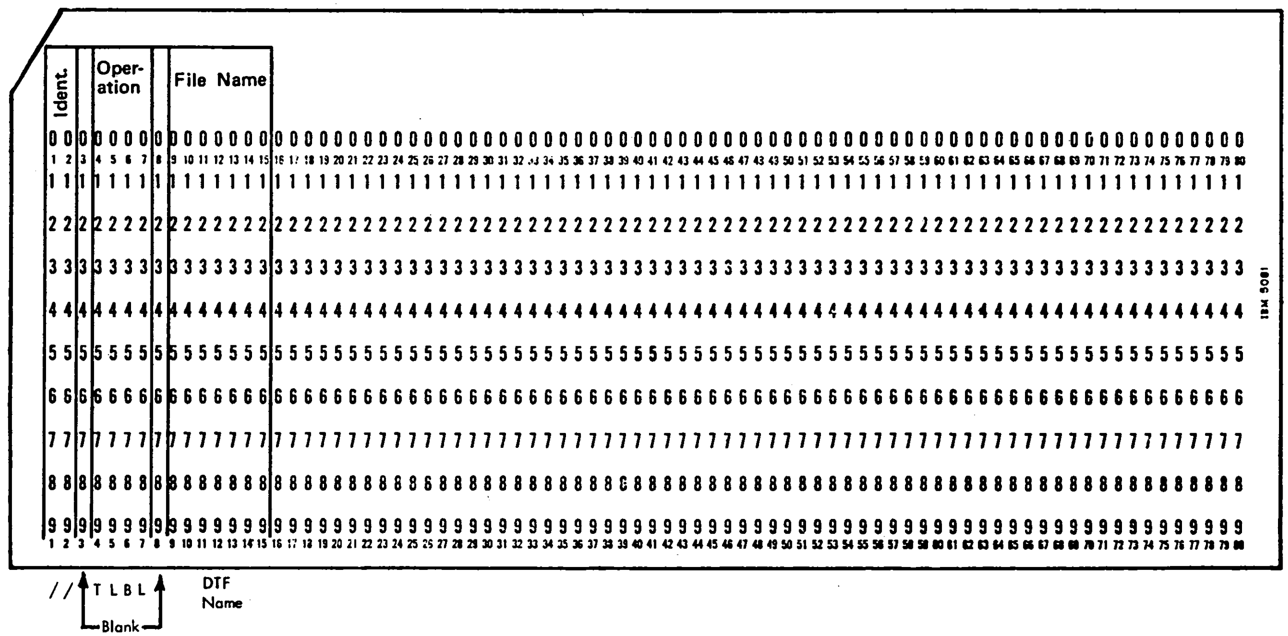


Figure 36. Standard Tape File Label and TLBL Card (Showing Minimum Requirements)

LABEL PROCESSING CONSIDERATIONS

The labels which may appear on tape are shown in Figures 37 and 38. The compiler allows the programmer to work with all the previously mentioned labels as well as with unlabeled files.

If user standard labels are to be created or checked in the COBOL program, the USE AFTER BEGINNING/ENDING LABELS declarative sentence and the LABEL RECORDS clause with the <u>data-name</u> option must be specified.

```
Load Point Marker
  |
  V
          R N   N R N   N P   P R           R R N   N P   P R R N   N P   P R
  ---------------------------------------------------------------------------------
  |--     |V|V|-|V|H|H|-|H|U|-|U| |          | |E|E|-|E|U|-|U| |H|H|-|H|U|-|U| |
  |       |O|O|-|O|D|D|-|D|H|-|H|T|          |T|O|O|-|O|T|-|T|T|D|D|-|D|H|-|H|T|
  |       |L|L|-|L|R|R|-|R|L|-|L|M| FILE #1  |M|F|F|-|F|L|-|L|M|R|R|-|R|L|-|L|M| FILE #2
  |       |1|2|-|8|1|2|-|8|1|-|8| |          | |1|2|-|8|1|-|8| |1|2|-|8|1|-|8| |
  ---------------------------------------------------------------------------------

End of Tape Marker
               |
               |
                R R N   N P   P R R
  ---------------------------------------------
              --| |E|E|-|E|U|-|U| | |
     FILE #2    |T|O|O|-|O|T|-|T|T|T|
                |M|V|V|-|V|L|-|L|M|M|
                | |1|2|-|8|1|-|8| | |
  ---------------------------------------------

Notes:  R = Required, processed by IOCS.
        N = Permitted, but not written or checked, by IOCS and not available to user.
        P = Processed by IOCS and available to user.
```

Figure 37. Standard, User Standard, and Volume Labels

```
Load Point Marker
  |
  V
                  O          R       C
  ---------------------------------------------
  |--      |L| |L| |         | |L| |L| |
  |        |A| |A| |         | |A| |A| |
  |        |B|-|B|T|         |T|B|-|B|T|
  |        |E| |E|M| FILE #1 |M|E| |E|M|
  |        |L|-|L| |         | |L|-|L| |
  |        |S| |S| |         | |S| |S| |
  ---------------------------------------------

Notes:  R = Required, processed by IOCS.
        O = Optional.
        C = Written by COBOL compiler.
```

Figure 38. Nonstandard Labels

Header labels are written or read when the file is opened or when a volume switch occurs. Trailer labels are written when the physical end of the reel is reached, or when a CLOSE REEL or CLOSE file-name is issued. Trailer labels are read on each reel except the last when a tapemark is reached. For the last reel (i.e., EOF labels), trailer labels are not read until the file is closed.

For multivolume input files with nonstandard labels, the programmer must specify the integer-1 option of the source language ASSIGN clause, where integer-1 is the number of reels in the file. This number can be overridden at execution time by storing a nonzero integer in the special register NSTD-REELS before opening the file. The number of reels is available to the programmer while the file is opened both in the special register NSTD-REELS and in the field reserved for this purpose which precedes the DTF table for DTFMT (see "DTF Tables" in this chapter). In addition, the number of reels remaining after each volume switch can also be found in the field reserved for this purpose which precedes the DTF table for DTFMT.

When processing a multivolume file with nonstandard labels (i.e., when the data-name option of the LABEL RECORDS clause is specified), if the programmer wishes to stop reading or writing before the physical end of a reel is reached, he must set a switch in the appropriate declarative section. In the Procedure Division, he can either CLOSE REEL or CLOSE FILE depending on the switch setting. Volume switching is done by LIOCS when CLOSE REEL is executed.

Sample Programs

Figure 39 illustrates the manner in which unlabeled input files on a multifile volume are processed by a COBOL program. The input volume contains four files, only three of which are being used by the program. This unused file, which resides between the first and third file on the volume, must be bypassed during file processing. The program creates a single multivolume file with standard labels.

(1) All input files residing on the same volume are assigned to the same symbolic unit.

(2) The second file on the input reel is not used in this program and is bypassed through use of the POSITION option of the MULTIPLE FILE TAPE clause.

(3) The first and second input files are closed by the execution of the CLOSE statement with the NO REWIND option, leaving the tape positioned in mid-reel for the next OPEN.

(4) All volumes with the exception of the last volume of the multivolume output file are closed by a close statement with the REEL OPTION. Volume switching is performed as noted in Step (8).

(5) The second and third input files processed by the program are opened by an OPEN statement with the NO REWIND option.

(6) At job completion, a standard CLOSE is issued to reposition the tapes of the closed files at their physical beginnings.

(7) An LBLTYP control statement is included because a tape file requiring label information is to be processed.

(8) Alternate assignments have been made for SYS011. Because there alternate assignments are in the sequence in which the ASSGN statements are submitted, the first volume of the output file will be on tape drive 282, the second on 283, and the third on 181. When the first CLOSE OUT-PUT REEL statement is executed, a standard EOV label is written on the volume assigned to drive 282 and the reel is rewound and positioned at its physical beginning. The next WRITE RECO statement executed will then be written on the volume mounted on drive 283.

(9) Although the file OUT-PUT consists of multiple volumes, only one TLBL control statement need be submitted.

Figure 40 is a sample program that illustrates the manner in which the multivolume file created in Figure 39 is read as an input file. The sample program also creates a multifile volume with standard labels.

(1) All output files residing on the same volume are assigned to the same symbolic unit.

The name field of the system-name in the ASSIGN clause is specified. This is the external-name by which the file is known to the system. When specified, it is the name that appears in the filename field of the VOL, DLBL, or TLBL job control statements.

(2) For the multivolume input file IN-PUT, the AT END option of the READ statement applies only to the last volume containing the EOF label. For prior volumes containing EOV labels, automatic volume switching will take place as indicated in the ASSGN control statements pertaining to the file IN-PUT.

(3) The first and second file written on the volume are closed using the NO REWIND option of the CLOSE statement. This option leaves the tape positioned in mid-reel following the EOF label of the file just closed.

(4) At job's completion, a standard CLOSE is issued to reposition the tapes of the closed files at their physical beginning.

(5) A LBLTYP control statement is included because tape files requiring label information label information are being processed.

(6) There are three TLBL control statements for the volume assigned to SYS013, one for each file referenced on the volume. The filename field of the TLBL control statements for these files contains the names used in the ASSIGN clauses of the COBOL source program, not the programmer logical unit name.

(7) Alternate assignments have been made for SYS012 to handle the multiple volumes of the file IN-PUT.

Figure 41 illustrates the creation of an unlabeled multivolume file. The number of output volumes is determined dynamically during program execution. The program's input consists of the labeled multivolume file created in Figure 40.

(1) All input files residing on the same volume are assigned to the same symbolic unit. The name field of the system-name of the ASSIGN clause is specified. These names will appear on the TLBL control statements that refer to these files.

The MULTIPLE FILE TAPE clause is not required for the multifile volume because each file is being processed in the sequence in which it appears on the reel. A rewind will not be executed for any file on the reel except for that processed last.

(2) The CLOSE statement for files IN-PUT-1 and IN-PUT-2, and the OPEN statement for files IN-PUT-2 and IN-PUT-3, use the NO REWIND option. This leaves the tape positioned in mid-reel for the multifile volume's next OPEN statement.

(3) When it has been determined from the input data that a new output reel is required for the multivolume output file, a CLOSE OUT-PUT REEL statement is executed, processing is halted, and a message is issued to the operator which requests a new volume to be mounted.

(4) At job's completion, a standard CLOSE is issued to reposition the tapes of the closed file at their physical beginning.

(5) An LBLTYP control statement is included because tape files requiring label information are being processed.

(6) There are three TLBL control statements for the volume assigned to SYS014, one for each file referenced on the volume. The filename field of the TLBL control statements for these files contains the names used in the ASSIGN clauses of the source program and not the programmer logical unit names.

(7) Only one tape drive is assigned to the multivolume file OUT-PUT. Therefore, each time a volume is closed, processing must be halted and the operator informed to mount a new tape. This is illustrated in Step (3).

```
// JOB SAMPLE
*  UNLABELED MULTIFILE VOLUME TO MULTIVOLUME FILE WITH STANDARD LABELS
// OPTION LOG,DUMP,LINK,LIST,LISTX,XREF,SYM,ERRS,NODECK
// EXEC ECOBOL


IDENTIFICATION DIVISION.
PROGRAM-ID. SAMPLE-1.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. IBM-360-F50.
OBJECT-COMPUTER. IBM-360-F50.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT INPUT1 ASSIGN TO SYS010-UT-2400-S-FILE1.
    SELECT INPUT2 ASSIGN TO SYS010-UT-2400-S-FILE2.  1
    SELECT INPUT3 ASSIGN TO SYS010-UT-2400-S-FILE3.
    SELECT OUT-PUT ASSIGN TO SYS011-UT-2400-S.
I-O-CONTROL.
    MULTIPLE FILE TAPE CONTAINS INPUT1 POSITION 1
                                INPUT2 POSITION 3  2
                                INPUT3 POSITION 4.
DATA DIVISION.
FILE SECTION.
FD  INPUT1
    RECORD CONTAINS 80 CHARACTERS
    LABEL RECORD IS OMITTED.
01  REC1 PIC X(80).
FD  INPUT2
    RECORD CONTAINS 80 CHARACTERS
    LABEL RECORD IS OMITTED.
01  REC2 PIC X(80)
FD  INPUT3
    RECORD CONTAINS 80 CHARACTERS
    LABEL RECORD IS OMITTED.
01  REC3 PIC X(80).
FD  OUT-PUT
    RECORD CONTAINS 80 CHARACTERS
    BLOCK CONTAINS 3 RECORDS
    LABEL RECORD IS STANDARD.
01  REC0 PIC X(80).
PROCEDURE DIVISION.
    OPEN INPUT INPUT1 OUTPUT OUT-PUT.
READ1.
    READ INPUT1 INTO REC0 AT END GO TO CLOSE1.
A.  WRITE REC0.
B.  GO TO READ1.
CLOSE1.
    CLOSE INPUT1 WITH NO REWIND. 3
C.  CLOSE OUT-PUT REEL. 4
D.  OPEN INPUT INPUT2 WITH NO REWIND. 5
READ2.
    READ INPUT2 INTO RECO AT END GO TO CLOSE2.
    PERFORM A.
    GO TO READ2.
CLOSE2.
    CLOSE INPUT2 WITH NO REWIND. 3
    PERFORM C.
    OPEN INPUT INPUT3 WITH NO REWIND. 5
```

Figure 39. Processing an Unlabeled Multifile Volume (Part 1 of 2)

```
READ3.
     READ INPUT3 INTO RECO AT END GO TO CLOSE3.
     PERFORM A.
     GO TO READ3.
CLOSE3.
     CLOSE INPUT3 OUT-PUT. 6
     STOP RUN.

// LBLTYP TAPE 7
// EXEC LNKEDT


// ASSGN SYS010,X'281'
// ASSGN SYS011,X'282'
// ASSGN SYS011,X'283',ALT   } 8
// ASSGN SYS011,X'181',ALT
// TLBL SYS011,'MULTI-VOL FILE',99/214 9
// EXEC
```

Figure 39. Processing an Unlabeled Multifile Volume (Part 2 of 2)

```
// JOB SAMPLE
*  LABELED MULTIVOLUME FILE TO LABELED MULTIFILE VOLUME
// OPTION LOG,DUMP,LINK,LIST,LISTX,XREF,SYM,ERRS,NODECK
// EXEC FCOBOL


000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. SAMPLE-2.
000030 ENVIRONMENT DIVISION.
000040 CONFIGURATION SECTION.
000050 SOURCE-COMPUTER. IBM-360-F50.
000060 OBJECT-COMPUTER. IBM-360-F50.
000060 INPUT-OUTPUT SECTION.
000080 FILE-CONTROL.
000090     SELECT IN-PUT ASSIGN TO SYS012-UT-2400-S.
000100     SELECT OUT-PUT1 ASSIGN TO SYS013-UT-2400-S-FILE1.
000110     SELECT OUT-PUT2 ASSIGN TO SYS013-UT-2400-S-FILE2.   1
000120     SELECT OUT-PUT3 ASSIGN TO SYS013-UT-2400-S-FILE3.
000130 DATA DIVISION.
000140 FILE SECTION.
000150 FD  IN-PUT
000160     RECORD CONTAINS 80 CHARACTERS
000170     BLOCK CONTAINS 3 RECORDS
000180     LABEL RECORD IS STANDARD.
000190 01  IN-REC.
000200     05  FILLER PIC X(4).
000210     05  CODA PIC X.
000220     05  FILLER PIC X(6).
000230     05  CODB PIC X.
000240         88  SW-FIL1 VALUE '9'.
000250         88  SW-FIL2 VALUE '8'.
000260     05  FILLER PIC X(68).
000270 FD  OUT-PUT1
000280     RECORD CONTAINS 80 CHARACTERS
000290     BLOCK CONTAINS 3 RECORDS
000300     LABEL RECORD IS STANDARD.
000310 01  OUT-REC1 PIC X(80).
000320 FD  OUT-PUT2
000330     RECORD CONTAINS 80 CHARACTERS
000340     BLOCK CONTAINS 3 RECORDS
000350     LABEL RECORD IS STANDARD.
000360 01  OUT-REC2 PIC X(80).
000370 FD  OUT-PUT3
000380     RECORD CONTAINS 80 CHARACTERS
000390     BLOCK CONTAINS 3 RECORDS
000400     LABEL RECORD IS STANDARD.
000410 01  OUT-REC3 PIC X(80).
000420 WORKING-STORAGE SECTION.
000430 77  TAPE-NUMBER PIC 9 VALUE 0.
000440 PROCEDURE DIVISION.
000450     OPEN INPUT IN-PUT OUTPUT OUT-PUT1.
```

Figure 40. Reading a Multivolume File with Standard Labels; Creating a Multifile Volume with Standard Labels (Part 1 of 2)

```
000460 READ-IN.
000470     READ IN-PUT AT END GO TO END-OF-JOB. (2)
000480 A.  MOVE IN-REC TO OUT-REC1.
000490     WRITE OUT-REC1.
000500     IF SW-FILL NEXT SENTENCE ELSE GO TO READ-IN.
000510     CLOSE OUT-PUT1 WITH NO REWIND. (3)
000520     OPEN OUTPUT OUT-PUT2.
000530     ADD 1 TO TAPE-NUMBER.
000540 B.  PERFORM READ-IN.
000550     MOVE IN-REC TO OUT-REC2.
000560     WRITE OUT-REC2.
000570     IF SW-FIL2 NEXT SENTENCE ELSE GO TO B.
000580     CLOSE OUT-PUT2 WITH NO REWIND. (3)
000590     OPEN OUTPUT OUT-PUT3.
000600     ADD 1 TO TAPE-NUMBER.
000610 C.  PERFORM READ-IN.
000620     MOVE IN-REC TO OUT-REC3.
000630     WRITE OUT-REC3.
000640     GO TO C.
000650 END-OF-JOB.
000660     CLOSE IN-PUT.
000670     IF TAPE-NUMBER = 0 CLOSE OUT-PUT1 GO TO D.                        } (4)
000680     IF TAPE-NUMBER = 1 CLOSE OUT-PUT2 ELSE CLOSE OUT-PUT3.            }
000690 D.  STOP RUN.


// LBLTYP TAPE (5)
// EXEC LNKEDT


// ASSGN SYS013,X'182'
// TLBL FILE1,'MULTI-FILE1 VOL'  }
// TLBL FILE2,'MULTI-FILE2 VOL'  } (6)
// TLBL FILE2,'MULTI-FILE3 VOL'  }
// ASSGN SYS012,X'282'           }
// ASSGN SYS012,X'283',ALT       } (7)
// ASSGN SYS012,X'181',ALT       }
// TLBL SYS012,'MULTI-VOL FILE'
// EXEC
```

Figure 40. Reading a Multivolume File with Standard Labels; Creating a Multifile Volume with Standard Labels (Part 2 of 2)

```
// JOB SAMPLE
*  LABELED MULTIFILE VOLUME TO UNLABELED MULTIVOLUME FILE
// OPTION LOG,DUMP,LINK,LIST,LISTX,XREF,SYM,ERRS,NODECK
// EXEC FCOBOL
000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. SAMPLE-3.
000030 ENVIRONMENT DIVISION.
000040 CONFIGURATION SECTION.
000050 SOURCE-COMPUTER. IBM-360F50.
000060 OBJECT-COMPUTER. IBM-360-F50.
000070 INPUT-OUTPUT SECTION.
000080 FILE-CONTROL.
000090     SELECT IN-PUT-1 ASSIGN TO SYS014-UT-2400-S-FILE1.
000100     SELECT IN-PUT-2 ASSIGN TO SYS014-UT-2400-S-FILE2.  1
000110     SELECT IN-PUT-3 ASSIGN TO SYS014-UT-2400-S-FILE3.
000120     SELECT OUT-PUT ASSIGN TO SYS015-UT-2400-S.
000130 DATA DIVISION.
000140 FILE SECTION.
000150 FD  IN-PUT-1
000160     RECORD CONTAINS 80 CHARACTERS
000170     BLOCK CONTAINS 3 RECORDS
000180     LABEL RECORD IS STANDARD.
000190 02  IN-REC1 PIC X(80).
000200 FD  IN-PUT-2
000210     RECORD CONTAINS 80 CHARACTERS
000220     BLOCK CONTAINS 3 RECORDS
000230     LABEL RECORD IS STANDARD.
000240 01  IN-REC2 PIC X(80).
000250 FD  IN-PUT-3
000260     RECORD CONTAINS 80 CHARACTERS
000270     BLOCK CONTAINS 3 RECORDS
000280     LABEL RECORD IS STANDARD.
000290 01  IN-REC3 PIC X(80).
000300 FD  OUT-PUT
000310     RECORD CONTAINS 80 CHARACTERS
000320     BLOCK CONTAINS 3 RECORDS
000330     LABEL RECORD IS OMITTED.
000340 01  OUT-REC.
000350     05  FILLER PIC X(4).
000360     05  CODA PIC X.
000370         88  HI VALUE '9'.
000380     05  FILLER PIC X(6).
000390     05  CODB PIC X.
000400         88  LO VALUE '8'.
000410     05  FILLER PIC X(68).
000420 PROCEDURE DIVISION.
000430     OPEN INPUT IN-PUT-1 OUTPUT OUT-PUT.
000440 IN-1.
000450     READ IN-PUT-1 INTO OUT-REC AT END GO TO CLOSE1.
000460 TESTER.
000470     IF HI AND LO PERFORM CLOSE-OUT ELSE WRITE OUT-REC.  3
000480 A.  GO TO IN-1.
000490 CLOSE1.
000500     CLOSE IN-PUT-1 WITH NO REWIND.      2
000510     OPEN INPUT IN-PUT-2 WITH NO REWIND.
000520 IN-2.
000530     READ IN-PUT-2 INTO OUT-REC AT END GO TO CLOSE2.
000540     PERFORM TESTER.
000550     GO TO IN-2.
```

Figure 41. Creating an Unlabeled Multivolume File (Part 1 of 2)

```
 CLOSE2.
     CLOSE IN-PUT-2 WITH NO REWIND.                     2
     OPEN INPUT IN-PUT-3 WITH NO REWIND.
 IN-3.
     READ IN-PUT-3 INTO OUT-REC AT END GO TO CLOSE3.
     PERFORM TESTER.
     GO TO IN-3.
 CLOSE-OUT.
     CLOSE OUT-PUT REEL.                                            3
     STOP 'REMOVE TAPE ON SYS015 AND MOUNT NEW TAPE'.
 CLOSE3.
     CLOSE IN-PUT-3 OUT-PUT. 4
     STOP RUN.


// LBLTYP TAPE  5
// EXEC LNKEDT


// ASSGN SYS014,X'182'
// TLBL FILE1,'MULTI-FILE1 VOL'
// TLBL FILE2,'MULTI-FILE2 VOL'  6
// TLBL FILE3,'MULTI-FILE3 VOL'
// ASSGN SYS015,X'282' 7
// EXEC
```

Figure 41. Creating an Unlabeled Multivolume File (Part 2 of 2)

MASS STORAGE FILE LABELS

The IBM System/360 Disk Operating System provides postive identification and protection of all files on mass storage devices by recording labels on each volume. These labels ensure that the correct volume is used for input, and that no current information is destroyed on output.

The mass storage labels always include one volume label for each volume and one or more file labels for each logical file on the volume. There may also be user header labels and user trailer labels.

Volume Labels

The volume label is an 80-byte data field preceded by a 4-byte key field. Both the key field and the first four bytes of the data field contain the label identifier VOL1. IOCS creates a standard volume label for every volume processed by the Disk Operating System. It is always the third record on cylinder 0, track 0. The format and contents of a standard volume label can be found in the publication DOS Data Management Concepts.

Standard File Labels

A standard file label identifies a particular logical file, gives its location(s) on the mass storage device, and contains information to prevent premature destruction of current files. A standard file label for a file located on a mass storage device is a 140-character label created (OPEN/CLOSE OUTPUT) in part by IOCS using the VOL and DLAB, or DLBL control statements. The fields contained within the label follow three standard formats.

1. Format 1 is used for all logical files. The contents of the fields of a Format 1 label is discussed in "Appendix C: Standard Mass Storage Device Labels."

2. Format 2 is required for indexed files. The contents of the fields of a Format 2 label can be found in the publication DOS Data Management Concepts.

3. Format 3 is required if a logical file uses more than three extents of any volume. The contents of the fields of a Format 3 label can be found in the publication DOS Data Management Concepts.

User Labels

The programmer can include additional labels to further define his file. The labels are referred to as user standard labels. They cannot be specified for indexed files. A user label is an 80-character label containing UHL (user header label) or UTL (user trailer label) in the first three character positions. The fourth position contains a number 1 through 8 which represents the relative position of the user label with a group of user labels. The contents of the remaining 76 positions is entirely up to the programmer. User header and trailer labels are written on the first track of the first extent of each volume allocated by the programmer for the file. User header labels are resequenced starting with one (UHL1) at the beginning of each new volume.

LABEL PROCESSING CONSIDERATIONS

Files on Mass Storage Device Opened as Input

1. Standard labels checked

   a. The volume serial numbers in the volume labels are compared to the file serial numbers in the EXTENT (or XTENT) cards.

   b. Fields 1 through 3 in Format 1 label are compared to the corresponding fields in the DLBL (or DLAB) card. Fields 4 through 6 are then checked against their EBCDIC equivalents in the DLAB continuation card.

   c. Each of the extent definitions in the Format 1 and Format 3 labels is checked against the limit fields supplied in the EXTENT (or XTENT) cards.

2. User labels checked

   a. If user header labels are indicated for directly or sequentially organized files, they are read as each volume of the file is opened. After reading each label, the OPEN routine branches to the programmer's label routine if the appropriate USE AFTER STANDARD LABEL PROCEDURE declarative is specified in the source program. The LABEL RECORDS clause with the data-name option must be specified in the Data

Division. The programmer's label routine then performs any processing required.

b. If user trailer labels are indicated on a sequential file, they are read after reaching the end of the last extent on each volume when the file is closed, provided end-of-file has been reached. Trailer labels are processed by the programmer's label routine if the appropriate USE AFTER STANDARD LABEL PROCEDURE declarative is specified in the source program. The LABEL RECORDS clause with the data-name option must be specified in the Data Division.

Files on Mass Storage Devices Opened as Output

1. Standard labels created

   a. The volume serial numbers in the volume labels are compared to the file serial numbers in the EXTENT (or XTENT) cards.

   b. The extent definitions in all current labels on the volume are checked to determine whether any extend into those defined in the EXTENT (or XTENT) cards. If any overlap, the expiration date is checked against the current date in the Communication Region of the Supervisor. If the expiration date has passed, the old labels are deleted. If not, the operator is notified of the condition.

   c. The new Format 1 label is written with information supplied in the DLBL card (or the DLAB card and the DLAB continuation card). If an indexed file is being processed, the DTFIS routine supplies information for the Format 2 label.

   d. The information in the EXTENT (or XTENT) cards is placed in the Format 1 labels and, if necessary, in the additional Format 3 labels.

2. User header labels created

   a. If user header labels are indicated by the presence of the appropriate USE AFTER STANDARD LABEL PROCEDURE declarative and the LABEL RECORDS clause with the data-name option, the programmer's label routine is entered to furnish the labels as each volume of the file is opened. This can be done for as many as eight user header labels per volume. As each label is presented, IOCS writes it out on the first track of the first extent of the volume.

   b. If user trailer labels are indicated by the presence of the appropriate USE AFTER STANDARD LABEL PROCEDURE declarative and the LABEL RECORDS clause with the data-name option, the programmer's label routine is entered to furnish the labels when the end of the last extent on each volume is reached. This can be done for as many as eight user trailer labels. The CLOSE statement must be issued to create trailer labels for the last volume of a sequential file or for a direct file.

UNLABELED FILES

When a multivolume tape file is opened as INPUT and integer as specified in the ASSIGN clause is greater than 1, the compiler will generate the following message to the operator:

    C126D IS IT EOF?

The operator must respond either with N if it is not the last reel, or with Y if it is the last reel. If it is end-of-file, control passes to the imperative-statement specified in the AT END phrase of the READ statement; if it is not end-of-file, processing of the next volume is initiated.

If the integer specified in the ASSIGN clause is not greater than 1, control always passes at end-of-volume to the imperative-statement specified in the AT END phrase of the READ statement.

Logical records may be in one of four formats: fixed-length (format F), variable-length (format V), undefined (format U), or spanned (format S). F-mode files must contain records of equal lengths. Files containing records of unequal lengths must be V-mode, S-mode, or U-mode. Files containing logical records that are longer than physical records must be S-mode.

The record format is specified in the RECORDING MODE clause in the Data Division. If this clause is omitted, the compiler determines the record format from the record descriptions associated with the file. If the file is to be blocked, the BLOCK CONTAINS clause must be specified in the Data Division.

The prime consideration in the selection of a record format is the nature of the file itself. The programmer knows the type of input his program will receive and the type of output it will produce. The selection of a record format is based on this knowledge as well as an understanding of the type of input/output devices on which the file is written and of the access method used to read or write the file.

FIXED-LENGTH (FORMAT F) RECORDS

Format F records are fixed-length records. The programmer specifies format F records by including RECORDING MODE IS F in the file description entry in the Data Division. If the clause is omitted and both of the following are true:

- All records in the file are the same size
- BLOCK CONTAINS [integer-1 TO] integer-2... does not specify integer-2 less than the length of the maximum level-01 record

the compiler determines the recording mode to be F. All records in the file are the same size if there is only one record description associated with the file and it contains no OCCURS clause with the DEPENDING ON option, or if multiple record descriptions are all the same length.

The number of logical records within a block (blocking factor) is normally constant for every block in the file. When fixed-length records are blocked, the programmer specifies the BLOCK CONTAINS clause in the file description entry in the Data Division.

In unblocked format F, the logical record constitutes the block. The BLOCK CONTAINS clause is unnecessary for unblocked records.

Format F records are shown in Figure 42. The optional control character, represented by C in Figure 42, is used for stacker selection and carriage control. When carriage control or stacker selection is desired, the WRITE statement with the ADVANCING or POSITIONING option is used to write records on the output file. In this case one character position must be included as the first character of the record. This position will be automatically filled in with the carriage control or stacker select character. The carriage control character never appears when the file is written on the printer or punched on the card punch.

```
                 Logical Record
        ┌───┬───────────────────────────┐
        │ C │           Data            │
        └───┴───────────────────────────┘

                 Blocked Records
     ┌────────────┬────────────┬────────────┐
     │  Logical   │  Logical   │  Logical   │
     │  Record    │  Record    │  Record    │
     └────────────┴────────────┴────────────┘
     <------------Fixed Length------------>

                 Unblocked Record
     ┌────────────────────────────────────────┐
     │             Logical Record             │
     └────────────────────────────────────────┘
     <------------Fixed Length------------>
```

Figure 42. Fixed-Length (Format F) Records

UNDEFINED (FORMAT U) RECORDS

Format U is provided to permit the processing of any blocks that do not conform to F or V formats. Format U records are shown in Figure 43. The optional control character C, as discussed under "Fixed-Length (Format F) Records," may be used in each logical record.

The programmer specifies format U records by including RECORDING MODE IS U in the file description entry in the Data Division. U-mode records may be specified only for directly organized or standard sequential files.

If the RECORDING MODE clause is omitted, and BLOCK CONTAINS [integer-1 TO] integer-2... does not specify integer-2 less than the maximum level-01 record, the compiler determines the recording mode to be U if the file is directly organized and one of the following conditions exist:

- The FD entry contains two or more level-01 descriptions of different lengths.
- A record description contains an OCCURS clause with the DEPENDING ON option.
- A RECORD CONTAINS clause specifies a range of record lengths.

Each block on the external storage media is treated as a logical record. There are no record-length or block-length fields.

Note: When a READ INTO statement is used for a U-mode file, the size of the longest record for that file is used in the MOVE statement. All other rules of the MOVE statement apply.

```
┌──────────────────────────────────────────┐
│              Logical Record              │
│    ┌───┬───────────────────────┐         │
│    │ C │         Data          │         │
│    └───┴───────────────────────┘         │
│                                          │
│              Format U Record             │
│  ┌─────────────────────────────────┐     │
│  │          Logical Record         │     │
│  └─────────────────────────────────┘     │
│                                          │
└──────────────────────────────────────────┘
```

Figure 43. Undefined (Format U) Records

VARIABLE-LENGTH (FORMAT V) RECORDS

The programmer specifies format V records by including RECORDING MODE IS V in the file description entry in the Data Division. V-mode records may only be specified for standard sequential files. If the RECORDING MODE clause is omitted and BLOCK CONTAINS [integer-1 TO] integer-2... does not specify integer-2 less than the maximum level-01 record, the compiler determines the recording mode to be V if the file is standard sequential and one of the following conditions exists:

- The FD entry contains two or more level 01 descriptions of different lengths.
- A record description contains an OCCURS clause with the DEPENDING ON option.
- A RECORD CONTAINS clause specifies a range of record lengths.

V-mode records, unlike U-mode or F-mode records, are preceded by fields containing control information. These control fields are illustrated in Figures 44 and 45.

The first four bytes of each block contain control information (CC):

LL -- represents two bytes designating the length of the block (including the 'CC' field).

BB -- represents two bytes reserved for system use.

The first four bytes of each logical record contain control information (cc):

ll -- represents two bytes designating the logical record length (including the 'cc' field).

bb -- represents two bytes reserved for system use.

For unblocked V mode records (see Figure 46) the data portion + CC + cc constitute the block.

```
┌──────────────────────────────────────────┐
│                                          │
│     4         4            variable      │
│<--bytes-><--bytes--><------bytes-------->│
│┌────┬────┬────┬────┬───────────────────┐ │
││ LL │ BB │ ll │ bb │       Data        │ │
│└────┴────┴────┴────┴───────────────────┘ │
│ └───┬───┘ └───┬───┘                      │
│   'CC'      'cc'                         │
│                                          │
└──────────────────────────────────────────┘
```

Figure 44. Unblocked V-Mode Records

For blocked V-mode records (see Figure 45) the data portion of each record + the cc of each record + CC constitute the block.

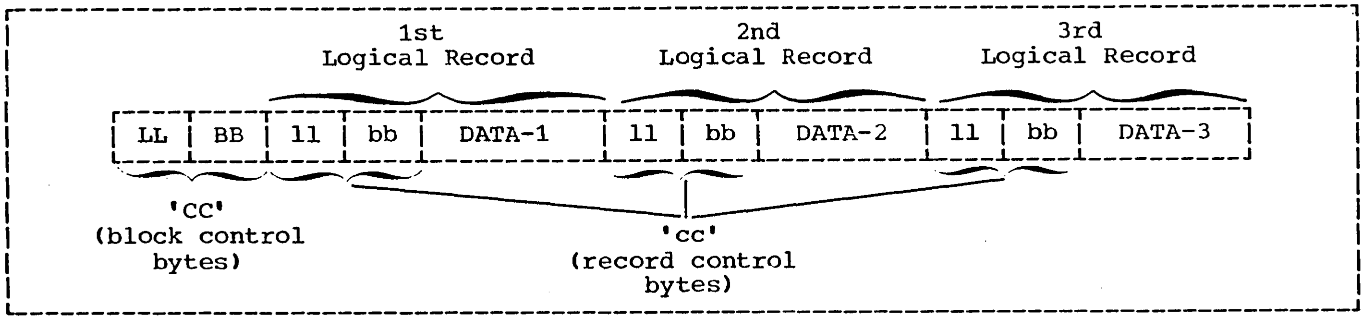


Figure 45. Blocked V-Mode Records

The control bytes are automatically provided when the file is written and are not communicated to the programmer when the file is read. Although they do not appear in the description of the logical record provided by the programmer, the compiler will allocate input and output buffers which are large enough to accomodate them. When variable-length records are written on unit record devices, control bytes are neither printed nor punched. They appear, however, on other external storage devices as well as in buffer areas of core storage. V-mode records moved from an input buffer to a working-storage area will be moved without the control bytes.

Note: When a READ INTO statement is used for a V-mode file, the size of the longest record for that file is used in the MOVE statement. All other rules of the MOVE statement apply.

Example 1:

Consider the following standard sequential file consisting of unblocked V-mode records:

```
FD  VARIABLE-FILE-1
    RECORDING MODE IS V
    BLOCK CONTAINS 35 TO 80 CHARACTERS
    RECORD CONTAINS 27 TO 72 CHARACTERS
    DATA RECORD IS VARIABLE-RECORD-1
    LABEL RECORDS ARE STANDARD.

01  VARIABLE-RECORD-1.
    05  FIELD-A      PIC X(20).
    05  FIELD-B      PIC 99.
    05  FIELD-C  OCCURS 1 TO 10 TIMES
        DEPENDING ON
        FIELD-B      PIC 9(5).
```

The LABEL RECORDS clause is always required. The DATA RECORD(S) clause is never required. If the RECORDING MODE clause is omitted, the compiler determines the mode as V since the record associated with VARIABLE-FILE-1 varies in length depending on the contents of FIELD-B. The RECORD CONTAINS clause is never required. The compiler determines record sizes from the record description entries. Record length calculations are affected by the following:

- When the BLOCK CONTAINS clause with the RECORDS option is used, the compiler adds four bytes to the logical record length and four more bytes to the block length.

- When the BLOCK CONTAINS clause with the CHARACTERS option is used, the programmer must include each cc + CC in the length calculation (see Figure 45). In the definition of VARIABLE-FILE-1, the BLOCK CONTAINS clause specifies 8 more bytes than does the record contains clause. Four of these bytes are the logical record control bytes and the other four are the block control bytes.

Assumming that FIELD-B contains the value 02 for the first record of a file and FIELD-B contains the value 03 for the second record of the file, the first two records will appear on an external storage device and in buffer areas of core storage as shown in Figure 46.

If the file described in Example 1 had a blocking factor of 2, the first two records would appear on an external storage medium as shown in Figure 47.

1st Block								2nd Block								
0040	BB	0036	bb	FIELD-A	02	FIELD-C	FIELD-C	0045	BB	0041	bb	FIELD-A	03	FIELD-C	FIELD-C	FIELD-C

Note: Lengths appear in decimal notation for illustrative purposes.

Figure 46. Fields in Unblocked V-Mode Records

		1st Record						2nd Record						
0081	BB	0036	bb	FIELD-A	02	FIELD-C	FIELD-C	0041	bb	FIELD-A	03	FIELD-C	FIELD-C	FIELD-C

Note: Lengths appear in decimal notation for illustrative purposes.

Figure 47. Fields in Blocked V-Mode Records

Example 2:

If VARIABLE-FILE-2 is blocked, with space allocated for three records of maximum size per block, the following FD entry could be used when the file is created:

```
FD  VARIABLE-FILE-2
    RECORDING MODE IS V
    BLOCK CONTAINS 3 RECORDS
    RECORD CONTAINS 20 TO 100 CHARACTERS
    DATA RECORDS ARE VARIABLE-RECORD-1,
    VARIABLE-RECORD-2
    LABEL RECORDS ARE STANDARD.

01  VARIABLE-RECORD-1.
    05  FIELD-A  PIC X(20).
    05  FIELD-B  PIC X(80).

01  VARIABLE-RECORD-2.
    05  FIELD-X  PIC X(20).
```

As mentioned previously, the RECORDING MODE, RECORD CONTAINS, and DATA RECORDS clauses are unnecessary. By specifying that each block contains three records, the programmer allows the compiler to provide space for three records of maximum size plus additional space for the required control bytes. Hence, 316 character positions are reserved by the compiler for each output buffer. If this size is other than the maximum, the BLOCK CONTAINS clause with the CHARACTERS option should be specified.

Assuming that the first six records written are five 100-character records followed by one 20-character record, the first two blocks of VARIABLE-FILE-2 will appear on the external storage device as shown in Figure 48.

The buffer for the second block is truncated after the sixth WRITE statement is executed since there is not enough space left for a maximum size record. Hence, even if the seventh WRITE to VARIABLE-FILE-2 is a 20-character record, it will appear as the first record in the third block. This situation can be avoided by using the APPLY WRITE-ONLY clause when creating files of variable-length blocked records.

316	BB	104	bb	Data	104	bb	Data	104	bb	Data

1st Block

236	BB	104	bb	Data	104	bb	Data	24	bb	Data

2nd Block

Note: Lengths appear in decimal notation for illustrative purposes.

Figure 48. First Two Blocks of VARIABLE-FILE-2

APPLY WRITE-ONLY Clause

The APPLY WRITE-ONLY clause is used to make optimum use of buffer and external storage space when creating a standard sequential file with blocked V-mode records.

Suppose VARIABLE-FILE-2 is being created with the following FD entry:

```
FD  VARIABLE-FILE-2
    RECORDING MODE IS V
    BLOCK CONTAINS 316 CHARACTERS
    RECORD CONTAINS 20 TO 100 CHARACTERS
    DATA RECORDS ARE VARIABLE-RECORD-1,
    VARIABLE-RECORD-2
    LABEL RECORDS ARE STANDARD.

01  VARIABLE-RECORD-1.
    05  FIELD-A   PIC X(20).
    05  FIELD-B   PIC X(80).

01  VARIABLE-RECORD-2.
    05  FIELD-X   PIC X(20).
```

The first three WRITE statements to the file create one 20-character record followed by two 100-character records. Without the APPLY WRITE-ONLY clause, the buffer is truncated after the third WRITE statement is executed, since the maximum size record no longer fits. The block is written as shown below:

236	bb	24	bb	Data	104	bb	Data	104	bb	Data

Using the APPLY WRITE-ONLY clause will cause a buffer to be truncated only when the next record does not fit in the buffer. That is, if the next three WRITE statements to the file specify VARIABLE-RECORD-2, the block will be created containing six logical records, as shown below:

308	bb	24	bb	Data	104	bb	Data	104	bb	Data

24	bb	Data	24	bb	Data	24	bb	Data

Note: When using the APPLY WRITE-ONLY clause, records must not be constructed in buffer areas. An intermediate work area must be used with a WRITE FROM statement.

SPANNED (FORMAT S) RECORDS

A spanned record is a logical record that may be contained in one or more physical blocks. Format S records may be specified for direct files and for standard sequential files assigned to magnetic tape or to mass storage devices.

When creating files with S-mode records, if a record is larger than the remaining space in a block, a segment of the record is written to fill the block. The remainder of the record is stored in the next block or blocks, as required.

When retrieving a file with S-mode records, only complete records are made available to the programmer.

Spanned records are preceded by fields containing control information. Figure 45 illustrates the control fields.

BDF (Block Descriptor Field):

LL -- represents 2 bytes designating the length of the physical block (including the block descriptor field itself).

BB -- represents 2 bytes reserved for system use.

SDF (Segment Descriptor Field):

ll -- represents 2 bytes designating the length of the record segment (including the segment descriptor field itself).

bb -- represents 2 bytes reserved for system use.

Note: There is only one block descriptor field at the beginning of each physical block. There is, however, one segment descriptor field for each record segment within the block.

Each segment of a record in a block, even if it is the entire record, is preceded by a segment descriptor field. The segment descriptor field also indicates whether the segment is the first, the last, or an intermediate segment. Each block includes a block descriptor field. These fields are not described in the Data Division; provision is automatically made for them. These fields are not available to the programmer.

A spanned blocked file may be described as a file composed of physical blocks of fixed length established by the programmer. The logical records may be either fixed or variable in length and that size may be smaller, equal to, or larger than the physical block size. There are no required relationships between logical records and physical block sizes.

A spanned unblocked file may be described as a file composed of physical blocks each containing one logical record or one segment of a logical record. The logical records may be either fixed or variable in length. When the physical block contains one logical record, the length of the block is determined by the logical record size. When a logical record has to be segmented, the system always writes the largest physical block possible. The system segments the logical record when the entire logical record cannot fit on the track.

Figure 50 is an illustration of blocked spanned records of SFILE. SFILE is described in the Data Division with the following file description entry:

```
FD SFILE
    RECORD CONTAINS 250 CHARACTERS
    BLOCK CONTAINS 100 CHARACTERS
    .
    .
    .
```

Figure 50 also illustrates the concept of record segments. Note that the third block contains the last 50 bytes of REC-1 and the first 50 bytes of REC-2. Such portions of logical records are called record segments. It is therefore correct to say that the third block contains the last segment of REC-1 and the first segment of REC-2. The first block contains the first segment of REC-1 and the second block contains an intermediate segment of REC-1.

S-MODE CAPABILITIES

Formatting a file in the S-mode allows the programmer to make the most efficient use of external storage while organizing data files with logical record lengths most suited to his needs.

1. Physical record lengths can be designated in such a manner as to make the most efficient use of track capacities on mass storage devices.

2. The programmer is not required to adjust logical record lengths to maximum physical record lengths and their device-dependent variants when designing his data files.

3. The programmer has greater flexibility in transferring logical records across DASD types.

Spanned record processing will support the 2400 tape series, the 2311 and 2314 disk storage devices, and the 2321 data cell drive.

```
<--4 bytes---> <--4 bytes--> <----------------Variable bytes----------------->
┌──────┬───────┬──────┬──────┬──────────────────────────────────────────────┐
│  LL  │  BB   │  ll  │  bb  │            Data Record or Segment            │
└──────┴───────┴──────┴──────┴──────────────────────────────────────────────┘
      BDF            SDF
```

Figure 49. Control Fields of an S-Mode Record

```
 <--------100 bytes-------->  <--------100 bytes-------->  <-50 bytes-> <-50 bytes->
 +-------------------------+   +-------------------------+   +-----------+-------------+
 |          REC-1          | G |          REC-1          | G |   REC-1   |    REC-2    |
 +-------------------------+   +-------------------------+   +-----------+-------------+
          1st Block                     2nd Block                     3rd Block
```

Figure 50. One Logical Record Spanning Physical Blocks

SEQUENTIALLY ORGANIZED S-MODE FILES ON TAPE OR MASS STORAGE DEVICES

When the spanned format is used for DTFMT or DTFSD files, the logical records may be either fixed or variable in length and are completely independent of physical record length. A logical record may span physical records. A physical record may contain one or more logical records and/or segments of logical records.

Source Language Considerations

The programmer specifies S-mode by describing the file with the following clauses in the file description (FD) entry of his COBOL program:

- BLOCK CONTAINS integer-2 CHARACTERS
- RECORD CONTAINS [integer-1 TO] integer-2 CHARACTERS
- RECORDING MODE IS S

The size of the physical record must be specified using the BLOCK CONTAINS clause with the CHARACTERS option. Any block size may be specified. Block size is independent of logical record size.

The size of the logical record may be specified by the RECORD CONTAINS clause. If this clause is omitted, the compiler will determine the maximum record size from the record descriptions under the FD.

Format S may be specified by the RECORDING MODE IS S clause. If this clause is omitted, the compiler will set the recording mode to S if the BLOCK CONTAINS integer-2 CHARACTERS clause was specified and either:

1. integer-2 is less than the largest fixed-length level-01 FD entry
2. integer-2 is less than the maximum length of a variable level-01 FD entry (i.e., an entry containing one or more OCCURS clauses with the DEPENDING ON option).

When the spanned recording mode is being used, each logical record is processed in a work area, not in the buffer. Logical records are always aligned on a double-word boundary. Therefore, the programmer is not required to add inter-record slack bytes for alignment purposes.

Except for the APPLY WRITE-ONLY clause, all the options for a variable file apply to a spanned file.

Processing Sequentially Organized S-Mode Files

Suppose a file has the following file description entry:

```
FD  SPAN-FILE
    BLOCK CONTAINS 100 CHARACTERS
    LABEL RECORDS ARE STANDARD
    DATA RECORD IS DATAREC.


01  DATAREC.
    05 FIELD-A PIC X(100).
    05 FIELD-B PIC X(50).
```

Figure 51 illustrates the first four blocks of SPAN-FILE as they would appear on external storage devices (i.e., tape or mass storage) or in buffer areas of core storage.

Note:

1. The RECORDING MODE clause is not specified. The compiler determines the recording mode to be S since the block size is less than the record size.
2. The length of each physical block is 100 bytes, as specified in the BLOCK CONTAINS clause. All required control fields, as well as data, must be contained within these 100 bytes.
3. No provision is made for the control fields within the level-01 entry DATAREC.

```
   4        4                   92                      4        4        58        4        30
<-bytes-><-bytes-><----------bytes------------>  <-bytes-><-bytes-><---bytes---><-bytes-><--bytes--->
|LL |BB |ll | bb |          DATAREC (1)       |  |LL |BB |ll | bb | DATAREC (1) |ll | bb |DATAREC (2)|

                  1st Block                                          2nd Block

   4        4                   92                      4        4       28        4         60
<-bytes-><-bytes-><----------bytes------------>  <-bytes-><-bytes-><--bytes---><-bytes-><---bytes---->
|LL |BB |ll | bb |          DATAREC (2)       |  |LL |BB |ll | bb |DATAREC (2)|ll | bb | DATAREC (3) |

                  3rd Block                                          4th Block
```

Figure 51. First Four Blocks of SPAN-FILE

```
|          RECORDING MODE IS V             |            RECORDING MODE IS S               |
|------------------------------------------|----------------------------------------------|
| | 150 | 150 | G | 150 | 100 | G | 150 |  | | 150 | 150 |  50 | G | 100 | 100 | 150 |   |
|    R1    R2        R3    R4        R5    |    R1    R2        R3          R4    R5      |
|------------------------------------------|----------------------------------------------|
```

Note: The enclosed diagrams are for illustrative purposes only. Neither takes into account the space required for control fields.

Figure 52. Advantage of S-Mode Records Over V-Mode Records

The preceding discussion dealt with S-mode records which were larger than the physical blocks that contained them. It is also possible to have S-mode records which are equal to or smaller than the physical blocks that contain them. In such cases, the RECORDING MODE clause must specify S (if so desired) since the compiler cannot determine this by comparing block size and record size.

One advantage of S-mode records over V-mode records is illustrated by a file with the following characteristics:

1. RECORD CONTAINS 50 TO 150 CHARACTERS
2. BLOCK CONTAINS 350 CHARACTERS
3. The first five records written are 150, 150, 150, 100, and 150 characters in length.

For V-mode records, buffers are truncated if the next logical record is too large to be completely contained in the block (see Figure 52). This results in more physical blocks and more inter-record gaps on the external storage device.

Note: For V-mode records, buffer truncation occurs:

1. When the maximum level-01 record is too large
2. If APPLY WRITE-ONLY or SAME RECORD AREA is specified and the actual logical record is too large

For S-mode records, all blocks are 350 bytes long and records that are too large to fit entirely into a block will be segmented. This results in more efficient use of external storage devices since the number of inter-record gaps are minimized (Figure 52).

With the exception of the last block, the actual physical block size will always fall between the limits of specified block size and four bytes less than the specified block size, depending on whether or not the residual space of an incomplete block in the buffer is sufficient to add a segment length field and at least one byte of data. That is, specified block size - 4 ≤ actual block size ≤ specified block size.

The last block may be short when an incomplete block remains in the buffer at CLOSE time.

A second advantage of S-mode processing over that of V-mode is that the programmer is no longer limited to a record length that does not exceed the track capacity of the mass storage device selected. Records may span track, cylinders, and extents, but not volumes.

DTFMT and DTFSD spanned records differ from other formats because of an allocation of an area of core know as the "logical record area." If logical records span physical blocks, COBOL will use this logical record area to assemble complete logical records. If logical records do not span blocks (i.e., they are contained within a single physical block) the logical record area is not used. Regardless, it is complete logical records that are made available to the programmer. Both READ and WRITE statements should be thought of as manipulating complete logical records and not record segments.

DIRECTLY ORGANIZED S-MODE FILES

When S-mode is used for a directly organized file, only unblocked records are permitted. Logical records may be either fixed or variable in length. A logical record will span physical records if, and only if, it spans tracks. A physical record will contain only one logical record or a segment of a logical record, or segments of two logical records and/or whole logical records. Records may span tracks, cylinders, and extents, but not volumes.

Source Language Considerations

The programmer specifies S-mode by describing the file with the following clauses in the file description (FD) entry of his COBOL program:

- BLOCK CONTAINS integer-2 CHARACTERS
- RECORD CONTAINS [integer-1 TO] integer-2 CHARACTERS
- RECORDING MODE IS S

The size of a logical record may be specified by the RECORD CONTAINS clause. If this clause is omitted, the compiler will determine the maximum record size from the record descriptions under the FD.

The spanned format may be specified by the RECORDING MODE IS S clause. If this clause is omitted, the compiler will set the recording mode to S if the BLOCK

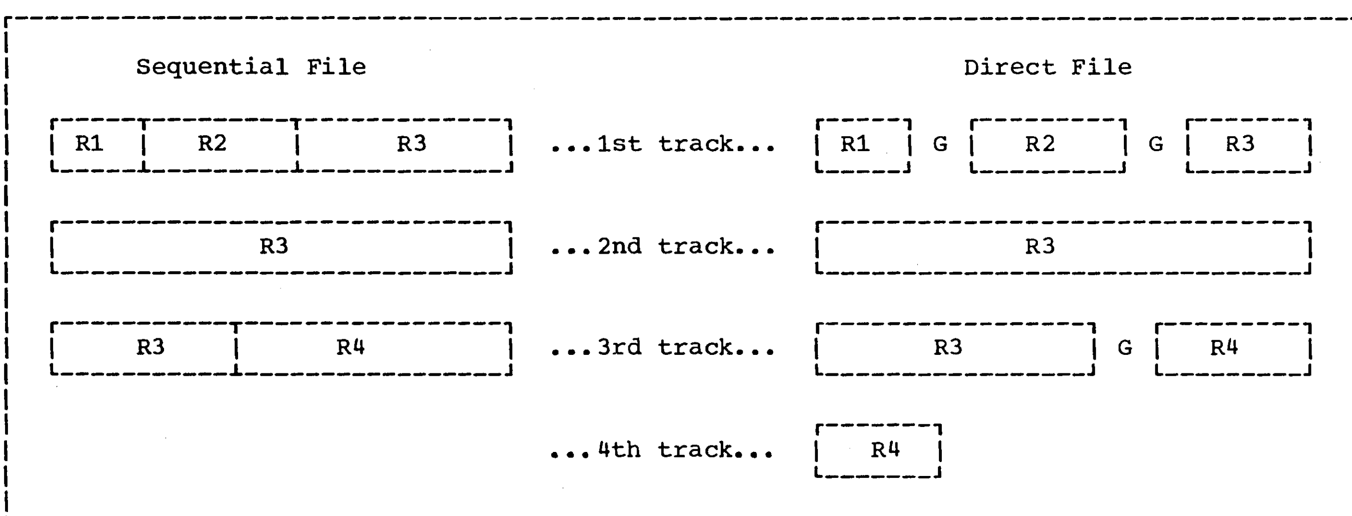


Figure 53. Direct and Sequential Spanned Files on a Mass Storage Device

CONTAINS integer-2 CHARACTERS clause was specified and integer-2 is less than the greatest logical record size. This is the only use of the BLOCK CONTAINS clause. It is otherwise treated as comments.

The physical block size is determined by either:

1. The logical record length

2. The track capacity of the device being used

If, for example, the track capacity of a mass storage device is 3625 characters, any record smaller than 3625 characters may be written as a single physical block. If a logical record is greater than 3625 characters, the record is segmented. The first segment may be contained in a physical block of up to 3625 bytes, and the remaining segments must be contained in succeeding blocks. In other words, a logical record will span physical blocks if, any only if, it spans tracks.

Figure 53 illustrates four variable-length records (R1, R2, R3, and R4) as they would appear in direct and sequential files on a mass storage device. In both cases, control fields have been omitted for illustrative purposes. For both files, assume:

1. BLOCK CONTAINS 3625 CHARACTERS (track capacity = 3,625)

2. RECORD CONTAINS 500 TO 5000 CHARACTERS

In the sequential file, each physical block is 3625 bytes in length and is completely filled with logical records. The file consists of three physical blocks, occupies three tracks, and contains no inter-record gaps.

In the direct file, the physical blocks vary in length. Each block contains only one logical record or one record segment. Logical record R3 spans physical blocks only because it spans tracks. The file consists of seven physical blocks, occupies more than three tracks, and contains three inter-record gaps.

Processing Directly Organized S-Mode Files

When processing directly organized files, there are two advantages spanned format has over the other record formats:

1. Logical record lengths may exceed the length restriction of the track capacity of the mass storage device.

   If, for example, the track capacity of a mass storage device is 2000 bytes, the length of each logical record for formats other than spanned is, by necessity, restricted to the track capacity.

   Note: Even when the spanned format is used, the COBOL restriction on the length of logical records (i.e., a maximum length of 32,767 characters) must be adhered to.

2. For formats other than spanned, only complete logical records can be written on any single track. This means that if a track has only 1000 unoccupied bytes and the programmer attempts to add a record of 1100 bytes to this track, an INVALID KEY condition will occur. When the spanned format is used, a 1000 byte segment will be written on the specified track, and the remainder will be written on the next track. The segmenting is transparent to the programmer.

OCCURS CLAUSE WITH THE DEPENDING ON OPTION

If a record description contains an OCCURS clause with the DEPENDING ON option, the record length is variable. This is true for records described in an FD as well as in the Working-Storage section. The previous sections discussed four different record formats. Three of them, V-mode, U-mode, and S-mode, may contain one or more OCCURS clauses with the DEPENDING ON option.

This section discusses some factors that affect the manipulation of records containing OCCURS clauses with the DEPENDING ON option. The text indicates whether the factors apply to the File or Working-Storage sections, or both.

The compiler calculates the length of V-mode records containing the OCCURS clause with the DEPENDING ON option at two different times, as follows (the first applies to FD entries only; the second to both FD and Working-Storage entries):

1. When a file is read and the object of the DEPENDING ON option is within the record.

2. When the object of the DEPENDING ON option is changed as a result of a move to it or any item within its group. (The length is not calculated when a move is made to an item which redefines or renames it.)

Note: Care must be taken within subprogram structures to ensure that changes to the object of the DEPENDING ON option are made within the program that references the variable-length record.

Consider the following example:

```
WORKING-STORAGE SECTION.

77  CONTROL-1     PIC 99.
77  WORKAREA-1    PIC 9(6)V99.
        .
        .
        .
01  SALARY-HISTORY.
    05  SALARY OCCURS 0 TO 10 TIMES
        DEPENDING ON
        CONTROL-1  PIC 9(6)V99.
```

The Procedure Division statement MOVE 5 TO CONTROL-1 will cause a recalculation of the length of SALARY-HISTORY. MOVE SALARY (5) TO WORKAREA-1 will not cause the length to be recalculated.

The compiler permits the occurrence of more than one level-01 record, containing the OCCURS clause with the DEPENDING ON option, in the same FD entry (see Figure 54). If the BLOCK CONTAINS clause is omitted, the buffer size is calculated from the longest level-01 record description entry. In Figure 54, the buffer size is determined by the description of RECORD-1 (RECORD-1 need not be the first record description under the FD).

During the execution of a READ statement, the length of each level-01 record description entry in the FD will be calculated (see Figure 54). The length of the variable portion of each record will be the product of the numeric value contained in the object of the DEPENDING ON option and the length of the subject of the OCCURS clause. In Figure 54, the length of FIELD-1 is calculated by multiplying the contents of CONTROL-1 by the length of FIELD-1; the length of FIELD-2, by the product of the contents of CONTROL-2 and the length of FIELD-2; the length of FIELD-3 by the contents of CONTROL-3 and the length of FIELD-3.

Since the execution of a READ statement makes available only one record type (i.e., RECORD-1 type, RECORD-2 type, or RECORD-3 type), two of the three record descriptions in Figure 54 will be inappropriate. In such cases, if the contents of the object of the DEPENDING ON option does not conform to its picture, the length of the corresponding record will not be calculated. For the contents of an item to conform to its picture:

- An item described as USAGE DISPLAY must contain external decimal data.
- An item described as USAGE COMPUTATIONAL-3 must contain internal decimal data.
- An item described as USAGE COMPUTATIONAL must contain binary data.

The following example illustrates the length calculations made by the system when a READ statement is executed:

```
FD
    .
    .
    .
01  RECORD-1.
    05  A  PIC  99.
    05  B  PIC  99.
    05  C  PIC  99  OCCURS 5 TIMES
        DEPENDING ON A.

01  RECORD-2.
    05  D  PIC  XX.
    05  E  PIC  99.
    05  F  PIC  99.
    05  G  PIC  99  OCCURS 5 TIMES
        DEPENDING ON F.

WORKING-STORAGE SECTION.
    .
    .
    .
01  TABLE-3.
    05  H OCCURS 10 TIMES DEPENDING ON B.

01  TABLE-4.
    05  I OCCURS 10 TIMES DEPENDING ON E.
```

When a record is read, lengths are determined as follows:

1. The length of RECORD-1 is calculated using the contents of field A.
2. The length of RECORD-2 is calculated using the contents of field F.
3. The length of TABLE-3 is calculated using the contents of field B.
4. The length of TABLE-4 is calculated using the contents of field E.

The programmer should be aware of several characteristics of the previously cited length calculations. The following example illustrates a group item (i.e., REC-1) whose subordinate items contain an OCCURS clause with the DEPENDING ON option and the object of that DEPENDING ON option.

```
FD  INPUT-FILE
    .
    .
    DATA RECORDS ARE RECORD-1 RECORD-2 RECORD-3.

01  RECORD-1.
    05  CONTROL-1                PIC 99.
    05  FIELD-1 OCCURS 0 TO 10 TIMES DEPENDING ON CONTROL-1  PIC 9(5).

01  RECORD-2.
    05  CONTROL-2                PIC 99.
    05  FIELD-2 OCCURS 1 TO 5 TIMES DEPENDING ON CONTROL-2  PIC 9(4).

01  RECORD-3.
    05  FILLER                   PIC XX.
    05  CONTROL-3                PIC 99.
    05  FIELD-3 OCCURS 0 TO 10 TIMES DEPENDING ON CONTROL-3  PIC X(4).
```

Figure 54. Calculating Record Lengths When Using the OCCURS Clause with the DEPENDING ON Option

```
WORKING-STORAGE SECTION.
01  REC-1.
    05  FIELD-1 PIC 9.
    05  FIELD-2 OCCURS 5 TIMES DEPENDING ON
                FIELD-1  PIC X(5).

01  REC-2.
    05  REC-2-DATA  PIC X(50).
```

The results of executing a MOVE to the group item REC-1 will be affected by the following:

- The length of REC-1 may have been calculated at some time prior to the execution of this MOVE statement.
- The length of REC-1 may never have been calculated at all.
- After the move, since the contents of FIELD-1 have been changed, an attempt will be made to recalculate the length of REC-1. This recalculation, however, will only be made if the new contents of FIELD-1 conform to its picture (i.e., USAGE DISPLAY must contain an external decimal item, USAGE COMPUTATIONAL-3 must contain an internal decimal item and USAGE COMPUTATIONAL must contain a binary item). In the preceding example, if FIELD-1 does not contain an external decimal item, the length of REC-1 will not be calculated.

Note: According to the COBOL description, FIELD-2 can occur a maximum of five times. If, however, FIELD-1 contains an external decimal item whose value exceeds five, the length of REC-1 will still be calculated.

One possible consequence of this invalid calculation will be encountered if the programmer attempts to initialize REC-1 by moving zeros or spaces to it. This initialization would inadvertently delete part of the adjacent data stored in REC-2.

The following discussion applies to updating a record containing an OCCURS clause with the DEPENDING ON option and at least one other subsequent entry. In this case, the subsequent entry is another OCCURS clause with the DEPENDING ON option.

```
WORKING-STORAGE SECTION.
01  VARIABLE-REC.
    05  FIELD-A      PIC X(10).
    05  CONTROL-1    PIC 99.
    05  CONTROL-2    PIC 99.
    05  VARY-FIELD-1 OCCURS 10 TIMES
        DEPENDING ON CONTROL-1 PIC X(5).
    05  VARY-FIELD-2 OCCURS 10 TIMES
        DEPENDING ON CONTROL-2 PIC X(9).

01  STORE-VARY-FIELD-2.
    05  VARY-FLD-2 OCCURS 10 TIMES
        DEPENDING ON CONTROL-2 PIC X(9).
```

Assume that CONTROL-1 contains the value 5 and VARY-FIELD-1 contains 5 entries.

In order to add a sixth field to VARY-FIELD-1 the following steps are required:

```
MOVE VARY-FIELD-2 TO STORE-VARY-FIELD-2.
ADD 1 TO CONTROL-1.
MOVE 'additional field' TO VARY-FIELD-1
  (CONTROL-1).
MOVE STORE-VARY-FIELD-2 TO VARY-FIELD-2.
```

This chapter describes several techniques for increasing the efficiency of a COBOL program. It is divided into seven parts. The first four parts deal with the divisions of a COBOL program. The fifth is concerned with the Report Writer Feature; the sixth with Table Handling Feature, and the seventh with using Sort in a segmented program.

GENERAL CONSIDERATIONS

Spacing the Source Program Listing

There are four statements that can be coded in any or all of the four divisions of a source program: SKIP1, SKIP2, SKIP3, and EJECT. These statements provide the programmer with the ability to control the spacing of a source listing and thereby improve its readability.

ENVIRONMENT DIVISION

SELECT Sentence

SELECT sentences for the most active files should appear first, since the COBOL compiler assigns registers to files until it runs out of registers and then reuses the last registers for all subsequent files.

RESERVE Clause

When using an additional buffer to process standard sequential files, care must be taken to ensure that the buffer is filled before the execution of each WRITE or REWRITE statement.

APPLY WRITE-ONLY Clause

To make optimum use of buffer and external storage space allocated when creating a standard sequential file with blocked V-mode records, the programmer should use the APPLY WRITE-ONLY clause for the file. Using this clause causes a buffer to be truncated only when the next record does not fit in the buffer. (If APPLY WRITE-ONLY is not specified, the buffer is truncated when the maximum size record will not fit in the space remaining in the buffer.)

DATA DIVISION

OVERALL CONSIDERATIONS

Prefixes

Assign a prefix to each level-01 item in a program, and use this prefix on every subordinate item (except FILLER) to associate a file with its records and work areas. For example, MASTER is the prefix used here:

```
FILE SECTION.
FD  MASTER-INPUT-FILE
     .
     .
     .
01  MASTER-INPUT-RECORD.
     .
     .
     .
WORKING-STORAGE SECTION.
01  MASTER-WORK-AREA.
    05  MASTER-PAYROLL PICTURE 9(3).
    05  MASTER-SSNO PICTURE 9(9).
```

If files or work areas have the same fields, use the prefix to distinguish between them. For example, if three files all have a date field, instead of DATE, DAT, and DA-TE, use MASTER-DATE, DETAIL-DATE, and REPORT-DATE. Using a unique prefix for each level-01 item and all subordinate fields makes it easier for a programmer unfamiliar with the program to find fields in the program listing, and to know which fields are logically part of the same record or area.

When using the MOVE statement with the CORRESPONDING option and referring to individual fields, redefine or rename "corresponding" names with the prefixed unique names. This technique eliminates excessive qualifying. For example:

```
01  MST-WORK-AREA.
    05  SAME-NAMES.      (***)
        10  LAST-NAME  PIC...
        10  FIRST-NAME  PIC...
        10  PAYROLL  PIC...
        .
        .
        .
    05  DIFF-NAMES REDEFINES SAME-NAMES.
        10  MST-LAST-NAME  PIC...
        10  MST-FIRST-NAME  PIC...
        10  MST-PAYROLL  PIC...
01  RPT-WORK-AREA.
    05  SAME-NAMES.      (***)
        10  PAYROLL  PIC...
        10  FILLER  PIC...
        10  FIRST-NAME  PIC...
        10  FILLER  PIC...
        10  LAST-NAME  PIC...
        .
        .
        .
PROCEDURE DIVISION.
    .
    .
    IF MST-PAYROLL IS EQUAL TO HDQ-PAYROLL
    AND MST-LAST-NAME
    IS NOT EQUAL TO PRRV-LAST-NAME
    MOVE CORRESPONDING
    MST-WORK-AREA
    TO RPT-WORK-AREA.
```

Note: Fields marked *** above must have exactly the same names for their subordinate fields to be considered "corresponding." The same names must not be the redefining ones or they will not be considered to correspond.

Level Numbers

The programmer should use widely incremented level numbers such as 01, 05, 10, 15, etc., instead of 01, 02, 03, 04, etc., in order to allow space for future insertions of group levels. For readability, indent level numbers. Use level number 88 for codes. Thus, if the codes must be changed, the Procedure Division coding for tests need not be changed.

FILE SECTION

RECORD CONTAINS Clause

The programmer should use the RECORD CONTAINS clause with the integer CHARACTERS option in order to save himself, as well as any future programmer, the task of counting the data record description positions. In addition, the compiler can then diagnose errors if the data record description conflicts with the RECORD CONTAINS clause.

WORKING-STORAGE SECTION

Separate Modules

In a large program, the programmer should plan ahead for breaking the programs into separately compiled modules, as follows:

1. When using separate modules, an attempt should be made to combine entries of each Working-Storage Section into a single level-01 record (or a single level-01 record for each 32K bytes). Logical record areas can be indicated by using level-02, -03, etc., entries. A CALL statement with the USING option is more efficient when a single item is passed than when many level-01 and/or -77 items are passed. When this method is employed, mistakes are more easily avoided.

2. Areas which do not contain VALUE clauses should be separated from areas that do contain VALUE clauses. VALUE clauses (except for level-88 items) are invalid in the Linkage Section.

3. When the Working-Storage Section consists of one level-01 item without any VALUE clauses, the COPY statement can easily be used to include the item as the description of a Linkage Section in a separately compiled module.

4. See the chapter "Using the Segmentation Feature" for additional information on how to modularize the Procedure Division of a COBOL program.

Locating the Working-Storage Section in Dumps

A simple method of locating the Working-Storage Section of a program in object-time dumps is to include the two following statements as the first and last Working-Storage statements, respectively, in the program.

```
77  FILLER PICTURE X(44), VALUE "PROGRAM
    XXXXXXXX WORKING-STORAGE BEGINS HERE".

01  FILLER PICTURE X(42), VALUE "PROGRAM
    XXXXXXXX WORKING-STORAGE ENDS HERE".
```

These two nonnumeric literals will appear in all dumps of the program, delimiting the Working-Storage Section. The program-name specified in the PROGRAM-ID clause should replace the XXXXXXXX in the literal.

DATA DESCRIPTION

The Procedure Division operations that most often require adjustment of data items include the MOVE statement, the IF statement when used in a relation test, and arithmetic operations. Efficient use of data description clauses, such as REDEFINES, PICTURE, and USAGE, avoids the generation of extra code.

REDEFINES Clause

REUSING DATA AREAS: The main storage area can be used more efficiently by writing different data descriptions for the same data area. For example, the coding that follows shows how the same area can be used as a work area for the records of several input files that are not processed concurrently.

```
WORKING-STORAGE SECTION.
01  WORK-AREA-FILE1.
     (largest record description for FILE1)
.
.
.
01  WORK-AREA-FILE2 REDEFINES
    WORK-AREA-FILE1.
     (largest record description for FILE2)
.
.
.
```

ALTERNATE GROUPINGS AND DESCRIPTIONS: Program data can often be described more efficiently by providing alternate groupings or data descriptions for the same data. For example, a program references both a field and its subfields, each of which is more efficiently described with a different usage. This can be done by using the REDEFINES clause as follows:

```
   01  PAYROLL-RECORD.
   05  EMPLOYEE-RECORD PICTURE X(28).
   05  EMPLOYEE-FIELD REDEFINES
       EMPLOYEE-RECORD.
       10  NAME PICTURE X(24).
       10  NUMBERX PICTURE S9(5) COMP.
   05  DATE-RECORD PICTURE X(10).
```

The following illustrates how a table (TABLEA) can be initialized by having different data descriptions for the same data:

```
   05  VALUE-A.
       10  A1 PICTURE S9(9) COMPUTATIONAL
           VALUE IS ZEROES.
       10  A2 PICTURE S9(9) COMPUTATIONAL
           VALUE IS 1.
       .
       .
       .
       10  A100 PICTURE S9(9) COMPUTATIONAL
           VALUE IS 99.
   05  TABLEA REDEFINES VALUE-A
       PICTURE S9(9) COMPUTATIONAL
       OCCURS 100 TIMES.
```

Note: Caution should be exercised when redefining a subscript. If the value of the redefining data item is changed in the Procedure Division, no new calculation for the subscript is performed.

PICTURE Clause

DECIMAL-POINT ALIGNMENT: Procedure Division operations are most efficient when the decimal positions of the data items involved are aligned. If they are not, the compiler generates instructions to align the decimal positions before any operations involving the data items can be executed.

Assume, for example, that a program contains the following instructions:

```
WORKING-STORAGE SECTION.
77  A PICTURE S999V99.
77  B PICTURE S99V9.
.
.
.
PROCEDURE DIVISION.
.
.
.
   ADD A TO B.
```

Time and internal storage space are saved by defining B as:

```
77 B PICTURE S99V99.
```

If it is inefficient to define B differently, a one-time conversion can be done, as explained in "Data Format Conversion" in this chapter.

<u>FIELDS OF UNEQUAL LENGTH</u>: When a data item is moved to another data item of a different length, the following should be considered:

- If the items are external decimal items, the compiler generates instructions to insert zeros in the high-order positions of the receiving field, when it is the larger.

- If the items are nonnumeric, the compiler generates instructions to insert spaces in the low-order positions of the receiving field (or the high-order positions if the JUSTIFIED RIGHT clause is specified). This generation of extra instructions can be avoided if the sending field is described with a length equal to or greater than the receiving field.

<u>SIGN USAGE</u>: The presence or absence of a plus or minus sign in the description of an arithmetic field often can affect the efficiency of a program. The following paragraphs discuss some of the considerations.

<u>Decimal Items</u>: The sign position in an internal or external decimal item can contain:

1. A plus or minus sign. If S is specified in the PICTURE clause, a plus or minus sign is inserted when either of the following conditions prevail:

   a. The item is in the Working-Storage Section and a VALUE clause has been specified.

   b. A value for the item is assigned as a result of an arithmetic operation during execution of the program.

   If an external decimal item is punched, printed, or displayed, an overpunch will appear in the low-order digit. In EBCDIC, the configuration for low-order zeros normally is a nonprintable character. Low-order digits of positive values will be represented by one of the letters A through I (digits 1 through 9); low-order digits of negative values will be represented by one of the letters J through R (digits 1 through 9).

2. A hexadecimal F. If S is not specified in the PICTURE clause, an F is inserted in the sign position when either of the following conditions prevail:

   a. The item is in the Working-Storage Section and a VALUE clause has been specified

   b. A value for the item is developed during the execution of the program.

   An F is treated as positive, but is not an overpunch.

3. An invalid configuration. If an internal or external decimal item contains an invalid configuration in the sign position, and if the item is involved in a Procedure Division operation, the program will be abnormally terminated.

<u>Unsigned items</u> (items for which no S has been specified) are treated as absolute values. Whenever a value (signed or unsigned) is stored in or moved in an elementary move to an unsigned item, a hexadecimal F is stored in the sign position of the unsigned item. For example, if an arithmetic operation involves signed operands and an unsigned result field, compiler-generated code will insert an F in the sign position of the result field when the result is stored.

For internal and external decimal items used as input, it is the programmer's responsibility to ensure that the input data is valid. The compiler does not generate a test to ensure that the configuration in the sign position is valid.

When a group item is being moved, the data is moved without regard to the level structure of the group items involved. The possibility exists that the configuration in the sign position of a subordinate numeric item may be destroyed. Therefore, caution should be exercised in moving group items with subordinate numeric fields or with other group operations such as READ or ACCEPT.

USAGE Clause

The USAGE clause should be written at the highest level possible.

DATA FORMAT CONVERSION: Operations involving mixed, elementary numeric data formats require conversion to a common format. This usually means that additional storage is used and execution time is increased. The code generated must often move data to an internal work area, perform any necessary conversion, and then execute the indicated operation. Often, too, the result may have to be converted in the same way. Table 23 indicates when data conversion is necessary.

If it is impractical to use the same data formats throughout a program, and if two data items of different formats are frequently used together, a one-time conversion can be effected. For example, if A is defined as a COMPUTATIONAL item and B as a COMPUTATIONAL-3 item, A can be moved to a work area that has been defined as COMPUTATIONAL-3. This move causes the data in A to be converted to COMPUTATIONAL-3. Whenever A and B are used in a Procedure Division operation, reference can be made to the work area rather than to A. When this technique is used, the conversion is performed only once, instead of each time an operation is performed.

Table 23. Data Format Conversion (Part 1 of 2)

Usage	Bytes Required	Boundary Alignment Required	Typical Usage	Converted for Arithmetic Operations	Special Characteristics
DISPLAY (external decimal)	1 per digit (except for V)	No	Input from cards, output to cards, listings	Yes	May be used for numeric fields up to 18 digits long. Fields over 15 digits require extra instructions if used in computations.
DISPLAY (external floating point)	1 per character (except for V)	No	Input from cards, output to cards, listings	Yes	Converted to COMP-2 format via COBOL library subroutine.
COMP-3 (internal decimal)	1 per 2 digits plus 1 byte for low-order digit and sign	No	Input to a report item Arithmetic fields Work areas	Sometimes when a small COMP-3 item is used with a small COMP item	Requires less space than DISPLAY. Convenient form for decimal alignment. Can be used in arithmetic computations without conversion. Fields over 15 digits require a subroutine when used in computations.

Table 23. Data Format Conversion (Part 2 of 2)

Usage	Bytes Required	Bountary Alignment Required	Typical Usage	Converted for Arithmetic Operations	Special Characteristics
COMP (binary)	2 if 1≤N≤4 4 if 5≤N≤9 8 if 10≤N≤18 where N is the number of 9's in the picture	Halfword Fullword Fullword	Subscripting Arithmetic fields	Sometimes for both mixed and unmixed usages	Rounding and testing for the ON SIZE ERROR condition are cumbersome if calculated result is greater than 9(9). Extra instructions are generated for computations if the SYNCHRONIZED clause is not specified. Fields of over nine digits require additional handling.
COMP-1 (internal floating point)	4 (short-precision)	Fullword	Fractional exponentiation	No	Tends to produce less accurate results if more than 17 significant digits are required and if the exponent is large. Extra instructions are generated for computations if the SYNCHRONIZED clause is not specified. Requires floating-point feature.
COMP-2 (internal floating point)	8 (long-precision)	Double-word	Fractional exponentiation when additional precision is required	No	Same as COMP-1.

The following seven cases show how data conversions are handled on mixed elementary items for names, data comparisions, and arithmetic operations. Moves without the CORRESPONDING option to and from group items, as well as comparisons involving group items, are done without conversion.

Numeric DISPLAY to COMPUTATIONAL-3:

To Move Data: Converts DISPLAY data to COMPUTATIONAL-3 data.

To Compare Data: Converts DISPLAY data to COMPUTATIONAL-3 data.

To Perform Arithmetic Operations: Converts DISPLAY data to COMPUTATIONAL-3 data.

Numeric DISPLAY to COMPUTATIONAL:

To Move Data: Converts DISPLAY data to COMPUTATIONAL-3 data and then to COMPUTATIONAL data.

To Compare Data: Converts DISPLAY to COMPUTATIONAL or converts both DISPLAY and COMPUTATIONAL data to COMPUTATIONAL-3 data.

To Perform Arithmetic Operations: Converts DISPLAY data to COMPUTATIONAL-3 or COMPUTATIONAL data.

COMPUTATIONAL-3 to COMPUTATIONAL:

To Move Data: Moves COMPUTATIONAL-3 data to a work area and then converts COMPUTATIONAL-3 data to COMPUTATIONAL data.

To Compare Data: Converts COMPUTATIONAL data to COMPUTATIONAL-3 or vice versa, depending on the size of the field.

To Perform Arithmetic Operations: Converts COMPUTATIONAL data to COMPUTATIONAL-3 or vice versa, depending on the size of the field.

COMPUTATIONAL to COMPUTATIONAL-3:

To Move Data: Converts COMPUTATIONAL data to COMPUTATIONAL-3 data in a work area, and then moves the work area.

To Compare Data: Converts COMPUTATIONAL to COMPUTATIONAL-3 data or vice versa, depending on the size of the field.

To Perform Arithmetic Operations: Converts COMPUTATIONAL to COMPUTATIONAL-3 data or vice versa, depending on the size of the field.

COMPUTATIONAL to Numeric DISPLAY:

To Move Data: Converts COMPUTATIONAL data to COMPUTATIONAL-3 data and then to DISPLAY data.

To Compare Data: Converts DISPLAY to COMPUTATIONAL or both COMPUTATIONAL and DISPLAY data to COMPUTATIONAL-3 data, depending on the size of the field.

To Perform Arithmetic Operations: Depending on the size of the field, converts DISPLAY data to COMPUTATIONAL data, or both DISPLAY and COMPUTATIONAL data to COMPUTATIONAL-3 data in which case the result is generated in a COMPUTATIONAL-3 work area and then converted and moved to the DISPLAY result field.

COMPUTATIONAL-3 to Numeric DISPLAY:

To Move Data: Converts COMPUTATIONAL-3 data to DISPLAY data.

To Compare Data: Converts DISPLAY data to COMPUTATIONAL-3 data. The result is generated in a COMPUTATIONAL-3 work area and is then converted and moved to the DISPLAY result field.

Numeric DISPLAY to Numeric DISPLAY:

To Perform Arithmetic Operations: Converts all DISPLAY data to COMPUTATIONAL-3 data. The result is generated in a COMPUTATIONAL-3 work area and is then converted to DISPLAY and moved to the DISPLAY result field.

Internal Floating-point to Any Other: When an item described as COMPUTATIONAL-1 or COMPUTATIONAL-2 (internal floating-point) is used in an operation with another data format, the item in the other data format is always converted to internal floating-point. If necessary, the internal floating-point result is then converted to the format of the other data item.

SYNCHRONIZED Clause

As illustrated in Table 23, COMPUTATIONAL, COMPUTATIONAL-1 and COMPUTATIONAL-2 items have specific boundary alignment requirements. To ensure correct alignment, either the programmer or the compiler may have to insert slack bytes or the compiler must generate extra instructions to move the item to a correctly aligned work area when reference is made to the item.

The SYNCHRONIZED clause may be used at the elementary level to specify the automatic alignment of elementary items on their proper boundaries, or at the 01 level to synchronize all elementary items within the group. For COMPUTATIONAL items, if the PICTURE is in the range of S9 through S9(4), the item is aligned on a halfword boundary. If the PICTURE is in the range of S9(5) through S9(18), the item is aligned on a fullword boundary. For COMPUTATIONAL-1 items, the item is aligned on a fullword boundary. For COMPUTATIONAL-2 items, the item is aligned on a doubleword boundary. The SYNCHRONIZED clause and slack bytes are fully discussed in the publication IBM System/360 Disk Operating System: Full American National Standard COBOL.

Special Considerations for DISPLAY and COMPUTATIONAL Fields

NUMERIC DISPLAY FIELDS: Zeros are not inserted into numeric DISPLAY fields by the instruction set. When numeric DISPLAY data is moved, the compiler generates instructions that insert any necessary zeros into the DISPLAY fields. When numeric DISPLAY data is compared, and one field is smaller than the other, the compiler generates instructions to move the smaller item to a work area where zeros are inserted.

COMPUTATIONAL FIELDS: COMPUTATIONAL fields can be aligned on either a halfword or fullword boundary. If an operation involves COMPUTATIONAL fields of different lengths, the halfword field is automatically expanded to a fullword field. Therefore, mixed halfword and fullword fields require no additional operations.

COMPUTATIONAL-1 AND COMPUTATIONAL-2 FIELDS: If an arithmetic operation involves a mixture of short-precision and long-precision fields, the compiler generates instructions to expand the short-precision field to a long-precision field before the operation is executed.

COMPUTATIONAL-3 FIELDS: The compiler does not have to generate instructions to insert high-order zeros for ADD and SUBTRACT statements that involve COMPUTATIONAL-3 data. The zeros are inserted by the instruction set.

Data Formats in the Computer

The following examples illustrate how the various COBOL data formats appear in the computer in EBCDIC (Extended Binary-Coded-Decimal Interchange Code) format. More detailed information about these data formats appear in the publication IBM System/360 Principles of Operation.

Numeric DISPLAY (External Decimal): Suppose the value of an item is -1234, and its PICTURE and USAGE clauses are:

```
PICTURE 9999 DISPLAY.

          or

PICTURE S9999 DISPLAY.
```

The item appears in the computer in the following forms, respectively:

```
| F1 | F2 | F3 | F4 |
└────┴────┴────┴────┘
                Byte

| F1 | F2 | F3 | D4 |
└────┴────┴────┴────┘
                Byte
```

Hexadecimal F is treated arithmetically as positive; hexadecimal D represents a minus sign.

COMPUTATIONAL-3 (Internal Decimal): Suppose the value of an item is +1234, and its PICTURE and USAGE clauses are:

```
PICTURE 9999 COMPUTATIONAL-3.

          or

PICTURE S9999 COMPUTATIONAL-3.
```

The item appears internally in the following forms, respectively:

```
| 01 | 23 | 4F |
└────┴────┴────┘
           Byte

| 01 | 23 | 4C |
└────┴────┴────┘
           Byte
```

Hexadecimal F is treated arithmetically as positive; hexadecimal C represents a plus sign.

Note: Since the low-order byte of an internal decimal number always contains a sign field, an item with an odd number of digits can be stored more efficiently than an item with an even number of digits. Note that a leading zero is inserted in the above example.

COMPUTATIONAL (Binary): Suppose the value of an item is 1234, and its PICTURE and USAGE clauses are:

```
PICTURE S9999 COMPUTATIONAL.
```

The item appears internally in the following form:

```
| 0000 | 0100 | 1101 | 0010 |
└──────┴──────┴──────┴──────┘
 ↑
 Sign
Position
```

A 0 in the sign position indicates that the number is positive. Negative numbers are represented in two's complement form; thus, the sign position of a negative number will always contain a 1.

For example -1234 would appear as follows:

```
| 1111 | 1011 | 0010 | 1110 |
└──────┴──────┴──────┴──────┘
 ↑
 Sign
Position
```

Table 24. Relationship of PICTURE to Storage Allocation

PICTURE	Maximum Working Value	Assigned Storage
S9 through S9(4)	32,767	One halfword
S9(5) through S9(9)	2,147,483,647	One fullword
S9(10) through S9(18)	9,223,372,036,854,775,807	Two fullwords

Binary Item Manipulation: A binary item is allocated storage ranging from one halfword to two fullwords, depending on the number of 9's in its PICTURE. Table 24 is an illustration of how the compiler allocates this storage. Note that it is possible for a value larger than that implied by the PICTURE clause to be stored in the item. For example, PICTURE S9(4) implies a maximum value of 9999, although it could actually hold the number 32,767.

Because most binary items are manipulated according to their allotted storage capacity, the programmer can ignore this situation. For the following reasons, however, he must be careful of his data:

1. When the ON SIZE ERROR option is used, the size test is made on the basis of the maximum value allowed by the picture of the result field. If a size error condition exists, the value of the result field is not altered and control is given to the imperative-statements specified by the error option.

2. When a binary item is displayed or exhibited, the value used is a function of the number of 9's specified in the PICTURE clause.

3. When the acutal value of a positive number is significantly larger than its picture value, a value of 1 could appear in the sign position of the item, causing the item to be treated as a negative number in subsequent operations.

Figure 55 illustrates three binary manipulations. In each case, the result field is an item described as PICTURE S9 COMPUTATIONAL. One halfword of storage has been allocated, and no ON SIZE ERROR option is involved. Note that if the ON SIZE ERROR option had been specified, it would have been executed for cases B and C.

COMPUTATIONAL-1 or COMPUTATIONAL-2 (Floating-point): Suppose the value of an item is +1234 and that its USAGE is COMPUTATIONAL-1, the item appears internally in the following form:

```
|0|100  0011|0100 1101 0010 0000 0000 0000|
└─┴─────────┴─────────────────────────────┘
 S 1       7 8                           31
```

S is the sign position of the number.

A 0 in the sign position indicates that the sign is plus.

A 1 in the sign position indicates that the sign is minus.

Bits 1 through 7 are the exponent (characteristic) of the number.

Bits 8 through 31 are the fraction (mantissa) of the number.

This form of data is referred to as floating point. The example illustrates short-precision floating-point data (COMPUTATIONAL-1). In long-precision (COMPUTATIONAL-2), the fraction length is 56 bits. (For a detailed explanation of floating-point representation, see the publication IBM System/360 Principles of Operation.)

Case	Hexadecimal Result of Binary Calculation	Decimal Equivalent	Actual Decimal Value in Halfword of Storage	DISPLAY or EXHIBIT Value
A	0008	8	+8	8
B	000A	10	+10	0
C	C350	50000	-15536	6

Figure 55. Treatment of Varying Values in a Data Item of PICTURE S9

PROCEDURE DIVISION

The Procedure Division of a program can often be made more efficient or easier to debug by using some of the techniques described below.

MODULARIZING THE PROCEDURE DIVISION

Modularization involves organizing the Procedure Division into at least three functional levels: a main-line routine, processing subroutines, and input/output subroutines. When the Procedure Division is modularized, programs are easier to maintain and document. In addition, modularization makes it simple to break down a program using the segmentation feature, resulting in a more efficient segmented program.

Main-Line Routine

The main-line routine should be short and simple, and should contain all the major logical decisions of the program. This routine controls the order in which second-level subroutines are executed. All second-level subroutines should be invoked from the main-line routine by PERFORM statements.

Processing Subroutines

Processing subroutines should be broken down into as many functional levels as necessary, depending on the complexity of the program. These must be completely closed subroutines, with one entry point and one exit point. The entry point should be the first statement of the subroutine. The exit point should be the EXIT statement. Processing subroutines can PERFORM only lower level subroutines; return to the higher level subroutine (processing subroutine) must be accomplished by a GO TO statement that references the EXIT statement.

Input/Output Subroutines

The input/output subroutines should be the lowest level subroutines, since all higher level subroutines have access to them. There should be one OPEN subroutine and one CLOSE subroutine for the program, and only one functional (READ or WRITE) subroutine for each file. Having one READ or WRITE subroutine per file has several advantages:

1. Coding can be added to count records on a file, transform blanks into zeros, check for 9's padding, etc.
2. Input and output files can be reformatted without changing the logic of the program.
3. DEBUG statements can be added during testing to create input or to DISPLAY formatted output, instead of having to create a test file.

INTERMEDIATE RESULTS

The compiler treats arithmetic statements as a succession of operations and sets up intermediate result fields to contain the results of these operations. Examples of such statements are the arithmetic statements and statements containing arithmetic expressions. See the appendix "Intermediate Results" in the publication IBM System/360 Disk Operating System: Full American National Standard COBOL for a description of the algorithms used by the compiler to determine the number of places reserved for intermediate result fields.

Intermediate Results and Binary Data Items

If an operation involving binary operands requires an intermediate result greater than 18 digits, the compiler converts the operands to internal decimal before performing the operation. If the result field is binary, the result will be converted from internal decimal to binary.

If an intermediate result will not be greater than nine digits, the operation is performed most efficiently on binary data fields.

Intermediate Results and COBOL Library Subroutines

If a decimal multiplication operation requires an intermediate result greater than 30 digits, a COBOL library subroutine is used to perform the multiplication. The result of this multiplication is then truncated to 30 digits.

A COBOL library subroutine is used to perform division if:

1. The divisor is equal to or greater than 15 digits.
2. The length of the divisor plus the length of the scaled dividend is greater than 16 bytes.
3. The scaled dividend is greater than 30 digits. (A scaled dividend is a number that has been multiplied by a power of ten in order to obtain the desired number of decimal places in the quotient.)

Intermediate Results Greater Than 30 Digits

Whenever the number of digits in a decimal intermediate result is greater than 30, the field is truncated to 30 digits. A warning message will be generated during compilation, and program flow will not be interrupted at execution time. This truncation may cause a result to be incorrect.

If binary or internal decimal data is in agreement with its data description, no interrupt can occur because of an overflow condition in an intermediate result. This is due to the truncation described in the preceding paragraph.

If the possibility exists that an intermediate result field may exceed 30 digits, truncation can be avoided by the specification of floating-point operands (COMPUTATIONAL-1 or COMPUTATIONAL-2); however, accuracy may not be maintained.

Intermediate Results and Floating-point Data Items

If a floating-point operand has an intermediate result field in which exponent overflow occurs, the job will be abnormally terminated.

Regardless of how B and C are defined in the following statement, if A is a floating-point data item, no decimal places will be calculated in the intermediate result.

```
COMPUTE A = B / C
```

Intermediate Results and the ON SIZE ERROR Option

The ON SIZE ERROR option applies only to the final calculated results and not to intermediate result fields.

EXPONENTIATION

When the exponent is not a literal, one of the following three subroutines is invoked, depending on the base and the exponent:

1. If the base is not a floating-point item and the exponent is an integer item, a call to the subroutine ILBDXPR0 is generated and the exponentiation is executed in packed decimal arithmetic.
2. If the base is a floating-point item and the exponent is an integer item, a call to the subroutine ILBDGPW0 is generated and the exponentiation is executed in floating-point arithmetic.
3. If the exponent is a floating-point item or has a PICTURE specifying a decimal places, a call to the subroutine ILBDFPW0 is generated and the exponentiation is executed in floating-point arithmetic.

When the exponent is an integer literal, one of the following applies:

1. If the base is a floating-point item, a call to the subroutine ILBDGPW0 is generated and the exponentiation is executed in floating-point arithmetic.

2. If the base is not a floating-point item, an inline loop is generated to perform the exponentiation unless the maximum possible result exceeds 30 digits, in which case a call to the subroutine ILBDXPR0 is generated. In either case, the exponentiation is executed in packed decimal arithmetic.

PROCEDURE DIVISION STATEMENTS

COMPUTE Statement

The use of the COMPUTE statement generates more efficient code than does the use of individual arithmetic statements, since the compiler can keep track of internal work areas and does not have to store the results of intermediate calculations. It is the programmer's responsibility, however, to ensure that the data is defined with the level of significance required in the answer.

IF Statement

Nested and compound IF statements should be avoided as the logic is difficult to debug.

MOVE Statement

Performing a MOVE operation for an item longer than 256 bytes requires the generation of more instructions than are required for that of a MOVE operation for an item of 256 bytes or less.

When a MOVE statement with the CORRESPONDING option is executed, data items are considered as "corresponding" <u>only</u> if their respective data-names are the same, including all implied qualification up to, but not including, the data-names used in the MOVE statement itself.

For example:

```
01 AA                   01  XX
   05 BB                    05 BB
     10 CC                    10 CC
     10 DD                    10 DD
   05 EE                    05 YY
     10 FF                    10 FF
```

The statement MOVE CORRESPONDING AA TO XX will result in moving CC and DD, but not FF, since FF of EE does not correspond to FF of YY.

<u>Note</u>: The other rules for MOVE CORRESPONDING, of course, must still be satisfied.

The compiler assumes that the data being moved conforms to PICTURE and USAGE specifications. If it does not, dissimilar results will occasionally occur because of the different code generated for various sending and receiving fields. This fact is most apparent when the sending field is COMPUTATIONAL, the value in the item exceeds the number of digits specified in the PICTURE clause, and the option NOTRUNC is in effect.

NOTE Statement

When the NOTE statement is the first statement in a paragraph, it will cause the whole paragraph to be treated as part of the NOTE. Programmer errors can be avoided by using the asterisk (*) in place of the NOTE statement.

PERFORM Statement

PERFORM is a useful statement if the programmer adheres to the following rules:

1. Always execute the last statement of a series of routines being operated on by a PERFORM statement. When branching out of the routine, make sure control will eventually return to the last statement of the routine, which should be an EXIT statement. Although no code is generated, the EXIT statement allows a programmer to immediately recognize the extent of a series of routines within the range of a PERFORM statement.

2. Always either PERFORM routine-name THRU routine-name-exit, or PERFORM section-name. A PERFORM paragraph-name can create problems for the programmer trying to maintain the

program. For example, if one paragraph must be broken into two paragraphs, the programmer must examine every statement to determine whether this paragraph is within the range of the PERFORM statement. As a result, all statements referencing the paragraph-name must be changed to PERFORM THRU statements.

3. A PERFORM statement containing embedded PERFORMs or a PERFORM VARYING with one or more AFTER options causes the compiler to generate complex code. If a series of simple PERFORM statements can accomplish the same function, the programmer would be wise to substitute these since more efficient code is generated.

READ INTO and WRITE FROM Options

Always use READ INTO and WRITE FROM, and process all files in the Working-Storage Section for the following reasons:

1. Debugging is much simpler. Working-Storage areas are easier to locate in a dump than are buffer areas. And, if files are blocked, it is much easier to determine which record in a block was being processed when the abnormal termination occurred.

2. Trying to access a record-area after the AT END condition has occurred (for example, AT END MOVE HIGH-VALUE TO INPUT-RECORD) can cause problems if the record area is defined only in the File Section.

Note: The programmer should be aware that additional time is used to execute the move operation involved in each READ INTO or WRITE FROM instruction.

When a READ INTO statement is used for a V-mode or U-mode file, the size of the longest record for that file is used in the MOVE statement. All other rules of the MOVE statement apply.

TRANSFORM Statement

The TRANSFORM statement generates more efficient code than the EXAMINE REPLACING BY statement when only one character is being transformed. The TRANSFORM statement, however, uses a 256-byte table.

USING THE REPORT WRITER FEATURE

REPORT Clause in a File Description (FD) Entry

A given report-name may appear in a maximum of two file description entries. The file description entries need not have the same characteristics. If the same report-name is specified in two file description entries, the report will be written on both files. For example:

```
ENVIRONMENT DIVISION.
    SELECT FILE-1  ASSIGN SYS005-UR-1403-S.
    SELECT FILE-2  ASSIGN SYS001-UT-2400-S.
    .
    .
DATA DIVISION.
FD  FILE-1  RECORDING MODE F
            RECORD CONTAINS 121 CHARACTERS
            REPORT IS REPORT-A.
FD  FILE-2  RECORDING MODE V
            RECORD CONTAINS 101 CHARACTERS
            REPORT IS REPORT-A.
```

For each GENERATE statement, the records for REPORT-A will be written on FILE-1 and FILE-2, respectively. The records on FILE-2 will not contain columns 102 through 121 of the corresponding records on FILE-1.

Summing Techniques

Execution time of an object program can be decreased by keeping in mind that Report Writer source coding is treated as though the programmer had written the program in COBOL without the Report Writer feature. Therefore, a complex source statement or series of statements will generally be executed faster than simple statements that perform the same function. The following example shows two coding techniques for the Report Section of the Data Division. Method 2 uses the more complex statements.

```
RD...CONTROLS ARE YEAR MONTH WEEK DAY.
```

Method 1:

```
01 TYPE CONTROL FOOTING YEAR.
   02 SUM COST.
01 TYPE CONTROL FOOTING MONTH.
   02 SUM COST.
01 TYPE CONTROL FOOTING WEEK.
   02 SUM COST.
01 TYPE CONTROL FOOTING DAY.
   02 SUM COST.
```

Method 2:

```
01 TYPE CONTROL FOOTING YEAR.
   02 SUM A.
01 TYPE CONTROL FOOTING MONTH.
   02 A SUM B.
01 TYPE CONTROL FOOTING WEEK.
   02 B SUM C.
01 TYPE CONTROL FOOTING DAY.
   02 C SUM COST.
```

Method 2 will execute faster. One addition will be performed for each day, one more for each week, and one for each month. In Method 1, four additions will be performed for each day.

Use of SUM

Unless each identifier is the name of a SUM counter in a TYPE CONTROL FOOTING report group at an equal or lower position in the control hierarchy, the identifier must be defined in the File, Working-Storage, or Linkage Sections as well as in a TYPE DETAIL report group as a source item. A SUM counter is algebraically incremented just before presentation of the TYPE DETAIL report group in which the item being summed appears as a source item or the item being summed appeared in a SUM clause that contained an UPON option for this DETAIL report group. This is known as SOURCE-SUM corresponding. In the following example, SUBTOTAL is incremented only when DETAIL-1 is generated.

```
FILE SECTION.
       .
       .
       .
    02 NO-PURCHASES PICTURE 99.
       .
       .
       .
REPORT SECTION.
01 DETAIL-1 TYPE DETAIL.
    02 COLUMN 30 PICTURE 99 SOURCE
       NO-PURCHASES.
       .
       .
       .
01 DETAIL-2 TYPE DETAIL.
       .
       .
       .
01 DAY TYPE CONTROL FOOTING
    LINE PLUS 2.
       .
       .
       .
    02 SUBTOTAL COLUMN 30 PICTURE 999
       SUM NO-PURCHASES.
       .
       .
       .
01 MONTH TYPE CONTROL FOOTING
    LINE PLUS 2 NEXT GROUP
    NEXT PAGE.
```

SUM Routines

A SUM routine is generated by the Report Writer for each DETAIL report group of the report. The operands included for summing are determined as follows:

1. The SUM operand(s) also appears in a SOURCE clause(s) for the DETAIL report group.

2. The UPON detail-name option was specified in the SUM clause. In this case, all the operands are included in the SUM routine for only that DETAIL report group, even if the operand appears in a SOURCE clause in other DETAIL report groups.

When a GENERATE detail-name statement is executed, the SUM routine for that DETAIL report group is executed in its logical sequence. When GENERATE report-name statement is executed and the report contains more than one DETAIL report group, the SUM routine is executed for each one. The SUM routines are executed in the sequence in which the DETAIL report groups are specified.

The following two examples show the SUM routines that are generated by the Report Writer. Example 1 illustrates how operands are selected for inclusion in the routine on the basis of simple SOURCE-SUM correlation. Example 2 illustrates how operands are selected when the UPON detail-name option is specified.

Example 1: The following statements are coded in the Report Section:

```
01 DETAIL-1 TYPE DE ...
   02 ...SOURCE A.
                 .
                 .
                 .
01 DETAIL-2 TYPE DE ...
   02 ...SOURCE B.
   02 ...SOURCE C.
                 .
                 .
                 .
01 DETAIL-3 TYPE DE ...
   02 ...SOURCE B.
                 .
                 .
                 .
01 TYPE CF ...
   02 SUM-CTR-1 ...SUM A, B, C.
                 .
                 .
                 .
01 TYPE CF ...
   02 SUM-CTR-2 ...SUM B.
```

A SUM routine is generated for each DETAIL report group, as follows:

SUM-ROUTINE FOR DETAIL-1

```
   REPORT-SAVE
      ADD A TO SUM-CTR-1.
   REPORT-RETURN
```

SUM-ROUTINE FOR DETAIL-2

```
   REPORT-SAVE
      ADD B TO SUM-CTR-1.
      ADD C TO SUM-CTR-1.
      ADD B TO SUM-CTR-2.
   REPORT-RETURN
```

SUM-ROUTINE FOR DETAIL-3

```
   REPORT-SAVE
      ADD B TO SUM-CTR-1.
      ADD B TO SUM-CTR-2.
   REPORT-RETURN
```

Example 2: This example uses the same coding as Example 1, with one exception: the UPON detail-name option is used for SUM-CTR-1, as follows:

```
01 TYPE CF ...
   02 SUM-CTR-1 ...SUM A, B, C
      UPON DETAIL-2.
```

The following SUM routines would then be generated instead of those shown in the previous example:

SUM Routine for DETAIL-1

```
   REPORT-SAVE
   REPORT-RETURN
```

SUM Routine for DETAIL-2

```
   REPORT-SAVE
      ADD A TO SUM-CTR-1.
      ADD B TO SUM-CTR-1.
      ADD C TO SUM-CTR-1.
      ADD B TO SUM-CTR-2.
   REPORT-RETURN
```

SUM Routine for DETAIL-3

```
   REPORT-SAVE
      ADD B TO SUM-CTR-2.
   REPORT-RETURN
```

Output Line Overlay

The Report Writer output line is created using an internal REDEFINES specification, indexed by integer-1. No check is made to prevent overlay on any line. For example:

```
    02  COLUMN 10  PICTURE X(23)
        VALUE "MONTHLY SUPPLIES REPORT".
    02  COLUMN 12  PICTURE X(9)
        SOURCE CURRENT-MONTH.
```

A length of 23 starting from column 10, followed by a specification for column 12, will cause field overlay when this line is printed.

Page Breaks

The Report Writer page break routine operates independently of the routines that are executed after any control breaks (except that a page break will occur as the result of a LINE NEXT PAGE clause). Thus, the programmer should be aware of the following facts:

1. A Control Heading is not printed after a Page Heading except for first generation. If the programmer wishes to have the equivalent of a Control Heading at the top of each page, he must include the information and data to be printed as part of the Page Heading. Since only one Page Heading may be specified for each report, he should be selective in considering his Control Heading because it will be the same for each page, and may be printed at inappropriate times (see "Control Footings and Page Format" in this chapter).

2. GROUP INDICATE items are printed after page and control breaks. Figure 56 contains a GROUP INDICATE clause and illustrates the execution output.

```
REPORT SECTION.
    .
    .
    .
01  DETAIL-LINE TYPE IS DETAIL LINE
    NUMBER IS PLUS 1.
    02  COLUMN IS 2 GROUP INDICATE
        PICTURE IS A(9) SOURCE IS
        MONTHNAME OF RECORD-AREA (MONTH).
    .
    .
    .

(Execution Output)
-----------------------------------------
JANUARY   15   A00...
               A02...

PURCHASES AND COST...
-----------------------------------------
JANUARY   21   A03...
               A03...
```

Figure 56. Sample of GROUP INDICATE Clause and Resultant Execution Output

WITH CODE Clause

When more than one report is being written on a file and the reports are to be selectively written, a unique 1-character code must be given for each report. A mnemonic-name is specified in the RD-level entry for each report and is associated with the code in the Special-Names paragraph of the Environment Division.

Note: If a report is written with the CODE option, the report should not be written directly on a printer device.

This code will be written as the first character of each record that is written on the file. When the programmer wishes to write a report from this file, he needs only to read a record, check the first character for the desired code, and have it printed if the desired code is found. The record should be printed starting from the third character, as illustrated in Figure 57.

Code	Control Character	Record	...
1	2	3	n

Figure 57. Format of a Report Record When the CODE Clause is Specified

The following example shows how to create and print a report with a code of A. A Report Writer program contains the following statements:

```
ENVIRONMENT DIVISION.
.
.
SPECIAL-NAMES.  "A" IS CODE-CHR-A
                "B" IS CODE-CHR-B.
.
.
DATA DIVISION.
.
.
REPORT SECTION.
RD  REP-FILE-A   CODE CODE-CHR-A ...
.
.
RD  REP-FILE-B   CODE CODE-CHR-B ...
```

A second program could then be used to print only the report with the code of A, as follows:

```
DATA DIVISION.
FD  RPT-IN-FILE
    RECORD CONTAINS 122 CHARACTERS
    LABEL RECORDS ARE STANDARD
    DATA RECORD IS RPT-RCD.
01  RPT-RCD.
    05  CODE-CHR          PICTURE X.
    05  PRINT-PART.
        10  CTL-CHR       PICTURE X.
        10  RECORD-PART   PICTURE X(120).
FD  PRINT-FILE
    RECORD CONTAINS 121 CHARACTERS
    LABEL RECORDS ARE STANDARD
    DATA RECORD IS PRINT-REC.
01  PRINT-REC.
    05  FILLER            PICTURE X(121).
.
.
.
PROCEDURE DIVISION.
.
:
LOOP.  READ RPT-IN-FILE AT END
           GO TO CONTINUE.
           IF CODE-CHR = "A"
           WRITE PRINT-REC FROM PRINT-PART
           AFTER POSITIONING CTL-CHR LINES.
           GO TO LOOP.
CONTINUE.
           .
           .
           .
```

Control Footings and Page Format

Depending on the number and size of Control Footings (as well as the page depth of the report), all of the specified Control Footings may not be printed on the same page if a control break occurs for a high-level control. When a page condition is detected before all required Control Footings are printed, the Report Writer will print the Page Footing (if specified), skip to the next page, print the Page Heading (if specified) and then continue to print Control Footings.

If the programmer wishes all of his Control Footings to be printed on the same page, he must format his page in the RD-level entry for the report (by setting the LAST DETAIL integer to a sufficiently low line number) to allow for the necessary space.

NEXT GROUP Clause

Each time a CONTROL FOOTING report group with a NEXT GROUP clause is printed, the clause is activated only if the report group is associated with the control that causes the break. This is illustrated in Figure 58.

```
RD  EXPENSE-REPORT CONTROLS ARE FINAL,
    MONTH, DAY
        .
        .
        .
01  TYPE CONTROL FOOTING DAY
    LINE PLUS 1 NEXT GROUP
    NEXT PAGE.
        .
        .
        .
01  TYPE CONTROL FOOTING MONTH
    LINE PLUS 1 NEXT GROUP
    NEXT PAGE.
        .
        .
        .

(Execution Output)

EXPENSE REPORT
        .
        .
        .
January 31.........29.30
    (Output for CF DAY)
January total.....131.40
    (Output for CF MONTH)
```

Figure 58. Activating the NEXT GROUP Clause

Note: The NEXT GROUP NEXT PAGE clause for the Control Footing DAY is not activated.

Floating First Detail

The first presentation of a body group (PH, PF, CH, CF, DE) that contains a relative line as its first line will have its relative line spacing suppressed; the first line will be printed on either the value of FIRST DETAIL or INTEGER PLUS 1 of a NEXT GROUP clause from the preceding page. For example:

1. If the following body group was the last to be printed on a page

   01 TYPE CF NEXT GROUP NEXT PAGE

   then this next body group

   01 TYPE DE LINE PLUS 5

   would be printed on value of FIRST DETAIL (in PAGE clause).

2. If the following body group was the last to be printed on a page

   01 TYPE CF NEXT GROUP LINE 12

   and after printing, line-counter = 40, then this next body group

   01 TYPE DETAIL LINE PLUS 5

   would be printed on line 12 + 1 (i.e., line 13).

Report Writer Routines

At the end of the analysis of a report description (RD) entry, the Report Writer routines are generated, based on the contents of the RD. Each routine references the compiler-generated card number of its respective RD.

TABLE HANDLING CONSIDERATIONS

Subscripts

If a subscript is represented by a constant and if the subscripted item is of fixed length, the location of the subscripted data item within the table or list is resolved during compilation.

If a subscript is represented by a data-name, the location is resolved at execution time. The most efficient format in this case is COMPUTATIONAL, with a PICTURE size less than five integers.

The value contained in a subscript is an integer which represents an occurrence number within a table. Every time a subscripted data-name is referenced in a program, the compiler generates up to 16 instructions to calculate the correct displacement. Therefore, if a subscripted data-name is to be processed extensively, move the subscripted item to an unsubscripted work area, do all necessary processing, and then move the item back into the table. Even when subscripts are described as COMPUTATIONAL, subscripting takes time and core storage.

Note: Caution should be observed when redefining a subscript. If the value of the redefining data item is changed in the Procedure Division, no new calculation for the subscript is performed.

Index-names

Index-names are compiler-generated items, one fullword in length, assigned storage in the TGT (Task Global Table). An index-name is defined by the INDEXED BY clause. The value in an index-name represents an actual displacement from the beginning of the table that corresponds to an occurrence number in the table. Address calculation for a direct index requires a maximum of four instructions; address calculation for a relative index requires a few more. Therefore, the use of index-names in referencing tables is more efficient than the use of subscripts. The use of direct indexes is faster than the use of relative indexes.

Index-names can only be referenced in the PERFORM, SEARCH, and SET statements.

Index Data Items

Index data items are compiler-generated storage positions, one fullword in length, that are assigned storage within the COBOL program area. An index data item is defined by the USAGE IS INDEX clause. The programmer can use index data items to save values of index-names for later reference.

Great care must be taken when setting values of index data items. Since an index data item is not part of any table, the compiler is unable to change any displacement value contained in an index-name when an index data item is set to the value of an index-name or another index data item. See the SET statement examples later in this chapter.

Index data items can only be referenced in SEARCH and SET statements.

OCCURS Clause

If indexing is to be used to reference a table element and the Format 2 (SEARCH ALL) statement is also used, the KEY option must be specified in the OCCURS clause. A table element is represented by the subject of an OCCURS clause, and is equivalent to one level of a table. The table element must then be ordered upon the key(s) and data-name(s) specified.

DEPENDING ON Option

If a data item described by an OCCURS clause with the DEPENDING ON data-name option is followed by nonsubordinate data items, a change in the value of data-name during the course of program execution will have the following effects:

1. The size of any group described by or containing the related OCCURS clause will reflect the new value of data-name.
2. Whenever a MOVE to a field containing an OCCURS clause with the DEPENDING ON option is executed, the MOVE is done on the basis of the current contents of the object of the DEPENDING ON option.
3. The location of any nonsubordinate items following the item described with the OCCURS clause will be affected by the new value of data-name. If the programmer wishes to preserve the contents of these items, the following procedure can be used: prior to the change in data-name, move all nonsubordinate items following the variable item to a work area; after the change in data-name, move all the items back.

Note: The value of data-name may change because a move is made to it or to the group in which it is contained; or the value of data-name may change because the group in which it is contained is a record area that has been changed by execution of a READ statement.

For example, assume that the Data Division of a program contains the following coding:

```
01  ANYRECORD.
    05  A PICTURE S999 COMPUTATIONAL-3.
    05  TABLEA PICTURE S999 OCCURS 100
        TIMES DEPENDING ON A.
    05  GROUPB.

        Subordinate data items.
                End of record.
```

GROUPB items are not subordinate to TABLEA, which is described by the OCCURS clause. Assuming that WORKB is a work area with the same data structure as GROUPB, the following procedural coding could be used:

```
MOVE GROUPB TO WORKB

Calculate a new value of A

MOVE WORKB TO GROUPB
```

The preceding statements can be avoided by placing the OCCURS clause with the DEPENDING ON option at the end of the record.

Note: data-name can also change because of a change in the value of an item that redefines it. In this case, the group size and the location of nonsubordinate items as described in the two preceding paragraphs cannot be determined.

SEARCH ALL Statement

The SEARCH ALL statement is used to search an entire table for an item without having to write a loop procedure. For example, a programmer-defined table may be the following:

```
01  TABLE.
    05  ENTRY-IN-TABLE OCCURS 90 TIMES
        ASCENDING KEY-1,KEY-2
        DESCENDING KEY-3
        INDEXED BY INDEX-1.
        10  PART-1   PICTURE 9(2).
        10  KEY-1    PICTURE 9(5).
        10  PART-2   PICTURE 9(6).
        10  KEY-2    PICTURE 9(4).
        10  PART-3   PICTURE 9(33).
        10  KEY-3    PICTURE 9(5).
```

A search of the entire table can be initiated with the following instruction:

```
SEARCH ALL ENTRY-IN-TABLE AT END GO TO
NOENTRY WHEN KEY-1 (INDEX-1) = VALUE-1
AND KEY-2 (INDEX-1) = VALUE-2 AND KEY-3
(INDEX-1) = VALUE-3 MOVE PART-1
(INDEX-1) TO OUTPUT-AREA.
```

The preceding instructions will execute a search on the given array TABLE, which contains 90 elements of 55 bytes and 3 keys. The primary and secondary keys (KEY-1 and KEY-2) are in ascending order whereas the least significant key (KEY-3) is in descending order. If an entry is found in which the three keys are equal to the given values (i.e., VALUE-1, VALUE-2, VALUE-3), PART-1 of that entry will be moved to OUTPUT-AREA. If matching keys are not found in any of the entries in TABLE, the NOENTRY routine is entered.

If a match is found between a table entry and the given values, the index (INDEX-1) is set to a value corresponding to the relative position within the table of the matching entry. If no match is found, the index remains at the setting it had when execution of the SEARCH ALL statement began.

Note: It is more efficient to test keys in order of significance (i.e., KEY-1 should be specified before KEY-2 in the WHEN statement). The WHEN statement can only test for equality, and only one side of the equation may be a key.

The table search is performed using a binary search technique. The table must be presorted on all keys, and all entries must be the same length.

SET Statement

The SET statement is used to assign values to index-names and to index data items.

When an index-name is set to the value of a literal, identifier, or an index-name from another table element, it is set to an actual displacement from the beginning of the table that corresponds to the occurrence number indicated by the second operand in the statement. The compiler performs the necessary calculations. If an index-name is set to another index-name for the same table, the compiler need make no conversion of the actual displacement value contained in the second operand.

However, when an index data item is set to another index data item or to an index-name, or when an index-name is set to an index data item, the compiler is unable to change any displacement value it finds, since an index data item is not part of any table. Thus, no conversion of values can take place. Remember this to avoid making programming errors.

For example, suppose that a table has been defined as:

```
01 A.
   05 B OCCURS 2 INDEXED BY I1, I5.
      10 C OCCURS 2 INDEXED BY I2, I6.
         15 D OCCURS 3 INDEXED BY I3, I4.
            20 E PIC X(20).
            20 F PIC 9(5).
```

The table appears in core storage as shown in Figure 59.

```
                                                                              Byte
                                                      ┌──────────────┬─────┐   0
                                    ⎧D (1, 1, 1)      │ E            │  F  │
                                    ⎪                 ├──────────────┼─────┤  25
                    ⎧C (1, 1)      ⎨D (1, 1, 2)      │ E            │  F  │
                    ⎪               ⎪                 ├──────────────┼─────┤  50
                    ⎪               ⎩D (1, 1, 3)      │ E            │  F  │
       ⎧B(1)       ⎨                                 ├──────────────┼─────┤  75
       ⎪            ⎪               ⎧D (1, 2, 1)      │ E            │  F  │
       ⎪            ⎪               ⎪                 ├──────────────┼─────┤ 100
       ⎪            ⎩C (1, 2)      ⎨D (1, 2, 2)      │ E            │  F  │
       ⎪                            ⎪                 ├──────────────┼─────┤ 125
       ⎪                            ⎩D (1, 2, 3)      │ E            │  F  │
 A    ⎨                                              ├──────────────┼─────┤ 150
       ⎪                            ⎧D (2, 1, 1)      │ E            │  F  │
       ⎪                            ⎪                 ├──────────────┼─────┤ 175
       ⎪            ⎧C (2, 1)      ⎨D (2, 1, 2)      │ E            │  F  │
       ⎪            ⎪               ⎪                 ├──────────────┼─────┤ 200
       ⎪            ⎪               ⎩D (2, 1, 3)      │ E            │  F  │
       ⎩B(2)       ⎨                                 ├──────────────┼─────┤ 225
                    ⎪               ⎧D (2, 2, 1)      │ E            │  F  │
                    ⎪               ⎪                 ├──────────────┼─────┤ 250
                    ⎩C (2, 2)      ⎨D (2, 2, 2)      │ E            │  F  │
                                    ⎪                 ├──────────────┼─────┤ 275
                                    ⎩D (2, 2, 3)      │ E            │  F  │
                                                      └──────────────┴─────┘ 300
```

Figure 59. Table Structure in Core Storage

Suppose that a reference to D (2, 2, 3) is necessary. The following method is incorrect:

```
SET I3 TO 2.
SET INDX-DATA-ITM TO I3.
SET I3 UP BY 1.
SET I2, I1 TO INDX-DATA-ITM.
MOVE D (I1, I2, I3) TO WORKAREA.
```

The value contained in I3 after the first SET statement is 25, which represents the beginning point of the second occurrence of D. When the second SET statement is executed, the value 25 is placed in INDX-DATA-ITM, and the fourth SET statement moves the value 25 into I2 and I1. The third SET statement increases the value in I3 to 50. The calculation for the address D (I1, I2, I3) would then be as follows:

```
(address of D (1, 1, 1)) + 25 + 25 + 50
  = (address of D (1, 1, 1)) + 100
```

This is not the address of D (2, 2, 3).

The following method will find the correct address:

```
SET I3 TO 2.
SET I2, I1 TO I3.
SET I3 UP BY 1.
```

In this case, the first SET statement places the value 25 in I3. Since the compiler is able to calculate the lengths of B and C, the second SET statement places the value 75 in I2, and the value 150 in I1. The third SET statement places the value 50 in I3. The correct address calculation will be:

```
(address of D (1, 1, 1)) + 150 + 75 + 50
  = (address of D (1, 1, 1)) + 275
```

The rules for the SET statement are shown in Table 25.

Use care when setting the value of index-names associated with tables described as OCCURS DEPENDING ON. If the table entry length is changed, the value contained within the index-name will become invalid unless a new SET statement corrects it.

programmer with respect to the location of the SORT verb in the program and conditions under which the SORT verb is executed.

```
      ┌───────────────────────────┐
      │                           │
      │           ROOT            │
      │                           │
     ┌├───────────────────────────┤
     ││                           │
  L  {│ TRANSIENT OR OVERLAY AREA │
     ││                           │
     └├───────────────────────────┤
      │                           │
      │       SORT PROGRAM        │
      │                           │
      └───────────────────────────┘
```

Figure 60. Partition Diagram when Sort is Used with Segmentation

USING THE TECHNIQUE

To cause the Sort program to be loaded into the same area used by the overlayable segments and thus share this area of core, a simple change must be made to the linkage editor control cards generated by the compiler.

The compiler will generate the following linkage editor control cards for the Sort:

```
PHASE   XXXXXX00,XXXXXXYY + X'L'
INCLUDE ILBDDUM0
```

where XXXXXX is the first six letters of the PROGRAM-ID name, YY is the priority of the last segment of the program, and L is the size, in hexadecimal, of the largest overlayable segment rounded to the next highest doubleword boundary.

ILBDDUM0 is a dummy CSECT of 2 bytes used to load the Sort program.

To cause the Sort program to be loaded in the overlay area, the + X'L' parameter must be removed from the PHASE card for PHASE XXXXXX00. To do this, the programmer must first produce an object deck (compile only) and then manually change the PHASE card. This PHASE card is usually three cards from the back of the object deck.

RESTRICTIONS WHEN USING THE TECHNIQUE

When the previously described technique is used, the following restrictions apply to the use of the SORT verb:

1. The SORT verb and its corresponding INPUT and/or OUTPUT Procedures may appear only in the permanently resident segments of the program. The reason for this is that after the Sort operation is complete, control returns to the instruction in the COBOL program immediately following the SORT verb. If the SORT verb were in an overlayable segment, the Sort program itself would overlay the invoking segment. The COBOL subroutine that keeps track of which overlayable segment is currently in core (ILBDSEGM) is unaware of this. Therefore, when control is returned following the Sort operation, the proper segment is not reloaded as is necessary.

2. The SORT verb may not be invoked via a PERFORM from an overlayable segment even though the SORT verb is in the permanently resident area of the program. The reason for this is similar to the reason given above. Eventually, the PERFORM is satisfied and control is returned to the instruction following the PERFORM. However, in the meantime, the Sort program has overlaid the segment in which the PERFORM was issued without notifying the subroutine ILBDSEGM. Therefore, the correct overlayable segment will not be reloaded as necessary.

3. If a SORT verb is executed at any time in the program, control can not be passed back to the overlayable segment that was the last one executed, without first going through another overlay segment in the program. The reason is again the same as previously cited. The Sort program has overlaid the segment currently in the overlay area without informing ILBDSEGM. Therefore, if control is passed back to the segment that ILBDSEGM assumes is in core, no reload of the segment is made. However, if control is passed to another overlayable segment, ILBDSEGM causes a load to occur and all of its pointers are reset accordingly.

Note: Restrictions 2 and 3 can be eliminated by employing the technique explained below. This technique accomplishes the same effect as the one described above but requires a subroutine linkage in the problem program.

Alternate Technique

The COBOL subroutine ILBDSEGM keeps track of which overlayable segment is currently in the overlay area. This is done by keeping the priority number of the proper segment in a field called CURSEGM. Before leaving an overlayable segment to execute a SORT verb, the contents of CURSEGM are changed to indicate that segment FF is currently in core. When the Sort operation is complete and control is returned to the overlayable segment, ILBDSEGM checks CURSEGM to determine whether the proper segment is in core. Since ILBDSEGM now thinks that segment FF is in core, a load is made for the program segment that has been overlaid by the Sort program and processing continues normally. The idea is to force a reload, when necessary, of the segment overlaid by the Sort program. This can be accomplished as follows:

- Catalog the subroutine CHGPRTY listed in Figure 61 to the relocatable library. In the COBOL program, just before leaving an overlayable segment to execute the Sort program, include the following linkage - CALL 'CHGPRTY'.

- The CALL to CHGPRTY need be made only if before returning to this segment both of the following conditions prevail:

  (a) A SORT verb will be executed, and

  (b) Control will not pass through any other overlayable segment prior to the return to the current segment.

As mentioned previously, this technique elimates only restrictions 2 and 3. The restriction that the SORT verb be coded only in the resident portion of the program still applies. The reason for this is that the compiler generates in-line code that is used by the Sort exits when the USING and/or GIVING options of the SORT verb are used. This requires that the segment containing the SORT verb and the Sort program itself both be resident in core simultaneously.

```
CHGPRTY     CSECT
            USING     *,15
            ST        1,SAVE          SAVE REG. 1
            L         1,ADCON         GET ADDR. OF "CURSEGM"
            LTR       1,1             TEST ADDR. FOR ZERO
            BZ        RETURN          YES. EXIT
            MVI       0(1),X'FF'      CHANGE PRTY TO FF
RETURN      L         1,SAVE          RESTORE REG. 1
            BR        14              RETURN TO CALLER
ADCON       DC        V(CURSEGM)      LINKAGE TO "CURSEGM"
SAVE        DC        F'0'            SAVE AREA
            END       CHGPRTY
```

Figure 61. CHGPRTY Subroutine

The following is a sample COBOL program and the output listing resulting from its compilation, link editing, and execution. The program creates a blocked, labeled, standard sequential file, writes it out on tape, and then reads it back in. It also does a check on the field called NO-OF-DEPENDENTS. All data records in the file are displayed. Those with a zero in the NO-OF-DEPENDENTS field are displayed with the special character Z. The records of the file are not altered from the time of creation, despite the fact that the NO-OF-DEPENDENTS field is changed for display purposes. The individual records of the file are created using the subscripting technique. TRACE is used as a debugging aid during program execution.

The output formats illustrated in the listing are described in the chapter "Interpreting Output."

```
// JOB SAMPLE
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
```

```
 CBL QUOTE,SEQ
000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. TESTRUN.
000030     AUTHOR. PROGRAMMER NAME.
000040     INSTALLATION. NEW YORK PROGRAMMING CENTER.
000050     DATE-WRITTEN.  FEBRUARY 2,1971
000060 DATE-COMPILED. 04/24/71
000070    REMARKS. THIS PROGRAM HAS BEEN WRITTEN AS A SAMPLE PROGRAM FOR
000080     COBOL USERS. IT CREATES AN OUTPUT FILE AND READS IT BACK AS
000090     INPUT.
000100
000110 ENVIRONMENT DIVISION.
000120 CONFIGURATION SECTION.
000130 SOURCE-COMPUTER. IBM-360-H50.
000140 OBJECT-COMPUTER. IBM-360-H50.
000150 INPUT-OUTPUT SECTION.
000160 FILE-CONTROL.
000170     SELECT FILE-1 ASSIGN TO SYS008-UT-2400-S.
000180     SELECT FILE-2 ASSIGN TO SYS008-UT-2400-S.
000190
000200 DATA DIVISION.
000210 FILE SECTION.
000220 FD  FILE-1
000230     LABEL RECORDS ARE OMITTED
000240     BLOCK CONTAINS 5 RECORDS
000250     RECORDING MODE IS F
000255     RECORD CONTAINS 20 CHARACTERS
000260     DATA RECORD IS RECORD-1.
000270 01  RECORD-1.
000280     05  FIELD-A PIC X(20).
000290 FD  FILE-2
000300     LABEL RECORDS ARE OMITTED
000310     BLOCK CONTAINS 5 RECORDS
000320     RECORD CONTAINS 20 CHARACTERS
000330     RECORDING MODE IS F
000340     DATA RECORD IS RECORD-2.
000350 01  RECORD-2.
000360     05  FIELD-A PIC X(20).
```

```
WORKING-STORAGE SECTION.
01  FILLER.
    02  COUNT PIC S99 COMP SYNC.
    02  ALPHABET PIC X(26) VALUE IS "ABCDEFGHIJKLMNOPQRSTUVWXYZ".
    02  ALPHA REDEFINES ALPHABET PIC X OCCURS 26 TIMES.
    02  NUMBR PIC S99 COMP SYNC.
    02  DEPENDENTS PIC X(26) VALUE "01234012340123401234012340".
    02  DEPEND REDEFINES DEPENDENTS PIC X OCCURS 26 TIMES.
01  WORK-RECORD.
    05  NAME-FIELD PIC X.
    05  FILLER PIC X VALUE IS SPACE.
    05  RECORD-NO PIC 9999.
    05  FILLER PIC X VALUE IS SPACE.
    05  LOCATION PIC AAA VALUE IS "NYC".
    05  FILLER PIC X VALUE IS SPACE.
    05  NO-OF-DEPENDENTS PIC XX.
    05  FILLER PIC X(7) VALUE IS SPACES.

PROCEDURE DIVISION.
BEGIN. READY TRACE.
    NOTE THAT THE FOLLOWING OPENS THE OUTPUT FILE TO BE CREATED
    AND INITIALIZES COUNTERS.
STEP-1. OPEN OUTPUT FILE-1. MOVE ZERO TO COUNT, NUMBR.
    NOTE THAT THE FOLLOWING CREATES INTERNALLY THE RECORDS TO BE
    CONTAINED IN THE FILE, WRITES THEM ON TAPE, AND DISPLAYS
    THEM ON THE CONSOLE.
STEP-2. ADD 1 TO COUNT, NUMBR. MOVE ALPHA (COUNT) TO
    NAME-FIELD.
    MOVE DEPEND (COUNT) TO NO-OF-DEPENDENTS.
    MOVE NUMBR TO RECORD-NO.
STEP-3. DISPLAY WORK-RECORD UPON CONSOLE. WRITE RECORD-1 FROM
    WORK-RECORD.
STEP-4. PERFORM STEP-2 THRU STEP-3 UNTIL COUNT IS EQUAL TO 26.
    NOTE THAT THE FOLLOWING CLOSES THE OUTPUT FILE AND REOPENS
    IT AS INPUT.
STEP-5. CLOSE FILE-1. OPEN INPUT FILE-2.
    NOTE THAT THE FOLLOWING READS BACK THE FILE AND SINGLES
    OUT EMPLOYEES WITH NO DEPENDENTS.
STEP-6. READ FILE-2 RECORD INTO WORK-RECORD AT END GO TO STEP-8.
STEP-7. IF NO-OF-DEPENDENTS IS EQUAL TO "0" MOVE "Z" TO
    NO-OF-DEPENDENTS. EXHIBIT NAMED WORK-RECORD. GO TO STEP-6.
STEP-8. CLOSE FILE-2.
    STOP RUN.
```

INTRNL NAME	LVL	SOURCE NAME	BASE	DISPL	INTRNL NAME	DEFINITION	USAGE	R	O	Q	M
DNM=1-148	FD	FILE-1	DTF=01		DNM=1-148		DTFMT				F
DNM=1-178	01	RECORD-1	BL=1	000	DNM=1-178	DS OCL20	GROUP				
DNM=1-199	02	FIELD-A	BL=1	000	DNM=1-199	DS 20C	DISP				
DNM=1-216	FD	FILE-2	DTF=02		DNM=1-216		DTFMT				F
DNM=1-246	01	RECORD-2	BL=2	000	DNM=1-246	DS OCL20	GROUP				
DNM=1-267	02	FIELD-A	BL=2	000	DNM=1-267	DS 20C	DISP				
DNM=1-287	01	FILLER	BL=3	000	DNM=1-287	DS OCL56	GROUP				
DNM=1-306	02	COUNT	BL=3	000	DNM=1-306	DS 1H	COMP				
DNM=1-321	02	ALPHABET	BL=3	002	DNM=1-321	DS 26C	DISP				
DNM=1-339	02	ALPHA	BL=3	002	DNM=1-339	DS 1C	DISP	R	O		
DNM=1-357	02	NUMBR	BL=3	01C	DNM=1-357	DS 1H	COMP				
DNM=1-372	02	DEPENDENTS	BL=3	01E	DNM=1-372	DS 26C	DISP				
DNM=1-392	02	DEPEND	BL=3	01E	DNM=1-392	DS 1C	DISP	R	O		
DNM=1-408	01	WORK-RECORD	BL=3	038	DNM=1-408	DS OCL20	GROUP				
DNM=1-432	02	NAME-FIELD	BL=3	038	DNM=1-432	DS 1C	DISP				
DNM=1-452	02	FILLER	BL=3	039	DNM=1-452	DS 1C	DISP				
DNM=1-471	02	RECORD-NO	BL=3	03A	DNM=1-471	DS 4C	DISP-NM				
DNM=1-490	02	FILLER	BL=3	03E	DNM=1-490	DS 1C	DISP				
DNM=2-000	02	LOCATION	BL=3	03F	DNM=2-000	DS 3C	DISP				
DNM=2-018	02	FILLER	BL=3	042	DNM=2-018	DS 1C	DISP				
DNM=2-037	02	NO-OF-DEPENDENTS	BL=3	043	DNM=2-037	DS 2C	DISP				
DNM=2-063	02	FILLER	BL=3	045	DNM=2-063	DS 7C	DISP				

MEMORY MAP

TGT	003E0
SAVE AREA	003E0
SWITCH	00428
TALLY	0042C
SORT SAVE	00430
ENTRY-SAVE	00434
SORT CORE SIZE	00438
NSTD-REELS	0043C
SORT RET	0043E
WORKING CELLS	00440
SORT FILE SIZE	00570
SORT MODE SIZE	00574
PGT-VN TBL	00578
TGT-VN TBL	0057C
SORTAB ADDRESS	00580
LENGTH OF VN TBL	00584
LNGTH OF SORTAB	00586
PGM ID	00588
A(INIT1)	00590
UPSI SWITCHES	00594
OVERFLOW CELLS	0059C
BL CELLS	0059C
DTFADR CELLS	005A8
TEMP STORAGE	005B0
TEMP STORAGE-2	005B8
TEMP STORAGE-3	005B8
TEMP STORAGE-4	005B8
BLL CELLS	005B8
VLC CELLS	005BC
SBL CELLS	005BC
INDEX CELLS	005BC
SUBADR CELLS	005BC
ONCTL CELLS	005C4
PFMCTL CELLS	005C4
PFMSAV CELLS	005C4
VN CELLS	005C8
SAVE AREA =2	005CC
XSASW CELLS	005CC
XSA CELLS	005CC
PARAM CELLS	005CC
RPTSAV AREA	005D0
CHECKPT CTR	005D0
IOPTR CELLS	005D0

```
LITERAL POOL (HEX)

00610 (LIT+0)  *  00000001  001A5B5B  C2D6D7C5  D5405B5B  C2C3D3D6  E2C55B5B
00628 (LIT+24)    C2C6C3D4  E4D3F0E9  C0000000

     DISPLAY LITERALS (BCD)

00634 (LTL+36)    'WORK-RECORD'


                PGT                       005D8

           OVERFLOW CELLS                 005D8
           VIRTUAL CELLS                  005D8
           PROCEDURE NAME CELLS           005E4
           GENERATED NAME CELLS           005F8
           SUBDTF ADDRESS CELLS           00608
           VNI CELLS                      00608
           LITERALS                       00610
           DISPLAY LITERALS               00634

 REGISTER ASSIGNMENT

  REG 6    BL =3
  REG 7    BL =1
  REG 8    BL =2
```

```
57         000640                          START    EQU    *
           000640  58 F0 C 004                      L      15,004(0,12)         V(ILBDDSP0)
           000644  05 1F                            BALR   1,15
           000646  000140                           DC     X'000140'
           000649  04F5F7404040                     DC     X'04F5F7404040'
57         000650  96 40 D 048                      OI     048(13),X'40'        SWT+0
60         000654  58 F0 C 004                      L      15,004(0,12)         V(ILBDDSP0)
           000658  05 1F                            BALR   1,15
           00065A  000140                           DC     X'000140'
           00065D  04F6F0404040                     DC     X'04F6F0404040'
60         000664  41 10 C 03E                      LA     1,03E(0,12)          LIT+6
           000668  58 00 D 1C8                      L      0,1C8(0,13)          DTF=1
           00066C  18 40                            LR     4,0
           00066E  05 F0                            BALR   15,0
           000670  50 00 F 008                      ST     0,008(0,15)
           000674  45 00 F 00C                      BAL    0,00C(0,15)
           000678  00000000                         DC     X'00000000'
           00067C  0A 02                            SVC    2
           00067E  41 00 D 1C8                      LA     0,1C8(0,13)          DTF=1
           000682  58 F0 C 008                      L      15,008(0,12)         V(ILBDIML0)
           000686  05 EF                            BALR   14,15
           000688  58 10 D 1C8                      L      1,1C8(0,13)          DTF=1
           00068C  96 10 1 020                      OI     020(1),X'10'
           000690  50 20 D 1BC                      ST     2,1BC(0,13)          BL =1
           000694  58 70 D 1BC                      L      7,1BC(0,13)          BL =1
60         000698  D2 01 6 000 C 038                MVC    000(2,6),038(12)     DNM=1-306      LIT+0
           00069E  D2 01 6 01C C 038                MVC    01C(2,6),038(12)     DNM=1-357      LIT+0
64         0006A4                          PN=01    EQU    *
           0006A4  58 F0 C 004                      L      15,004(0,12)         V(ILBDDSP0)
           0006A8  05 1F                            BALR   1,15
           0006AA  000140                           DC     X'000140'
           0006AD  04F6F4404040                     DC     X'04F6F4404040'
64         0006B4  48 30 C 03A                      LH     3,03A(0,12)          LIT+2
           0006B8  4A 30 6 000                      AH     3,000(0,6)           DNM=1-306
           0006BC  4E 30 D 1D0                      CVD    3,1D0(0,13)          TS=01
           0006C0  D7 05 D 1D0 D 1D0                XC     1D0(6,13),1D0(13)    TS=01          TS=01
           0006C6  94 0F D 1D6                      NI     1D6(13),X'0F'        TS=01+6
           0006CA  4F 30 D 1D0                      CVB    3,1D0(0,13)          TS=01
           0006CE  40 30 6 000                      STH    3,000(0,6)           DNM=1-306
           0006D2  48 30 C 03A                      LH     3,03A(0,12)          LIT+2
           0006D6  4A 30 6 01C                      AH     3,01C(0,6)           DNM=1-357
           0006DA  4E 30 D 1D0                      CVD    3,1D0(0,13)          TS=01
           0006DE  D7 05 D 1D0 D 1D0                XC     1D0(6,13),1D0(13)    TS=01          TS=01
           0006E4  94 0F D 1D6                      NI     1D6(13),X'0F'        TS=01+6
           0006E8  4F 30 D 1D0                      CVB    3,1D0(0,13)          TS=01
           0006EC  40 30 6 01C                      STH    3,01C(0,6)           DNM=1-357
64         0006F0  41 40 6 002                      LA     4,002(0,6)           DNM=1-339
           0006F4  48 20 6 000                      LH     2,000(0,6)           DNM=1-306
           0006F8  4C 20 C 03A                      MH     2,03A(0,12)          LIT+2
           0006FC  1A 42                            AR     4,2
           0006FE  5B 40 C 038                      S      4,038(0,12)          LIT+0
           000702  50 40 D 1DC                      ST     4,1DC(0,13)          SBS=1
           000706  58 E0 D 1DC                      L      14,1DC(0,13)         SBS=1
           00070A  D2 00 6 038 E 000                MVC    038(1,6),000(14)     DNM=1-432      DNM=1-339
66         00071C  41 40 6 01E                      LA     4,01E(0,6)           DNM=1-392
           000714  48 20 6 000                      LH     2,000(0,6)           DNM=1-306
           000718  4C 20 C 03A                      MH     2,03A(0,12)          LIT+2
           00071C  1A 42                            AR     4,2
           00071E  5B 40 C 038                      S      4,038(0,12)          LIT+0
           000722  50 40 D 1E0                      ST     4,1E0(0,13)          SBS=2
           000726  58 E0 D 1E0                      L      14,1E0(0,13)         SBS=2
           00072A  D2 00 6 043 E 000                MVC    043(1,6),000(14)     DNM=2-37       DNM=1-392
           000730  92 40 6 044                      MVI    044(6),X'40'         DNM=2-37+1
67         000734  48 30 6 01C                      LH     3,01C(0,6)           DNM=1-357
           000738  4E 30 D 1D0                      CVD    3,1D0(0,13)          TS=01
           00073C  F3 31 6 03A D 1D6                UNPK   03A(4,6),1D6(2,13)   DNM=1-471      TS=07
           000742  96 F0 6 03D                      OI     03D(6),X'F0'         DNM=1-471+3
```

```
68          000746  58 F0 C 004                  L     15,004(0,12)        V(ILBDDSP0)
            00074A  05 1F                        BALR  1,15
            00074C  000140                       DC    X'000140'
            00074F  04F6F8404040                 DC    X'04F6F8404040'
68          000756  58 F0 C 004                  L     15,004(0,12)        V(ILBDDSP0)
            00075A  05 1F                        BALR  1,15
            00075C  0002                         DC    X'0002'
            00075E  00                           DC    X'00'
            00075F  000014                       DC    X'000014'
            000762  0D0001C4                     DC    X'0D0001C4'         BL =3
            000766  0038                         DC    X'0038'
            000768  FFFF                         DC    X'FFFF'
68          00076A  D2 13 7 000 6 038            MVC   000(20,7),038(6)    DNM=1-178      DNM=1-408
            000770  58 10 D 1C8                  L     1,1C8(0,13)         DTF=1
            000774  18 41                        LR    4,1
            000776  58 F0 1 010                  L     15,010(0,1)
            00077A  45 E0 F 00C                  BAL   14,00C(0,15)
            00077E  50 20 D 1BC                  ST    2,1BC(0,13)         BL =1
            000782  58 70 D 1BC                  L     7,1BC(0,13)         BL =1
            000786  58 10 D 1E8                  L     1,1E8(0,13)         VN=01
            00078A  07 F1                        BCR   15,1
70          00078C                     PN=02     EQU   *
            00078C  58 F0 C 004                  L     15,004(0,12)        V(ILBDDSP0)
            000790  05 1F                        BALR  1,15
            000792  000140                       DC    X'000140'
            000795  04F7F0404040                 DC    X'04F7F0404040'
70          00079C  58 00 D 1E8                  L     0,1E8(0,13)         VN=01
            0007A0  50 00 D 1E4                  ST    0,1E4(0,13)         PSV=1
            0007A4  58 00 C 020                  L     0,020(0,12)         GN=01
            0007A8  50 00 D 1E8                  ST    0,1E8(0,13)         VN=01
            0007AC                     GN=01     EQU   *
            0007AC  48 30 6 000                  LH    3,000(0,6)          DNM=1-306
            0007B0  49 30 C 03C                  CH    3,03C(0,12)         LIT+4
            0007B4  58 F0 C 024                  L     15,024(0,12)        GN=02
            0007B8  07 8F                        BCR   8,15
            0007BA  58 10 C 00C                  L     1,00C(0,12)         PN=01
            0007BE  07 F1                        BCR   15,1
            0007C0                     GN=02     EQU   *
            0007C0  58 00 D 1E4                  L     0,1E4(0,13)         PSV=1
            0007C4  50 00 D 1E8                  ST    0,1E8(0,13)         VN=01
73          0007C8  58 F0 C 004                  L     15,004(0,12)        V(ILBDDSP0)
            0007CC  05 1F                        BALR  1,15
            0007CE  000140                       DC    X'000140'
            0007D1  04F7F3404040                 DC    X'04F7F3404040'
73          0007D8  58 10 D 1C8                  L     1,1C8(0,13)         DTF=1
            0007DC  94 EF 1 020                  NI    020(1),X'EF'
            0007E0  18 01                        LR    0,1
            0007E2  18 40                        LR    4,0
            0007E4  41 10 C 046                  LA    1,046(0,12)         LIT+14
            0007E8  07 00                        BCR   0,0
            0007EA  05 F0                        BALR  15,0
            0007EC  50 00 F 008                  ST    0,008(0,15)
            0007F0  45 00 F 00C                  BAL   0,00C(0,15)
            0007F4  00000000                     DC    X'00000000'
            0007F8  0A 02                        SVC   2
            0007FA  58 00 D 1C8                  L     0,1C8(0,13)         DTF=1
            0007FE  41 10 C 04E                  LA    1,04E(0,12)         LIT+22
            000802  0A 02                        SVC   2
73          000804  41 10 C 03E                  LA    1,03E(0,12)         LIT+6
            000808  58 00 D 1CC                  L     0,1CC(0,13)         DTF=2
            00080C  18 40                        LR    4,0
            00080E  05 F0                        BALR  15,0
            000810  50 00 F 008                  ST    0,008(0,15)
            000814  45 00 F 00C                  BAL   0,00C(0,15)
            000818  00000000                     DC    X'00000000'
            00081C  0A 02                        SVC   2
            00081E  41 00 D 1CC                  LA    0,1CC(0,13)         DTF=2
            000822  58 F0 C 008                  L     15,008(0,12)        V(ILBDIML0)
            000826  05 EF                        BALR  14,15
            000828  58 10 D 1CC                  L     1,1CC(0,13)         DTF=2
            00082C  96 10 1 020                  OI    020(1),X'10'
```

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76    000830                      PN=03   EQU   *
      000830  58 F0 C 004                 L     15,004(0,12)        V(ILBDDSPO)
      000834  05 1F                       BALR  1,15
      000836  000140                      DC    X'000140'
      000839  04F7F6404040                DC    X'04F7F6404040'
76    000840  58 10 D 1CC                 L     1,1CC(0,13)         DTF=2
      000844  58 F0 C 028                 L     15,028(0,12)        GN=03
      000848  91 20 1 010                 TM    010(1),X'20'
      00084C  07 1F                       BCR   1,15
      00084E  18 41                       LR    4,1
      000850  41 F0 C 028                 LA    15,028(0,12)        GN=03
      000854  D2 02 1 025 F 001           MVC   025(3,1),001(15)
      00085A  58 F0 1 010                 L     15,010(0,1)
      00085E  45 E0 F 008                 BAL   14,008(0,15)
      000862  50 20 D 1C0                 ST    2,1C0(0,13)         BL =2
      000866  58 80 D 1C0                 L     8,1C0(0,13)         BL =2
      00086A  D2 13 6 038 8 000           MVC   038(20,6),000(8)    DNM=1-408        DNM=1-246
      000870  58 F0 C 018                 L     15,018(0,12)        PN=04
      000874  07 FF                       BCR   15,15
76    000876                      GN=03   EQU   *
      000876  58 10 C 01C                 L     1,01C(0,12)         PN=05
      00087A  07 F1                       BCR   15,1
77    00087C                      PN=04   EQU   *
      00087C  58 F0 C 004                 L     15,004(0,12)        V(ILBDDSPO)
      000880  05 1F                       BALR  1,15
      000882  000140                      DC    X'000140'
      000885  04F7F7404040                DC    X'04F7F7404040'
77    00088C  58 20 C 02C                 L     2,02C(0,12)         GN=04
      000890  D5 00 C 056 6 043           CLC   056(1,12),043(6)    LIT+30           DNM=2-37
      000896  07 72                       BCR   7,2
      000898  95 40 6 044                 CLI   044(6),X'40'        DNM=2-37+1
      00089C  07 72                       BCR   7,2
77    00089E  D2 00 6 043 C 057           MVC   043(1,6),057(12)    DNM=2-37         LIT+31
      0008A4  92 40 6 044                 MVI   044(6),X'40'        DNM=2-37+1
78    0008A8                      GN=04   EQU   *
      0008A8  58 10 C 058                 L     1,058(0,12)         LIT+32
      0008AC  50 10 D 1EC                 ST    1,1EC(0,13)         PRM=1
      0008B0  41 20 D 1EC                 LA    2,1EC(0,13)         PRM=1
      0008B4  58 F0 C 004                 L     15,004(0,12)        V(ILBDDSPO)
      0008B8  05 1F                       BALR  1,15
      0008BA  8001                        DC    X'8001'
      0008BC  10                          DC    X'10'
      0008BD  00000B                      DC    X'00000B'
      0008C0  0C00005C                    DC    X'0C00005C'         LIT+36
      0008C4  0000                        DC    X'0000'
      0008C6  00                          DC    X'00'
      0008C7  000014                      DC    X'000014'
      0008CA  0D0001C4                    DC    X'0D0001C4'         BL =3
      0008CE  0038                        DC    X'0038'
      0008D0  FFFF                        DC    X'FFFF'
78    0008D2  58 10 C 014                 L     1,014(0,12)         PN=03
      0008D6  07 F1                       BCR   15,1
79    0008D8                      PN=05   EQU   *
      0008D8  58 F0 C 004                 L     15,004(0,12)        V(ILBDDSPO)
      0008DC  05 1F                       BALR  1,15
      0008DE  000140                      DC    X'000140'
      0008E1  04F7F9404040                DC    X'04F7F9404040'
79    0008E8  58 10 D 1CC                 L     1,1CC(0,13)         DTF=2
      0008EC  94 EF 1 020                 NI    020(1),X'EF'
      0008F0  18 01                       LR    0,1
      0008F2  18 40                       LR    4,0
      0008F4  41 10 C 046                 LA    1,046(0,12)         LIT+14
      0008F8  07 00                       BCR   0,0
      0008FA  05 F0                       BALR  15,0
      0008FC  50 00 F 008                 ST    0,008(0,15)
      000900  45 00 F 00C                 BAL   0,00C(0,15)
      000904  00000000                    DC    X'00000000'
      000908  0A 02                       SVC   2
      00090A  58 00 D 1CC                 L     0,1CC(0,13)         DTF=2
      00090E  41 10 C 04E                 LA    1,04E(0,12)         LIT+22
```

```
     000912  0A 02                           SVC   2
80   000914  0A 0E                           SVC   14
     000916  0A 0E                           SVC   14
     000918  50 D0 5 008           INIT2     ST    13,008(0,5)
     00091C  50 50 D 004                     ST    5,004(0,13)
     000920  58 20 C 000                     L     2,000(0,12)          VIR=1
     000924  95 00 2 000                     CLI   000(2),X'00'
     000928  07 79                           BCR   7,9
     00092A  92 FF 2 000                     MVI   000(2),X'FF'
     00092E  96 10 D 048                     OI    048(13),X'10'        SWT+0
     000932  50 E0 D 054           INIT3     ST    14,054(0,13)
     000936  05 F0                           BALR  15,0
     000938  91 20 D 048                     TM    048(13),X'20'        SWT+0
     00093C  47 E0 F 016                     BC    14,016(0,15)
     000940  58 00 B 048                     L     0,048(0,11)
     000944  98 2D B 050                     LM    2,13,050(11)
     000948  58 E0 D 054                     L     14,054(0,13)
     00094C  07 FE                           BCR   15,14
     00094E  96 20 D 048                     OI    048(13),X'20'        SWT+0
     000952  41 60 0 004                     LA    6,004(0,0)
     000956  41 10 C 00C                     LA    1,00C(0,12)          PN=01
     00095A  41 70 C 038                     LA    7,038(0,12)          LIT+0
     00095E  06 70                           BCTR  7,0
     000960  05 50                           BALR  5,0
     000962  58 40 1 000                     L     4,000(0,1)
     000966  1E 4B                           ALR   4,11
     000968  50 40 1 000                     ST    4,000(0,1)
     00096C  87 16 5 000                     BXLE  1,6,000(5)
     000970  41 80 D 1BC                     LA    8,1BC(0,13)          OVF=1
     000974  41 70 D 1CF                     LA    7,1CF(0,13)          TS=01-1
     000978  05 10                           BALR  1,0
     00097A  58 00 8 000                     L     0,000(0,8)
     00097E  1E 0B                           ALR   0,11
     000980  50 00 8 000                     ST    0,000(0,8)
     000984  87 86 1 000                     BXLE  8,6,000(1)
     000988  D2 03 D 1E8 C 030               MVC   1E8(4,13),030(12)    VN=01           VNI=1
     00098E  58 60 D 1C4                     L     6,1C4(0,13)          BL =3
     000992  58 70 D 1BC                     L     7,1BC(0,13)          BL =1
     000996  58 80 D 1C0                     L     8,1C0(0,13)          BL =2
     00099A  58 E0 D 054                     L     14,054(0,13)
     00099E  07 FE                           BCR   15,14
     000000  05 F0                 INIT1     BALR  15,0
     000002  07 00                           BCR   0,0
     000004  90 0E F 00A                     STM   0,14,00A(15)
     000008  47 F0 F 082                     BC    15,082(0,15)
     00000C                                  DS    30F
     000084  58 C0 F 0C6                     L     12,0C6(0,15)
     000088  58 E0 C 000                     L     14,000(0,12)         VIR=1
     00008C  58 D0 F 0CA                     L     13,0CA(0,15)
     000090  95 00 E 000                     CLI   000(14),X'00'
     000094  47 70 F 0A2                     BC    7,0A2(0,15)
     000098  96 10 D 048                     OI    048(13),X'10'        SWT+0
     00009C  92 FF E 000                     MVI   000(14),X'FF'
     0000A0  47 F0 F 0AC                     BC    15,0AC(0,15)
     0000A4  98 CE F 03A                     LM    12,14,03A(15)
     0000A8  90 EC D 00C                     STM   14,12,00C(13)
     0000AC  18 5D                           LR    5,13
     0000AE  98 9F F 0BA                     LM    9,15,0BA(15)
     0000B2  91 10 D 048                     TM    048(13),X'10'        SWT+0
     0000B6  07 19                           BCR   1,9
     0000B8  07 FF                           BCR   15,15
     0000BA  07 00                           BCR   0,0
     0000BC  00000932                        ADCON L4(INIT3)
     0000C0  00000000                        ADCON L4(INIT1)
     0000C4  00000000                        ADCON L4(INIT1)
     0000C8  000005D8                        ADCON L4(PGT)
     0000CC  000003E0                        ADCON L4(TGT)
     0000D0  00000640                        ADCON L4(START)
     0000D4  00000918                        ADCON L4(INIT2)
     0000D8  C3D6C2C6F0F0F0F1                DC    X'C3D6C2C6F0F0F0F1'
     0000E0  E3C5E2E3D9E4D540                DC    X'E3C5E2E3D9E4D540'
```

CROSS-REFERENCE DICTIONARY

DATA NAMES	DEFN	REFERENCE					
FILE-1	00017	00060	00060	00068	00073		
RECORD-1	00028	00068	00068				
FILE-2	00018	00073	00073	00076	00076	00079	
RECORD-2	00036	00076					
COUNT	00040	00060	00064	00064	00064	00066	00070
ALPHA	00042	00064	00064				
NUMBR	00043	00060	00064	00064	00067		
DEPEND	00045	00066	00066				
WORK-RECORD	00046	00068	00068	00068	00076	00078	
NAME-FIELD	00047	00064					
RECORD-NO	00049	00067	00067				
NO-OF-DEPENDENTS	00053	00066	00066	00077	00077	00077	00077

PROCEDURE NAMES	DEFN	REFERENCE
STEP-2	00064	00070
STEP-3	00068	00070
STEP-6	00076	00078
STEP-8	00079	00076

CARD	ERROR MESSAGE	
64	ILA5011I-W	HIGH ORDER TRUNCATION MIGHT OCCUR.
64	ILA5011I-W	HIGH ORDER TRUNCATION MIGHT OCCUR.

```
// EXEC LNKEDT
```

```
JOB  SAMPLE               DISK LINKAGE EDITOR DIAGNOSTIC OF INPUT

ACTION TAKEN     MAP
LIST    AUTOLINK    IJFFBZZN
LIST    AUTOLINK    ILBDDSP0
LIST    INCLUDE IJJCPD1
LIST    AUTOLINK    ILBDIML0
LIST    AUTOLINK    ILBDMNS0
LIST    AUTOLINK    ILBDSAE0
LIST    ENTRY
```

```
   PHASE   XFR-AD  LOCORE  HICORE  DSK-AD   ESD TYPE   LABEL     LOADED  REL-FR

PHASE***  0032A0  0032A0  004ACB  53 01 2  CSECT      TESTRUN   0032A0  0032A0

                                            CSECT      IJFFBZZN  003C40  003C40
                                            *  ENTRY   IJFFZZZN  003C40
                                            *  ENTRY   IJFFBZZZ  003C40
                                            *  ENTRY   IJFFZZZZ  003C40

                                            CSECT      ILBDSAE0  0049E0  0049E0
                                               ENTRY   ILBDSAE1  0049F6

                                            CSECT      ILBDMNS0  0049D8  0049D8

                                            CSECT      ILBDDSP0  0041A8  0041A8
                                            *  ENTRY   ILBDDSP1  0046F8
                                            *  ENTRY   ILBDDSP2  004790
                                            *  ENTRY   ILBDDSP3  004948

                                            CSECT      ILBDIML0  004980  004980

                                            CSECT      IJJCPD1   003FB0  003FB0
                                               ENTRY   IJJCPD1N  003FB0
                                            *  ENTRY   IJJCPD3   003FB0
```

```
// ASSGN SYS008,X'183'
// EXEC

60
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73
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77
WORK-RECORD = A 0001 NYC Z
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77
WORK-RECORD = B 0002 NYC 1
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77
WORK-RECORD = C 0003 NYC 2
76
77
WORK-RECORD = D 0004 NYC 3
76
77
WORK-RECORD = E 0005 NYC 4
76
77
WORK-RECORD = F 0006 NYC Z
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77
WORK-RECORD = G 0007 NYC 1
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77
```

```
WORK-RECORD = H 0008 NYC 2
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WORK-RECORD = I 0009 NYC 3
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WORK-RECORD = J 0010 NYC 4
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WORK-RECORD = K 0011 NYC Z
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77
WORK-RECORD = L 0012 NYC 1
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77
WORK-RECORD = M 0013 NYC 2
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77
WORK-RECORD = N 0014 NYC 3
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WORK-RECORD = O 0015 NYC 4
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WORK-RECORD = P 0016 NYC Z
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WORK-RECORD = Q 0017 NYC 1
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WORK-RECORD = R 0018 NYC 2
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WORK-RECORD = S 0019 NYC 3
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WORK-RECORD = T 0020 NYC 4
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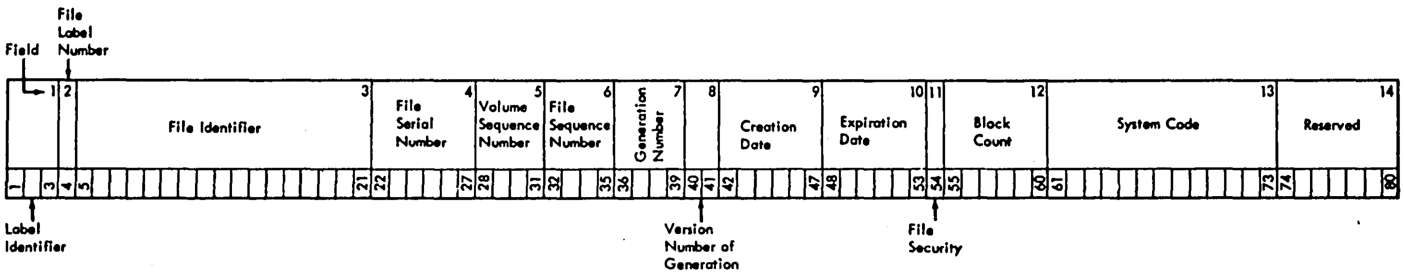
77
WORK-RECORD = U 0021 NYC Z
76
77
WORK-RECORD = V 0022 NYC 1
76
77
WORK-RECORD = W 0023 NYC 2
76
77
WORK-RECORD = X 0024 NYC 3
76
77
WORK-RECORD = Y 0025 NYC 4
76
77
WORK-RECORD = Z 0026 NYC Z
76
79


EOJ SAMPLE
```

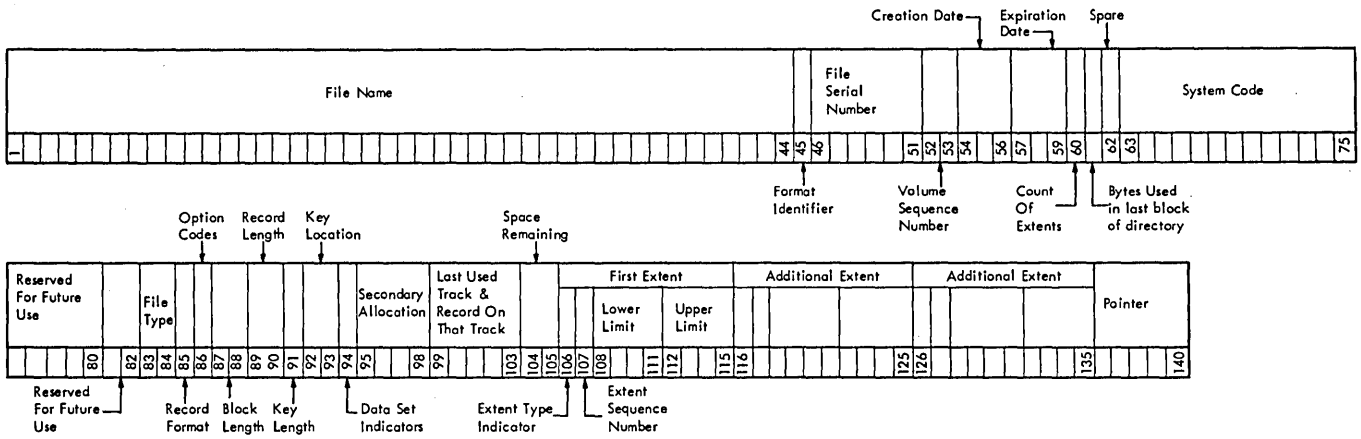
```
BG // assgn sys008,x'183'
BG
BG A 0001 NYC 0
BG B 0002 NYC 1
BG C 0003 NYC 2
BG D 0004 NYC 3
BG E 0005 NYC 4
BG F 0006 NYC 0
BG G 0007 NYC 1
BG H 0008 NYC 2
BG I 0009 NYC 3
BG J 0010 NYC 4
BG K 0011 NYC 0
BG L 0012 NYC 1
BG M 0013 NYC 2
BG N 0014 NYC 3
BG O 0015 NYC 4
BG P 0016 NYC 0
BG Q 0017 NYC 1
BG R 0018 NYC 2
BG S 0019 NYC 3
BG T 0020 NYC 4
BG U 0021 NYC 0
BG V 0022 NYC 1
BG W 0023 NYC 2
BG X 0024 NYC 3
BG Y 0025 NYC 4
BG Z 0026 NYC 0
BG EOJ SAMPLE
     05.11.43,DURATION 00.02.25
```



The standard tape file label format and contents are as follows:

Field	Name and Length	Description
1.	LABEL IDENTIFIER 3 bytes, EBCDIC	Identifies the type of label. HDR = Header (beginning of a data file) EOF = End-of-file (end of a set of data) EOV = End-of-volume (end of the physical reel)
2.	FILE LABEL NUMBER 1 byte, EBCDIC	Always a 1.
3.	FILE IDENTIFIER 17 bytes, EBCDIC	Uniquely identifies the entire file, may contain only printable characters. Some other systems will not accept embedded blanks in the file identifier.
4.	FILE SERIAL NUMBER 6 bytes, EBCDIC	Uniquely identifies a file/volume relationship. This field is identical to the volume serial number in the volume label of the first or only volume of a multivolume file or a multifile set. This field will normally be numeric (000001 to 999999), but may contain any six alphanumeric characters.
5.	VOLUME SEQUENCE NUMBER 4 bytes	Indicates the order of a volume in a given file or multifile set. The first must be numbered 0001, and subsequent numbers must be in proper numeric sequence.
6.	FILE SEQUENCE 4 bytes	Assigns numeric sequence to a file within a multifile set. The first must be numbered 0001.
7.	GENERATION TIME 4 bytes	Uniquely identifies the various editions of the file. May be from 0001 to 9999 in proper numeric sequence.
8.	VERSION NUMBER OF GENERATION 2 bytes	Indicates the version of a generation of a file.

Field	Name and Length	Description
9.	CREATION DATE 6 bytes	Indicates the year and the day of the year that the file was created. Position / Code / Meaning 1 / blank / none 2-3 / 00-99 / year 4-6 / 001-366 / day of year (e.g., January 31, 1971 would be entered as 71031).
10.	EXPIRATION DATE 6 bytes	Indicates the year and the day of the year when the file may become a scratch tape. The format of this field is identical to field 9. On a multifile reel processed sequentially, all files are considered to expire on the same day.
11.	FILE SECURITY 1 byte	Indicates security status of the file. 0 = No security protection. 1 = Security protection. Additional identification of the file is required before it can be processed.
12.	BLOCK COUNT 6 bytes	Indicates the number of data blocks written in the file from the last header label to the first trailer label, exclusive of tapemarks. Count does not include checkpoint records. This field is used in trailer labels.
13.	SYSTEM CODE 13 bytes	Uniquely identifies the operating system.
14.	RESERVED 7 bytes	Reserved. Should be recorded as blanks.



Format 1: This format is common to all data files on disk.

Field	Name and Length	Description
1.	<u>FILE NAME</u> 44 bytes, alphanumeric EBCDIC	This field serves as the key portion of the file label. It can consist of three sections:

1. <u>File ID</u> is an alphanumeric field assigned by the programmer and identifies the file. It can be 1 through 35 bytes in length if generation and version numbers are used, or 1 through 44 bytes in length if they are not used.

2. <u>Generation Number</u>. If used, this field is separated from File ID by a period. It has the format Gnnnn, where G identifies the field as the generation number and nnnn (in decimal) identifies the generation of the file.

3. <u>Version Number of Generation</u>. If used, this section immediately follows the generation number and has the format Vnn, where V identifies the field as the version of generation number and nn (in decimal) identifies the version of generation of the file.

<u>Note</u>: IBM System/360 Disk Operating System compares the entire field against the filename given in the DLAB and DLBL cards. The generation and version numbers are treated differently by the IBM System/360 Operating System.

Fields 2 through 33 constitute the DATA portion of the file label.

Field	Name and Length	Description
2.	FORMAT IDENTIFIER 1 byte, EBCDIC numeric	1 = format 1
3.	FILE SERIAL NUMBER 6 bytes, alphanumeric EBCDIC	Uniquely identifies a file/volume relationship. It is identical to the volume serial number of the first or only volume of a multivolume file.
4.	VOLUME SEQUENCE NUMBER 2 bytes, binary	Indicates the order of a volume relative to the first volume on which the data file resides.
5.	CREATION DATE 3 bytes, discontinuous binary	Indicates the year and the day of the year the file was created. It is of the form YDD, where Y signifies the year (0-99) and DD the day of the year (1-366).
6.	EXPIRATION DATE 3 bytes, discontinuous binary	Indicates the year and the day of the year the file may be deleted. The form of this field is identical to that of field 5.
7a.	EXTENT COUNT 1 byte, binary	Contains a count of the number of extents for this file on this volume. If user labels are used, the count includes the user label track as a separate extent. This field is maintained by the Disk Operating System.
7b.	BYTES USED IN LAST BLOCK OF DIRECTORY 1 byte, binary	Used by IBM System/360 Operating System only for partitioned (library structure) data sets. Not used by the Disk Operating System.
7c.	SPARE 1 byte	Reserved for future use.
8.	SYSTEM CODE 13 bytes	Uniquely identifies the operating system.
9.	RESERVED 7 bytes	Reserved for future use.
10.	FILE TYPE 2 bytes	The contents of this field uniquely identify the type of data file.

Hex Code	Meaning
4000	Sequential organization
2000	Direct organization
8000	Indexed organization
0200	Library organization
0000	Organization not defined in the file label

Field	Name and Length	Description
11.	RECORD FORMAT 1 byte	The contents of this field indicate the type of records contained in the file.
12.	OPTION CODES 1 byte	Bits within this field are used to indicate various options used in building the file.
13.	BLOCK LENGTH 2 bytes, binary	Indicates the block length for fixed-length records, or maximum block size for variable-length blocks.
14.	RECORD LENGTH 2 bytes, binary	Indicates the record length for fixed-length records, or the maximum record length for variable-length records.
15.	KEY LENGTH 1 byte, binary	Indicates the length of the key portion of the data records in the file.
16.	KEY LOCATION 2 bytes, binary	Indicates the high-order position of the data record.

Field 11, RECORD FORMAT:

Bit Position	Content	Meaning
0 and 1	01	Variable-length records
	10	Fixed-length records
	11	Undefined format
2	0	No track overflow
	1	File is organized using track overflow (IBM System/360 Operating System only)
3	0	Unblocked records
	1	Blocked records
4	0	No truncated records
	1	Truncated records in file
5 and 6	01	Control character ASA code
	10	Control character machine code
	00	Control character not stated
7	0	Records are written without keys
	1	Records are written with keys

Field 12, OPTION CODES:

Bit Position	Meaning
0	If on, indicates data file was created using write validity check.
1-7	Unused.

Field	Name and Length	Description
17.	DATA SET INDICATORS 1 byte	Bits within this field are used to indicate the following: **Bit Position** — **Meaning** 0 — If on, indicates that this is the last volume on which this file normally resides. This bit is used by the Disk Operating System DTFSR routine only. None of the other bits in this byte are used by the Disk Operating System. 1 — If on, indicates that the data set described by this file must remain in the same absolute location on the direct-access device. 2 — If on, indicates that block length must always be a multiple of eight bytes. 3 — If on, indicates that this data file is security protected; a password must be provided in order to access it. 4-7 — Space. Reserved for future use.
18.	SECONDARY ALLOCATION 4 bytes, binary	Indicates the amount of storage to be requested for this data file at end-of-extent. This field is used by the IBM System/360 Operating System only. It is not used by the Disk Operating System routines.
19.	LAST USED TRACK AND RECORD ON THAT TRACK 5 bytes, discontinuous binary	Indicates the last occupied track in a consecutive file organization data file. This field has the format CCHHR. It is all binary zeros if the last track in a consecutive data file is not on this volume, or if it is not consecutive organization.
20.	AMOUNT OF SPACE REMAINING ON LAST TRACK USED 2 bytes, binary	A count of the number of bytes of available space remaining on the last track used by this data file on this volume.
21.	EXTENT TYPE INDICATOR 1 byte	Indicates the type of extent with which the following fields are associated: **Hex Code** — **Meaning** 00 — Next three fields do not indicate any extent. 01 — Prime area (indexed) or consecutive area, etc., (i.e., the extent containing the user's data records). 02 — Overflow area of an indexed file. 04 — Cylinder index or master index area of an indexed file. 40 — User label track area. 80 — Shared cylinder indicator.

Field	Name and Length	Description
22.	EXTENT SEQUENCE NUMBER 1 byte, binary	Indicates the extent sequence in a multi-extent file.
23.	LOWER LIMIT 4 bytes, discontinuous binary	The cylinder and the track address specifying the starting point (lower limit) of this extent component. This field has the format CCHH.
24.	UPPER LIMIT 4 bytes	The cylinder and the track address specifying the end point (upper limit) of this extent component. This field has the format CCHH.
25-28.	ADDITIONAL EXTENT 10 bytes	These fields have the same format as the fields 21 through 24, above.
29-32.	ADDITIONAL EXTENT 10 bytes	These fields have the same format as fields 21 through 24, above.
33.	POINTER TO NEXT FILE LABEL WITHIN THIS LABEL SET 5 bytes, discontinuous binary	The disk address (format CCHHR) of a continuation label is needed to further describe the file. If field 9 indicates indexed organization, this field will point to a Format 2 file label within this label set. Otherwise, it points to a Format 3 file label, and then only if the file contains more than three extent segments. If no additional file label is pointed to, this field contains all binary zeros.

The track format for the 2311, 2314, and 2321 direct-access storage devices is illustrated in Figure 62. The names of the fields are given in the following discussion.

Index Marker: All tracks start with an index marker. It is a signal to the hardware that indicates beginning of the track.

Home Address: The home address, preceded by a gap, follows the index marker. The home address uniquely identifies each track by specifying the cylinder and head number.

Track Descriptor Record (Record 0): Record 0 consists of two parts: a count portion and a data portion. The count portion is the same as it is for any other record (see the following description of count for record 1. The 8-byte data portion is used to record information used by LIOCS. The information in the data portion depends on the data organization (direct or indexed) that is being used.

For direct organization, this portion in the form of CCHHR contains the address of the last record on the track and the number of bytes remaining on the track. This information is used to determine whether there is space for another record on the track. For indexed organization, the data portion contains the address of the last record in the cylinder overflow area and the number of tracks remaining in the cylinder overflow area. Record 0 is then used as the cylinder overflow control record.

Address Marker: All records after record 0 will be preceded by a 2-byte address marker. The address marker is a signal to the hardware that a record is starting.

Data Records: Data records can consist of a count and data portion for sequential organization, or a count, key, and data portion for direct and indexed organizations.

1. Count Portion. The count portion contains the identification of each record, the key length, and the data length.

   a. Identification. Each record is identified with its cylinder number, head number, or record number. The cylinder and head numbers will be the same as those of the home address. The record number will indicate a particular record on the track. That is, the first record after record 0 will be record 1, followed by record 2. etc. This 5-byte binary field in the form of CCHHR is often referred to as the record ID.

   b. Key Length. The key length is specified in an 8-bit byte; its length can range from 0 to 255. This field will contain a zero if there is no key.

   c. Data Length. The data length is specified in the 16 bits of the next two bytes.

   Note: It is the count portion that identifies the presence or absence of a key, in addition to indicating the data length. In this way, each record is unique and self formatting.

2. Key Portion. The key portion of the record is normally used to store the control field of the data record such as a man number. Direct and indexed files must have a key portion.

3. Data Portion. The data portion of the record contains the data record.

Note that all records, including the data record, terminate with a 2-byte cyclic check. The hardware uses this cyclic check to ensure that is correctly reread what it had written. The cyclic check is cumulative and is appended to each record when it is written. Upon reading the record, the cyclic check is again accumulated and then compared with the appended cyclic check. If they do not agree, a data check is initiated.

The first byte of the count portion of each record and the home address is reserved for a flag byte. If a track becomes defective, a utility program may be used to transfer the data to an alternate track. (Cylinders 200 through 202 are reserved for alternate tracks on the 2321. Strips 6 through 9 of subcell 19 of each cell are reserved for alternate tracks on the 2321.) In this case, a flag bit within the byte is set on to indicate that this is a defective track and the address of an alternate track will be placed in the record ID of record 0. Subsequent references to this defective track will result in the Supervisor accessing record 0 for the address of the alternate track.

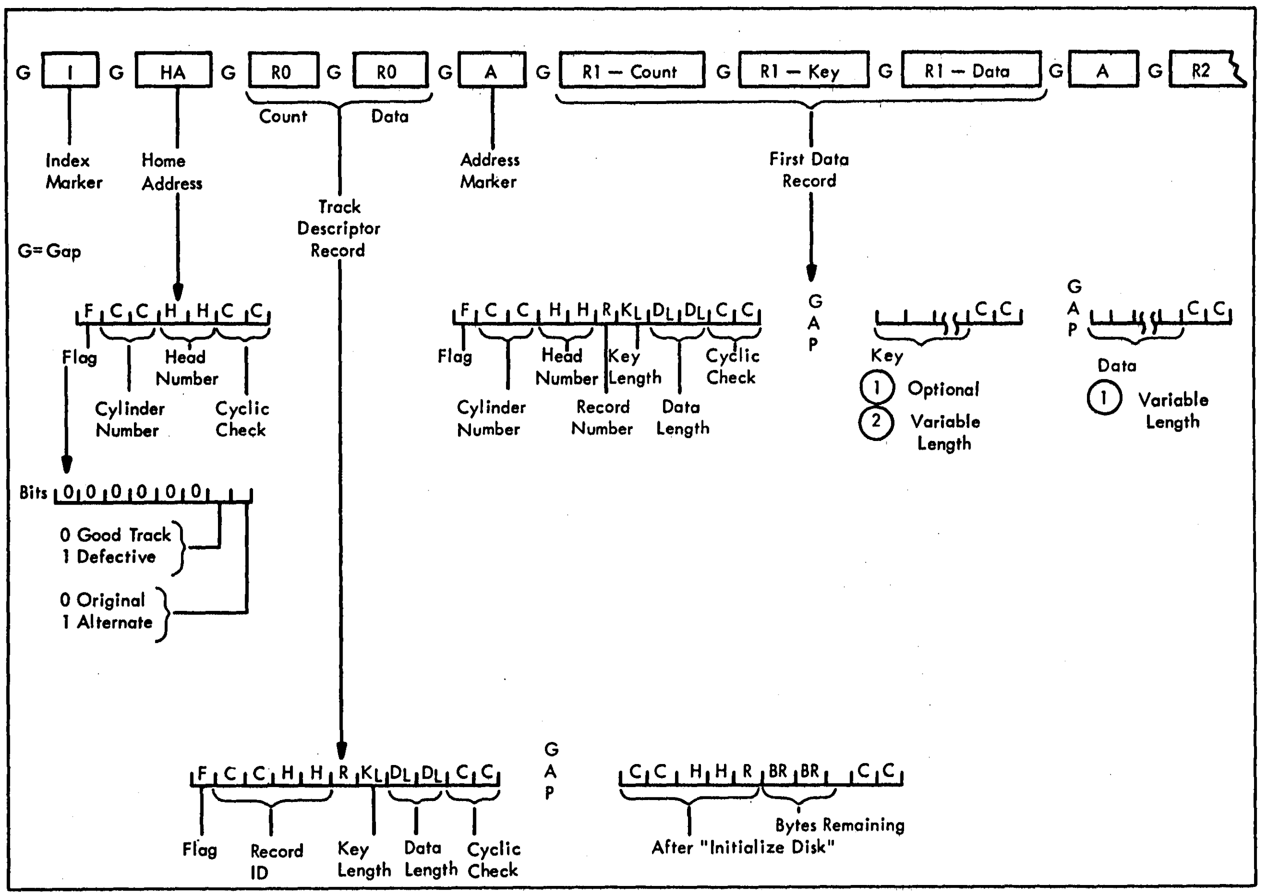


Figure 62. Track Format

COBOL library subroutines perform operations requiring extensive coding. For this reason it would be inefficient to place the coding in the object module each time it is needed. Most COBOL library subroutines are stored in the relocatable library. When required, they are combined at link-edit time with the object module produced by the compiler. Subroutines stored in the core image library are dynamically fetched during problem program execution.

There are several major categories of COBOL library subroutines:

- Input/output verb routines
- Conversion routines
- Arithmetic verb routines
- Sort Feature interface routines
- Checkpoint (RERUN) routines
- Segmentation Feature routines
- Other verb routines
- Transient routines

The following sections describe some of the more commonly used subroutines.

INPUT/OUTPUT SUBROUTINES

The input/output subroutines are used for the COBOL verbs DISPLAY (TRACE and EXHIBIT), ACCEPT, STOP (literal), READ, WRITE, and REWRITE, printer spacing, printer overflow, input/output errors, disk formatting and extent handling, and tape and sequential disk labels.

Printer Spacing

The ILBDSPA0 subroutine is used to control printer spacing when the WRITE statement with the BEFORE/AFTER ADVANCING or POSITIONING option is specified in the source program.

Tape and Sequential Disk Labels

The ILBDUSL0 and ILBDNSL0 subroutines are used when user or nonstandard labels, respectively, are to be processed (LABEL RECORDS ARE data-name).

CLOSE WITH LOCK Subroutine

The ILBDCLK0 subroutine is given control to issue an object-time message when an OPEN statement is used to open a file previously closed WITH LOCK.

WRITE Statement Subroutines

The ILBDVBL0 subroutine is used to write variable-length blocked records.

The ILBDDIO0 subroutine is used for writing files with direct organization (DTFDA).

The ILBDISM0 subroutine is used for writing files with indexed organization.

READ Statement Subroutines

The ILBDDSR0 subroutine is used to read sequentially the records of a directly organized file.

The ILBDDIO0 subroutine is used to read randomly the records of a directly organized file.

The ILBDISM0 subroutine is used to read an indexed file.

REWRITE Statement Subroutines

The ILBDDIO0 subroutine is used to update records on a directly organized file.

The ILBDISM0 subroutine is used to update an indexed file.

DISPLAY (EXHIBIT and TRACE) Subroutines

The ILBDDSP0 subroutine formats one or more operands into printed lines, performing conversions as needed.

The ILBDOSY0 and ILBDASY0 subroutines open SYSLST and/or SYSPCH and/or SYSIPT if there are DISPLAY or ACCEPT statements in a label declarative.

ACCEPT and STOP (literal) Statement Subroutines

The ILBDACP0 subroutine is used to handle ACCEPT statements for both SYSIPT and the console, as well as the STOP (literal) statement. The ILBDACP0 subroutine does not format or convert operands. For operands greater than 80 characters in length, any remainder in excess of the nearest multiple of 80 is ignored when accepting data from SYSIPT.

CLOSE Subroutine

The ILBDCRD0 subroutine is given control when a CLOSE UNIT statement is issued for a sequential input file with direct organization.

Multiple File Tape Subroutine

The ILBDMFT0 subroutine is given control when a reel contains more than one file and there are no standard labels.

Tape Pointer Subroutine

The ILBDIML0 subroutine locates the pointer to the physical tape drive associated with the logical unit for a particular tape file.

Input/Output Error Subroutines

The ILBDSAE0 subroutine is used for processing input/output errors that occur on tape and sequential disk.

The ILBDDAE0 subroutine is used for processing input/output errors that occur on directly organized files.

The ILBDISE0 subroutine is called whenever an input/output error occurs during the processing an indexed file.

The ILBDABX0 subroutine is used to issue a STXIT macro instruction causing control to be passed to it if there is an error on a unit-record device.

Disk Extent Subroutines

The ILBDFMT0 subroutine writes record 0 (R0) on each track of each extent of a directly organized file opened as output. This subroutine is called after the file has been opened.

The ILBDXTN0 subroutine stores for subsequent use the extent information for directly organized files.

Auxiliary Subroutines

Certain input/output subroutines use auxiliary subroutines as follows:

Auxiliary Routine	Used By
ILBDMOV0	ILBDSPA0, ILBDNSL0, ILBDVBL0
ILBDIDA0	ILBDFMT0, ILBDDSR0

CONVERSION SUBROUTINES

Eight numeric data formats are permitted in COBOL: five external (for input and output) and three internal (for internal processing).

The five external formats are:

- External or zoned decimal
- External floating-point
- Sterling display
- Numeric edited
- Sterling report

The three internal formats are:

- Internal or packed decimal
- Binary
- Internal floating-point

The conversions from internal decimal to external decimal, from external decimal to internal decimal, and from internal decimal to numeric edited are performed in-line. The other conversions are performed by the COBOL library subroutines shown in Table 26.

Table 26. Functions of COBOL Library Conversion Subroutines

Subroutine Name and Entry Points	Conversion From	Conversion To
ILBDEFL2	External floating-point	Internal decimal
ILBDEFL1	External floating-point	Binary
ILBDEFL0	External floating-point	Internal floating-point
ILBDBID0[1] ILBDBID1[1] ILBDBID2[1]	Binary	Internal decimal
ILBDBIE0[1] ILBDBIE1[1] ILBDBIE2[1]	Binary	External decimal
ILBDBII0[2] ILBDBII1[2]	Binary	Internal floating-point
ILBDTEF0[2] ILBDTEF1[2]	Binary	External floating-point
ILBDTEF2	Internal decimal	External floating-point
IFBDTEF3	Internal floating-point	External floating-point
ILBDIDB0	Internal decimal	Binary
ILBDIDB1	External decimal	Binary
ILBDDCI1	Internal decimal	Internal floating-point
ILBDDCI0	External decimal	Internal floating-point
ILBDIFD0	Internal floating-point	Internal decimal
ILBDIFD1	Internal floating-point	External decimal
ILBDIFB1 ILBDIFB2[3]	Internal floating-point	Binary integer and a power of 10 exponent
ILBDIFB0[3]	Internal floating-point	Binary
ILBDIDR0	Internal decimal	Sterling report
ILBDIDT0	Internal decimal	Sterling non-report
ILBDSTI0	Sterling non-report	Internal decimal

[1]The entry points used depend on whether the double-precision number is in registers 0 and 1, 2 and 3, or 4 and 5, respectively.
[2]The entry points are for single-precision binary and double-precision binary, respectively.
[3]This entry point is used for calls from other COBOL library subroutines.

ARITHMETIC VERB SUBROUTINES

Most arithmetic operations are performed in-line. However, involved calculations with very large numbers, such as decimal multiplication of two 30-digit numbers, are performed by COBOL library arithmetic subroutines. These subroutine names and their functions are shown in Table 27.

SORT FEATURE INTERFACE ROUTINE

Communication between the Sort/Merge program and the COBOL program is maintained by ILBDSRT0.

CHECKPOINT (RERUN) SUBROUTINE

The ILBDCKP0 subroutine issues the checkpoint macro instruction, which will write checkpoint records on a programmer-specified tape or disk checkpoint device. There are two calling sequences to this subroutine. The first, ILBDCKP1, is activated during initialization when the addresses of all files in the program are entered in a table. The second, ILBDCKP2, is required to take checkpoints during a sorting operation.

If RERUN is requested during a sorting operation, ILBDSRT0 must gather a list of physical IOCS files in use by the Sort program every time Sort exits at E11, E21, and E31. ILBDSRT0 then calls the checkpoint subroutine which will take a checkpoint of all active files.

SEGMENTATION FEATURE SUBROUTINE

The Segmentation Feature requires an object time subroutine, ILBDSEM0. The ILBDSEM0 subroutine performs the following functions when segments are needed:

1. Loads and initializes independent segments not in core.

2. Loads overlayable segments not in core.

3. Initializes independent segments if the segment is in core.

4. Branches to desired entry points.

OTHER VERB ROUTINES

There are also COBOL library subroutines for comparisons, the verbs MOVE and TRANSFORM, and other features of the COBOL language.

Compare Subroutines

The ILBDVCO0 subroutine compares two operands, one or both of which is variable in length. Each may exceed 256 bytes.

The ILBDIVL0 subroutine is used in comparisons involving the figurative constant ALL 'literal', where literal is greater than one character.

Table 27. Functions of COBOL Library Arithmetic Subroutines

Subroutine Name	Function
ILBDXMU0	Internal decimal multiplication (30 digits * 30 digits = 60 digits)
ILBDXDI0	Internal decimal division (60 digits/30 digits = 30 digits)
ILBDXPR0	Decimal fixed-point exponentiation
ILBDFPW0	Floating-point exponentiation
ILBDGPW0[1]	Floating-point exponentiation

[1]The ILBDGPW0 entry point is used if the exponent has a PICTURE clause specifying an integer. The ILBDFPW0 entry point is used in all other cases.

MOVE Subroutines

The ILBDVMO0 subroutine is used when one or both operands is variable in length. Each may exceed 256 bytes. The subroutine has two entry points, depending on the type of MOVE: ILBDVMO0 (left-justified) and ILBDVMO1 (right-justified).

The ILBDANF0 subroutine is used to move the figurative constant ALL 'literal', where literal is greater than one character.

The ILBDANE0 subroutine is used to perform a right-or left-justified alphanumeric edited move.

TRANSFORM Subroutine

The ILBDVTR0 subroutine transforms variable-length items using the ILBDTRN0 transform table.

Class Test Subroutine

The ILBDCLS0 subroutine is used to perform class tests for variable-length items and those fixed-length items longer than 256 bytes.

Note: The following tables are placed in the library for use by the in-line coding generated by the compiler and the subroutines called for by both the class test and TRANSFORM:

ILBDATB0 -- Alphabetic class test
ILBDETB0 -- External decimal class test
ILBDITB0 -- Internal decimal class test
ILBDUTB0 -- Unsigned internal decimal
ILBDWTB0 -- Unsigned external decimal

SEARCH Subroutine

The ILBDSCH0 subroutine processes each search argument key according to type.

Main Program or Subprogram Subroutine

The ILBDMNS0 subroutine is a 1-byte switch tested in the code generated for EXIT PROGRAM, GOBACK, INIT1, and INIT2.

The ILBDSET0 subroutine must be called by a non-American National Standard COBOL program prior to any call to an American National Standard COBOL program. When calling ILBDSET0, standard linkage conventions must be observed; there are no parameters to be passed. The ILBDSET0 subroutine sets the 1-byte switch (ILBDMNS0) to X'FF'. This switch is tested in the American National Standard COBOL program to determine whether it is a main or a called program. The name of this subroutine can be changed to any name desired by the COBOL user.

TRANSIENT SUBROUTINES

The subroutine library includes routines that are dynamically fetched during program execution. These routines are as follows:

Error Message Subroutine

The $$BCOBER subroutine prepares input/output error messages, prints the error messages, and calls the system transient routine $$PDUMP to provide a dump if the DUMP option is in effect.

Reposition Tape Subroutine

The $$BFCMUL subroutine resets the PUB pointer for a particular (SYSnnn) device to the same as that saved earlier by the subroutine ILBDIML0.

This appendix contains information concerning system requirements for the DOS Full American National Standard COBOL compiler, execution time considerations, and the Sort Feature.

MINIMUM MACHINE REQUIREMENTS FOR THE COMPILER

1. At least a System/360 Model 30. The compiler also operates on Models 40, 50, 65, 67 (in 65 mode), or 75. A minimum of 54K bytes of main storage is required.

2. Five work files. The system logical unit SYSLNK must be assigned to a single area (extent) on a 2311 or 2314 mass storage device. Four programmer logical units (SYS001 through SYS004) must reside on 2400 tape units, or on 2311 or 2314 mass storage devices. At least one programmer logical unit as well as the operating system must reside on a mass storage device (i.e., a 2311 or 2314). If the three remaining logical units reside on tape, there must be a separate tape unit for each data set. If they reside on a mass storage device, there must be enough space on that device.

   Work file assignments must be made as follows:

   SYSLNK - mass storage device
   SYS001 - mass storage device
   SYS002 - mass storage device or tape unit
   SYS003 - mass storage device or tape unit
   SYS004 - mass storage device or tape unit

   Note that SYSLNK need only be assigned at compile time if the CATAL or LINK option is in effect.

   The filenames for SYSLNK and SYS001 through SYS004 on the TLBL or DLBL statements are IJSYSLN, IJSYS01, IJSYS02, IJSYS03, and IJSYS04, respectively.

3. A device, such as a printer keyboard, for direct operator communication.

4. A device, such as a card reader, for the job input stream.

5. A device, such as a printer or tape unit, for system output files.

6. The commercial instruction set, and floating-point arithmetic feature, if floating-point literals, floating-point calculations, or fractional exponents are used.

Note: All devices currently supported by IBM System/360 Disk Operating System COBOL are supported by IBM System/360 Disk Operating System American National Standard COBOL.

SOURCE PROGRAM SIZE CONSIDERATIONS

Compiler Capacity

This section contains information which must be considered in determining the limitations on the SIZE of a COBOL source program in a specific core size. It also contains information to aid the programmer in determining how his source program affects usage of space at compilation time.

The capacity of the COBOL compiler is limited by two general conditions: (1) the total table requirement may be greater than the space available and (2) the fact that an individual table (with the exception of the ADCON and cross-reference tables) may need to be longer than 32,767 bytes. If either of these conditions are met during compilation, one of the following error messages will be issued:

ILA0001I-D NO MORE TABLE SPACE AVAILABLE. COMPILATION ABANDONED.

ILA0003I-D A TABLE HAS EXCEEDED THE MAXIMUM SIZE. COMPILATION ABANDONED.

In either case, compilation is terminated. However, in the first case, or in the case of overflow of the ADCON or cross-reference table, the program may be recompiled with a larger size parameter.

The compiler will accept and compile a 1500 card program in a 54K region, which is the maximum available space in 65K core size. In this configuration, the minimum size compiler input/output areas must be allocated. If both LINK and DECK are specified, more core is required for buffer space, which reduces the space available to a given program. Within this configuration, the compiler will accept programs much larger than 1500; the specific size limitation for any core size depends entirely on the statement mix in that program, but the limiting factors are described in the next section.

The overall critical limit using the minimum buffer specification may be expressed as follows:

2 (number of pn's + gn's + literals + virtuals) + 8A + S (L + 5D + 8V + 3P) $\leq$ 14390 + C

where the number of virtuals is the number of calls to COBOL object-time subroutine entry points and user subprograms specified by a CALL statement, and V is the number of unique such names; also

A = number of entries in the ADCON table as defined below

S = 1 if the Segmentation Feature is required; otherwise 0

L = length of optimized literals

D = number of segment discontiguities in the Procedure Division

P = number of PERFORM exits and altered GO TO statements

C = any core over 54K assigned to the program

Within this configuration, assuming no REPORT SECTION, the compiler will accept for example:

300 procedure references assuming an average procedure-name length of 12 characters

25 OCCURS clauses with the DEPENDING ON option

10 files, assuming an average of 3 subordinate record entries

Effective Storage Considerations

The amount of core storage within the compiler's partition and the limitation on the size of an individual internal table are two factors that limit the capacity of the compiler. The limitation on the size of internal tables can, in some instances, be overcome by the spilling over of some tables onto external devices. However, spilling over may cause a severe degradation of performance. The core storage limitation should not be reached by any reasonable use of the language. However, within a limited storage capacity excessive use of certain features and combination of features in the language could make compilation impossible. Some of the features that significantly affect storage usage are:

1. ADCON Table

   Each entry occupies 8 bytes. This table is not limited to the maximum size of 32,767 bytes. Entries are based on:

   - Number of 4096-byte segments in the Working-Storage Section
   - Number of 4096-byte segments in a file buffer area
   - Number of referenced procedure-names
   - Number of implicit procedure-name references such as those generated by IF, SEARCH, and GENERATE statements, ON SIZE ERROR, INVALID KEY, and AT END options, the OCCURS clause with the DEPENDING ON option, USE sentences, and the Segmentation Feature
   - Number of files

2. Procedure-Name Table

   This table contains the number of definitions written in a section and unresolved procedure references. Procedure references are resolved at the end of a section if the definition of the procedure-name is in that section or a preceding section. Therefore, forward references beyond a section impact space.

3. OCCURS DEPENDING ON Table

   This table contains an entry for each unique object of an OCCURS clause with the DEPENDING ON option. The size of an entry is (2 + length of name + length of each qualifier) bytes.

4. Index Table

   An entry is made for each INDEXED BY clause consisting of 11 bytes for each index.

5. File Table

6. Report Writer Tables

A considerable amount of information is maintained concerning each RD such as controls, sums, headings, footings, routines to be generated, etc. The contents of the table is increased by the existence of qualification and subscripting in the Report Section. Approximately 30 reports can be processed, without exceeding the limit of a table.

7. Operand Table

Entries are made depending on the number of operands in a statement. This table could reach its limits by the use of compound nested IF statements or GO TO DEPENDING ON statements with an excessive number of branch points.

8. Dictionary Table

An entry is made for each procedure-name and each data-name in the program. A procedure entry consists of (7 or 9 + length of name) bytes. A data entry consists of (length of name + n) bytes, where n is determined by the attributes of the data item. Some of the features that contribute to the value n are:

- One byte for each character in a numeric edited or alpha-numeric edited item picture.
- Five bytes for an elementary item with a sterling report PICTURE clause.
- Three bytes for an item subordinate to an OCCURS clause.

9. Literal Tables

The total length of all literals (after optimization) may not exceed 32511 bytes. No more than 16255 literals may be specified.

If the Segmentation Feature is used, an area corresponding to the total length of all optimized literals must be kept free during the time the ADCON table is being built. Therefore, a segmented program with literals may need more core.

10. Miscellaneous Tables

The existence of the following items causes entries to be made into tables that impact the total space required for compilation.

- SAME (RECORD) AREA clause
- Subscripting
- Intermediate Arithmetic Results
- Complex Arithmetic Expressions
- Complex Logical Expressions
- APPLY clauses
- Special-Names
- RERUN clauses
- Error messages
- XREF
- Segmentation Feature

EXECUTION TIME CONSIDERATIONS

The amount of main storage must be sufficient to accomodate at least:

- The selected control program
- Support for the file processing techniques used
- Load module to be executed

MULTIPROGRAMMING CONSIDERATIONS

In a system which supports the batch-job foreground (MPS=BJF) and private core image library options, the Linkage Editor can execute in either foreground partition (as well as the background partition) provided a minimum of 10K of storage is assigned to the partition. When executing in a foreground partition, a private core image library must be assigned.

In the multiprogramming environment described above, the COBOL compiler can be executed in any partition having a minimum of 54,272 bytes in the following manner:

1. At system generation time, link edit the compiler in the background partition and place it in the system core image library.
2. Link edit the compiler in each desired foreground partition and place the output in a private core image library assigned to that partition.
3. When executing the compiler in a foreground partition, assign the appropriate private core image library.

SORT FEATURE CONSIDERATIONS

The Sort/Merge program must be executed under control of the Disk Operating System. The program requires the following minimum machine configuration:

1. 16K (16,384) bytes of main storage if the program is to use IBM 2400 Series Magnetic Tape Units or IBM 2311 Disk Storage Drives for intermediate storage. The Sort/Merge program uses 10,240 bytes; an additional 6K bytes are needed for the Disk Operating System and user-written routines.

2. 32K (32,768) bytes of main storage if the program is to use the IBM 2314 Direct Access Facility for intermediate storage. The Sort/Merge program uses 22,528 bytes; an additional 10K bytes are needed for the Disk Operating System and programmer-written routines.

   Note: Performance increases significantly if 50K is available for operation of the Sort/Merge program. At the 100K level, the performance is very high.

3. Standard instruction set.

4. One 2311 or 2314 disk unit attached to one selector channel for sort input, output, and work files. (System residence requirements may necessitate having an additional disk storage unit for sorting.)

5. One IBM 1403 and 1443 Printer, or one IBM 1052 Printer Keyboard.

6. One IBM 1442, 2501, 2520, and 2540 Card Reader, or one IBM 2400 Series Magnetic Tape Unit (7- or 9-track) assigned to SYSIPT and SYSRDR.

7. Three IBM 2400 Series Magnetic Tape Units for work files when tape units are to be used for intermediate storage.

8. One IBM 2400 Series Magnetic Tape Unit if tape input/output is to be used.

When tape units are used for intermediate storage, five input/output devices are required as the minimum for a sorting operation (one input, three work, one output). When disk units are used for intermediate storage, three extents are required (one input, one work, one output).

Three extents are required as a minimum for a disk merging operation (two input, one output). A one-way merge, which simply copies the input file, may be executed with two input units or one disk unit.

COMMUNICATION REGION

The Communication Region is a 46-byte storage area within the Supervisor used by the Supervisor and the COBOL compiler. The structure of the Communication Region is illustrated in Figure 63.

Fields in the Communication Region are addressed relative to the first byte of the region. An asterisk (*) identifies the fields available to the COBOL programmer.

Byte(s)	Meaning
0-7*	Calendar date supplied during the IPL procedure or by the DATE control statement. This field can be used for dating printed output of the COBOL program via the special register CURRENT-DATE. The date can be in one of two forms: mm/dd/yy or dd/mm/yy where mm is month, dd is day, and yy is year. The form is chosen by the installation at system generation time.
8,9	Address of the background program label area.
10,11	Reserved for control program use.
12-22*	User area for inter-program or intra-program communication. This field can be referenced in a COBOL program executing in the background via the special register COM-REG. All eleven bytes are initialized to binary zeros when a JOB control statement is encountered.
23*	User program switch indicators (UPSI). The condition-name associated with the status of the UPSI switches can be specified in the COBOL program via the Special-Names paragraph of the Environment Division. UPSI byte switches are set by the UPSI control statement. The condition-name associated with each may be tested in the Procedure Division of the COBOL program. UPSI byte switches are initialized to binary zeros when a JOB control statement is encountered.
24-31	Jobname for background programs located in the operand field of the JOB control statement.
32-35	Address of the uppermost byte of the background program area.
36-39	Address of the uppermost byte of the last phase loaded into the background program area.
40-43	Address of the uppermost byte used in loading any phase of the background program.
44,45	Length of the background program label area.

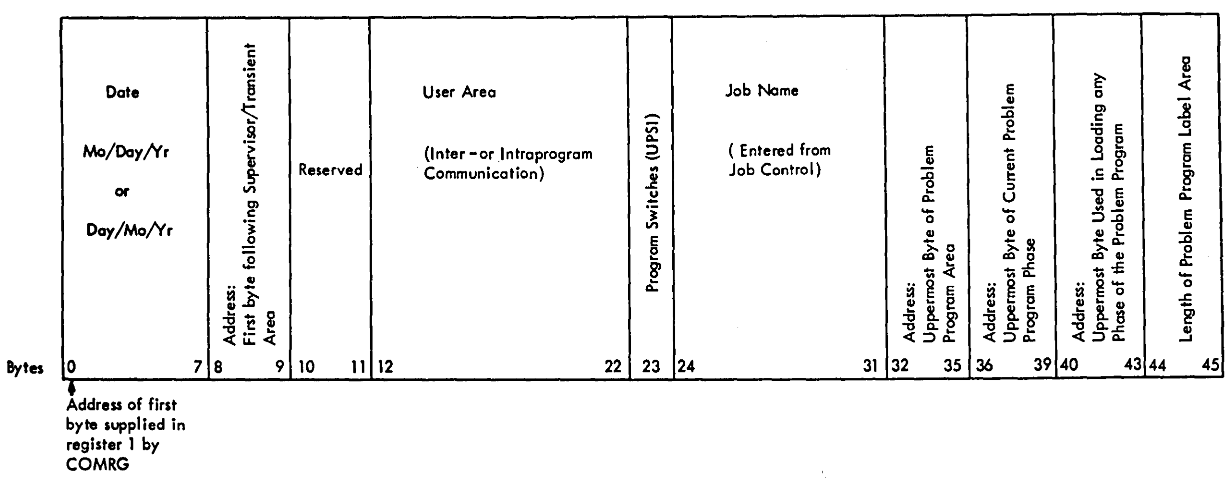


Figure 63. Communication Region in the Supervisor

This appendix illustrates the necessary job control statements and their sequence for five typical programs:

1. Creating a Direct File
2. Retrieving and Updating a Direct File
3. Creating an Indexed File
4. Retrieving and Updating an Indexed File
5. Sorting an Unlabeled Tape File

In all five programs the programmer has requested the following compiler options through the OPTION control statement:

NODECK -- No punched card output for the object program is needed.

LINK -- The object module is to be linkage edited.

LIST -- The COBOL source statements are to be printed on SYSLST.

LISTX -- A Procedure Division map with global tables, literal pool, and register assignments is to be printed on SYSLST.

SYM -- A Data Division map is to be printed on SYSLST.

ERRS -- The diagnostic messages of the COBOL compiler are to be printed on SYSLST.

The EXEC FCOBOL statement calls for execution of the FCOBOL compiler.

By using the CBL card, the programmer indicates that in this source program the quotation mark (") is used for nonnumeric literals.

The ASSIGN clause in the COBOL source program specifies a system-name with the following fields:

SYSnnn-class-device-organization[-name]

The ASSGN control statement for a file must specify the same logical unit as the _SYSnnn_ field of system-name. The ASSGN statement assigns the logical unit to a specific hexadecimal address. The address specified must be associated with the device whose number is given in the _device_ field of system-name.

The DLBL control statememt for a labeled file on a mass storage device must contain the same _name_ as system-name. This is the name by which the file is known to the control program. (The _name_ field of system-name is optional. If _name_ is omitted, the DLBL statement must specify the logical unit (SYSnnn) as the file-name.) The code field of the DLBL statement must correspond to the _class_ and _organization_ fields of system-name as follows:

DLBL "code"	ASSIGN "class"	ASSIGN "organization"
SD	DA or UT	S
DA	DA	A or U, D or W
ISC	DA	I
ISE	DA	I

The first EXTENT control statement for a file on a mass storage device must specify the same logical unit as the _SYSnnn_ field of system-name. (Subsequent EXTENT statements for the same file, if they immediately follow the first, may omit this field.) The type of the extent must be compatible with the _organization_ field of system-name as follows:

EXTENT "type"		ASSIGN "organization"
1	(data area, no split cylinder)	S, A, U, I, D, W
2	(overflow area for indexed file)	I
3	(index area for indexed file)	I
4	(data area, split cylinder)	S, A, U, I, D, W

DIRECT FILES

The following two examples illustrate the job control statements necessary for programs that create and update a direct file.

In the COBOL source programs, the programmer has written:

```
SELECT DA-FILE ASSIGN TO
  SYS015-DA-2311-A-MASTER...

SELECT CARD-FILE ASSIGN TO
  SYS007-UR-2540R-S...
```

In the READFILE source program, the programmer has written:

```
SELECT PRINT-FILE ASSIGN TO
  SYS008-UR-2403-S...
```

(Note the relationship between the system-names in the source programs and the control statements.)

The LBLTYP statement defines the amount of storage to be reserved to process labels for the DA file. The file has one extent.

The EXEC LNKEDT statement causes the object program to be link edited.

An ASSGN control statement assigns logical unit SYS007 to the hexadecimal address 00C -- a 2540R Card Reader.

In the updating program, another ASSGN statement assigns logical unit SYS008 to the hexadecimal address 00E -- a 1403 Printer.

The next series of statements identify the direct file completely.

The ASSGN statement identifies the file as residing on logical unit SYS015, which has the hexadecimal address of 192 -- a 2311 Disk Drive.

The DLBL statement specifies the filename as MASTER, with an expiration date of the 365th day of 1970, and that the file has direct organization (DA).

The EXTENT statement specifies that the file residing on logical unit SYS015 has a serial number 111111, that the extent is a data area with no split cylinder and that this is the first (and only) extent for the file (type and sequence number 1,0), that the file begins on relative track 1020 (track 0 of cylinder 102), and that the file occupies 100 tracks.

(Note that in the EXTENT statement, the relative track number (1020) is not required for the input DA file of the updating program, since the system will use the file labels for this information.)

The EXEC statement begins execution of the problem program, and is followed by input data.

The /* statements indicate end-of-data, the /& statement indicates end-of-job.

Creating a Direct File

```
// JOB CREATEDA
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
 CBL QUOTE

    {COBOL source deck}
/*
// LBLTYP NSD(01)
// EXEC LNKEDT
// ASSGN SYS007,X'00C'
// ASSGN SYS015,X'192'
// DLBL MASTER,99/365,DA
// EXTENT SYS015,111111,1,0,1020,100
// EXEC

    {input data cards}
/*
/&
```

Retrieving and Updating a Direct File

```
// JOB READFILE
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
 CBL QUOTE

    {COBOL source deck}
/*
// LBLTYP NSD(01)
// EXEC LNKEDT
// ASSGN SYS007,X'00C'
// ASSGN SYS008,X'00E'

// ASSGN SYS015,X'192'
// DLBL MASTER,99/365,DA
// EXTENT SYS015,111111,1,0,1020,100

    {input data cards}
/*
/&
```

INDEXED FILES

The following two examples illustrate the job control statements necessary for programs that create and update an indexed file.

In the CREATEIS source program, the programmer has written:

```
SELECT IS-FILE ASSIGN TO
  SYS015-DA-2311-I-MASTER
ACCESS IS SEQUENTIAL
RECORD KEY IS REC-ID.
```

In the RANDIS source program, the programmer has written:

```
SELECT IS-FILE ASSIGN TO
  SYS015-DA-2311-I-MASTER
ACCESS IS RANDOM
NOMINAL KEY IS KEY-ID
RECORD KEY IS REC-ID.

SELECT PRINT-FILE ASSIGN TO
  SYS008-UR-1403-S
RESERVE NO ALTERNATE AREAS.
```

In both source programs, he has written:

```
    SELECT CARD-FILE ASSIGN TO
      SYS007-UR-2540R-S.

I-O-CONTROL.
    APPLY MASTER-INDEX TO 2311 ON IS-FILE.
```

(Note the relationship between the source program statements and the job control statements.)

The LBLTYP statement defines the amount of storage reserved to process labels for the indexed file. The file has three extents: a master index extent, a cylinder index extent, and a data extent.

The EXEC LNKEDT statement causes the object module to be link edited.

An ASSGN control statement assigns logical unit SYS007 to the hexadecimal address 00C -- a 2540R Card Reader.

In the retrieval program, another ASSGN statement assigns logical unit SYS008 to the hexadecimal address 00E -- a 1403 Printer.

The next ASSGN statement assigns logical unit SYS015 to the hexadecimal address 193 -- a 2311 Disk Drive.

The DLBL statement names the file as MASTER, and indicates the expiration date as the 365th day of 1970. In the file creation program, the file label is indexed sequential using Load Create (code ISC); in the retrieval program, the file label is indexed sequential using Load Extension, Add or Retrieve (code ISE).

The first EXTENT statement is identified as a master index (type and sequence numbers are 4,0), and the relative track is 1800 (the extent begins on cylinder 180 track 0), and the extent is 10 tracks long.

The second EXTENT statement is identified as a cylinder index (type and sequence number are 4,1), the relative track is 1810 (the extent begins on cylinder 181, track 0), and the extent is 10 tracks long.

(Note that the extents assigned to master and cylinder indexes must be contiguous, and that the master index must precede the cylinder index on the disk pack. Also note, that if a master index is not requested, the first extent is that for the cylinder index, which would be type 4, sequence number 1.)

The third EXTENT statement is identified as a data area (type 1) and is the third extent named for this file. The relative track is 0010 (the extent begins on cylinder 1, track 0), and the extent is 1750 tracks long.

End-of-data is indicated with the /* statement; end-of-job is indicated with the /& statement.

<u>Creating an Indexed File</u>

```
// JOB CREATEIS
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
 CBL QUOTE

   {COBOL source deck}
/*
// LBLTYP NSD(03)
// EXEC LNKEDT
// ASSGN SYS007,X'00C'
// ASSGN SYS015,X'193'
// DLBL MASTER,99/365,ISC
// EXTENT SYS015,111111,4,0,1800,10
// EXTENT SYS015,111111,4,1,1810,10
// EXTENT SYS015,111111,1,2,0010,1750
// EXEC

   {input data card}
/*
/&
```

Retrieving and Updating an Indexed File

```
// JOB RANDIS
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL

   {COBOL source deck}
// LBLTYP NSD(03)
// EXEC LNKEDT
// ASSGN SYS007,X'00C'
// ASSGN SYS008,X'00E'
// ASSGN SYS015,X'193'
// DLBL MASTER,99/365,ISE
// EXTENT SYS015,111111,4,0,1800,5
// EXTENT SYS015,111111,4,1,1810,10
// EXTENT SYS015,111111,1,2,0010,1750
// EXEC

   {input data cards}
/*
/&
```

FILES USED IN A SORT OPERATION

The following example illustrates the job control statements necessary for a program that sorts an unlabeled tape file.

In the COBOL source program, the programmer has written:

```
SELECT NET-FILE-IN ASSIGN TO
  SYS007-UT-2400-S.

SELECT NET-FILE-OUT ASSIGN TO
  SYS008-UT-2400-S.

SELECT NET-FILE ASSIGN TO 3
  SYS001-UT-2400-S.
```

NET-FILE-IN is the input file; NET-FILE-OUT is the output file; NET-FILE is the sort work file, which utilizes three tape units.

(Note the relationship between the system-names in the COBOL source program and the control statements.)

The EXEC LNKEDT statement causes the job to be link edited.

The first two ASSGN control statements assign the logical unit SYS007 to hexadecimal address 181, and logical unit SYS008 to hexadecimal address 182. SYS007 is the sort input file, and SYS008 is the sort output file.

The last three ASSGN statements assign logical unit SYS001 to hexadecimal address 183, logical unit SYS002 to hexadecimal address 281, and logical unit SYS003 to hexadecimal address 282. SYS001, SYS002, and SYS003 are the logical units that must be used for sort work files. The sort work files must be assigned to 9-track tape units. At this installation, 9-track tape drives are associated with hexadecimal addresses 183, 281, and 282.

Sorting an Unlabeled Tape File

```
// JOB SORTCOB
// OPTION NODECK,LINK,LIST,LISTX,SYM,ERRS
// EXEC FCOBOL
 CBL QUOTE

   {COBOL source deck}
// EXEC LNKEDT
// ASSGN SYS007,X'181'
// ASSGN SYS008,X'182'
// ASSGN SYS001,X'183'
// ASSGN SYS002,X'281'
// ASSGN SYS003,X'282'
// EXEC
/&
```

This appendix describes diagnostic messages generated by the compiler and by compiler-generated object code.

COMPILER DIAGNOSTIC MESSAGES

Using one of the messages as an example, COBOL compiler messages are in the following format:

105 ILA1002I-W ***** SECTION HEADER MISSING. ASSUMED PRESENT.

The code 105 is the compiler-generated card number of the statement where the error has occurred. ILA identifies this as a Disk Operating System Full American National Standard COBOL compiler message; 1002 is the identifying number of the message. The symbol I indicates that this is a message to the programmer for his action. W is a level of severity in the error code with an explanation as follows:

W Warning -- Indicates that an error was made in the source program. However, it is not serious enough to hinder the execution of the program.

C Conditional -- Indicates that an error was made but the compiler usually makes a corrective assumption. The statement containing the error is retained. Execution can be attempted for the debugging value.

E Error -- Indicates that a serious error was made. Usually the compiler makes no corrective assumption. The statement containing the error is dropped. Execution of the program should not be attempted.

D Disaster -- Indicates that a serious error was made. Compilation is not completed. Results are unpredictable.

The message text usually describes the error and describes the action taken by the compiler as a result of the error. Most of the messages are self-explanatory, except in two situations:

1. When no compiler action is given. These messages are numbered in the 3000 series. They appear in combination with other messages that do have the compiler action described.

2. When messages describe errors that require an explanation too long to include in a message. These explanations appear in text under the messages.

Words in a message that must vary according to the program being compiled are denoted by five asterisks (*****) in the messages printed below.

COMPILE-TIME MESSAGES

ILA0001I-D NO MORE TABLE SPACE AVAILABLE. COMPILATION ABANDONED.

Explanation: Because of the size or complexity of the source program, all of the space available for internal tables was exhausted.

Response: Allocate more core storage for the compiler or make the program smaller or less complex before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA0002I-D BASIS LIBRARY NOT FOUND OR LIB OPTION NOT SPECIFIED. COMPILATION ABANDONED.

Explanation: The source statement book specified in a BASIS card at the beginning of compilation was not found or LIB was not specified on the CBL card.

Programmer Response: Correct the BASIS card, make the source code available in the library before recompiling, or specify LIB on the CBL card.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA0003I-D A TABLE HAS EXCEEDED MAXIMUM SIZE. COMPILATION ABANDONED.

Explanation: A table other than the ADCON or Cross Reference table has exceeded 32767 bytes.

Program Response: The program must be written as two or more separate COBOL programs.

ILA0004I- LINK OPTION RESET - D OR E LEVEL ERROR FOUND.

Explanation: The LINK option (set by a // OPTION LINK job control statement) was reset if it had been set previously. This prevents the execution of a partially compiled program or a program with serious errors in it. If a // EXEC LNKEDT card is read later, the job control diagnostic - 1S13D STATEMENT OUT OF SEQUENCE - is logged. The operator usually cancels the job at this point. Ensure that all E- and D-level errors have been eliminated from the program before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA0005I-D LOGIC OR MACHINE ERROR IN TAMER. COMPILATION ABANDONED.

Explanation: A program logic error was detected in the FCOBOL table management routines.

Programmer Response: Compiler error. Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

Note: Messages numbered ILA0001I, ILA0003I, and ILA0005I may be printed at any time during compilation and may be followed by a dump. Message ILA0002I is printed at the beginning of compilation. Message ILA0004I follows the last message issued.

The following messages are grouped in the compiler output listing.

ILA1001I-C NUMERIC LITERAL NOT RECOGNIZED AS LEVEL NUMBER BECAUSE '*****' ILLEGAL AS USED. SKIPPING TO NEXT LEVEL, SECTION OR DIVISION.

Programmer Response: Probable user error. Check the word following the level number and correct its misuse before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1002I-W ***** SECTION HEADER MISSING. ASSUMED PRESENT.

Programmer Response: Probable user error. Supply section header or, if present, correct its syntax (check for a margin error or a mispelling) and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1003I-W ***** PARAGRAPH NAME MISSING. ASSUMED PRESENT.

Programmer Response: Probable user error. Supply paragraph name or, if present, correct its syntax (check for a margin error or a misspelling) and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1004I-E INVALID WORD *****. SKIPPING TO NEXT RECOGNIZABLE WORD.

Programmer Response: Probable user error. Correct invalid word or syntax error before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1005I-E INVALID ORDER IN ENVIRONMENT DIVISION. SKIPPING TO NEXT DIVISION.

Programmer Response: Probable user error. Correct the sequence of sections and/or paragraphs in the Environment Division before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1006I-E DECLARATIVES SECTION WITHOUT USE SENTENCE. SECTION CAN NEVER BE EXECUTED.

Programmer Response: Probable user error. Supply USE sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1007I-W ***** NOT PRECEDED BY A SPACE. ASSUMED SPACE.

Programmer Response: Probable user error. Check syntax, supply space where needed, and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1008I-W RIGHT PAREN SHOULD NOT BE PRECEDED BY SPACE.

Programmer Response: Probable user error. Remove space preceding right parenthesis and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1009I-E COPY MUST BE PRECEDED BY PROCEDURE-NAME. IGNORED.

Programmer Response: Probable user error. Supply procedure-name or, if present, correct its syntax (check for a margin error or a misspelling) before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1010I-W LEFT PAREN SHOULD NOT BE FOLLOWED BY SPACE.

Programmer Response: Probable user error. Remove space following left parenthesis and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1011I-C RECORDING MODE SPECIFICATION IS INVALID. ASSUMED VARIABLE.

Programmer Response: Probable user error. Correct RECORDING MODE specification ensuring that it is compatible with the record description and the file organization before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1012I-E FILE-NAME NOT UNIQUE. USING FIRST DEFINITION.

Programmer Response: Probable user error. Correct the duplication either by removing a redundant SELECT sentence or by replacing a misspelled file-name in a SELECT sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1013I-E CHARACTER LENGTH IN SPECIAL-NAMES MUST BE ONE.

Programmer Response: Probable user error. Change length of nonnumeric literal to one before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1014I-W 'FILE' NOT PRESENT IN MULTIPLE FILE CLAUSE. ASSUMED PRESENT.

Programmer Response: Probable user error. Ensure that the key word 'FILE' is present in the MULTIPLE FILE TAPE clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1015I-E ***** INVALID AS EXTERNAL-NAME. IGNORED.

Programmer Response: Probable user error. Ensure that the name conforms to rules for the formation of procedure-names. If it is a library-name, make sure that member exists in library before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1016I-E MORE THAN ONE ***** CLAUSE. SKIPPING TO NEXT CLAUSE.

Programmer Response: Probable user error. Remove multiple occurrence of clause from entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1017I-E ***** INVALID IN ***** CLAUSE. SKIPPING TO NEXT CLAUSE.

Programmer Response: Probable user error. Replace or remove the invalid specification before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and programming support.

ILA1018I-E COPY CLAUSE INVALID IN A COPY LIBRARY OR LIB OPTION NOT SPECIFIED. IGNORED.

Programmer Response: Probable user error. Correct library member before recompiling or specify LIB on the CBL card.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1019I-E NO LIBRARY NAME. COPY CLAUSE IGNORED.

Programmer Response: Probable user error. Supply library-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1020I-E ***** MUST BE PROCEDURE-NAME FOLLOWING DEBUG.*****.

Programmer Response: Probable user error. Add or correct word following DEBUG to conform to rules for a valid procedure-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1021I-E ***** DOES NOT BELONG ON A DEBUG CARD. SKIPPING TO NEXT CARD.

Programmer Response: Probable user error. Remove invalid specification from DEBUG card before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1022I-W PERIOD DOES NOT BELONG ON DEBUG CARD. DELETED.

Programmer Response: Probable user error. Remove period from debug card and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1023I-E INVALID FILE-NAME. USE IGNORED.

Programmer Response: Probable user error. Supply valid file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1024I-E UNDEFINED FILE-NAME. USE IGNORED.

Programmer Response: Probable user error. Supply valid SELECT sentence for file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1025I-C REDEFINES CLAUSE NOT FIRST CLAUSE FOLLOWING DATA-NAME. ASSUMED FIRST.

Programmer Response: Probable user error. Ensure that the REDEFINES clause is the first clause following data-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1026I-W FOUND ***** EXPECTING ENVIRONMENT. ALL ENV. DIV. STATEMENTS IGNORED.

Programmer Response: Probable user error. Supply valid Environment Division header before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1027I-E DUPLICATE FD. IGNORED.

Programmer Response: Probable user error. Eliminate duplicate FD or correct duplicate file-name if misspelled before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1028I-E ***** SENTENCE IMPROPERLY WRITTEN. SENTENCE IGNORED.

Programmer Response: Probable user error. Correct syntax of sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1029I-E ***** IN ***** SENTENCE NOT DEFINED AS FILE-NAME. SENTENCE IGNORED.

Programmer Response: Probable user error. Ensure that file-name is validly defined in a SELECT sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1030I-E ***** IN ***** SENTENCE IS INVALID. WORD IGNORED.

Programmer Response: Probable user error. Supply valid word before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1031I-C USE SENTENCE NOT PRECEDED BY SECTION-NAME. SECTION-NAME ASSUMED.

Programmer Response: Probable user error. Supply section-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1032I-E ***** INCORRECTLY USED IN USE SENTENCE. SENTENCE IGNORED.

Programmer Response: Probable user error. Correct syntax of USE sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1033I-W ***** FILE-NAME ALREADY ASSIGNED THIS SAME CLAUSE OPTION. USING FIRST ONE.

Programmer Response: Probable user error. Remove duplicate SAME clause, specify correct SAME clause option, or correct a misspelled file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1034I-E ***** CLAUSE ILLEGAL IN ***** LEVEL. SKIPPING TO NEXT VALID CLAUSE.

Programmer Response: Probable user error. Correct SD entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1035I-E INTEGER NOT PRESENT IN MULTIPLE FILE CLAUSE.

Programmer Response: Probable user error. Indicate position of file by specifying the "POSITION integer-n" option.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1036I-C QUALIFIED NAME INVALID AFTER LEVEL NUMBER. USING LOWEST NAME.

Programmer Response: Probable user error. Correct data-name following level number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1037I-E ***** INVALID IN DATA DESCRIPTION. SKIPPING TO NEXT CLAUSE.

Programmer Response: Probable user error. Correct or remove invalid clause in data description entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1038I-E ***** INVALID AFTER LEVEL NUMBER. SKIPPING TO NEXT LEVEL.

Programmer Response: Probable user error. Correct data-name following level number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1039I-W DATA-NAME IN ***** CLAUSE NEED NOT BE QUALIFIED. USING LOWEST NAME.

Programmer Response: Probable user error. Remove qualification of data-name and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1040I-E IMPROPER LEVEL NUMBER FOR FILE SECTION.

Programmer Response: Probable user error. Remove invalid level numbers or indicators from the File Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1041I-E ***** INVALID AS USED IN ***** SECTION. SKIPPING TO NEXT LEVEL, SECTION OR DIVISION.

Programmer Response: Probable user error. Correct invalid specification by removing it or moving it to its proper place in source program before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1042I-E ASSIGN CLAUSE MISSING IN SELECT. CONTINUING.

Programmer Response: Probable user error. Supply ASSIGN clause for file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1043I-W END OF SENTENCE SHOULD PRECEDE *****. ASSUMED PRESENT.

Programmer Response: Probable user error. Supply period to terminate sentence and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1044I-E INVALID OR MISSING USING AND/OR GIVING CLAUSE IN SORT STATEMENT. PROGRAM CANNOT BE EXECUTED.

Programmer Response: Probable user error. Supply correct USING and/or GIVING option in SORT statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1045I-E INVALID ORDER IN ***** SECTION.

Programmer Response: Probable user error. Correct sequence of paragraphs before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1046I-E MEMBER NOT FOUND IN LIBRARY. IGNORING COPY.

Programmer Response: Probable user error. Correct misspelled library-name or ensure that member is in the library before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, compiler output, and a listing of the source statement library available.

ILA1047I-W SYNTAX INCORRECT. TREATED AS COMMENTS.

Programmer Response: Probable user error. Correct the syntax of the item in error before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1048I-W REEL (UNIT) NOT IN ASSIGN CLAUSE. ASSUMED PRESENT.

Programmer Response: Probable user error. Correct the syntax of MULTIPLE REEL/UNIT clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1049I-E ***** FILE-NAME ALREADY ASSIGNED THIS MULTIPLE FILE CLAUSE OPTION. USING FIRST ONE.

Programmer Response: Probable user error. Remove duplicate specification of file-name or correct a misspelled file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1050I-C ***** FILE ALREADY ASSIGNED THIS APPLY OPTION. FILE-NAME IGNORED.

Programmer Response: Probable user error. Remove duplicate APPLY option for file-name or correct a misspelled file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1051I-E NO DATA-NAME IN USE SENTENCE. SENTENCE IGNORED.

Programmer Response: Probable user error. Include data-name in USE sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1052I-E ***** ILLEGALLY USED IN USE SENTENCE. END SENTENCE, RESCANNING AT NEXT RECOGNIZABLE WORD.

Programmer Response: Probable user error. Supply valid SELECT sentence for file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1053I-E ***** CLAUSE INVALID. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct invalid clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1054I-E OPERAND FOR INITIATE NOT FOUND OR ILLEGAL. OPERAND DROPPED.

Programmer Response: Probable user error. Supply valid operand for INITIATE statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1055I-E VALID FILE-NAME NOT PRESENT. DESCRIPTION IGNORED.

Programmer Response: Probable user error. Supply valid file-name or sort-file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1056I-E FILE-NAME NOT DEFINED IN A SELECT. DESCRIPTION IGNORED.

Programmer Response: Probable user error. Check that the SELECT sentence has not been discarded due to a syntax error or correct a misspelled file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1057I-E FIRST WORD IN REPORT SECTION NOT RD. IGNORED.

Programmer Response: Probable user error. Correct the syntax of Report Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1058I-E NO REPORTS CLAUSE IN FILE SECTION. REPORT SECTION IGNORED.

Programmer Response: Probable user error. Ensure that a valid REPORT clause is included in File Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1059I-E NO REPORT CLAUSE FOR RD. RD IGNORED.

Programmer Response: Probable user error. Ensure that the report-name is specified in a REPORT clause in the File Section for the file on which the report is to be written before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1060I-E INVALID WORD IN REPORT WRITER STATEMENT. IGNORED.

Programmer Response: Probable user error. Remove invalid word before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1061I-E DUPLICATE CLAUSE. DROPPED.

Programmer Response: Probable user error. Remove duplicate occurrence of same clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1062I-E ***** IN COPY REPLACING STATEMENT INVALID AS BCD NAME.

Programmer Response: Probable user error. Replace indicated word with valid configuration before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1063I-E DUPLICATE ENTRY IN PAGE CLAUSE. DUPLICATE DROPPED.

Programmer Response: Probable user error. Remove duplicate entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1064I-E NO TYPE CLAUSE SPECIFIED. SKIPPING TO NEXT 01.

Programmer Response: Probable user error. Supply TYPE clause for this report group before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1065I-E INTEGER MISSING IN PAGE CLAUSE. ENTRY IGNORED.

Programmer Response: Probable user error. Ensure that an integer is specified for each PAGE clause entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1066I-E INVALID WORD IN PAGE CLAUSE. SKIPPING TO NEXT RECOGNIZABLE WORD.

Programmer Response: Probable user error. Correct syntax of PAGE clause entries before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1067I-E INVALID HEADER. SKIPPING TO NEXT RECOGNIZABLE WORD.

Programmer Response: Probable user error. Remove invalid headers from the Report Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1068I-E OPERAND FOR GENERATE NOT FOUND. STATEMENT DROPPED.

Programmer Response: Probable user error. Supply GENERATE statement operand before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1069I-E INVALID TYPE CLAUSE. SKIPPING TO NEXT 01.

Programmer Response: Probable user error. Correct TYPE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1070I-C FLT-PT LIT MANTISSA EXCEEDS 16 DIGITS. TRUNCATED TO 16.

Programmer Response: Probable user error. Supply a mantissa of no more than 16 digits before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1071I-C FLT-PT LIT EXPONENT EXCEEDS 2 DIGITS. TRUNCATED TO 2. RESCANNING.

Programmer Response: Probable user error. Specify an exponent of no more than 2 digits before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1072I-C FLT-PT LIT EXPONENT FOLLOWED BY NON-BLANK. RESCANNING AT NON-BLANK.

Programmer Response: Probable user error. Ensure that a blank follows exponent before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1073I-C FLT-PT LIT E FOLLOWED BY INVALID CHARACTER. SKIPPING TO NEXT WORD.

Programmer Response: Probable user error. Supply valid character to follow E before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1074I-C FLT-PT LIT SIGN FOLLOWED BY INVALID CHARACTER. RESCANNING AT E.

Programmer Response: Probable user error. Supply valid character to follow sign before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1075I-C FLT-PT LIT EXCEEDS LIMIT. ASSUME MAX OR MIN PER SIGN OF EXPONENT.

Programmer Response: Probable user error. Respecify valid literal before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1076I-C NONNUMERIC LIT EXCEEDS 120 CHARACTERS. TRUNCATED TO 120.

Programmer Response: Probable user error. Ensure that the nonnumeric literal contains no more than 120 characters before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1077I-C NONNUMERIC LIT CONTINUES IN AREA A. ASSUME AREA B.

Programmer Response: Probable user error. Continue nonnumeric literal in Area B of the continuation card before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1078I-W NONNUMERIC LIT CONTINUED WITHOUT HYPHEN OR QUOTE. ASSUMED.

Programmer Response: Probable user error. Insert hyphen in column 7 or a quotation mark in Area B of continuation line, whichever is missing, and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1079I-W NONNUMERIC LIT HAS ZERO LENGTH. ASSUME ONE SPACE.

Programmer Response: Probable user error. Specify valid nonnumeric literal before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1080I-W PERIOD PRECEDED BY SPACE. ASSUME END OF SENTENCE.

Programmer Response: Probable user error. Ensure that no spaces precede period and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1081I-W PERIOD NOT FOLLOWED BY SPACE. ASSUME END OF SENTENCE.

Programmer Response: Probable user error. Ensure that at least one blank follows period and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1082I-C NUMERIC LIT EXCEEDS 18 DIGITS. TRUNCATED TO 18.

Programmer Response: Probable user error. Supply a numeric literal of no more than 18 digits before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1083I-C ILLEGAL CHARACTER. SCAN RESUMED AT NEXT VALID CHARACTER.

Programmer Response: Probable user error. Remove or replace invalid character before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1084I-W COMMA SHOULD NOT BE PRECEDED BY SPACE.

Programmer Response: Probable user error. Ensure that no spaces precede comma and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1085I-C WORD OR PICTURE EXCEEDS 30 CHARACTERS. TRUNCATED TO 30 CHARACTERS.

Programmer Response: Probable user error. Supply a word or PICTURE of no more than 30 characters before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1086I-W ***** SHOULD BEGIN IN AREA A.

Programmer Response: Probable user error. Begin indicated word in Area A before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1087I-W '*****' SHOULD NOT BEGIN IN AREA A.

Programmer Response: Probable user error. Begin indicated word in Area B before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1088I-E MISSING FIRST INSERT OR DELETE CARD. PASS CARDS UNTIL FOUND. *****.

Programmer Response: Probable user error. Supply INSERT or DELETE card before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1089I-E INSERT OR DELETE NUMBER OUT OF SEQUENCE. SKIPPING TO NEXT INSERT CARD OR DELETE NUMBER. *****.

Programmer Response: Probable user error. Correct sequence of inserted or deleted numbers before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1090I-E DELETE THRU NUMBER OUT OF SEQUENCE. PASS CARDS UNTIL NEXT INSERT OR DELETE. *****.

Programmer Response: Probable user error. Ensure that ranges of sequence numbers specified on DELETE card are in the proper order before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1091I-C ***** IN AREA A NOT VALID AS PROC-NM. ASSUME AREA B.

Programmer Response: Probable user error. If indicated name is a procedure-name, correct its formation before recompiling. If indicated name is not a procedure-name, ensure that it begins in Area B and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1092I-E DECLARATIVES DO NOT FOLLOW PROCEDURE DIVISION. IGNORED.

Programmer Response: Probable user error. Ensure that Declaratives Section header immediately follows Procedure Division header before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1093I-E NO DECLARATIVES SECTION. END DECLARATIVES IGNORED.

Programmer Response: Probable user error. Depending upon the logic of the program, either remove END DECLARATIVES statement and recompile if necessary, or add a Declaratives Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1094I-E INTEGER IN NEXT GROUP CLAUSE DOES NOT CONFORM TO PAGE CLAUSE SPECIFICATIONS. CONTINUING.

Programmer Response: Probable user error. Supply an "integer" in NEXT GROUP clause that is compatible with PAGE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1095I-W WORD 'SECTION' OR 'DIVISION' MISSING. ASSUMED PRESENT.

Programmer Response: Probable user error. Add missing word and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1096I-E DATA-NAME IN UPON OPTION NOT SPECIFIED AS A DATA-NAME FOR A TYPE DETAIL REPORT GROUP IN THIS REPORT. UPON OPTION IGNORED.

Programmer Response: Probable user error. Ensure that the TYPE DETAIL clause is specified for the data-name at the 01 level before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1097I-E PROGRAM-ID MISSING OR MISPLACED. IF PROGRAM-ID DOES NOT IMMEDIATELY FOLLOW IDENTIFICATION DIVISION, IT WILL BE IGNORED.

Programmer Response: Probable user error. Ensure that the PROGRAM-ID paragraph immediately follows IDENTIFICATION DIVISION header before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1098I-C NONNUMERIC LIT NOT CONTINUED WITH HYPHEN AND QUOTE. END LITERAL ON LAST CARD.

Programmer Response: Probable user error. If a continuation is desired, insert a hyphen in column 7 of the continuation card and a quotation mark preceding the continuation in Area B before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1099I-E ***** IS INVALID AS USED.

Programmer Response: Probable user error. Remove or replace indicated word before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1100I-W ***** SEQUENCE ERRORS IN SOURCE PROGRAM.

Programmer Response: Probable user error. Correct sequence errors and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1101I-E NEXT PAGE NOT IN FIRST LINE CLAUSE. IGNORED.

Programmer Response: Probable user error. Correct placement of NEXT PAGE option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1102I-W INCOMPLETE ELEMENTARY ITEM. ASSUME VALUE SPACES.

Programmer Response: Probable user error. Correct description of elementary item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1103I-E GROUP TYPE ALLOWED ONCE FOR RD. IGNORED.

Programmer Response: Probable user error. Remove duplicate TYPE option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1104I-E CONTROL NAME NOT SPECIFIED IN RD. SKIPPING TO NEXT 01.

Programmer Response: Probable user error. Ensure that identifier is specified in a CONTROL clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1105I-W ELEMENTARY ITEM EXPECTED. ASSUMED.

Programmer Response: Probable user error. Supply proper level number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1106I-E OPERAND FOR TERMINATE NOT FOUND OR ILLEGAL. OPERAND DROPPED.

Programmer Response: Probable user error. Ensure that a valid report-name has been specified in the TERMINATE statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1107I-C 'NEXT GROUP' CLAUSE IS ILLEGAL FOR THIS REPORT GROUP. IGNORED.

Programmer Response: Probable user error. Remove NEXT GROUP clause from PH, PF, or CF report group entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1108I-E ***** IS NOT A POSITIVE INTEGRAL NUMBER. ASSUMED ONE.

Programmer Response: Probable user error. Supply a valid positive integer before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1109I-E DUPLICATE USE OF CONTROL NAME. SKIPPING TO NEXT 01.

Programmer Response: Probable user error. Eliminate duplication before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1110I-W INVALID USE OF SUM CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct invalid use of SUM clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1111I-W ELEMENTARY LEVEL WITHOUT COLUMN OR SUM CLAUSE.

Programmer Response: Probable user error. If entry is not to be suppressed, supply COLUMN clause before recompiling. If sum counter is to be referenced elsewhere in the program, supply SUM clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1112I-E '*****' ALREADY SPECIFIED IN TWO FILE DESCRIPTION ENTRIES. IGNORED.

Programmer Response: Probable user error. Ensure that a given report-name appears in no more than two REPORT clauses before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1113I-E EXPECTING 6-DIGIT SEQUENCE NUMBER. SKIPPING TO NEXT INSERT OR DELETE NUMBER. *****.

Programmer Response: Probable user error. Correct sequence-number-field before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1114I-C EXTRANEOUS COMMA OR HYPHEN ON DELETE CARD. IGNORED.

Programmer Response: Probable user error. Correct syntax of DELETE card and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1115I-E NO BLANK, COMMA, OR HYPHEN FOLLOWING SEQUENCE NUMBER. ASSUME BLANK. *****.

Programmer Response: Probable user error. Provide valid sequence number separator before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1116I-E EXPECTING 6-DIGIT SEQUENCE NUMBER AFTER HYPHEN. IGNORING DELETE FROM THRU NUMBER. *****.

Programmer Response: Probable user error. Provide valid sequence number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1117I-E DELETE NUMBER GREATER THAN LAST SEQUENCE NUMBER. STOP INSERT AND DELETE. *****.

Programmer Response: Probable user error. Ensure that DELETE sequence number is within library entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1118I-E INSERT NUMBER GREATER THAN LAST SEQUENCE NUMBER. STOP INSERT AND DELETE. *****.

<u>Programmer Response</u>: Probable user error. Ensure that INSERT sequence number is within library entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1119I-E INTEGER IN 'LINE' CLAUSE DOES NOT CONFORM TO PAGE CLAUSE SPECIFICATIONS. CONTINUING.

<u>Programmer Response</u>: Probable user error. Ensure that LINE clause is compatible with PAGE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1120I-W COMMA NOT FOLLOWED BY SPACE. ASSUMED.

<u>Programmer Response</u>: Probable user error. Insert a space after comma and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1121I-W PERIOD OR COMMA INVALID AS USED IN PICTURE CLAUSE.

<u>Programmer Response</u>: Probable user error. Supply valid PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1122I-E EXTERNAL-NAME IN RERUN CLAUSE MUST NOT BE THE SAME AS SYSTEM-NAME USED IN ASSIGN CLAUSE. RERUN IGNORED.

<u>Programmer Response</u>: Probable user error. Correct duplicate use of name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1123I-E NUMBER IS ZERO OR NEGATIVE. SENTENCE IGNORED.

<u>Programmer Response</u>: Probable user error. Supply valid positive integer before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1124I-E NUMBER TOO LARGE FOR RERUN. CLAUSE IGNORED.

<u>Programmer Response</u>: Probable user error. Provide a number no larger than allowable maximum before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1125I-C ***** FILE-NAME USED IN PREVIOUS RERUN. USING FIRST ONE.

Programmer Response: Probable user error. Ensure that a given file-name appears in only one RERUN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1127I-C ***** INVALID IN ***** SENTENCE. REST OF SENTENCE IGNORED.

Programmer Response: Probable user error. Correct invalid entry in indicated sentence before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1129I-C ID DIV. HEADER MISSING OR MISPLACED. ASSUMED PRESENT.

Programmer Response: Probable user error. Ensure that an Identification Division header appears as first source statement in program and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1130I-E ***** DIV. HEADER MISSING. WORDS IN ***** STATEMENTS ARE INVALID.

Programmer Response: Probable user error. Supply indicated division header before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1131I-W INVALID PRIORITY NUMBER. ZERO ASSUMED.

Programmer Response: Probable user error. Supply a valid priority number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1132I-E INVALID SYSTEM-NAME. SKIPPING TO NEXT CLAUSE.

Programmer Response: Probable user error. Correct system-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1133I-W MORE THAN 1 USE ON STANDARD ERROR SPECIFIED FOR SAME FILE OR OPEN OPTION. DUPLICATE USE IGNORED.

Programmer Response: Probable user error. Ensure that a given file-name is not referred to implicitly or explicitly in more than one USE AFTER STANDARD ERROR procedure before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1134I-E USE SPECIFIED FOR FILE WITH LABEL RECORDS OMITTED OR STANDARD. SENTENCE IGNORED.

Programmer Response: Probable user error. Either specify the LABEL RECORDS clause with the data-name option or remove USE procedure for labels before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1135I-W INTEGER-1 OUTSIDE OF ALLOWABLE LIMITS. 1 ASSUMED.

Programmer Response: Probable user error. Correct integer-1 specification before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1136I-E DATA-NAME ALREADY SPECIFIED FOR A TYPE DETAIL REPORT GROUP. SKIPPING TO NEXT 01, RD, OR SECTION.

Programmer Response: Probable user error. Ensure that each DETAIL report group has a unique data-name at the 01 level before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1137I-W MINIMUM NUMBER OF OCCURRENCES IN OCCURS CLAUSE NOT LESS THAN MAXIMUM NUMBER. CONTINUING.

Programmer Response: Probable user error. Correct the OCCURS clause to ensure that integer-1 is less than integer-2 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1139I-W ***** DUPLICATELY DEFINED SECTION. SECTION NAME IGNORED.

Programmer Response: Probable user error. Remove duplication of indicated section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1140I-C NUMERIC LITERAL EXCEEDS MAXIMUM. SUBSTITUTING 32767.

Programmer Response: Probable user error. Supply a literal no larger than 32767 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1141I-C FILE ORGANIZATION FIELD INVALID IN SYSTEM-NAME. SEQUENTIAL ASSUMED.

Programmer Response: Probable user error. Supply a valid organization field in system-name of ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1142I-E USE FOR STANDARD ERROR OR LABEL PROCESSING SPECIFIED FOR FILE AND OPEN OPTION. USE FOR OPEN OPTION IGNORED.

Programmer Response: Probable user error. Ensure that a given file-name is not referred to, implicitly or explicitly, in more than one USE statement for error or label processing declarative before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1143I-E USE STATEMENTS IMPLY STANDARD AND NONSTANDARD LABELS. USE IGNORED.

Programmer Response: Probable user error. Ensure that if a USE BEFORE label procedure is specified for the file or for an OPEN option, a USE AFTER is not also specified for the same file or OPEN option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1144I-W POSITIONING AND ADVANCING ILLEGALLY USED FOR SAME FILE.

Programmer Response: Probable user error. Ensure that the ADVANCING and POSITIONING options are not both specified for the same file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1145I-E ***** DUPLICATELY DEFINED IN SPECIAL NAMES PARAGRAPH. SENTENCE IGNORED.

Programmer Response: Probable user error. Eliminate duplicate definition of indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1147I-E SD FILE ILLEGALLY SPECIFIED IN SAME AREA CLAUSE. CLAUSE FOR SD IGNORED.

Programmer Response: Probable user error. Ensure that a sort-file-name does not appear in a SAME AREA clause without the SORT or RECORD options before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1148I-C INVALID SEGMENT LIMIT. FIFTY ASSUMED.

Programmer Response: Probable user error. Supply a valid segment limit before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1149I-E FILES IN SAME AREA CLAUSE DO NOT ALL APPEAR IN THE SAME SORT/RECORD AREA CLAUSE. '*****' NOT GIVEN SAME AREA NUMBER.

Programmer Response: Probable user error. Ensure that if one or more file-names of a SAME AREA clause appear in a SAME SORT/RECORD AREA clause, all file-names in the former clause appear in the latter clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1151I-E ILLEGAL CHARACTER USE IN CURRENCY SIGN CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct literal in CURRENCY SIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

IAL1152I-E ON AND/OR OFF STATUS MUST BE SPECIFIED ON UPSI CLAUSE. SPECIAL NAME IGNORED.

Programmer Response: Probable user error. Ensure that an ON or OFF status is defined for an UPSI switch in the Special-Names paragraph if the status is tested in the Procedure Division before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1154I-E 2 DIFFERENT LABEL PROCEDURES FOR EOF AND EOV WITH 'BEFORE' OPTION. BOTH LABEL PROCEDURES IGNORED.

Programmer Response: Probable user error. Ensure that a file is not referenced, implicitly or explicitly, in more than one USE statement with the BEFORE option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1155I-E DEVICE CLASS INVALID IN SYSTEM-NAME. SKIPPING TO NEXT FIELD.

Programmer Response: Probable user error. Supply a valid device-class field in system-name of ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1156I-C DEVICE NUMBER INVALID IN SYSTEM-NAME. '*****' ASSUMED.

Programmer Response: Probable user error. Supply valid device-number field in system-name of ASSIGN clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1158I-E '*****'IN ENTRY STATEMENT IS SAME AS PROGRAM-ID. '*****' IGNORED FOR ENTRY VERB.

Programmer Response: Probable user error. Ensure that the literal specified in the ENTRY statement is not the same name as the PROGRAM-ID before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

| ILA1159I-W PAGE LIMIT INTEGER-1 NOT SPECIFIED OR INVALID. ASSUME HIGH-VALUE.

Programmer Response: Probable user error. Specify integer-1 if other than relative LINE NUMBERS are to be used before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1160I-E CONTINUATION OF WORD FOUND IN AREA A. IGNORED.

Programmer Response: Probable user error. Begin continued word in Area B before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1161I-W RESERVED WORD MISSING. ASSUMED PRESENT.

Programmer Response: Probable user error. Correct syntax of clause or statement and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1162I-E INTEGER IN LINE CLAUSE IS LESS THAN PREVIOUS VALUE. IGNORED.

Programmer Response: Probable user error. Ensure that LINE NUMBER entries are given in ascending order before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1163I-E ABSOLUTE LINE NUMBER IS PRECEDED BY A RELATIVE LINE NUMBER. IGNORED.

Programmer Response: Probable user error. Ensure that an absolute LINE NUMBER is not preceded by a relative LINE NUMBER before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1164I-E NO PAGE CLAUSE SPECIFIED. ALL LINE CLAUSES MUST BE 'LINE PLUS INTEGER'. IGNORED.

Programmer Response: Probable user error. Specify the PAGE LIMIT clause if other than relative LINE NUMBER entries are desired before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1165I-E 'HEADING' EQUALS 'FIRST DETAIL' IN PAGE CLAUSE. PAGE HEADING IS ILLEGAL. CONTINUING.

Programmer Response: Probable user error. Correct PAGE LIMIT clause so that FIRST DETAIL integer is greater than HEADING integer before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1166I-E 'FOOTING' EQUALS 'PAGE LIMIT' IN PAGE CLAUSE. PAGE FOOTING IS ILLEGAL. CONTINUING.

Programmer Response: Probable user error. Ensure that the line number of the FOOTING is less than the integer specified in the PAGE LIMIT clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1167I-W 'LINE NEXT PAGE' CLAUSE IS ILLEGAL FOR THIS REPORT GROUP. IGNORED.

Programmer Response: Probable user error. Ensure that LINE NEXT PAGE is not specified for RH, PH, or PF report groups, or for report groups within reports with no PAGE LIMIT clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1168I-E DUPLICATE REPORT NAME. SKIPPING TO NEW RD.

Programmer Response: Probable user error. Ensure that each report-name is unique before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1169I-E AN OPERAND IN THIS SUM CLAUSE DOES NOT APPEAR AS A SOURCE ITEM IN DETAIL *****. OPERAND IGNORED.

Programmer Response: Probable user error. Ensure that the SUM clause operand appears as a source item in the indicated DETAIL report group before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1170I-E DETAIL REPORT GROUP SPECIFIED WITH NO DATA-NAME. CONTINUING.

<u>Programmer Response</u>: Probable user error. Ensure that each DETAIL report group has a unique data-name at the 01 level in a report before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1171I-E INTEGERS IN PAGE CLAUSE ARE NOT IN ASCENDING ORDER. CONTINUING.

<u>Programmer Response</u>: Probable user error. Ensure that PAGE LIMIT integers (integer-2 through integer-5) are in ascending order before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1172I-E WORD INVALID AS REPORT NAME. RD IGNORED.

<u>Programmer Response</u>: Probable user error. Correct formation of report-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1173I-E GROUP INDICATE IS ILLEGAL FOR THIS REPORT GROUP. IGNORED.

<u>Programmer Response</u>: Probable user error. Remove GROUP INDICATE clause from all report groups except DETAIL before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1174I-E NO LINE CLAUSE SPECIFIED IN PRECEDING REPORT GROUP. NO OUTPUT GENERATED.

<u>Programmer Response</u>: Probable user error. For each report group, specify a LINE clause either at the report group level or prior to or for the first elementary item in the line before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1175I-E DATA-NAME FOR THIS REPORT GROUP IS NOT UNIQUE. SKIPPING TO NEW 01, RD, SECTION.

<u>Programmer Response</u>: Probable user error. Ensure that each report group data-name is a unique level-01 item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1176I-E SYS NUMBER NOT EQUAL TO 001 FOR SORT FILE. ASSUMED PRESENT.

<u>Programmer Response</u>: Probable user error. Ensure that sort work file assignments begin with SYS001 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1178I-E RESET CLAUSE SPECIFIED, AND IS EITHER ILLEGAL FOR THIS REPORT GROUP, OR ELEMENTARY ITEM DOES NOT CONTAIN A SUM CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Ensure that the RESET clause is used in conjunction with the SUM clause and is associated with a CF report group before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA1179I-E COLUMN NUMBER ILLEGAL. ASSUME COLUMN 1.

Programmer Response: Probable user error. Ensure that the column number does not exceed the record size before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2001I-C BLOCK SIZE SMALLER THAN RECORD SIZE. BLOCK CONTAINS IGNORED.

Programmer Response: Probable user error. Correct BLOCK CONTAINS clause or RECORDING MODE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2002I-E ORGANIZATION INCORRECT. USING STANDARD SEQUENTIAL.

Programmer Response: Probable user error. Correct organization or device class specification of system-name in ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2003I-E RANDOM ACCESS ILLEGAL FOR THIS FILE. USING SEQUENTIAL.

Programmer Response: Probable user error. Correct system-name in ASSGN clause, or if sequential access is desired, remove ACCESS MODE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2004I-E RECORDING MODE ILLEGAL FOR ORGANIZATION. RECORDING MODE IGNORED.

Programmer Response: Probable user error. Change recording mode statement to comply with file's organization before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2005I-E A CARD FILE MUST HAVE FIXED RECORD FORMAT. FIXED ASSUMED.

Programmer Response: Probable user error. If the card reader is the required device for this file, correct or remove the RECORDING MODE clause and recompile if necessary. If the error is a result of incorrect device assignment, correct system-name in the ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2006I-C SPANNED RECORDS INVALID FOR THIS DEVICE. USING VARIABLE.

Programmer Response: Probable user error. If S-format is the desired recording mode, specify a valid device type by correcting system-name in the ASSIGN clause before recompiling. If S-format is not the desired recording mode, correct the RECORDING MODE clause if specified, or correct the BLOCK CONTAINS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2007I-C RECORD CONTAINS CLAUSE CONFLICTS WITH RECORD DESCRIPTION. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct the RECORD CONTAINS clause and recompile if necessary. If the record description is in error, make the necessary corrections before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2008I-C APPLY MASTER/CYL INDEX VALID ONLY FOR INDEXED FILES. CLAUSE IGNORED.

Programmer Response: Probable user error. If indexed organization is desired, correct system-name in ASSIGN clause before recompiling. Otherwise, remove APPLY clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2009I-C SYNCHRONIZED ITEM NOT ON PROPER BOUNDARY. NO ALIGNMENT PERFORMED BECAUSE STARTING ADDRESS OF THE REDEFINED ITEM WOULD HAVE TO BE CHANGED.

Programmer Response: Probable user error. Correct boundary alignment of redefined item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2010I-E OBJECT OF REDEFINES CLAUSE IS OCCURS DEPENDING ON SUBJECT. REDEFINES CLAUSE IGNORED.

Programmer Response: Probable user error. Remove the DEPENDING ON option from OCCURS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2011I-E AN INDEX DATA ITEM MAY NOT BE A CONDITIONAL VARIABLE. 88(S) DISCARDED.

Programmer Response: Probable user error. Depending on the logic of the program, either supply appropriate level numbers or remove level-88 items before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2012I-E INDEX NAMES AND/OR KEYS IGNORED FOR TABLE WITH ILLEGAL SUBJECT.

Programmer Response: Probable user error. Ensure that subject of table is valid before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2013I-C BLOCK CONTAINS CLAUSE IMPROPERLY WRITTEN. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct syntax of BLOCK CONTAINS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2014I-C BLOCK CONTAINS CHARACTERS MUST BE USED FOR SPANNED RECORDS. USING VARIABLE.

Programmer Response: Probable user error. Either supply the CHARACTERS option of the BLOCK CONTAINS clause, correct the organization field of system-name in the ASSIGN clause if direct organization is intended, or respecify the RECORDING MODE clause if other than S-mode is desired.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2015I-W CONFLICTING SPECIFICATIONS FOR RECORD FORMAT. ***** ASSUMED.

Programmer Response: Probable user error. Correct RECORDING MODE clause, BLOCK CONTAINS clause, RECORD CONTAINS clause, or record description, to eliminate conflict, and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2016I-E DATA RECORD SIZE IS VARIABLE. 'RECORDING MODE F' IGNORED.

Programmer Response: Probable user error. Ensure that the record is associated with a valid FD, then correct RECORDING MODE clause or record description before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2017I-E IF THE SUBJECT OF AN INDEXED BY CLAUSE IS AN ELEMENTARY ITEM ONLY THAT ITEM MAY BE SPECIFIED IN THE KEY CLAUSE. REST OF KEYS DISCARDED.

Programmer Response: Probable user error. Remove all keys from ASCENDING/DESCENDING option except subject of INDEXED BY clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2018I-E OBJECT OF RENAMES CLAUSE WAS NOT FOUND OR NON-UNIQUE IN LOGICAL RECORD.

Programmer Response: Probable user error. Supply a data description entry for the data-name being used as the object of the RENAMES clause, delete or qualify a duplicate use of the same data-name, or correct a misspelled data-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2019I-C BLOCK CONTAINS CLAUSE INVALID WHEN RECORD FORMAT IS UNDEF. CLAUSE IGNORED.

Programmer Response: Probable user error. If U mode is the recording mode desired, remove the BLOCK CONTAINS clause and recompile if necessary. If other than U mode is desired, provide the proper RECORDING MODE clause and/or check the system-name of the file's ASSIGN clause and the record description for compatibility with the desired recording mode specification (or assumption) before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2020I-C TRACK-AREA CLAUSE ILLEGAL FOR THIS ACCESS METHOD. CLAUSE IGNORED.

Programmer Response: Probable user error. Delete TRACK-AREA clause if the desired access method for the file is sequential, and recompile if necessary. Otherwise, specify ACCESS MODE IS RANDOM before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2021I-C PICTURE DUPLICATION FACTOR TRUNCATED TO 5 SIGNIFICANT DIGITS.

Programmer Response: Probable user error. Correct picture duplication factor before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2022I-E THE OBJECT OF THE RENAMES OR RENAMES THRU CLAUSE CANNOT BE AN 01, 66, 77, OR 88. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct the object of the RENAMES or RENAMES THRU clause or its level number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2023I-E ***** KEY MISSING. FILE IGNORED.

Programmer Response: Probable user error. Supply indicated key for file or check that the desired combination or organization and access method has been specified before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2024I-E ***** KEY IS ILLEGAL FOR THIS ORGANIZATION. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove indicated key clause or check that the desired file organization has been specified in the ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2025I-E FILE NAME NOT UNIQUE. FILE IGNORED.

Programmer Response: Probable user error. Ensure that the file-name has not been defined elsewhere in the program. Either correct spelling of duplicate or check syntax of FD statement.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2027I-C APPLY CORE-INDEX ILLEGAL FOR THIS ACCESS METHOD. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove APPLY CORE-INDEX clause or, if random access is desired, correct ACCESS MODE clause before recompiling

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2028I-W RECORD CONTAINS CLAUSE IMPROPERLY WRITTEN. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct syntax of RECORD CONTAINS clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2029I-C FIRST NON 77, 88 ITEM IN SECTION IS NOT AN 01. THIS ITEM WAS CHANGED TO 01.

Programmer Response: Probable user error. Correct entry to ensure that a level-01 entry precedes subsequent levels of data description before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2030I-C 77 ITEM PRECEDED BY AN 01-49 ITEM OR 77 IN FILE SECTION. 77 CHANGED TO 01.

Programmer Response: Probable user error. Change 77 to a valid level number or rearrange items in the Linkage or Working-Storage Sections before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2031I-C 88 ITEM MUST MUST BE PRECEDED BY 01-49 OR 77 ITEM. 88 CHANGED TO 01.

Programmer Response: Probable user error. Correct entry so that condition-name (88) is subordinate to a conditional variable with a valid level number before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2032I-E 88 ITEM CONTAINED A CLAUSE OTHER THAN VALUE CLAUSE. CLAUSE DELETED.

Programmer Response: Probable user error. Remove clauses other than VALUE from condition-name (88) entry or correct level-number of entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2033I-C ITEM'S USAGE INCOMPATIBLE WITH USAGE OF GROUP IT BELONGS TO. USAGE CHANGED TO GROUP'S USAGE.

Programmer Response: Probable user error. Correct USAGE clause on group or elementary level before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2034I-E GROUP ITEM HAS PICTURE CLAUSE. CLAUSE DELETED.

Programmer Response: Probable user error. Remove PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2035I-E GROUP ITEM HAS BLANK WHEN ZERO CLAUSE. CLAUSE DELETED.

Programmer Response: Probable user error. Remove BLANK WHEN ZERO clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2036I-E GROUP ITEM HAS JUSTIFIED CLAUSE. CLAUSE DELETED.

Programmer Response: Probable user error. Remove JUSTIFIED clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2037I-E BLANK WHEN ZERO CLAUSE USED INCORRECTLY. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct syntax of BLANK WHEN ZERO clause or check compatability of clause with data type of item being described before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2038I-E ACTUAL KEY MUST BE GREATER THAN 4 AND LESS THAN 259 BYTES IN LENGTH. USING 5.

Programmer Response: Probable user error. Correct the ACTUAL KEY clause, specifying a data-name that represents a fixed item from 5 through 258 bytes in length before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2039I-C PICTURE CONFIGURATION ILLEGAL. PICTURE CHANGED TO 9 UNLESS USAGE IS 'DISPLAY-ST', THEN L(6)BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE configuration before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2040I-E JUSTIFIED CLAUSE SPEC'D FOR NON-ALPHABETIC OR NON-ALPHANUMERIC ITEM. CLAUSE DELETED.

Programmer Response: Probable user error. Remove JUSTIFIED clause or change PICTURE to alphabetic or alphanumeric before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2041I-E CONDITION NAME UNDER GROUP HAS VALUE CLAUSE THAT IS NUMERIC. 88 DISCARDED.

Programmer Response: Probable user error. Change group item's usage to ensure that values associated with condition-names refer to a conditional variable whose USAGE IS DISPLAY before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2042I-E THIS ITEM CAUSES OVER 3 LEVELS OF SUBSCRIPTING. OCCURS CLAUSE DROPPED FOR THIS ITEM.

Programmer Response: Probable user error. Remove OCCURS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2043I-E 01 OR 77 LEVEL HAS AN OCCURS CLAUSE. CLAUSE DELETED.

Programmer Response: Probable user error. Remove OCCURS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2044I-E DUPLICATE SD. IGNORED.

Programmer Response: Probable user error. Remove duplicate or correct misspelled sort-file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2045I-E REPORT CONTROL NAME UNDEFINED.

Programmer Response: Probable user error. Define the identifier specified in the CONTROL clause in the File or Working-Storage Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2046I-E REPORT CONTROL NAME NOT FIXED LENGTH.

Programmer Response: Probable user error. Correct the data description entry for the report control name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2047I-E MORE THAN 12 INDEX NAMES SPECIFIED FOR TABLE. FIRST 12 ACCEPTED.

Programmer Response: Probable user error. Remove all index-names in excess of 12 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2049I-C NO VALID OPEN FOR FILE. FILE IGNORED.

Programmer Response: Probable user error. Supply valid or missing OPEN statement for file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2050I-C BLOCK SIZE TOO LARGE. USING MAXIMUM FOR DEVICE. RECORD TRUNCATED.

Programmer Response: Probable user error. Adjust block size for file to a size compatible with the device before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2051I-C APPLY EXTENDED-SEARCH VALID ONLY FOR DIRECT FILES. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove APPLY EXTENDED-SEARCH clause and recompile if necessary. However, if direct organization and random access is desired, correct system-name in ASSIGN clause and ACCESS MODE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2052I-E MORE THAN 12 KEYS SPECIFIED FOR TABLE. FIRST 12 ACCEPTED.

Programmer Response: Probable user error. Remove reference to keys in excess of 12 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2053I-C 77 ITEM WITHOUT PICTURE CLAUSE. ASSUME PICTURE 9.

Programmer Response: Probable user error. Supply a PICTURE clause for level-77 item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2054I-C PICTURE LENGTH WOULD CAUSE OVERFLOW FROM REPORT LINE AT SPECIFIED COLUMN. TRUNCATED TO AVAILABLE SIZE.

Programmer Response: Probable user error. Ensure that compatibility of both PICTURE and COLUMN clauses before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2055I-C STERLING NONREPORT PICTURE - SIGN IN POUND FIELD MUST BE ON HI OR LO ORDER DIGIT. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2056I-C STERLING NONREPORT PICTURE - 9 IN ILLEGAL POSTION. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2057I-C STERLING NONREPORT PICTURE - SIGN IN SHILLING FIELD ILLEGAL. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2058I-C STERLING NONREPORT PICTURE - 8 IN ILLEGAL POSITION. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2059I-C STERLING NONREPORT PICTURE - SIGN IN PENCE FIELD ILLEGAL. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2060I-C STERLING NONREPORT PICTURE - 6 OR 7 IN ILLEGAL POSITION. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2061I-C STERLING NONREPORT PICTURE. USAGE NOT DISPLAY-ST. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Specify USAGE IS DISPLAY-ST or replace PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2062I-C STERLING NONREPORT PICTURE - V IN ILLEGAL POSITION. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2063I-C STERLING NONREPORT PICTURE - S IN ILLEGAL POSITION. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2064I-C STERLING NONREPORT PICTURE - DIGIT LENGTH GT 2. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2065I-C STERLING NONREPORT PICTURE - SHILLING FIELD GT 2. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2066I-C STERLING NONREPORT PICTURE - PENCE FIELD GT 2. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2067I-C STERLING NONREPORT PICTURE - NO POUND SEPARATOR. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2068I-C ONLY THE RENAMES CLAUSE MAY BE SPECIFIED FOR A LEVEL 66 ENTRY. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove all clauses except RENAMES clause for level-66 item and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2069I-C NUMERIC PICTURE - SIGN IN ILLEGAL POSITION. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2070I-C NUMERIC PICTURE - P IN ILLEGAL POSITION. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2071I-C NUMERIC PICTURE - V IN ILLEGAL POSITION. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2072I-C NUMERIC PICTURE - NO 9 IN PICTURE. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause or change USAGE clause to be compatible with the PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2073I-C NUMERIC PICTURE - P ENCLOSED BY 9'S. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2074I-D COMPILER ERROR - MINOR CODE FOR RENAMES ENTRY IS ILLEGAL.

Programmer Response: Compiler error.

If the problem recurs, do the following to complete your problem determination action before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2075I-C NUMERIC PICTURE - DIGIT LENGTH GT 18. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2076I-C NUMERIC PICTURE - DIGIT LENGTH + SCALE GT 18. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2077I-C EXTERNAL FLOATING-POINT PICTURE - USAGE NOT DISPLAY. PICTURE CHANGED TO 9.

Programmer Response: Probable user error. Supply USAGE IS DISPLAY clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2078I-W EXTERNAL FLOATING-POINT PICTURE - MORE THAN 1 SIGN. CHANGED TO 1.

Programmer Response: Probable user error. Correct PICTURE clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2079I-C EXTERNAL FLOATING-POINT PICTURE - SIGN IN ILLEGAL POSITION. PICTURE CHANGED TO +9.E+99.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2080I-C EXTERNAL FLOATING-POINT PICTURE - SIGN MISSING. ASSUME MINUS SIGN.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2081I-C EXTERNAL FLOATING-POINT PICTURE - REQUIRED CHARACTER BEFORE EXPONENT MISSING. PICTURE CHANGED TO +9.E+99.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2082I-W EXTERNAL FLOATING-POINT PICTURE - NO DECIMAL POINT IN MANTISSA. ASSUME IMPLIED V.

Programmer Response: Probable user error. Correct PICTURE clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2083I-C EXTERNAL FLOATING-POINT PICTURE - MANTISSA LENGTH GT 16. PICTURE CHANGED TO +9.E+99.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2084I-C EXTERNAL FLOATING-POINT PICTURE - TOTAL LENGTH GT 22. PICTURE CHANGED TO +9.E+99.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2085I-C EXTERNAL FLOATING-POINT PICTURE - EXPONENT LENGTH NOT 2 DIGITS. ASSUME 2 DIGITS.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2086I-C NUMERIC EDITED PICTURE - TWO FIXED DOLLAR SIGNS, +, - OR FIXED AND FLOATING DOLLAR SIGN. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2089I-C NUMERIC EDITED PICTURE - 9, Z OR * PRECEDES FLOATING STRING. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2090I-C NUMERIC EDITED PICTURE - P IN ILLEGAL POSITION. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2091I-C NUMERIC EDITED PICTURE - TWO DIFFERENT FLOATING STRING CHARACTERS. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2092I-C NUMERIC EDITED PICTURE - Z AND * IN PICTURE. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2093I-C NUMERIC EDITED PICTURE - 9 PRECEDES * OR Z. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct the order in the PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2094I-C NUMERIC EDITED PICTURE - FLOATING STRING PRECEDES * OR Z. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct order of PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2096I-C DECIMAL POINT MAY ONLY APPEAR ONCE IN A PICTURE CHARACTER STRING. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Remove all but one decimal point (or comma, if DECIMAL-POINT IS COMMA has been specified in Special-Names paragraph) before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2097I-C NUMERIC EDITED PICTURE - DECIMAL POINT OR V CONTRADICTORY TO P. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2098I-C INDEXED BY AND/OR KEY CLAUSE IS ILLEGAL FOR ITEM SUBORDINATE TO GROUP THAT HAS OCCURS BUT NO INDEXED BY CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Supply INDEXED BY clause on group item or eliminate the subordinate INDEXED BY clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2099I-C NUMERIC EDITED PICTURE - CR OR DB AND SIGN BOTH USED. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Remove duplicate sign symbol before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2100I-C NUMERIC EDITED PICTURE - CR OR DB NOT LAST TWO CHARACTERS IN PICTURE. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Ensure that CR or DB are the last two characters in the PICTURE before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2101I-C NUMERIC EDITED PICTURE - SIGN IS NOT FIRST OR LAST CHARACTER IN PICTURE. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Ensure that the sign is the leftmost or rightmost character in the PICTURE before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2102I-C NUMERIC EDITED PICTURE - NUMERIC CHARACTERS AFTER DECIMAL POINT ARE NOT THE SAME. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Supply valid numeric characters as suppression symbols after the decimal point before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2103I-C NUMERIC EDITED PICTURE - TOTAL LENGTH GT 127. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Reduce total length of PICTURE character string to 127 or less before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2104I-C NUMERIC EDITED PICTURE - NUMERIC LENGTH GT 18. PICTURE REPLACED BY 9(1).

Programmer Response: Probable user error. Reduce the number of digit positions represented to 18 or less before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2105I-E ONLY ONE KEY MAY BE SPECIFIED IF THE SUBJECT OF TABLE IS A KEY. REST OF KEYS DISCARDED.

Programmer Response: Probable user error. Eliminate all keys except table subject before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2106I-E THE RENAMES CLAUSE MUST BE THE LAST ENTRY IN A LOGICAL RECORD. SKIPPING TO NEXT LEVEL, SECTION, OR DIVISION.

Programmer Response: Probable user error. Correct placement of level-66 item, ensuring that it is the last entry in the record before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2107I-W NUMERIC EDITED PICTURE - USAGE NOT DISPLAY. PICTURE CHANGED TO 9.

Programmer Response: Probable user error. Correct PICTURE or USAGE clause for item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2108I-E KEYS IGNORED FOR ITEM WITH NO INDEXED BY CLAUSE.

Programmer Response: Probable user error. Supply INDEXED BY clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2110I-C APPLY WRITE-ONLY VALID ONLY FOR VARIABLE BLOCKED RECORDS. CLAUSE IGNORED.

Programmer Response: Probable user error. Ensure that blocked V-mode records have been specified before recompiling, or delete APPLY clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2113I-W ITEM WITH USAGE OF COMPUTATIONAL-1 OR COMPUTATIONAL-2 HAS PICTURE CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove PICTURE clause and recompile if necessary, or correct USAGE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2114I-E ONLY THE SYNCHRONIZED CLAUSE IS ALLOWED FOR A USAGE IS INDEX ITEM. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove invalid clause(s) before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2115I-E LENGTH OF VARIABLE GROUP GT 32K. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Reduce length of variable group to 32K or less before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2116I-E FIXED LENGTH GROUP ITEM IN WORKING-STORAGE OR LINKAGE SECTION IS GT 131K.

Programmer Response: Probable user error. Reduce length of group item to 131K or less before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2117I-E INVALID NUMERIC EDITED CHARACTER. PICTURE CHANGED TO 9.

Programmer Response: Probable user error. Supply valid combination of USAGE and PICTURE before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2118I-C LENGTH OF REDEFINES SUBJECT GREATER THAN LENGTH OF REDEFINES OBJECT. SUBJECT LENGTH USED.

Programmer Response: Probable user error. Ensure that length of redefined item is greater than or equal to length of item that redefines it before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2119I-E VALUE CLAUSE SPECIFIED FOR AN ITEM IN A REDEFINES GROUP. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove VALUE clause or place VALUE clause in redefined item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2120I-E OBJECT OF REDEFINES CLAUSE UNDEFINED OR ILLEGAL. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct object of REDEFINES clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2121I-W SUBJECT OF REDEFINES IS VARIABLE LENGTH.

Programmer Response: Probable user error. Remove DEPENDING ON option from OCCURS clause that describes subject of REDEFINES clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2122I-E REDEFINES SUBJECT LEVEL NUMBER NOT EQUAL TO REDEFINES OBJECT LEVEL NUMBER OR OBJECT NOT IMMEDIATELY PRECEDING SUBJECT. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct placement or level number of entry containing REDEFINES clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2123I-C OBJECT OF REDEFINES IS SUBSCRIPTED OR CONTAINS OCCURS CLAUSE ... DATA SPACE ALLOCATION MAY BE IMPROPER.

Programmer Response: Probable user error. Remove OCCURS clause from description of object of REDEFINES or use method other than REDEFINES to achieve desired purpose.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2124I-C OBJECT OF REDEFINES IS VARIABLE LENGTH GROUP ITEM. REDEFINES CLAUSE IGNORED.

Programmer Response: Probable user error. Correct REDEFINES clause or use method other than REDEFINES to achieve desired purpose.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2125I-W VALUE CLAUSE TREATED AS COMMENTS FOR ITEMS IN FILE AND LINKAGE SECTIONS.

Programmer Response: Probable user error. Remove VALUE clause from items other than level-88 items in File or Linkage Section and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2126I-C VALUE CLAUSE LITERAL TOO LONG. TRUNCATED TO PICTURE SIZE.

Programmer Response: Probable user error. Depending upon the logic of the program, either correct length of PICTURE or of the literal specified in the VALUE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2127I-C NUMERIC VALUE CLAUSE SPECIFIED FOR GROUP ITEM. CLAUSE IGNORED.

Programmer Response: Probable user error. Specify a nonnumeric literal or a figurative constant in the VALUE clause or remove VALUE clause from group level and define initial values at the elementary level before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2128I-C VALUE CLAUSE LITERAL DOES NOT CONFORM TO PICTURE. CHANGED TO BLANKS.

Programmer Response: Probable user error. Ensure that the VALUE and PICTURE clauses are compatible before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2129I-C VALUE CLAUSE LITERAL DOES NOT CONFORM TO PICTURE. CHANGED TO ZERO.

Programmer Response: Probable user error. Ensure that the VALUE and PICTURE clauses are compatible before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2130I-E ITEM CANNOT HAVE VALUE CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove VALUE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2132I-E RECORD KEY LENGTH GREATER THAN 255 BYTES. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Reduce PICTURE length of data-name specified in the RECORD KEY clause to 255 bytes or less before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2133I-W LABEL RECORDS CLAUSE INVALID OR MISSING. ***** ASSUMED.

Programmer Response: Probable user error. Supply missing LABEL RECORDS clause or, if present, correct specification and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2134I-C VALUE FOR SCALING CHARACTER SHOULD BE ZERO. CHANGED TO ZERO.

Programmer Response: Probable user error. Change value to zero before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2135I-C RECORDS IN ISAM FILE CANNOT BE VARIABLE LENGTH. ASSUMED FIXED AT MAXIMUM SIZE.

Programmer Response: Probable user error. Correct record description entries associated with the file so that each is the same length before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2136I-E NOMINAL KEY LENGTH FOR INDEXED FILE GREATER THAN 255 BYTES. KEY IGNORED.

Programmer Response: Probable user error. Correct PICTURE clause of data-name specified in the NOMINAL KEY clause to reflect length of 255 bytes or less before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2137I-E THE OBJECT OF THE RENAMES THRU CLAUSE IS SUBORDINATE TO THE SUBJECT. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct RENAMES THRU clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2139I-W APPLY WRITE-VERIFY VALID ONLY FOR MASS STORAGE DEVICES. CLAUSE IGNORED.

Programmer Response: Probable user error. Either remove APPLY WRITE-VERIFY clause or change ASSIGN clause to specify a mass storage device designation before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2140I-E VALUE CLAUSE SPECIFIED ON BOTH GROUP AND ELEMENTARY ITEM OR ON SUBORDINATE GROUP. SECOND ITEM'S VALUE CLAUSE IGNORED.

Programmer Response: Probable user error. Correct record description to ensure that a VALUE clause does not appear both on the group level and on a level subordinate to the group level, before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2141I-C LENGTH OF LITERAL IS MORE OR LESS THAN LENGTH OF GROUP. LENGTH OF LITERAL ASSUMED.

Programmer Response: Probable user error. Either change the length of the group by respecifying the PICTURE clause or respecify VALUE clause for group before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2142I-E ALPHABETIC OR ALPHANUMERIC ITEM HAS ILLEGAL USAGE. PICTURE CHANGED TO 9.

Programmer Response: Probable user error. Either correct PICTURE or USAGE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2143I-W STERLING NONREPORT PICTURE - MORE THAN ONE V OR S. ASSUMED ONE.

Programmer Response: Probable user error. Correct PICTURE clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2144I-C NUMERIC PICTURE - MORE THAN ONE V OR S. ASSUMED ONE.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2145I-E ALPHABETIC OR ALPHANUMERIC ITEM LENGTH GREATER THAN 32767. TRUNCATED TO 32767.

Programmer Response: Probable user error. Correct PICTURE clause for item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2146I-W RECORD CONTAINS DISAGREES WITH COMPUTED MAXIMUM. USING COMPUTED MAXIMUM.

Programmer Response: Probable user error. Correct RECORD CONTAINS clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2147I-W BLOCK CONTAINS CLAUSE FOR UNIT-RECORD DEVICE IS INVALID. CLAUSE IGNORED

Programmer Response: Probable user error. Delete BLOCK CONTAINS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2148I-W ON AN 01 (77) COPY LIBRARY-NAME CLAUSE, LIBRARY DID NOT HAVE AN 01 (77) AS FIRST CARD.

Programmer Response: Probable user error. Correct first entry of library member before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, compiler output, and a listing of the source statement library member available.

ILA2149I-E VALUE CLAUSE SPECIFIED FOR ITEM WITH OCCURS OR FOR ITEM SUBORDINATE TO AN ITEM WITH OCCURS. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove VALUE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2150I-E VALUE CLAUSE SPECIFIED FOR ITEM IN VARIABLE LENGTH PORTION OF A WORKING-STORAGE RECORD. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove VALUE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2151I-C ELEMENTARY ITEMS NOT INTERNAL FLOATING-POINT MUST HAVE PICTURE. PICTURE ASSUMED 9.

Programmer Response: Probable user error. Supply PICTURE clause for item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2152I-D COMPILER ERROR - PHASE 2 INPUT UNRECOGNIZABLE. SKIPPING TO NEXT PHASE.

Programmer Response: Compiler error.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2153I-C APPLY CYL-OVERFLOW VALID ONLY FOR INDEXED FILES. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove APPLY CYL-OVERFLOW clause and recompile if necessary. If the file is in fact an indexed file, correct system-name specification in the ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2154I-C THE AREA BEING REDEFINED IS NOT IMMEDIATELY PRECEDING THE ENTRY WHICH REDEFINES IT OR THE LEVEL NUMBERS OF THE SUBJECT AND OBJECT OF THE REDEFINES ARE NOT THE SAME. THE OBJECT OF THE REDEFINES IS ASSUMED TO BE THE LAST ENTRY WITH THE SAME LEVEL NUMBER AS THE SUBJECT OF THE REDEFINES.

Programmer Response: Probable user error. Correct level number of subject and/or object of the REDEFINES clause or, if correct, check placement of object of REDEFINES to ensure that it and its subordinate entries immediately precede the subject before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2155I-C ILLEGAL STERLING NONREPORT PICTURE CHARACTER. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE of sterling nonreport item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2156I-W PICTURE DOES NOT CONTAIN A SIGN. SIGN DROPPED FROM VALUE CLAUSE LITERAL.

Programmer Response: Probable user error. Include a sign in PICTURE clause before recompiling, or remove sign from literal and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2157I-W RESERVE CLAUSE TREATED AS COMMENTS FOR THIS FILE ORGANIZATION.

Programmer Response: Probable user error. If file organization is standard sequential, correct system-name of ASSIGN clause before recompiling. If file organization is other than standard sequential, delete RESERVE clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2158I-D OCCURS DEPENDING ON VARIABLE IS IN VARIABLE PORTION OF A RECORD. PROGRAM INTERRUPT WILL OCCUR.

Programmer Response: Probable user error. Ensure that DEPENDING ON variable is not in variable portion of record before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2159I-C OBJECT OF REDEFINES CLAUSE NOT DEFINED. PREVIOUS 01 ASSUMED TO BE OBJECT.

Programmer Response: Probable user error. Define object of REDEFINES clause and ensure that it and its subordinate fields immediately precede the subject before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2160I-E THE OBJECT OF THE RENAMES OR RENAMES THRU CLAUSE CANNOT CONTAIN AN OCCURS OR OCCURS DEPENDING ON CLAUSE NOR MAY IT BE SUBORDINATE TO AN ITEM THAT WAS ONE OF THESE CLAUSES. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply a valid RENAMES or RENAMES THRU object before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2161I-C PICTURE INVALID. ADJACENT C DELIMITERS. ASSUMED PICTURE L(6)9BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2162I-C PICTURE INVALID. ADJACENT D DELIMITERS. ASSUMED PICTURE L(6)9BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2163I-C PICTURE INVALID. MORE THAN 2 DELIMITERS. ASSUMED PICTURE L(6)9BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2164I-C PICTURE INVALID. NO STERLING DELIMITERS. ASSUMED PICTURE L(6)9BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2165I-C PICTURE INVALID. ONLY 1 STERLING DELIMITER. ASSUME PICTURE L(6)9BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2166I-C PICTURE INVALID. ERROR IN SHILLING FIELD. ASSUMED SHILLING PICTURE Z9B.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2167I-C PICTURE INVALID. NUMBER OF POUND DIGITS EXCEEDS 15. ASSUMED PICTURE L(6)9BD.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2168I-C PICTURE INVALID. ERROR IN WHOLE PENCE FIELD. ASSUMED PENCE PICTURE Z9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2169I-C PICTURE INVALID. ERROR IN DECIMAL PENCE FIELD. DECIMAL FIELD TRUNCATED.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2170I-C PICTURE INVALID. ERROR IN POUND FIELD. ASSUMED POUND PICTURE L(6)9B.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2171I-C PICTURE INVALID. NUMBER OF POUND DIGITS PLUS NUMBER OF PENCE DECIMAL EXCEEDS 15. DECIMAL PENCE DROPPED.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2172I-C PICTURE INVALID. SIZE OF REPORT FIELD EXCEEDS 127 BYTES. ASSUMED PICTURE L(6)9BDZ9BDZ9.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2173I-C PICTURE INVALID. CR OR DB NOT VALID WITH LEADING SIGN. DECIMAL FIELD TRUNCATED.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2174I-C PICTURE INVALID. SIGN IN DECIMAL PENCE FIELD NOT VALID WITH LEADING SIGN. DECIMAL FIELD TRUNCATED.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2175I-C TRACK-AREA EXCEEDS AND IS REDUCED TO 32,767 BYTES.

Programmer Response: Probable user error. Correct integer specification in TRACK-AREA clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2176I-W MULTIPLE FILE TAPE CLAUSE ONLY APPLIES TO MAGNETIC TAPE FILES. CLAUSE IGNORED.

Programmer Response: Probable user error. For files not assigned to magnetic tape units, remove MULTIPLE FILE TAPE clause and recompile if necessary. If assignment is to magnetic tape units, check the system-name in the ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2177I-W ZERO SUPPRESSION CHARACTER WILL OVERRIDE BLANK WHEN ZERO CLAUSE. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove BLANK WHEN ZERO clause and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2178I-E RECORD KEY IS NOT WITHIN FILE RECORD.

Programmer Response: Probable user error. Ensure that the data-name specified in the RECORD KEY clause is defined within the file record before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2179I-E RECORD KEY IS NOT FIXED LENGTH.

Programmer Response: Probable user error. Define the data-name specified in the RECORD KEY clause as a fixed length item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2180I-E RECORD KEY FOR UNBLOCKED FILE INCLUDES FIRST BYTE OF RECORD.

Programmer Response: Probable user error. For an unblocked file, correct the placement of the description of the data-name specified in the RECORD CONTAINS clause so that it excludes the first byte of the record before recompiling. If blocked records are desired, add or correct the BLOCK CONTAINS clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2181I-C TRACK-AREA VALID ONLY FOR ADD FUNCTION. IGNORED.

Programmer Response: Probable user error. Remove TRACK-AREA clause an recompile if necessary. If adding records to an indexed file in the random access mode, ensure that the system-name in the ASSIGN clause and the ACCESS MODE clause are correct before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2182I-E FILE MAY BE OPENED OUTPUT ONLY. FILE IGNORED.

Programmer Response: Probable user error. Ensure that if an indexed file is created in a program, it is not reopened as INPUT or I-O in the same program, before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2183I-W NO LEVEL 01 FOR FD OR SD.

Programmer Response: Probable user error. Supply a valid record description entry for the FD or SD before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2184I-E VALUE CLAUSE LITERAL DOES NOT CONFORM TO PICTURE. CLAUSE IGNORED.

Programmer Response: Probable user error. Ensure that the VALUE and PICTURE clauses are compatible before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2185I-E DATA-NAME-3 EITHER PRECEDES DATA-NAME-2 OR IS DATA-NAME-2 IN THE RENAMES THRU CLAUSE. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply valid objects of RENAMES THRU clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2186I-C PICTURE DUPLICATION FACTOR IS ZERO. ASSUMING ONE OCCURRENCE OF PICTURE CHARACTER.

Programmer Response: Probable user error. If a PICTURE duplication factor is required, supply a non-zero integer before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2187I-E OBJECT OF RENAMES CLAUSE OR RENAMES THRU CLAUSE IS NOT IN SAME LOGICAL RECORD. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply valid objects of the RENAMES clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2188I-C EXTERNAL FLOATING-POINT PICTURE ILLEGAL WHEN CURRENCY SIGN IS E. PICTURE CHANGED TO 9.

Programmer Response: Probable user error. Supply valid PICTURE clause or respecify CURRENCY SIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2190I-W PICTURE CLAUSE IS SIGNED, VALUE CLAUSE UNSIGNED. ASSUMED POSITIVE.

Programmer Response: Probable user error. If a negative value is intended, respecify VALUE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2191I-C THE SYNCHRONIZED CLAUSE SHOULD NOT BE SPECIFIED WHEN 88'S ARE UNDER GROUP. STATEMENT ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Remove SYNCHRONIZED clause from group with which condition-names (88's) are associated before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2192I-E ONLY USAGE IS DISPLAY SHOULD BE SPECIFIED WHEN VALUE CLAUSE IS ASSOCIATED WITH A GROUP ITEM. VALUE CLAUSE DROPPED.

Programmer Response: Probable user error. Remove clauses other than USAGE IS DISPLAY and VALUE from group level before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2193I-C LITERAL-1 IS GREATER THAN OR = TO LITERAL-2 IN VALUE THRU CLAUSE.

Programmer Response: Probable user error. Ensure that literal-2 is greater than literal-1 in the VALUE clause with the THRU option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2194I-C CHARACTERS OPTION IN BLOCK CONTAINS CLAUSE NOT LEGAL IN INDEXED FILE. CLAUSE IGNORED.

Programmer Response: Probable user error. Use the BLOCK CONTAINS clause with the RECORDS option to specify blocked records on an indexed file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2196I-C NO VALUE CLAUSE GIVEN FOR CONDITION NAME. VALUE ASSUMED ZERO OR SPACES DEPENDING ON PICTURE.

Programmer Response: Probable user error. Specify VALUE clause for condition-name entry or correct level number if condition-name is not desired before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2199I-C TRACK AREA TOO SMALL. CLAUSE IGNORED.

Programmer Response: Probable user error. Respecify "integer" in the TRACK-AREA clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2200I-E TAPE RECORD MUST CONTAIN AT LEAST 18 CHARACTERS. FILE IGNORED.

Programmer Response: Probable user error. Respecify logical record length or block the logical records to ensure that physical record size is at least 18 characters before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2201I-E NOMINAL KEY OR CORE-INDEX DATA-NAME MUST BE DEFINED IN WORKING-STORAGE SECTION.

Programmer Response: Probable user error. Define data-name in the Working-Storage Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2202I-E NOMINAL KEY OR CORE-INDEX DATA-NAME MUST BE DEFINED IN THE FIXED PORTION OF A RECORD. CONTINUING.

Programmer Response: Probable user error. Define data-name as a fixed-length item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2203I-E INVALID DEVICE TYPE FOR SD. DISK ASSUMED.

Programmer Response: Probable user error. Respecify device class as UT or DA in the system-name of the ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2204I-E RECORD KEY AND NOMINAL KEY MUST BE THE SAME LENGTH. CONTINUING.

Programmer Response: Probable user error. Correct data-names so that lengths are the same before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2205I-E ORGANIZATION ILLEGAL FOR ACCESS. FD IGNORED.

Programmer Response: Probable user error. ACCESS MODE must be sequential for a sequentially organized file. Remove ACCESS MODE IS RANDOM clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2206I-E REWRITE ILLEGAL FOR ORGANIZATION. STATEMENT IGNORED.

Programmer Response: Probable user error. Either specify organization as 'U', 'W', or 'I' in system-name of ASSIGN clause or use the WRITE statement instead of REWRITE before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2207I-C APPLY CORE-INDEX LEGAL ONLY FOR INDEXED ORGANIZATION. CLAUSE IGNORED.

Programmer Response: Probable user error. Remove APPLY CORE-INDEX clause or correct organization field of system-name of ASSIGN clause and insure that ACCESS MODE IS RANDOM before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2208I-E ***** KEY INVALID, UNDEFINED, OR NOT UNIQUE. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct indicated key clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2209I-C CORE-INDEX DATA-NAME INVALID, UNDEFINED, OR NOT UNIQUE. CLAUSE IGNORED.

Programmer Response: Probable user error. Correct CORE-INDEX data-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2210I-E ACTUAL KEY MUST BE GREATER THAN 8 AND LESS THAN 263 BYTES IN LENGTH. USING 9.

Programmer Response: Probable user error. Correct PICTURE of ACTUAL KEY data-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2211I-C CYLINDER OVERFLOW TOO LARGE. CLAUSE IGNORED.

Programmer Response: Probable user error. Ensure that the cylinder overflow area does not exceed eight tracks on a 2311 or 18 tracks on a 2314 or 2321 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2212I-W INVALID ALPHANUMERIC EDITED CHARACTER. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2213I-W USER LABEL RECORD NOT DESCRIBED UNDER FD. USER LABEL IGNORED.

Programmer Response: Probable user error. Describe the data-name specified in the LABEL RECORD(S) clause under the FD before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2214I-C STERLING NONREPORT PICTURE - NO SHILLING SEPARATOR. PICTURE REPLACED BY 9D8D7.

Programmer Response: Probable user error. Correct PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA2223I-E GROUP ITEM HAS PICTURE CLAUSE. PROCESSED AS ELEMENTARY ITEM.

Programmer Response: Probable user error. Remove PICTURE clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3001I-E ***** NOT DEFINED. ***.

Explanation: This message always appears in conjunction with another message.

Programmer Response: Probable user error. Define the indicated name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3002I-E ***** NOT UNIQUE. ***.

Explanation: This message always appears in conjunction with another message.

Programmer Response: Probable user error. Eliminate duplication by qualification or by substituting another name for the indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3003I-E HIGHEST LEVEL QUALIFIER ***** NOT DEFINED. ***.

<u>Explanation</u>: This message always appears in conjunction with another message.

<u>Programmer Response</u>: Probable user error. Define the indicated qualifier before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3004I-W QUALIFYING NAME ***** NOT UNIQUE. DISCARDED.

<u>Explanation</u>: This message always appears in conjunction with another message.

<u>Programmer Response</u>: Probable user error. Eliminate duplication by substituting another name for indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3005I-E ***** NOT A VALID QUALIFIER. ***.

<u>Explanation</u>: This message always appears in conjunction with another message.

<u>Programmer Response</u>: Probable user error. Correct indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3006I-E ***** NOT DEFINED AS PART OF *****. ***.

<u>Explanation</u>: This message always appears in conjunction with another message.

<u>Programmer Response</u>: Probable user error. Correct qualification before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3007I-W ***** NOT UNIQUELY QUALIFIED BY *****. DISCARDED.

<u>Explanation</u>: This message always appears in conjunction with another message.

<u>Programmer Response</u>: Probable user error. Correctly qualify indicated name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3008I-E ***** NOT VALID AS IDENTIFIER-1 IN ***** CORRESPONDING STATEMENT. STATEMENT DISCARDED.

<u>Programmer Resposne</u>: Probable user error. Correct identifier-1 in the indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3009I-E ***** NOT VALID AS IDENTIFIER-2 IN ***** CORRESPONDING STATEMENT.

Programmer Response: Probable user error. Correct identifier-2 in the indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3010I-W SUPERFLUOUS 'TO' IGNORED IN ***** CORRESPONDING STATEMENT.

Programmer Response: Probable user error. Remove superfluous TO from indicated statement and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3011I-W NO CORRESPONDENCE FOUND BETWEEN IDENTIFIER AND *****.

Programmer Response: Probable user error. Establish the correct correspondence between the items subordinate to the identifiers before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3012I-D COMPILER ERROR - LAST ITEM REFERENCED BY ACCESS WAS ELEMENTARY ITEM.

Programmer Response: Compiler error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3013I-D DICT PTR LESS THAN QVAR ENTRY FOR ELEMENTARY ITEM.

Programmer Response: Compiler error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3014I-D NO MATCH FOUND IN QVAR FOR ***** ELEMENTARY ITEM.

Programmer Response: Compiler error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3016I-D IMPOSSIBLE *****. COMPILER ERROR.

Programmer Response: Compiler error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3017I-D COMPILER ERROR. ***** MINOR CODE ILLEGAL.

Programmer Response: Compiler error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3018I-E SPECIAL REGISTERS TIME-OF-DAY OR CURRENT-DATE MAY ONLY BE USED IN THE MOVE STATEMENT.

Explanation: This message always appears in conjunction with another message.

Programmer Response: Probable user error. Remove references to TIME-OF-DAY and CURRENT-DATE from statements other than MOVE before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3019I-E ILLEGAL LEVEL FOR *****.

Programmer Response: Probable user error. Correct level of indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3020I-E REPORT NAME ILLEGAL AS USED. DISCARDED.

Programmer Response: Probable user error. Report-name may be specified only in the GENERATE, INITIATE, or TERMINATE statements. Remove all other references before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3021I-C ***** NOT UNIQUE IN ITS GROUP. DISCARDED.

Programmer Response: Probable user error. Eliminate duplication of indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3022I-E ***** NOT VALID AS IDENTIFIER-1 IN SEARCH STATEMENT. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct identifier-1 before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3023I-W ITEMS CONTAINING THE USAGE IS INDEX, REDEFINES, RENAMES, OR OCCURS CLAUSES DO NOT QUALIFY AS CORRESPONDING IDENTIFIERS.

Programmer Response: Probable user error. Make any necessary corrections before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3024I-E NO KEYS WERE SPECIFIED FOR *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Define keys specified as identifier-1 in SEARCH statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3025I-E AN ERROR WAS DETECTED PROCESSING THE KEY FOR *****. ***.

Programmer Response: Probable user error. For a SEARCH ALL statement, ensure that the KEY option appears in the OCCURS clause of identifier-1; for a SEARCH statement, ensure that the INDEXED BY option is specified. Then recompile the program.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3026I-E IDENTIFIER OMITTED IN ***** CORRESPONDING STATEMENT.

Programmer Response: Probable user error. Supply missing identifier in indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA3027I-W DATA-NAME UNDER LABEL RECORD IS NON-UNIQUE. LAST DATA DESCRIPTION OF ***** ASSUMED.

Programmer Response: Probable user error. Eliminate duplicate use of data-name and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4001I-C OUTCOME OF PRECEDING CONDITION LEADS TO NON-EXISTENT 'NEXT SENTENCE'. 'STOP RUN' INSERTED.

Programmer Response: Probable user error. Add a sentence after IF statement before recompiling, or if evaluation of condition leads to a logical end of program, add a STOP RUN statement and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4002I-E ***** STATEMENT INCOMPLETE. STATEMENT DISCARDED.

Programmer Response: Probable user error. Complete indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4003I-E EXPECTING NEW STATEMENT. FOUND *****. DELETING TILL NEXT VERB OR PROCEDURE-NAME.

Programmer Response: Probable user error. Replace indicated item with a valid statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4004I-E ***** ***** IS ILLEGALLY USED IN ***** STATEMENT. DISCARDED.

Programmer Response: Probable user error. Replace invalidly used items before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4005I-E ***** AND ***** VIOLATE RULE ABOUT LENGTH OF TRANSFORM OPERANDS. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct length of TRANSFORM statement operands before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4006I-C ***** STATEMENT CONTAINS UNPAIRED LEFT PARENTHESIS. OUTERMOST IGNORED.

Programmer Response: Probable user error. Ensure that a corresponding right parenthesis appears for each left parenthesis before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4007I-C ***** MISSING OR MISPLACED IN ***** STATEMENT. ASSUMED IN REQUIRED POSITION.

Programmer Response: Probable user error. Supply missing or misplaced item in indicated statement and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4008I-W SUPERFLUOUS ***** FOUND IN ***** STATEMENT. IGNORED.

Programmer Response: Probable user error. Remove superfluous item from indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4009I-E EXAMINE STATEMENT REQUIRES FIGURATIVE CONSTANT, SINGLE NONNUMERIC LITERAL, OR 1-DIGIT UNSIGNED NUMERIC INTEGRAL LITERAL. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct EXAMINE statement operand before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4010I-C ***** STATEMENT CONTAINS UNPAIRED RIGHT PARENTHESIS. OUTERMOST IGNORED.

Programmer Response: Probable user error. Ensure that a corresponding left parenthesis appears for each right parenthesis before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4011I-E ***** IS NOT AN ALLOWABLE CHARACTER FOR *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct indicated operand before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4012I-E COMPARISON BETWEEN TWO LITERALS IS ILLEGAL. TEST DISCARDED.

Programmer Response: Probable user error. Correct operands of comparison before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4013I-C RELATIONAL MISSING IN IF STATEMENT. 'EQUAL' ASSUMED.

Programmer Response: Probable user error. Supply desired relational operator in condition before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4014I-E EXAMINE STATEMENT REQUIRES IDENTIFIER WHOSE USAGE IS DISPLAY. FOUND ***** *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply valid EXAMINE statement operand before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4015I-E 'GO TO' ILLEGAL UNLESS ALTERED. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct the logic of the program to ensure that an ALTER statement whose operand is the name of the paragraph in which the GO TO appears has been included before recompiling.

If the problem recurs, do the following before calling IBM for programming support. Have source deck, control cards, and compiler output available.

ILA4016I-E OPERAND OF ***** APPEARS IN WRONG SEGMENT OF PROGRAM. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Place operand of indicated statement in the proper segment before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4017I-E ELSE UNMATCHED BY CONDITION IS DISCARDED.

Programmer Response: Probable user error. Correct logic of nested IF condition before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4018I-E SET STATEMENT HAS AN ILLEGAL OPERAND BEFORE 'TO' OR INCOMPATIBLE OPERANDS. OPERAND BEFORE 'TO' DISCARDED.

Programmer Response: Probable user error. Correct SET statement operand(s) before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4019I-E ***** ***** MAY NOT BE USED AS ARITHMETIC OPERAND IN ***** STATEMENT. ARBITRARILY SUBSTITUTING *****.

Programmer Response: Probable user error. Correct item in indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4020I-C SIGN BEFORE ***** IS DISCARDED.

Programmer Response: Probable user error. Remove or replace invalid sign on indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4021I-W MINUS SIGN FOLLOWED BY SPACE ACCEPTED AS REVERSING SIGN OF FOLLOWING LITERAL.

Programmer Response: Probable user error. Delete space after minus sign and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4022I-W EXIT MUST BE SINGLE-WORD PARAGRAPH PRECEDED BY A PROCEDURE-NAME. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct syntax of EXIT statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4023I-E STORE-FIELD WHEN USED IN COMPUTATION MUST BE TO NUMERIC DATA-NAME. FOUND ***** *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Respecify item as numeric or replace name of receiving field before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4024I-E TWO OPERANDS ARE REQUIRED BEFORE 'GIVING'. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct syntax of arithmetic statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4025I-E POSITIONING AND ADVANCING ILLEGALLY USED FOR SAME FILE. ADVANCING ASSUMED.

Programmer Response: Probable user error. Ensure that the ADVANCING and POSITIONING options are not both specified for the same file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4026I-E ***** ***** IS ILLEGALLY USED IN ***** TEST. TEST DISCARDED.

Programmer Response: Probable user error. Correct operand(s) of indicated test before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4027I-C RIGHT TERM OF A CONDITION MAY NOT BE NEGATED. NEGATION IS APPLIED TO THE RELATIONAL.

Programmer Response: Probable user error. Correct placement of NOT operator in relation condition before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4028I-C TWO 'NOT'S' IN SUCCESSION ILLEGAL. ACCEPTED AS CANCELLING EACH OTHER.

Programmer Response: Probable user error. Remove one of NOT operators in relation condition before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4029I-E ***** ***** MAY NOT BE COMPARED WITH ***** *****. TEST DISCARDED.

Programmer Response: Probable user error. Correct operands of relation condition before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4030I-E FOUND ***** AFTER CONDITION. EXPECT 'OR', 'AND', OR VERB TO IMMEDIATELY FOLLOW CONDITION. DELETING TILL ONE OF THESE IS FOUND.

Programmer Response: Probable user error. Ensure that either OR, AND, or an imperative-statement follows condition before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4031I-E PROCEDURE-NAME NOT THAT OF A SINGLE GO PARAGRAPH MAY NOT BE ALTERED. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct operand of ALTER statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4032I-C STATEMENT ACCEPTED WITH TRUE AND FALSE OUTCOMES IDENTICAL. NEXT STATEMENT ASSUMED.

Programmer Response: Probable user error. Correct logic of conditional statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4033I-C PROCEDURE-NAME WHICH IS THE END-OF-RANGE OF A PERFORM STATEMENT MAY NOT BE ALTERED. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct operand of ALTER statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4034I-C GO DEPENDING ON MUST BE FOLLOWED BY INTEGRAL IDENTIFIER LESS THAN 4 DIGITS IN LENGTH. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply valid operand of DEPENDING ON option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4035I-W NO MORE THAN 3 INDEX-NAMES OR IDENTIFIERS SHOULD BE VARIED IN PERFORM STATEMENT. ACCEPTED AS WRITTEN.

Explanation: This compiler can normally handle a program varying more than three data-names, but the practice is invalid under standard COBOL rules and is not recommended.

Programmer Response: Limit number of operands of VARYING option and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4036I-W PERFORM RANGE IS FROM ***** TO ***** , WHICH PRECEDES IT. ACCEPTED AS WRITTEN.

Explanation: This compiler can normally handle the perform range indicated, but the practice is not recommended.

Programmer Response: Change operands of PERFORM statement and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4037I-E SYNTAX REQUIRES PROCEDURE-NAME TO FOLLOW 'THRU'. FOUND *****. ***** OPTION DISREGARDED.

Programmer Response: Probable user error. Correct syntax of PERFORM statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4038I-E VARYING OPTION REQUIRES INDEX-NAME OR IDENTIFIER. FOUND LITERAL. ARBITRARILY SUBSTITUTING *****.

Programmer Response: Probable user error. Correct operand of VARYING option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4039I-E ***** ***** IN VARYING OR TIMES OPTION IS NOT NUMERIC. ARBITRARILY SUBSTITUTING *****.

Programmer Response: Probable user error. Correct operand of VARYING or TIMES option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4040I-E ***** FILE ***** MAY NOT BE OPENED ***** AND IS DISCARDED.

Programmer Response: Probable user error. Correct OPEN statement for indicated file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4041I-E SYNTAX REQUIRES 'INPUT', 'OUTPUT', OR 'I-O' AFTER OPEN. FOUND *****. DELETING TILL ONE OF THESE IS FOUND.

Programmer Response: Probable user error. Correct syntax of OPEN statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4042I-E SYNTAX REQUIRES FILE-NAME IN ***** STATEMENT. FOUND *****. DELETING TILL LEGAL ELEMENT FOUND.

Programmer Response: Probable user error. Supply valid file-name in indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4043I-W ADVANCING AND POSITIONING ILLEGALLY USED FOR SAME FILE. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Ensure that the ADVANCING and POSITIONING options are not both specified for the same file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4044I-C ***** ***** SHOULD NOT BE MOVED TO NUMERIC FIELD. SUBSTITUTING *****.

Programmer Response: Probable user error. Either correct usage of items moved to numeric field or correct usage of field before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4045I-E CODE CLAUSE ILLEGAL FOR ON-LINE DEVICE. CLAUSE DELETED.

Programmer Response: Probable user error. Remove CODE clause or respecify device type before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4047I-E WRITE ILLEGAL FOR LABEL RECORDS. STATEMENT DELETED.

Programmer Response: Probable user error. Specify label processing in the Declaratives Section of the program before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4048I-E USE VERB MAY NOT APPEAR EXCEPT IN DECLARATIVES SECTION. STATEMENT DISCARDED.

Programmer Response: Probable user error. Remove USE statement from non-declarative portion of Procedure Division before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4049I-W INAPPROPRIATE OPTIONAL COBOL WORDS PRECEDING ***** IGNORED.

Programmer Response: Probable user error. Remove inappropriate words preceding indicated entry before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4050I-E SYNTAX REQUIRES *****. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct syntax of statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4052I-E ***** ***** MAY NOT BE TARGET FIELD FOR ***** ***** IN ***** STATEMENT AND IS DISCARDED.

Programmer Response: Probable user error. Correct operands of indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4054I-E SYNTAX REQUIRES SORT-FILE NAME. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply valid sort-file-name before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4055I-C SORT SEQUENCE NOT SPECIFIED. ASCENDING ASSUMED.

Programmer Response: Probable user error. Specify ASCENDING and/or DESCENDING option and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4056I-E SYNTAX REQUIRES *****. FOUND *****. DISCARDED.

Programmer Response: Probable user error. Correct syntax of statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4057I-E NUMBER OF SORT KEYS EXCEEDS MAXIMUM OR TOTAL KEY LENGTH EXCEEDS 256 BYTES. ***** DISCARDED.

Programmer Response: Probable user error. Ensure that the number of sort keys is no more than 12 and the total length of all keys does not exceed 256 bytes before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4059I-E SORT-KEY MUST BE NON-SUBSCRIPTED OR NON-INDEXED FIXED-LENGTH DATA-NAME DEFINED UNDER AN SD. FOUND *****. DISCARDED.

Programmer Response: Probable user error. Correct type and/or position of sort key before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4060I-C ***** IS NOT A POSITIVE NUMERIC INTEGRAL LITERAL OF REQUIRED LENGTH. ***** OPTION DISCARDED.

Programmer Response: Probable user error. Correct operand of indicated option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4061I-W NEITHER NAMED NOR CHANGED SPECIFIED. NAMED ASSUMED.

Programmer Response: Probable user error. Specify an EXHIBIT statement option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4062I-W 'NAMED CHANGED' ACCEPTED AS 'CHANGED NAMED'.

Programmer Response: Probable user error. Correct EXHIBIT statement option and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4063I-W PREVIOUS DEBUG PACKET REFERS TO SAME PROCEDURE-NAME. CARD DELETED AND FOLLOWING STATEMENTS ATTACHED TO IMMEDIATELY PRECEDING PACKET.

Programmer Response: Probable user error. Ensure that only one DEBUG packet refers to a given location in program before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4064I-E ***** IS NOT A POSITIVE NUMERIC INTEGRAL LITERAL OF REQUIRED LENGTH. SUBSTITUTING *****.

Programmer Response: Probable user error. Correct indicated operand before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4065I-W NUMERIC LITERAL IN EXAMINE STATEMENT SHOULD BE UNSIGNED. SIGN IGNORED.

Programmer Response: Probable user error. Remove sign from numeric literal and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4066I-E SYNTAX REQUIRES 01 LEVEL SD DATA-NAME IN RELEASE STATEMENT. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct RELEASE statement operand before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4067I-W ALL CHARACTER SHOULD NOT BE USED AS LITERAL IN EXAMINE STATEMENT. STATEMENT ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Supply valid literal in EXAMINE statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4068I-D COMPILER ERROR. PHASE 4 TRYING TO GET DATA ATTRIBUTES FOR *****.

Programmer Response: The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4069I-C SYNTAX REQUIRES DEVICE-NAME. FOUND ***** IN ***** STATEMENT. SYSTEM UNIT ASSUMED.

Programmer Response: Probable user error. Specify a valid device-name or mnemonic-name associated with a device-name in the Special-Names paragraph before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4070I-E ***** STATEMENT REQUIRES IDENTIFIER WHOSE USAGE IS DISPLAY. FOUND SPECIAL REGISTER. STATEMENT DISCARDED.

Programmer Response: Probable user error. Supply an identifier in indicated statement whose usage is DISPLAY before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4071I-E ***** EXCEEDS LEGAL LENGTH. DISCARDED.

Programmer Response: Probable user error. Correct length of indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4072I-W EXIT FROM ***** PROCEDURE ASSUMED BEFORE *****.

Programmer Response: Probable user error. Ensure that END DECLARATIVES, a section-name within the declaratives section, or the end of the range of the PERFORM exists following routine before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4073I-W ***** SHOULD NOT APPEAR IN DECLARATIVE SECTION. ACCEPTED AS WRITTEN.

Explanation: The statement will be compiled, but its use is illegal under standard COBOL rules and is not recommended.

Programmer Response: Probable user error. Remove indicated statement from Declaratives Section before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4074I-C STATEMENT CONTAINS FLOATING-POINT DATA ITEMS. REMAINDER IGNORED.

Programmer Response: Probable user error. If the REMAINDER option of the DIVIDE statement is required, ensure that none of the operands are floating-point items before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4075I-C 'NEXT SENTENCE' ILLEGAL AND DISCARDED. BOTH ***** AND NOT ***** WILL CAUSE EXECUTION OF NEXT VERB.

Programmer Response: Probable user error. Remove invalid NEXT SENTENCE specification from AT END, ON SIZE ERROR, or END-OF-PAGE options before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4076I-E ***** REQUIRES ***** LEVELS OF SUBSCRIPTING OR INDEXING. SUBSTITUTING FIRST OCCURRENCE OF *****.

Programmer Response: Probable user error. Provide required level of subscripting or indexing for indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4077I-E ***** MAY NOT BE USED AS A SUBSCRIPT SINCE IT REQUIRES SUBSCRIPTING ITSELF. SUBSTITUTING FIRST OCCURRENCE OF *****.

Programmer Response: Probable user error. Provide a subscript that itself requires no subscripting before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4078I-E SUBSCRIPT MUST BE INTEGRAL DATA-NAME OR LITERAL. FOUND NON-INTEGER *****. SUBSTITUTING FIRST OCCURRENCE OF *****.

Programmer Response: Probable user error. Ensure that subscript is either a data-name representing an integral value or a literal before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4079I-E ***** FOUND AMONG SUBSCRIPTS. SUBSTITUTING FIRST OCCURRENCE OF *****.

Programmer Response: Probable user error. Substitute valid subscript for indicated item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4080I-W DEBUG CARD MAY NOT REFER TO A PROCEDURE NAME WHICH ITSELF IS IN A DEBUG PACKET. CARD DELETED AND FOLLOWING STATEMENTS ATTACHED TO IMMEDIATELY PRECEDING PACKET.

Programmer Response: Probable user error. Ensure that the location specified on one DEBUG card is neither used on any other DEBUG card, nor is a location within any other DEBUG packet before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4081I-C ***** EXCEEDS ***** CHARACTERS. UP TO 255 ACCEPTED.

Programmer Response: Probable user error. Correct length of the item represented by the ACCEPT statement "identifier" before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4082I-E ***** IS NOT DEFINED AS SUBSCRIPTED OR INDEXED. SUBSCRIPTS DISCARDED.

Programmer Response: Probable user error. Specify required options of OCCURS clause for item before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4083I-E OCCURS DEPENDING ON VARIABLE MUST BE INTEGRAL NON-SUBSCRIPTED DATA-NAME. FOUND *****. ARBITRARILY SUBSTITUTING *****.

Programmer Response: Probable user error. Correct operand of DEPENDING ON option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4084I-C ILLOGICAL USE OF PARENTHESES ACCEPTED WITH DOUBTS AS TO MEANING.

Programmer Response: Probable user error. Check the logic of the use of parentheses before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4085I-E RECORD DESCRIPTION FOR FILE ***** MISSING OR ILLEGAL. STATEMENT DISCARDED.

Programmer Response: Probable user error. Ensure that any errors detected by the compiler during the Data Division scan on the indicated file's record description are corrected before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4086I-C ***** CONDITION USED WHERE ONLY IMPERATIVE STATEMENTS ARE LEGAL MAY CAUSE ERRORS IN PROCESSING.

Programmer Response: Probable user error. Ensure that imperative-statements appear where required before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4087I-E 'END DECLARATIVES' MISSING OR MISPLACED. PROGRAM CANNOT BE EXECUTED.

Programmer Response: Probable user error. Ensure that the end of the Declaratives Section has been indicated by an END DECLARATIVES statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4088I-D COMPILER ERROR. I-C TEXT COUNT FIELD 0. SKIPPING TO PHASE 5.

Programmer Response: Compiler error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4089I-W ***** ***** SHOULD NOT BE TARGET FIELD FOR ***** ***** IN ***** STATEMENT. STATEMENT ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Correct operand being used as receiving field in indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4090I-E SORT KEY MUST BE IN FIXED POSITION NOT MORE THAN 4092 BYTES FROM START OF RECORD. ***** DISCARDED.

Programmer Response: Probable user error. Correct position of sort key within record before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4091I-E SYNTAX REQUIRES OPERAND. FOUND *****. TEST DISCARDED.

Programmer Resposne: Probable user error. Supply a valid operand for statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4092I-W EXTERNAL DECIMAL NAME USED IN TRANSFORM STATEMENT. STATEMENT ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Ensure that TRANSFORM statement operands are either alphabetic, alphanumeric, or numeric edited items (identifier-3 only), before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4093I-W EXPECTING SECTION-NAME. FOUND PROCEDURE-NAME. REFERENCE ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Specify section-name and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4094I-W ***** IS IN A RECORD OF AN APPLY WRITE-ONLY FILE, AND REFERRING TO IT MAY CAUSE ERRORS IF FILE IS OPENED AS OUTPUT WHEN ***** STATEMENT IS EXECUTED.

Programmer Response: Probable user error. Referring to subfields of records of a file for which APPLY WRITE-ONLY has been specified is not recommended. Make any necessary changes before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4095I-E WRITE FROM IDENTIFIER REQUIRED FOR *****, TO WHICH WRITE-ONLY IS APPLIED. STATEMENT DISCARDED.

Programmer Response: Probable user error. Specify WRITE with the FROM option for files for which APPLY WRITE-ONLY has been specified before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4096I-W ***** STATEMENT WILL NEVER BE EXECUTED.

Explanation: The logic of the COBOL source program prevents the computer from executing the statement noted. The compiler, however, accepts the statement as written.

Programmer Response: Probable user error. Correct placement of statement and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4097I-C UNIT (REEL) OPTION ILLEGAL FOR *****. DISCARDED.

Programmer Response: Probable user error. Remove or replace invalid option in indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4098I-E 'ALTER' STATEMENT VIOLATES RULE ABOUT REFERENCES TO A GO TO IN A DIFFERENT INDEPENDENT SEGMENT. IGNORED.

Programmer Response: Probable user error. Ensure that the operand of the ALTER statement refers to a paragraph-name within an independent segment of the same priority as the segment containing the ALTER statement, or that the ALTER statement and the GO TO statement are in the root segment before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards and compiler output available.

ILA4100I-W IDENTIFIER FOLLOWING INTO (FROM) IN READ (WRITE) STATEMENT SHOULD NOT BE DEFINED UNDER SAME FD AS RECORD-NAME. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Ensure that the operand of the INTO option is an identifier that is the name of a Working-Storage or Linkage Section item, or an output record of a previously opened file, or that the operand of the FROM option is defined in the Working-Storage or Linkage Section, or in another FD before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4101I-E SET STATEMENT REQUIRES OPERAND AFTER 'UP' OR 'DOWN' TO BE NUMERIC INTEGRAL DATA-NAME OR POSITIVE INTEGRAL NUMERIC LITERAL. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct operand of UP or DOWN option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4102I-E SET STATEMENT REQUIRES OPERAND AFTER 'TO' TO BE INDEX-NAME, INDEX DATA ITEM, NUMERIC INTEGRAL DATA-NAME, OR INTEGRAL NUMERIC LITERAL GREATER THAN ZERO. FOUND *****. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct operand of TO option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4103I-C 'ALL' MUST BE FOLLOWED BY NONNUMERIC LIT. FOUND *****. DISCARDING 'ALL'.

Programmer Response: Probable user error. Correct formation of figurative constant before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4104I-E SEARCH OR SEARCH ALL STATEMENT HAS EITHER SUBSCRIPTED OR INDEXED IDENTIFIER-1 OR ILLEGAL OPERAND. SCANNING TILL 'AT END' OR 'WHEN'. DELETING TILL ONE OF THESE IS FOUND.

Programmer Response: Probable user error. Correct operand of SEARCH or SEARCH ALL statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4105I-E DATA-NAME CANNOT BE BOTH INDEXED AND SUBSCRIPTED IN ***** STATEMENT. SUBSCRIPTS DISCARDED.

Programmer Response: Probable user error. Correct subscripting or indexing of data-name in indicated statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4106I-E DATA-NAME MUST BE INDEXED BY INDEX NAME OR INDEX NAME PLUS OR MINUS AN INTEGRAL NUMERIC LITERAL. SUBSTITUTING FIRST OCCURRENCE OF *****.

Programmer Response: Probable user error. Correct manner in which data-name is indexed before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4108I-E CALLED PROGRAM MAY NOT BE SEGMENTED. ENTRY STATEMENT IGNORED.

Programmer Response: Probable user error. Ensure that all restrictions on subprogram linkage are observed before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4109I-E KEY IN SEARCH-ALL FLOATING POINT OR STERLING. STATEMENT CHANGED TO SEARCH STATEMENT.

Programmer Response: Probable user error. Ensure that keys are either DISPLAY, COMPUTATIONAL, or COMPUTATIONAL-3 items before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4110I-E CONDITION IN SEARCH ALL STATEMENT TESTS KEY WITHOUT TESTING ALL PRECEDING KEYS. STATEMENT DISCARDED.

Programmer Response: Probable user error. Ensure that the condition specified in the SEARCH ALL statement tests all keys before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4111I-E INVALID CONDITION OR INVALID FORMULA IN CONDITION IN SEARCH ALL STATEMENT. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct condition in SEARCH ALL statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4112I-W SET UP OR DOWN SHOULD NOT INCREMENT INDEX-NAME BY INDEX DATA ITEM. ACCEPTED AS WRITTEN.

Programmer Response: Probable user error. Correct SET statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4113I-C BEFORE OR AFTER ADVANCING OR AFTER POSITIONING REQUIRED FOR *****. ASSUMING *****.

Programmer Response: Probable user error. Ensure that if the ADVANCING or POSITIONING option is specified for a record in a file, every WRITE statement for records in the same file also contains the same option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4114I-C INVALID ADVANCING/POSITIONING OPTION. 1 LINE ASSUMED.

Programmer Response: Probable user error. Supply valid operand for ADVANCING or POSITIONING option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4115I-C 'AFTER POSITIONING' EXPECTED BUT NOT FOUND. ASSUMED PRESENT.

Programmer Response: Probable user error. Supply AFTER POSITIONING option and recompile if necessary.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4116I-E ILLEGAL TO ***** FILE *****. STATEMENT DELETED.

Programmer Response: Probable user error. Remove invalid statement for indicated file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4117I-C ***** CLAUSE MISSING. ***** NEXT SENTENCE USED.

Programmer Response: Probable user error. Supply missing clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4118I-C NO REWIND IS AN INVALID OPTION FOR FILE *****. IGNORED.

Programmer Response: Probable user error. Remove invalid option for indicated file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4119I-C INVALID FILE TYPE FOR START VERB. STATEMENT DISCARDED.

Programmer Response: Probable user error. Ensure that a START statement is specified only for an indexed file before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA4120I-C REWRITE LEGAL ONLY FOR 'U' AND 'W' DIRECT FILE. ACCEPTED AS 'WRITE'.

Programmer Response: Probable user error. If the REWRITE statement is desired, correct system-name in the ASSIGN clause before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5001I-D ERROR OCCURRED WHILE TRYING TO ASSIGN A DOUBLE REGISTER. COMPILATION ABANDONED.

Programmer Response: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5002I-D ERROR OCCURRED WHILE PROCESSING A SUBSCRIPTED OR INDEXED DATA-NAME. COMPILATION ABANDONED.

Programmer Response: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5003I-C DIVISOR IS ZERO. RESULT WILL BE ALL 9'S.

Programmer Response: Probable user error. Correct divisor to prevent division by zero before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5004I-W ALPHANUMERIC SENDING FIELD TOO BIG. 18 LOW ORDER BYTES USED.

Programmer Response: Probable user error. Correct length of alphanumeric sending field or receiving field before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5005I-D ERROR OCCURRED WHILE PROCESSING A MOVE. COMPILATION ABANDONED.

<u>Programmer Response</u>: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5006I-D UNEXPECTED INPUT TO THE MOVE OR STORE PROCESSOR. COMPILATION ABANDONED.

<u>Programmer Response</u>: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5007I-D UNEXPECTED INPUT TO THE ARITHMETIC CODE GENERATOR. COMPILATION ABANDONED.

<u>Programmer Response</u>: Compiler error. The compiler has reached a point in its processing where it is unable to continue processing.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5008I-D UNEXPECTED INPUT TO THE FLOATING-POINT ARITHMETIC ROUTINE 'FBCVBH'. COMPILATION ABANDONED.

<u>Programmer Response</u>: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5009I-D LOST SUBSCRIPT OR INDEX ID IN TABLE 'XSSNT'. COMPILATION ABANDONED.

<u>Programmer Response</u>: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5010I-C HIGH ORDER TRUNCATION OF THE CONSTANT DID OCCUR.

<u>Programmer Response</u>: Probable user error. If high-order truncation is not desirable, make necessary corrections before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5011I-W HIGH ORDER TRUNCATION MIGHT OCCUR.

Programmer Response: Probable user error. If high-order truncation is not desirable, make necessary corrections before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5012I-D LOST INTERMEDIATE RESULT ATTRIBUTES IN 'XINTR' TABLE. COMPILATION ABANDONED.

Programmer Response: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and SYM available.

ILA5013I-E ILLEGAL COMPARISON OF TWO LITERALS. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct operands of the comparision before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5014I-E KEY IN SEARCH ALL AT INVALID OFFSET. STATEMENT DISCARDED.

Programmer Response: Probable user error. Correct displacement of key in SEARCH ALL statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5015I-E INVALID USE OF SPECIAL REGISTER. STATEMENT DISCARDED.

Programmer Response: Probable user error. Check data-names, procedure-names, etc., to ensure that a special register has not been used in an invalid capacity before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5016I-E MORE THAN 255 SUBSCRIPT ADDRESS CELLS USED. PROGRAM CANNOT EXECUTE CORRECTLY.

Programmer Response: Compiler error. The compiler has reached a point in its processing where it has encountered an unrecoverable error.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5017I-C INVALID ADVANCING OPTION FOR A DTFCD FILE. USING STACKER 1.

Programmer Response: Probable user error. Correct operand of ADVANCING option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5018I-C INTEGER IN POSITIONING OPTION NOT BETWEEN 0 AND 3. 1 ASSUMED.

Programmer Response: Probable user error. Correct operand of POSITIONING option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5019I-C PUNCH STACKER SELECT SPECIFIED FOR A DTFPR FILE. USING 'SKIP TO CHANNEL 1'.

Programmer Response: Probable user error. Ensure that operand of ADVANCING or POSITIONING option is compatible with device type before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5020I-C IDENTIFIER IN EXHIBIT EXCEEDS MAXIMUM. TRUNCATED TO 120 CHARACTERS.

Programmer Response: Probable user error. Correct operand length in EXHIBIT statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5021I-C INTEGER IN ADVANCING OR POSITIONING OPTION NOT POSITIVE. POSITIVE ASSUMED.

Programmer Response: Probable user error. Correct operand of ADVANCING or POSITIONING option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5022I-C MORE THAN 2-DIGIT INTEGER IN ADVANCING OPTION USING INTEGER 1.

Programmer Response: Probable user error. Supply valid integer in ADVANCING option before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5023I-E EOP INVALID FOR DOUBLE-BUFFERED FILE. IGNORED.

Programmer Response: Probable user error. Ensure that the END-OF-PAGE option is not used for files for which a double buffer has been requested (RESERVE clause) before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5024I-E END-OF-PAGE OPTION REQUESTED FOR NON-DTFPR FILE. IGNORED.

Programmer Response: Probable user error. Ensure that END-OF-PAGE option is compatible with device type before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5025I-C ADVANCING OR POSITIONING OPTION ILLEGAL FOR NON-SEQUENTIAL FILE. IGNORED.

Programmer Response: Probable user error. Ensure that the ADVANCING or POSITIONING options are used only for standard sequential files before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA5026I-C EXHIBIT OPERAND GREATER THAN 256 BYTES. LENGTH OF 256 ASSUMED.

Programmer Response: Probable user error. Correct operand length in EXHIBIT statement before recompiling.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

The following messages may be interspersed in phase 6 output.

ILA6003I-D ERROR FOUND PROCESSING F4 TEXT. UNKNOWN DATA A-TEXT CODE.

Programmer Response: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and DUMP available.

ILA6005I-D COMPILER ERROR. COMPILATION WILL NOT BE COMPLETE.

Programmer Response: Compiler error. The compiler has reached a point in its processing where it is unable to continue.

Do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and DUMP available.

ILA6006I-E MAP SUPPRESS SPECIFIED AND E-LEVEL DIAGNOSTIC HAS OCCURRED. LISTX, LINK, AND DECK WILL BE SUPPRESSED.

Programmer Response: Probable user error. To obtain LISTX, LINK, and DECK options, all E-level diagnostic messages must be eliminated from program during next compilation.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output available.

ILA6007I-D TABLE HAS EXCEEDED MAXIMUM SIZE. OBJECT MODULE AND DECK WILL BE INCOMPLETE.

Programmer Response: Table space has been exhausted and complete compiler output is unavailable. Rerun job in a larger partition.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, and compiler output with LISTX and DUMP available.

The following messages are issued during compilation on SYSLOG. They are also printed on SYSLST with the prefix ILA.

C100I PARTITION AREA IS LESS THAN 54K.

Explanation: At least 54K is required to compile using the Full American National Standard COBOL compiler.

System Action: The compilation is terminated.

Programmer Response: Not applicable.

Operator Response: Probable user error. Use the ALLOC command to allocate at least 54K to the partition. If the problem recurs, do the following to complete your problem determination action before calling IBM for programming support:

- Execute the MAP command and save the output.
- Have the source deck, control cards, output listing, and console sheet available.

C101I DEVICE NOT ASSIGNED - SYSnnn.

Explanation: nnn is either 001, 002, 003, or 004. The specified logical unit is unassigned and must be assigned.

System Action: The compilation is terminated.

Programmer Response: Not applicable.

Operator Response: Probable user error. Use the ASSGN command to assign a physical unit (magnetic tape or disk) to the file indicated. If the problem recurs, do the following before calling IBM for programming support:

- Execute the LISTIO command and save the output.
- Have the source deck, control cards, output listing, and console sheet available.

C102I UNSUPPORTED DEVICE TYPE - SYSnnn.

Explanation: nnn is either 001, 002, 003, or 004. The specified file must be a disk file if SYS001, or a tape or disk file if SYS002 through SYS004.

System Action: The compilation is terminated.

Programmer Response: Not applicable.

Operator Response: Probable user error. Use the ASSGN command to assign the appropriate physical unit to the file indicated -- SYS001 should be assigned to a disk unit; SYS002 through SYS004 should be assigned to a magnetic tape or disk unit. If the problem recurs, do the following before calling IBM for programming support:

- Execute the LISTIO command and save the output.
- Have the source deck, control cards, output listing, and console sheet available.

C103I END OF FILE ON SYSIPT.

Explanation: End-of-file was encountered in the initialization phase -- no source language was found.

System Action: The compilation is terminated.

Programmer Response: Not applicable or the same as the operator action.

Operator Response: Probable user error. Ensure that a /* card does not precede the source deck, or add the source deck to the job stream. If the problem recurs, do the following before calling IBM for programming support:

- Execute the LISTIO command and save the output.
- Have the source deck, control cards, output listing, and console sheet available.

C104I WARNING. SYS001 FILE IS TAPE.

Explanation: In small, simple programs that do not require dictionary spill, it is sometimes possible to compile with the spill file (SYS001) assigned to tape. However, if any spill does occur, an input/output error may occur.

System Action: Processing continues.

Programmer Action: Not applicable or the same as the operator action.

Operator Response: Probable user error. Use the ASSGN command to assign SYS001 to a disk unit if compilation cancels with an input/output error. If the problem recurs, do the following before calling IBM for programming support:

- Execute the LISTIO command and save the output.
- Have the source deck, control cards, output listing, and console sheet available.

OBJECT-TIME MESSAGES

The following messages are normally issued on SYSLOG.

C110A STOP literal

Explanation: The programmer has issued a STOP literal statement in the American National Standard COBOL source program.

System Action: Awaits operator response.

Programmer Response: Not applicable.

Operator Response: Operator should respond with end-of-block, or with any character in order to proceed with the program.

C111A AWAITING REPLY

Explanation: This message is issued in connection with the American National Standard COBOL ACCEPT statement.

System Action: Awaits operator response.

Programmer Response: Not applicable.

Operator Response: The operator should reply as specified by the programmer.

The following messages are issued on SYSLOG and SYSLST prior to cancellation of the job. If the DUMP option is specified, a partial dump is taken from the problem program origin to the highest core location of the last phase loaded. When this occurs, the eight bytes immediately preceding the DTF are destroyed. The messages have the form:

CmmmI SYSnnn filename DTFaddress text

where:

nnn is equal to 001 through 255
filename is seven or less characters and is generated from the file-name specified in the SELECT sentence.
address is the hexadecimal address of the file's DTF table
mmm and *text* correspond as follows:

mmm	text
112	DATA CHECK
113	WRONG LENGTH RECORD
114	PRIME DATA AREA FULL
115	CYLINDER INDEX TOO SMALL
116	MASTER INDEX TOO SMALL
117	OVERFLOW AREA FULL
118	DATA CHECK IN COUNT
119	DATA CHECK IN KEY OR DATA
120	NO ROOM FOUND
121	DASD ERROR
122	DASD ERROR WHILE ATTEMPTING TO WRITE RECORD ZERO
123	FILE CANNOT BE OPENED AFTER CLOSE WITH LOCK
124	CYLINDER AND MASTER INDEX TOO SMALL

Explanation: Condition indicated occurred on SYSnnn.

Programmer Response: Rerun the job or add a user declarative section to the Procedure Division of the source program to handle errors within the program.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, compiler output, and console sheet available.

Operator Response: Not applicable.

125 NO EXTENTS

Explanation: During CLOSE UNIT processing, no extent is found for the next volume.

Programmer Response: Rerun job with proper EXTENT (XTENT) statements.

If the problem recurs, do the following before calling IBM for programming support: have source deck, control cards, compiler output, and console sheet available.

Operator Response: Not applicable.

The following message is issued on SYSLOG:

C126D IS IT EOF?

Explanation: A tapemark was just read on an unlabeled tape file described at compilation time as having more than one reel.

Programmer Response: Not applicable.

Operator Response: The operator must respond either with N if it is end of volume, or with Y if it is end of file.

COBOL Object Program Unnumbered Messages

xxx...

Explanation: This message is written on the console and is recognizable because it is not preceded by a message code and action indicator. It is issued by an object program originally coded in COBOL. The message text is supplied by the object program and may indicate alternative action to be taken.

System Action: The job continues.

Operator Response: Operator response, if any is needed, is determined by the message text.

(Where more than one page reference is given, the major reference appears first.)

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