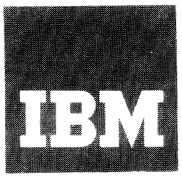
File No. S360-25
GC28-2025-4

TSS



Systems Reference Library

Version 8.1

IBM System/360 Time Sharing System

FORTRAN Programmer's Guide

This publication describes how to use the IBM System/360 Time Sharing System (TSS/360) for compiling and executing programs written in the FORTRAN IV language. It also describes how to use the services and features of TSS/360 that, while not directly related to FORTRAN programming, are frequently of use to the FORTRAN programmer.

FIFTH EDITION (September 1971)

This is a major revision of, and makes obsolete, C28-2025-3 and Technical Newsletters GN28-3067 and GN28-3141.

This edition is current with Version 8, Modification 1, of the IBM System/360 Time Sharing System (TSS/360), and remains in effect for all subsequent versions or modifications of TSS/360 unless otherwise noted. Significant changes or additions to this publication will be provided in new editions or Technical Newsletters. Before using this publication, refer to the latest edition of *IBM System/360 Time Sharing System: Addendum*, GC28-2043, which may contain information pertinent to the topics covered in this edition. The *Addendum* also lists the editions of all TSS/360 publications that are applicable and current.

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

A form is provided at the back of this publication for reader's comments. If the form has been removed, comments may be addressed to IBM Corporation, Time Sharing System/360 Programming Publications, Department 643, Neighborhood Road, Kingston, N. Y. 12401.

Preface

This publication is a guide to the facilities of the IBM System/360 Time Sharing System for the user of IBM FORTRAN IV. It is divided into three parts.

Part I is an introduction to the IBM System/360 Time Sharing System, directed to the user of the FORTRAN IV language. It contains basic information needed for effective use of the system and all of the information needed for effective use of Part II of this manual. Readers already familiar with the time-sharing system might profitably scan Part I and go directly to Part II.

Part II is a set of annotated examples. They begin with fundamental operations, such as logging on, and in succeeding examples progress to increasingly sophisticated concepts. The examples reproduce and comment on the user-system dialog as it would appear at a terminal with the exception that specific system response messages are not identified. The examples may be read for instruction; they may also be used as models for accomplishing common tasks.

Part III is a set of appendixes containing reference material for users who may need detailed information about the system.

Much of the material in the introduction and the appendixes duplicates or summarizes information in the examples (Part II) and other TSS/360 publications. Some material is unique, such as Appendix C, which gives guidelines for efficient programming and a discussion of the effects of compiler optimization on the use of the program control system (PCS).

Prerequisite Knowledge

Readers should be familiar with the IBM FORTRAN IV language, since this book does not describe the language, but rather describes the use of the language in the TSS/360 system.

The FORTRAN user will find the language specified in these publications:

IBM System/360 Time Sharing System: IBM FORTRAN IV, GC28-2007

IBM System/360 Time Sharing System: FORTRAN IV Library Subprograms, GC28-2026

If additional knowledge of the time-sharing system is needed, the following publications should be referred to:

IBM System/360 Time Sharing System: Concepts and Facilities, GC28-2003, provides a broader system survey than does this manual's introduction.

IBM System/360 Time Sharing System: Command System User's Guide, GC28-2001, describes the entire command language, including the program control system.

IBM System/360 Time Sharing System: System Messages, GC28-2037, lists all of the messages produced by the system.

IBM System/360 Time Sharing System: Terminal User's Guide, GC28-2017, gives details of the facilities and operations of the various terminals supported by TSS/360.

IBM System/360 Time Sharing System: Linkage Editor, GC28-2005, describes the linkage editor.

FORTRAN programmers who wish to use assembler language subroutines will need to be familiar with:

IBM System/360 Time Sharing System: Assembler Language, GC28-2000

IBM System/360 Time Sharing System: Assembler User Macro Instructions, GC28-2004

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Part I: Introduction

In the Time Sharing System/360 you can run a program *conversationally:* you and the system can exchange information during the entering and execution of your program.

To compile a program conversationally, you enter it at a typewriter-like terminal. The system analyzes each program statement as it is entered. If the system finds an error, it tells you so and offers you a chance to correct it. When the whole program has been entered, it is analyzed as a whole, and again you can correct any errors the system may find. Then you can execute the program and monitor its progress. For example, you can intervene during execution to check on the current value of a variable, or leave a flag to the system to stop execution should a specified condition arise. You can even make temporary patches to correct program troubles.

You can also run a program *nonconversationally* — for instance, when the program has been checked out and you know it will run satisfactorily, or when you cannot stay at the terminal to converse with the system. Nonconversational (background) processing in TSS/360 works much like batch processing in other IBM systems.

You can run in mixed mode — that is, you can start a program conversationally and switch to nonconversational processing. Once a program is running nonconversationally, however, you may not switch back to conversational processing.

The System

TSS/360 is a special set of programs that has been designed to make it easier for you to use a computer:

- A supervisor program controls the overall operation of the system, and provides the time sharing environment that lets a number of users employ the system concurrently.
- A group of service routines perform program control and data management functions for each user, as well as for the system.
- A third set of programs allows you to compile and develop your problem programs.

This publication explains how to use these programs, without involving you in their structure or their detailed internal operations.

Identifying You to the System

Before you first use TSS/360 you must be granted access to the system by either your system administrator or your system manager.[1] They, in effect, join you to the system by storing the following information about you:

- *User Identification (userid)* — a code that uniquely identifies you to the system.
- *Password* — a code word used in validating your attempt to get on the system under the above userid. The password is a further protection against unauthorized use of the system or unauthorized use of your data sets or charge number.
- *Charge Number(s)* — account number(s) against which your use of the system is charged.
- *Priority* — a code indicating the relative priority of your work in the system.
- *Privilege Class* — a code identifying you as a user, i.e., an individual who can employ the special set of commands reserved for users (as opposed to the commands reserved for, say, the operator).

From the information supplied by your manager or administrator, the system can recognize you, and validate your use of the system when you wish to begin processing. This information remains in the system until your system manager or administrator withdraws your right to use the system.

Conversational Use of the System

In conversational processing, you communicate with the system by means of a terminal. The terminal is a typewriter-like device. One type, the IBM 2741, is an IBM Selectric typewriter specially equipped for terminal use; another type, the IBM 1050 System, can include both a typewriter and a card reader. With the 1050 you can enter input into the system via the keyboard or the card reader. Your terminal may be located at the computer installation or at a remote location. In any event, all terminal operation is much the same: you enter a command directing the system to do certain work, the system responds, you enter another command, etc. You don't have to be an expert typist; correcting typing errors is a straightforward process, as shown in the examples.

[1] If you are interested in additional details on system management and administration, refer to *Manager's and Administrator's Guide.*

You will find that you do not require extensive computer training to use TSS/360. You must know three things:

- *The procedure for setting up your terminal for operation.* This is a matter of setting a few switches. This manual does not discuss the procedures and settings for the various terminals — see *Terminal User's Guide* or ask someone to show you the correct procedure for setting up your terminal.
- *The TSS/360 FORTRAN IV Language,* the language in which you express your problem-solving procedure. This language is used for illustration throughout this publication; it is explained in detail in *IBM FORTRAN IV.* In TSS/360, you also have a variety of mathematical and service subprograms available for your use. These are described in *FORTRAN IV Library Subprograms.*
- *The TSS/360 Command System,* involving the commands you will use to converse with the system. Almost every command is shown in the examples in Part II of this manual. Many typical uses are shown, but not every use of every command. Should you need more information than is in the examples or the appendixes, consult *Command System User's Guide,* which describes the commands in detail. The commands are explained briefly at the end of this introduction.

  In conversational mode, you engage in dialog with the system. The system responds to your requests, confirms actions, and informs you of any errors. Complete details on system response messages are presented in the *System Messages* publication.

The work done between logging on and logging off is called a *task.* You may run one or many programs as part of a single task. The work you do on a task at a terminal is called a *terminal session.* Since a task may begin conversationally but end nonconversationally, task is not necessarily synonymous with terminal session.

Conversational Task Initiation

You use the following procedure to initiate conversational processing:

1. Make certain the terminal is set up for operation under TSS/360 (proper switch settings, power on, etc.)
2. Either:
   a. Dial up the system, if it has a telephone-like modulator/demodulator (modem). The phone number is determined by your installation.
   b. Press the attention button on the terminal, if the terminal is "hardwired" (i.e., directly connected to the computer).

When you press the attention button or dial up the system, you begin the log-on process and set up a conversational task in the system. If you have been granted access to the system, and identify yourself properly in the LOGON command in accordance with the parameters set up for you at join time, the system completes the initiation of your task. (If you cannot log on, you should notify your system manager or system administrator.)

SYSIN and SYSOUT

From your point of view, initiating a task means that the system has prepared itself to perform work for you. You can now converse with the system as if you alone were using it. You have unique communication paths in the system, permitting it to read from and write to your terminal independently of all other tasks. You can thus define work for the system by issuing commands, and the required programs and data will be loaded into main storage and processed, as you specify, regardless of the work other users may be simultaneously specifying.

Your task's input to the system contains the sequence of commands you issue; this sequence is called SYSIN. Your system input stream can also include data to be prestored in the system, or actual input records to an executing program. When you are in the conversational mode, your terminal is your task's SYSIN device. Your task's system output stream, called SYSOUT, is directed to the terminal. It consists basically of system messages; it may also contain output from your programs if you so choose. Because the terminal is thus a combined SYSIN/SYSOUT device, the terminal listing will contain a mixture of the two system streams.

You and every other user have your own unique SYSIN/SYSOUT. You also have the following:

- Your own virtual storage space
- A scheduled time interval in which your task is executed
- Your own catalog

Virtual Storage

In TSS/360, you are not directly concerned with the physical limitations on main storage. Special addressing techniques, internal to the system, provide you with a storage capacity theoretically equal to the total range of addresses that can be specified in an instruction. The system's addressing techniques effectively combine sections of main and secondary storage, creating a virtual storage area in which your task operates. Your installation will inform you of specific virtual storage limits on your problem programs and data.

Although you have large virtual storage capacity, efficient programming is important; performance can

be degraded by excessive demands on the available storage at an installation.

When you log on, the system routines essential to your task are loaded into your virtual storage. These routines are a permanent part of your virtual storage, i.e., they remain there throughout your task.

You obtain other system routines by issuing commands and executing programs. These routines are loaded into, and unloaded from, your virtual storage on a demand basis.

You control the residence in your virtual storage of the linkage editor and your problem programs. (Refer to the LOAD, LNK, RUN, CALL, GO, and UNLOAD commands in the table at the end of this introduction.)

An important aspect of TSS/360 virtual storage management is the protection it provides. Each user has his own storage space for program execution. Another user cannot interfere with your executing programs, nor can you interfere with his, because neither of you can refer to the other's virtual storage space.

Sharing Time

Others may be using the system at the same time you are. The system appears to be serving each of you exclusively because it is repetitively giving each of you a time slice, or an interval, during which all the facilities required by your task, including computer execution time, are in fact exclusively yours. Unless the system is overloaded, its speed will allow it to do your work as well as that of other users without the intervals being apparent to you.

TSS/360 can also operate with several terminals sharing a single task. This mode of operation is not discussed in this publication; refer to *IBM System/360 Time Sharing System: Multiterminal Task Programming and Operation,* GC28-2034 for a description.

System Catalog

Conceptually, the system catalog is very much like the catalogs used in libraries. It is an index that points to items that reside elsewhere. You use it initially to record the location of data, so that you don't have to keep track of where the data is located and so that you can later retrieve the data by its name alone. The structure of the catalog protects your data sets from being accessed by other users, unless you specifically permit others to share them.

To understand the structure and significance of the system catalog, you must become familiar with the basic concepts of data set, data set name, and data set residence.

A *data set* is a named collection of one or more records. For example, all of the following are data sets: a source program, a library of compiled programs, the collection of FORTRAN input records needed by a program.

A *data set name* uniquely identifies a data set. It is in the form of one or more symbols separated by periods. For example, ROCKET.TESTFIRE.APRIL14. Each symbol can consist of from one to eight alphameric characters, the first of which must be alphabetic. Starting from the left, each symbol of the name is a category within which the next symbol is a unique subcategory. A fully qualified name identifies an individual data set. A partially qualified name identifies a group of data sets. For example, if ROCKETS.TESTFIRE.APRIL14 is a fully qualified data set name, ROCKETS and ROCKETS.TESTFIRE are partially qualified names identifying groups of data sets, one of which is ROCKETS.TESTFIRE.APRIL14. The group ROCKETS.TESTFIRE is a subgroup of ROCKETS.

For example, examine the gross structure of the system catalog illustrated in Figure 1, and note the following:

1. The system catalog consists of a master index and sets of subordinate catalog entries. It is, in effect, a collection of *separate* catalogs. The system has its own catalog and each user has his own catalog.
2. The various catalogs are an index of the data sets associated with them. Data sets that are to be cataloged must reside on one or more direct-access or magnetic tape volumes. A volume can be a removable disk pack or a tape reel. Some direct-access volumes are public, meaning that they are permanently mounted while the system is running, and they can be accessed by all users. Some direct-access volumes, and all magnetic tape volumes are *private.* This means that they are not mounted on the system until needed, that they are demounted when no longer needed, and that they can be used by only one user at a time. Data sets on either public or private volumes can be cataloged.

When the system was generated at your installation, all catalog entries for system data sets were created, including SYSLIB, which contains the system routines that are loaded on demand — for example, the FORTRAN-supplied subprograms.

Your master index entry in the system catalog is created when your system manager or administrator joins you to the system. At that time, your user identification is placed in the master index and another special entry is created in your catalog for a data set called your USERLIB. Your USERLIB is your own private library for object programs.

Except for USERLIB, you control all entries in your catalog by the way you name your data sets and by the way you use the cataloging and uncataloging fa-

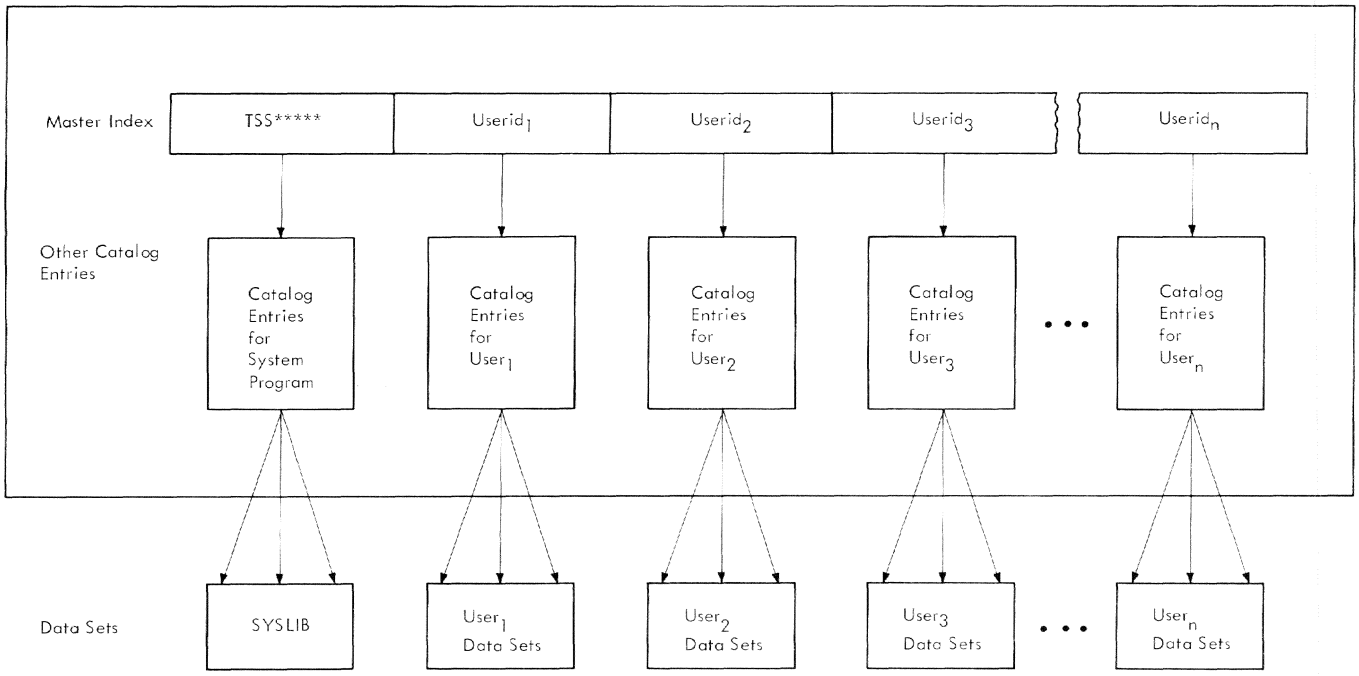


Figure 1. System Catalog

cilities of the system. Some of these facilities are for entering, removing, and renaming catalog entries. Others are for indicating which data sets can be shared by others and to what extent. These facilities are described later in this section. The key points here are these:

- Your catalog exists in the system from the time you are joined until the time your access privilege is withdrawn.
- Cataloging data sets is the only means of retaining data sets on public volumes from session to session. It also simplifies later use of those data sets.
- You can share your programs and data with others or not as you wish.

Terminal Session Activity

Entering Commands

To enter commands, you simply type in the required characters and press the return key on the terminal. What you type in, of course, depends on what you wish to do and the content of the commands required. Each command has an operation part specifying what is to be done (as RUN), and each may have one or more operands that qualifies the operation (as LOC= followed by the name of your object program, say MAIN. This qualifies the operation to mean "execute my object program, MAIN").

If you enter an incorrect command, the system issues a message which informs you of the error. The system also issues messages that give you information helpful in assessing the system's activity relative to your task. System messages are issued automatically as the conditions causing them arise.

Compiling and Running a Program

Suppose you wanted to simply compute sine A, for a single value of A, and print the result at the terminal. You might design the following source program to do this:

```
      A=.2
      SINE=SIN(A)
10    FORMAT ('THE SINE OF' ,F7.4, 'IS' ,F7.4)
      WRITE(6,10)A,SINE
      STOP
      END
```

You could then compile and run that program by the conversational task illustrated in Figure 2. The LOGON and LOGOFF commands are used to initiate and terminate the task. FTN initiates FORTRAN compiler processing. To control the compilation you specify a number of parameters: name of the compiled program, listings you want, etc. The compiled program is automatically stored in your USERLIB as an object program module. You execute it by the CALL or RUN command to obtain your result.

Log on	1. Press the attention button or dial up system. 2. Issue a LOGON command.	System makes you an active user.
Compile	1. Issue a FTN command (FTN is the name of the FORTRAN compiler). 2. Enter the parameters required to control the compilation (including the name by which you want to identify the object program). 3. Enter your source program.	System compiles your source program; it then stores your object program for you (in your USERLIB).
Run	1. Issue a CALL PGM command (where PGM is the name you assigned your object program at compile time above).	System retrieves your object program, executes it, and prints the result on your terminal: THE SINE OF 0.2000 IS 0.1987.
Log off	1. Issue a LOGOFF command.	System terminates your task and releases your terminal.

Figure 2. A Simple Compile and Run

In TSS/360 your source programs can use many of the system-supplied subprograms. For example, in the program illustrated in Figure 2, you used the SIN subprogram. These programs reside in SYSLIB and are available during execution when your program invokes them. Similarly, you can design and compile your own FUNCTION and SUBROUTINE subprograms, store them in your USERLIB (or some other library) and use them during later program executions.

Checking Out and Modifying Programs

The FORTRAN compiler includes conversational prompting and diagnostic facilities that assist you in debugging your source program. It also includes optional facilities for storing and cataloging your source and listing data sets, and for including an Internal Symbol Dictionary (ISD) in your object module. An ISD allows you to make full use of the Program Control System (PCS).

You can use PCS commands and statements to perform one, or any combination, of these:

1. Request display of data fields and instruction locations within your program, specifying these items by their symbolic names as used in the source language program.
2. Modify variables within your program, specifying these variables by their symbolic names and specifying the new value for each variable.
3. Specify the statements within your program at which execution is to be stopped or started. When program execution has been stopped, you may intervene, as described in items 1 and 2, before you direct resumption of program execution.
4. Specify the statements within your program at which the actions described in items 1 and 2 are to be automatically performed.
5. Obtain the values of your program's variables at a specified point in its execution, with the variables formatted according to their types.
6. Establish logical (true or false) conditions that allow or inhibit the actions described in items 3, 4, and 5.

The use of Program Control System facilities does not impose any restrictions on your source coding. In general, the use of program control facilities will greatly simplify the preparation of source programs, because many functions previously source-coded can conveniently be made available after compilation. PCS is discussed in greater detail in Appendix B.

Planning Problem Program Input/Output

In most TSS/360 installations, a problem program does not communicate directly with unit record devices (card reader/punches and printers). You organize input/output data flow as follows:

1. *Prior to program execution,* you store input data in the system on a direct-access device. If the data is the output of a previously executed program, you can simply write it on public storage during that program so that it will be retained for subsequent use. If the data involved is new input, you can prestore it using the following facilities:
   - Text editor facilities
   - DATA command
   - Operator procedures, involving your card input deck or magnetic tape reel
2. *During program execution,* you will generally READ input data from the direct-access device on which you stored it; and you will WRITE output data to a direct-access device (for later actual output, following execution). However, in TSS/360, you also have the following additional facilities for input/output during program execution:

   Input: You can READ a record dynamically from your terminal, READ input data from the system's tape devices; or SET data in your program (based on program conditions) if you like.

Output: You can WRITE a record to your terminal, WRITE output data on magnetic tape; and PAUSE in your program, print out data or a message at your terminal, and return control to the terminal for insertion of additional commands and then continue processing.

You can also STOP your program and DISPLAY the final results of its computation.

3. *Following execution,* you can print out or punch on cards the program output you stored on a direct-access device, using the PRINT and PUNCH commands, respectively. You can also produce a magnetic tape for subsequent printing by issuing a WT (write tape) command.

Since you can communicate with your programs during their execution, you can design programs that do not require use of conventional I/O devices; all I/O can be achieved via the terminal. For example, you can design your programs so that when predetermined events occur, intermediate results are printed out at your terminal. You can then decide how you want to proceed: supply additional or different data at that time; change the sequence of program execution; stop the programs; examine key final results prior to initiating their final printout; etc.

Specifying TSS/360 Problem Program I/O

In TSS/360, to specify problem program I/O activity, you must consider both of the following:

1. Use of appropriate FORTRAN I/O statements in the source program to indicate the data transfer or I/O control functions.
2. Use of (or omission of) DDEF (define data) commands to identify the name, location, organization, etc., of the data sets associated with the FORTRAN I/O statements.

Data Transfers: You use the FORTRAN READ and WRITE statements to transfer data to and from your program. You should regard a data set as a continuous string of data which you have subdivided for separate processing by your FORTRAN program; the subdivisions are termed FORTRAN logical records. FORTRAN logical records are defined by one of the following:

1. A FORMAT statement and a list referred to by an I/O statement (formatted records).
2. An I/O list appearing in an I/O statement that does not contain a reference to a FORMAT statement (unformatted records).
3. A NAMELIST name appearing in an I/O statement (NAMELIST records).

You define the overall relationship of a data set's records by specifying the data set's organization. (You do this in the DDEF commands discussed later in this section.) In TSS/360, there are two fundamentally different types of data set organizations: virtual storage data sets and physical sequential data sets.

Data Sets with Virtual Storage Organization

Data sets with a virtual storage organization can reside only on direct-access volumes. You process these data sets on the basis of the records they contain. Virtual storage data sets can have any of these specific organizations:

1. *Virtual sequential:* This is the standard FORTRAN I/O data set organization; the term VS is used to describe it. In a VS data set, the order of the logical records is determined solely by the order in which the records were created. In creating this type of data set, you provide the system with a stream of records. The system organizes the data into pages, and stores the data set on a direct-access device. After the data set has been created, you can read back the records in the order in which they were created merely by requesting one record after the other.
2. *Virtual index sequential:* A data set with this organization is referred to as a VI data set. As a FORTRAN user, you will probably use VI data sets only when interfacing with programs written in assembler language that require this organization. In a VI data set, the records are organized in sequence based on a data key associated with each record. During FORTRAN program execution, you can create and read VI data sets sequentially, but you cannot use the random-access capabilities of this organization.

   There are two special types of VI data sets — line data sets and list data sets. A *line data set* is one that is organized by line number, where each line is a record and is prefixed with the line number as its key. Source programs are line data sets. You can inspect and display these data sets by line number using the LINE? command. Other commands enable you to effect replacements, insertions, and deletions on line data sets. *Note:* Records in a line data set must be variable-length (format V); fixed-length (format F) records are not permitted.

   A *list data set* contains the listings produced as output by the system's language processors; it is organized by line number, where each print line is a record and is suffixed with a line number as its key.

In conversational mode, printing of language-processor listings is not automatic; you can have a listing printed only if you issue a PRINT command.

3. *Virtual Partitioned.* A virtual partitioned data set, referred to as a VP data set, is used to combine individually organized groups of data into a single data set. Each group of data is called a member, and each member is identified by a unique name. Program module libraries are a good example of a VP data set. Your USERLIB is organized this way, and the compiled program modules you store in USERLIB are its members.

   The partitioned organization allows you to refer to either the entire data set (via the partitioned data set's name) or to any member of that data set (via a name consisting of the name of the data set qualified by the member name in parentheses).

   The partitioned data set may be composed of VS or VI members or a mixture of both. Individual members, however, cannot be of mixed organization.

Physical Sequential Data Sets

Data sets with a physical sequential organization can reside on either direct-access or magnetic tape volumes. The logical records in these data sets have an organization which is determined solely on the basis of their position relative to the beginning of the data set. When these records are processed in TSS/360, the block is used as the unit of transfer to and from the device involved. A block can consist of one or more logical records. Data sets with physical sequential organization are called PS data sets. You will use PS data sets each time you process magnetic tape in your programs. Volumes containing data sets with PS organization can be interchanged among TSS/360 and IBM System/360 Operating System installations.

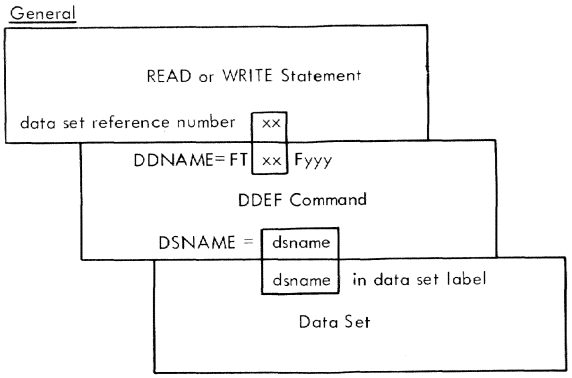
Generation Data Groups

The cataloging facilities of TSS/360 provide an option that assigns numbers to individual data sets in a sequentially ordered collection, thereby allowing you to catalog the entire collection under a single name. You can distinguish among successive data sets in the collection without assigning a new name to each data set. Because each data set is normally created from the data set created on the previous run, the new data set is called a generation, and the number associated with it is called a generation number. The entire structure of data sets of the same name is called a generation data group (GDG). You can refer to a particular generation by specifying, with the common name of the group, either the relative generation number or the absolute generation name of the data set.

Data Set Definition

In a FORTRAN I/O statement, the data set referred to is identified by an unsigned integer constant or integer variable whose value may be any number from 1 to 99. The relationship between a data set reference number and the actual data set is provided in the DDEF command. This I/O technique provides you with a degree of device independence; you do not need to change your program if the residence of data sets it processes changes from one execution to another.

The basic method used to identify FORTRAN data sets is illustrated in Figure 3. The system first relates the data set reference number of the READ or WRITE statement to the *ddname* operand of the corresponding DDEF command. For FORTRAN data sets, the ddname operand of the DDEF command is always of the form FTXXFyyy, where FT indicates FORTRAN, XX is the data set reference number, and yyy is a FORTRAN sequence number used to differentiate data sets, i.e., in a sequence of data sets which are to be referred to by the same data set reference number during the course of program execution (at any one time, the data set reference number refers to one data set only). Having



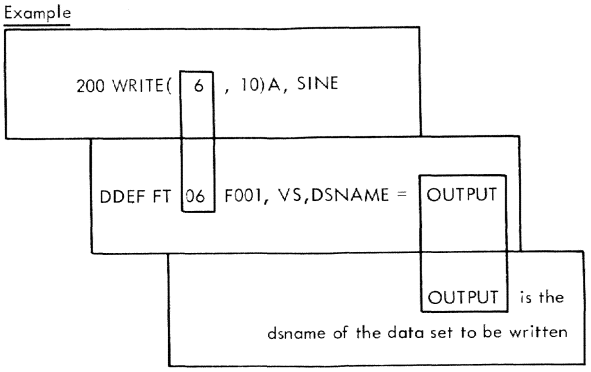


Figure 3. Data Set Identification, FORTRAN Programs

found the corresponding DDEF command, the system then obtains the name of the data set from the *dsname* operand of that DDEF command. Other information in the DDEF command (or already in the system, if the data set is cataloged) is then used to determine such things as: data set residence, i.e., where the data set is (input data set) or is to be placed (output data set); organization of the data set; routines necessary to process the data set; etc.

All object time FORTRAN data sets except those in SYSIN and SYSOUT require a DDEF command. In both conversational and nonconversational modes, if you omit a DDEF command normally associated with a READ or WRITE statement, the system will default to SYSIN or SYSOUT. There are also FORTRAN statements which automatically assume SYSIN or SYSOUT (STOP, PAUSE, and several I/O statements from previously implemented FORTRAN systems that were retained in TSS/360 FORTRAN). In a conversational task, SYSIN and SYSOUT involve your terminal. In a nonconversational task, you define the SYSIN data set (or submit it to the operator) and the system defines SYSOUT.

The DDEF command has other uses besides defining the data sets used during execution of a program. You can also use it to define the data sets used by certain commands, to define job libraries, to define a special data set (called PCSOUT) for the DUMP program checkout command, and to concatenate input data sets (i.e., relate them so that several different data sets can be read in as if they were a single data set).

Any DDEF command you issue during a task remains in force throughout the task, unless you enter a RELEASE command for that data set. The RELEASE command is the opposite of the DDEF command: the DDEF command sets up task control information for the data set; the RELEASE command removes that information.

The DDEF commands used in a session or in a command procedure need not be issued directly during the session or be included explicitly in the command procedure. One, or more, or all, of the DDEF commands needed can be made available by using the CDD (call data definition) command.

The CDD command is used to retrieve one or more DDEF commands from a data set; you must supply the name of the data set. If this is all you specify, the system assumes that you want to use all the DDEF commands in the data set. If you want to use only selected DDEF commands, you identify each by its ddname. You should prestore frequently used DDEF commands in a data set and call them in this fashion wherever possible. CDD can be used in either conversational or nonconversational tasks.

In a conversational task, the system analyzes the data set's requirements at the time the DDEF command is issued. It will then attempt to allocate the required resources (and, for private volumes, issue any mounting messages that are required) at that time. If the required space cannot be allocated, or the specified volumes cannot be mounted, the system will inform you, thereby allowing you to proceed with other work.

The DDEF command is illustrated in the examples, and is discussed in detail in Appendix E.

Cataloging and Uncataloging Data Sets

You can catalog and uncatalog data sets in several ways. Sometimes cataloging is automatic; in other cases, you must issue a CATALOG command to catalog the data set. All data sets with virtual storage organization that reside in public storage are automatically cataloged when they are created.

The CATALOG command sets up the catalog entry for the named data set. For example, suppose you are user JOHNDOE and you want to catalog a data set named ENG.PHYSICS.TEST2. If you issue a CATALOG command naming that data set, the system establishes entries in your catalog, as shown in Figure 4.

1. From your user identification, the system locates your catalog in the system catalog (via the master index).
2. It then sets up any indexes needed for each level of qualifier in your data set name. (Some of these may already exist.)
3. When it has established the lowest level index (in this case, TEST2), it records in the catalog the specific volume on which the beginning of the data set is located.

The CATALOG command can also be used to alter the entry of a previously cataloged data set; i.e., you can rename a cataloged data set. If you employ generation data groups (GDG), you must initially use the CATALOG command to set up the structure for the GDG: name, number of generations to be retained, disposition of old generations when the specified number of retentions is exceeded, etc. Then you can use the DDEF command to define new data sets as generation levels of the GDG, or you can use the CATALOG command with the NEWNAME operand to rename an existing data set as a generation level.

When you catalog a data set, you can specify either read-only or unlimited access. You can always erase your own data set, but if you have cataloged it with read-only access, you cannot write into it, thus ensuring against accidentally overlaying data.

You can use the DELETE command to remove a catalog entry for a data set if:

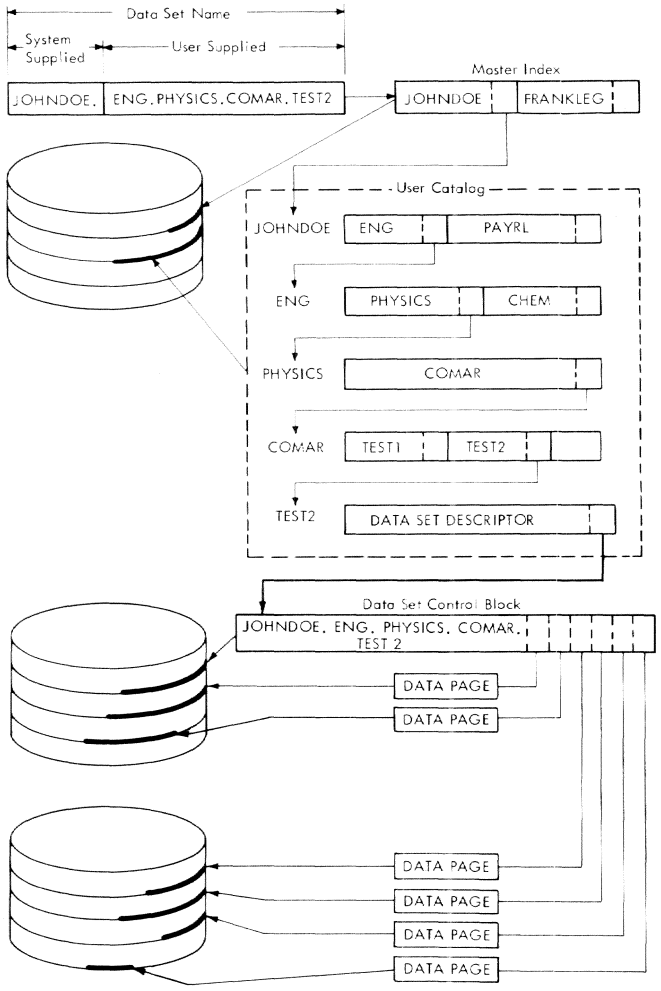


Figure 4. Catalog Example

1. You want to remove the catalog entry of a data set from the catalog without erasing the data set, and the data set resides on a private volume.
2. You want to remove the catalog entry of a data set you are sharing from your catalog (because you no longer have a need to share that data set).

The ERASE command can also be used for uncataloging. ERASE removes the catalog entry, and erases the data set as well *if* it resides on a direct-access volume. (Erasing means making the storage space of the data set available for other use.)

So that you can specify whether you want to be given one data set name at a time when you enter either the ERASE or DELETE command, provision is made to set the value of DEPROMPT (a value contained in your User Profile) to either YES or NO. If the value was set to YES, and you specify a partially qualified data set name, you will be given one data set name at a time for disposition. If the value was set to NO, all data sets grouped under this partially qualified name will be erased or deleted without individual presentation. If you specify a fully qualified name, the data set will be erased or deleted no matter what was specified for DEPROMPT.

You have the option in certain commands, as PRINT and PUNCH, if a cataloged data set is involved, of specifying whether it is to be erased or not after the output operation.

Using System Storage

The system assumes that you want storage on a public volume unless you specifically ask for storage on a private volume. When it is necessary to retain the data sets in the system, you make the most effective use of TSS/360 by storing your data sets on public volumes. Public volumes are always mounted and available for allocation to your task, within the limits of public allocation established for you by your installation.

If you use private volumes, you may need to wait for devices to become available; in any case, you must wait for the operator to mount the volume on the device. Each time a request is made for a device on which to mount a private volume, the system must determine whether or not it can honor the request, based on the current requirements throughout the system for those devices. If the system cannot allocate a private device to your task, one of two actions occurs, depending upon the operational mode:

- In a conversational task, if the system cannot allocate the required space or if the required volumes cannot be mounted, the system issues a diagnostic message to you during the execution of the DDEF command. The system cancels the DDEF command, returns control to the terminal, and awaits another command.
- In a nonconversational task, the system places your task in abeyance until all private devices required by the task are allocated. You must include a SECURE command to reserve all devices that will be required for private volumes during the execution of a nonconversational task. SECURE must appear immediately after the LOGON command, and only one SECURE command is allowed for each task. The devices specified for private volumes will be reserved so that the task can be executed without waiting for I/O devices; any waiting that may be necessary to reserve the devices occurs at SECURE time rather than during execution time. The SECURE command is never used in a conversational task; it is mandatory only in nonconversational tasks that include references to private volumes.

Protecting and Sharing Data Sets

You cannot gain access to any data sets other than your own unless you have system authorization to do

so, or you have been given authorization to share them by another user who owns the data set(s) involved.

A *shared* data set is one that is cataloged and for which the owner has issued a PERMIT command. It belongs to one user, but may be shared with other users on any of the following bases:

1. *Read-only access:* The sharer may read the data set, but may not change it in any way.
2. *Read-and-write access:* The sharer can both read and write to the data set, but he may not erase it.
3. *Unlimited access:* The sharer, in effect, can treat the data set as his own; he may thus even erase it.

You issue a PERMIT command to designate other users who may share your data sets, and to indicate the level of access those users may have. You also use the PERMIT command to withdraw from previously authorized sharers the right to continue sharing your data. Each time you issue a PERMIT command, your catalog is updated when the task is terminated by LOGOFF or ABEND. Information on who can share which of your data sets is stored in your catalog.

If you have been named in another user's PERMIT command, you must issue a SHARE command before you can actually access the data sets he has authorized you to use. To see how this command is used, assume that a sharer's user identification is JMC200 and that he has been permitted to share one data set. The data set is owned by user RKP100, and is cataloged by him under the fully qualified name ENG.PHYSICS.COMAR.TEST2. Assume also that the sharer wants to name the data set ENG.CHEM.NOTAR.TEST1. He would then issue the SHARE command shown at the top of Figure 5. In response to that command, the system would search the owner's catalog to see if the prospective sharer is authorized. If he is not, the command is ignored; if he is authorized, the system places the owner's complete name for the data set in the sharer's catalog with a pointer back to the master index. Whenever the sharer subsequently refers to the data set by his name, the system locates the data set by the search procedure shown on Figure 5.

To be concurrently accessible by more than one task, a data set must be cataloged and must be a virtual storage data set (VS, VI, or VP).

Maintaining Program Libraries

A program in TSS/360 can consist of one or more object modules. An object module is the output of a language processor or the linkage editor (exclusive of the listing). All programs in TSS/360 are stored in object module form in program libraries, which are VP data sets. A program consisting of only one object module is stored entirely within one library; however, if a program consists of several object modules, those modules may reside in different libraries, depending on how you store them.

There are four categories of program libraries:

- System library (SYSLIB)
- User library (USERLIB)
- User-defined job libraries
- Linkage editor libraries

SYSLIB is accessible to all users on a read-only basis.

USERLIB is the private library assigned to you when you are joined to the system. This library is automatically built for you and made a part of your catalog by the system. USERLIB is thus available each time you log on. If you do not use job libraries in a task, all the object modules resulting from your use of the language processors are automatically placed in USERLIB. You may wish to restrict your USERLIB to object modules that you execute frequently or that you use frequently in the buildup of other object modules.

The program library list is a defined hierarchy of program libraries. It is initialized at log-on time, and at that time consists of USERLIB and SYSLIB. The library at the top of the list always automatically receives all object modules resulting from language processing. As noted above, if no job libraries are defined, the library at the top of the list is always USERLIB. However, you can specify that a job library be added to the program library list to receive the output of the language processors. You do this by issuing a DDEF command defining that job library and containing the OPTION=JOBLIB parameter. When this command is executed, the name of that job library is added to the top of the program library list. That library then receives all subsequent output of the language processors until another job library is defined (and it is placed at the top of the list), or until a RELEASE command is issued for the first job library. The POD? command can be used to obtain a list of member names, alias (entry point) names, and other member oriented data from the task's USERLIB and such cataloged job libraries as have been established by the user.

In addition to using the program library list to store object modules, the system also uses this list to control its order of search when looking for object modules that must be loaded at execution time. The library at the top of the list is always searched first, then the next-to-the-top library, etc.; then, USERLIB and, finally, SYSLIB. By using the linkage editor, you can move object modules from one library to another.

Other user-defined libraries may be defined by DDEF commands that omit the JOBLIB parameter. They are not placed on the program library list and cannot be loaded. They are used principally with the linkage

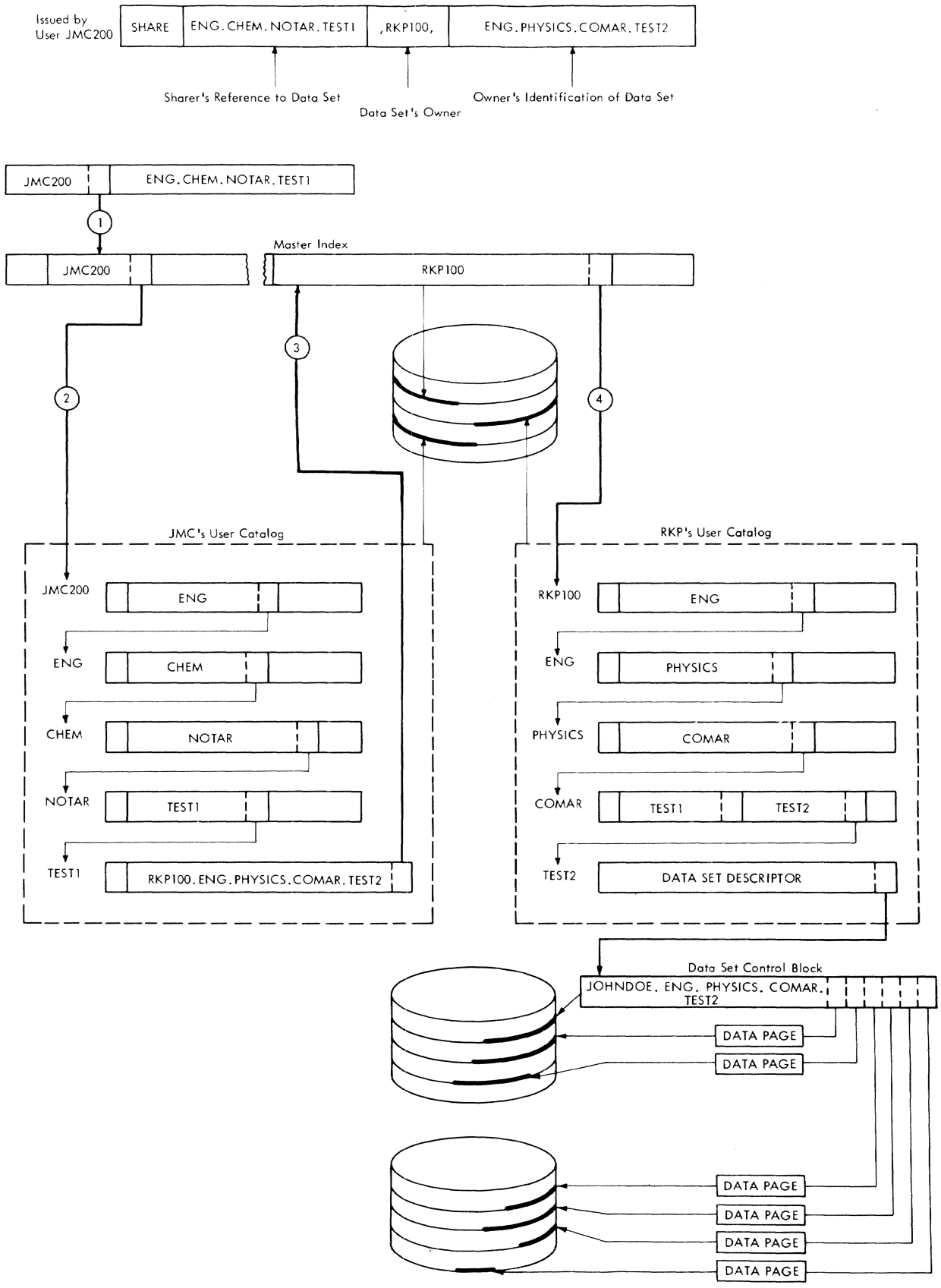


Figure 5. Sharing of Cataloged Data Sets

editor. (Refer to *Linkage Editor* for an explanation of linkage editor library control.)

Copying, Modifying, and Erasing Data Sets

You can use the CDS command to make a copy of any data set (or any member of a partitioned data set) to which you have access except data sets whose records are in undefined format (see Appendix E), such as program module libraries. You can also use the command to renumber the lines of a line data set as it is being copied. Both the original and copy data sets must be defined in your task.

You can use the MODIFY command to insert, delete, replace, or inspect records of a VI data set, or of a VI member of a VP data set. You have to identify the record to be modified (by its key or line number). You can review modifications, and play back corrected lines for confirmation of your changes.

You can use the VV, VT, and TV commands to copy your data sets, depending on their origin and desired destination. The VV command causes a VAM data set to be copied into public storage. The VT command causes a VAM data set to be reproduced on 9-track magnetic tape. The TV command retrieves and writes into public storage a data set previously written on 9-track magnetic tape by the VT command.

You can use the ERASE command to erase data sets that you own. If you are sharing someone else's data set, you can remove its entry from your catalog by issuing the DELETE command.

Conversational Task Termination

To terminate your conversational task, issue a LOGOFF command. The system will then update its internal accounting tables reflecting your use of the system during the session.

If you later want to communicate with the system again conversationally, you must again log on as described in the section "Conversational Task Initiation."

Nonconversational Use of the System

There are many applications where you will not require dynamic communication with the system or with your problem programs in order to obtain the problem solutions you desire.

Nonconversational Task Initiation

Figure 6 illustrates the various ways in which you can use the system for nonconversational processing.

You can issue the EXECUTE command in a conversational task to initiate nonconversational tasks. The EXECUTE command names a cataloged command procedure that is to be executed. The command procedure functions as the SYSIN data set for the nonconversational task. It must begin with a LOGON command; end with a LOGOFF command; and, it must be prestored in the system by you so that it can be retrieved merely by its name. If private devices are required in the task, a SECURE command must immediately follow the LOGON command.

You can issue PRINT, PUNCH, and WT commands in either a conversational or nonconversational task. These commands are, in effect, one-command-procedures. They initiate nonconversational tasks that transfer data between a direct-access device and a printer, card punch, or tape unit, respectively.

You can also have the operator initiate nonconversational tasks for you. You supply him with a card deck or magnetic tape; the contents of the deck or tape depend on what you want done:

- If you want to enter data into the system for later use (i.e., prestore it) you prepare a card deck (or magnetic tape) with a command procedure of the following form:

  DATASET descriptor card
Data cards
%ENDDS card } card images

If you do this, the task set up by the operator will transfer data from the input medium to a direct-ac-

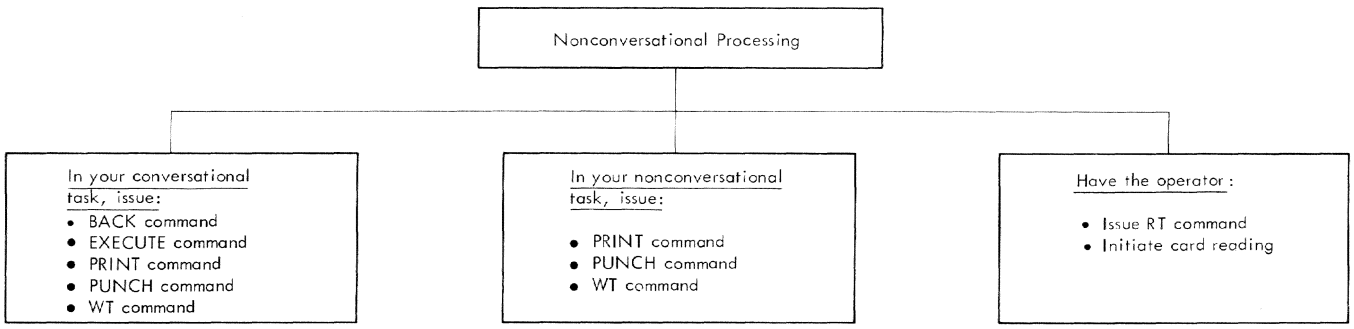


Figure 6. Nonconversational Task Initiation

cess device and catalog it so that it is later available to you by its name.

- If you want to enter a command procedure, you prepare a card deck as follows:

  LOGON card
  Other commands & data cards
  LOGOFF card

The task that is set up by the operator will execute the commands in the command procedure you have defined.

In all of the ways in which a nonconversational task is initiated, the system action is basically the same:

1. The request to set up the nonconversational task is enqueued and assigned a batch sequence number.
2. The individual requesting the task (you or the operator) is sent the batch sequence number (to later permit that individual to CANCEL that task if he wants).
3. The requested task is then executed when the required system resources become available.

Nonconversational Command Procedure Processing

When you use the EXECUTE command to initiate a nonconversational task, the commands are taken one at a time from the cataloged command procedure (SYSIN data set) you specified. The system specifies the task's SYSOUT. You can read SYSIN input in your programs, in a manner similar to conversational mode, if the data is properly positioned in the SYSIN data set. Similarly, you can write to SYSOUT from your program. Because there is no prompting in nonconversational processing, you must specify every command completely, you must take care to have your commands in proper sequence, you must include a SECURE command to obtain any devices needed for private volumes, and you must catalog any data sets you want to keep.

In nonconversational mode, listings produced by language processors (by the FORTRAN compiler, the assembler, or the linkage editor) are written automatically on SYSOUT unless you specify the LISTDS option (in the FTN, ASM, or LNK command) as "Y". If the LISTDS option is "Y", the listing is put into the list data set, as in the conversational mode, and will not be printed until you issue a PRINT command.

Nonconversational Task Termination

The execution of nonconversational tasks (except PRINT and PUNCH) is terminated when their LOGOFF command is executed. The system then automatically prints out the task's SYSOUT data set. For nonconversational tasks, the SYSOUT data set consists of the commands from SYSIN that were executed, any data that your program writes to SYSOUT, and the compiler-issued diagnostic messages (if no listings were requested).

Tasks created by the PRINT and PUNCH commands terminate when the data transfer is completed.

You can also terminate your nonconversational tasks by issuing a CANCEL command identifying each task to be terminated by its batch sequence number.

Mixed Mode Use of the System

You can begin a task at your terminal, and then issue a BACK command to have the task's execution completed in the nonconversational mode. Before issuing the BACK command, you must have stored a SYSIN data set that is to function as the command procedure and, if desired, input data for the nonconversational portion of your task. You must also have issued DDEF commands for any private volumes you may need. The SYSIN data set must not contain a LOGON command (because you have already logged on), but it should end with a LOGOFF command.

When you issue a BACK command for a task, the system determines whether it can provide sufficient resources to continue your task nonconversationally. If it cannot, the system will reject your request, and you can try later.

Once your BACK request is accepted, your terminal is inactive. You must then log on at your terminal again to initiate a new conversational task if you want to continue to use the terminal.

Remote Job Entry

The TSS/360 remote job entry feature makes high-speed printing and card reading available at locations outside the central computer installation. Each remote station has a card reader to accept input and a printer to produce output.

A complete description of this facility is provided in *IBM System/360 Time Sharing System: Remote Job Entry*, GC28-2057.

Command Directory

Table 1 presents a guide to the commands of TSS/360 as presented in the examples and appendixes of this book. The commands are grouped by general function. For each command, a sample usage and a statement of its general effect are shown, along with the numbers of all the examples in Part II in which this particular command appears.

Table 1. Command Directory

FUNCTION	COMMAND	SAMPLE USAGES	EFFECT	ILLUSTRATIVE EXAMPLES
Task Management	BACK	BACK DSNAME=PROC12A	Switches your conversational task to nonconversational mode. Here you specify PROC12A as the source of further commands.	12
	CA CB	CA	Specifies that card input will follow. Causes SYSIN to be switched to the card reader. The A signifies that you want to convert card input from 1057 card punch code to EBCDIC. A CB would signify conversion from 029 keypunch code to EBCDIC.	20
	CANCEL	CANCEL BSN=0375	Terminates execution of nonconversational task to which the system had assigned batch sequence number 0375.	19, 20
	EXECUTE	EXECUTE DSNAME=PROC12	Requests the execution in nonconversational mode of a sequence of commands contained in data set PROC12. You may then continue in conversational mode at the terminal.	12
	KA KB	KB	Specifies that keyboard input in folded mode will follow (i.e. the lower case characters a-z and ! " ¢ are to be translated into their uppercase equivalents (A-Z and $ # @). KA would specify that you want to use the full EBCDIC character set.	20
	LOGOFF	LOGOFF	Notifies system that you want to terminate your task. The system may then query you regarding any uncataloged data sets.	All but example 3
	LOGON	ADUSERID, MYPASS*,, ADACCT29	Identifies you to the system. You enter your identification, password, and account number.	All
	PROCDEF	PROCDEF ZLOGON	Defines a procedure (ZLOGON) which is automatically executed each time you log on, prior to any terminal processing you may initiate.	27
	SECURE	SECURE (TA=1,9)	Reserves devices for private volumes required for nonconversational tasks. This command at the beginning of your sequence of commands secures one 9-track tape unit.	14, 21
	TIME	TIME 15	Establishes the maximum amount of elapsed time that a task will be allowed to run. Here you have set a 15-minute limit on program execution time.	2
	USAGE	USAGE	Presents totals of system resources used since LOGON and since you were joined to system.	22
Data Set Management	CATALOG	CATALOG DSNAME= RESULT01, STATE=N, ACC=R	Causes your physical sequential output data set RESULT01 to be cataloged. The N indicates that the catalog entry is new. The R indicates that you want to restrict access to the data set to a read-only.	5, 11, 21, 23, 24
	CDD	CDD DDPACK, DDMAIN14	Causes execution of the DDEF commands defined by the data definition name DDMAIN14, which you had stored in the data set DDPACK.	14
	CDS	CDS DSNAME1=MYDATA, DSNAME2=MYDATA1	Copies the data set MYDATA, naming the copy MYDATA1.	18

Table 1. Command Directory (cont.)

FUNCTION	COMMAND	SAMPLE USAGES	EFFECT	ILLUSTRATIVE EXAMPLES
Data Set Management (Continued)	CLOSE	CLOSE	Closes data sets from the command level when normal processing has been interrupted and closure from the program level is difficult or impossible.	17
	DDEF	DDEF DDNAME=LIBDD, DSORG=VP, DSNAME=SCRATCH, OPTION=JOBLIB	Defines a data set for the current task. Every data set you use must be defined for the current task, even if previously cataloged. You assign LIBDD as the name of the data definition. The data set created by this DDEF is a virtual partitioned job library named SCRATCH.	4, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 18, 21, 23, 24
	DELETE	DELETE DSNAME=DATA5	Removes the entry for the data set DATA5 from your catalog.	22
	DSS?	DSS? PHI,SIGMA	Causes printing of information about your data sets PHI and SIGMA.	22
	ERASE	ERASE DSNAME=SCRATCH	Erases data set SCRATCH (releases direct-access storage for other use), and, if cataloged, deletes name from catalog.	4, 5, 7, 8, 19, 22
	EVV	EVV DEVICE=2311, VOLUME=(123ABC), USERID=ADUSERID	Presents a private VAM volume to the system and catalogs the data sets on it. The volume is a 2311 with volume serial number 123ABC. The data sets are to be cataloged in user ADUSERID's user catalog.	
	PC?	PC? PHI,SIGMA	Causes printing of limited information about your data sets PHI and SIGMA.	22
	PERMIT	PERMIT DSNAME=DATA, STATE=N, ACCESS=RO, USERID=ABPALID	Permits the user with the user ID,ABPALID, to have read-only access to all of your data set whose left-most name qualifier is DATA. The N signifies that this command creates a new sharer's list, rather than updates on existing list.	18
	POD?	POD? PODNAME=USERLIB	Causes printout of information about each object module in your USERLIB.	22
	RELEASE	RELEASE DDNAME=MYDD	Revokes the data definition established by a previously issued DDEF named MYDD.	10, 17
	SHARE	SHARE DSNAME=MYDATA, USERID=ADUSERID, OWNERDS=DATA	Creates an entry in your catalog for the data set named DATA, to which you are authorized access when the owner issues a PERMIT command.	18
	RET	RET DSNAME=ALPHA, RET=(TCU)	Modifies the RET field of the data set descriptor to specify that data set ALPHA be assigned to temporary storage with read/write access and that it be deleted when it is closed.	16
	TV	TV DSNAME1=COPY1, DSNAME2=COPY2	Causes data set copied on 9-track as COPY1 to be reproduced on direct-access storage in VAM format under the name COPY2.	24
	VT	VT DSNAME1=ORIGIN1, DSNAME2=COPY1	Causes VAM data set named ORIGIN1 to be copied on 9-track magnetic tape as COPY1.	24
	VV	VV DSNAME1=COPY2, DSNAME2=COPY3	Causes VAM data set named COPY2 to be copied into public storage under the name COPY3.	24

Table 1. Command Directory (cont.)

FUNCTION	COMMAND	SAMPLE USAGES	EFFECT	ILLUSTRATIVE EXAMPLES
Text Editing	CORRECT	CORRECT N1=100, SCOL=8	Causes the characters beginning with column 8 of line 100 in the current region to be displayed for correction purposes. Characters are inserted, deleted or changed by keying in correction symbols directly beneath the affected character(s).	26
	DISABLE and ENABLE	DISABLE ENABLE	DISABLE causes your modifications to the data set to be provisional, pending execution of an ENABLE command. By issuing a STET command instead of an ENABLE, you would cause all modifications made after the DISABLE to be deleted.	26
	EDIT	EDIT DSNAME=EX26	Invokes the facilities of the Text Editor. The operand identifies the data definition name associated with the data set which is to be edited.	25, 26
	END	END	Terminates processing of the Text Editor or the PROCDEF command.	25, 26
	EXCERPT	EXCERPT DDNAME=NEW1, RNAME=REGION2, N1=600,N2=1000	Excerpts lines 600 to 1000 from REGION2 of the data set associated with the data definition name NEW1 and inserts them into your current region. EXCERPT, following a REVISE command, replaces a range of lines in the current data set; following an INSERT command, it adds to lines being typed in from the terminal.	26
	EXCISE	EXCISE N1=0000200	Deletes line number 0000200 from the current region.	25
	INSERT	INSERT 0000400	Informs the system that you wish to insert the following lines from SYSIN into the current region, placing them immediately after line 0000400.	25
	LIST	LIST N1=100, N2=500	Lines 100 to 500 of the current region are displayed.	26
	LOCATE	LOCATE STRING=LINEF	Searches the current region for the first occurrence of character string LINEF. When the string is found, the line containing it is displayed.	26
	NUMBER	NUMBER N1=300, N2=500, BASE=300, INCR=50	Causes the lines within the current region to be renumbered. N1 and N2 define the range to be renumbered. The numbering will begin with 300 and increase in increments of 50.	26
	POST	POST	Makes all previous editing changes permanent and puts Text Editor into disabled state, making future changes reversible.	26
	REGION	REGION RNAME=FIXA	Used after invoking the Text Editor, this command identifies a region name to be assigned a line or range of lines that are to be edited.	25, 26
Data Editing	DATA	DATA DSNAME=PROC12A	Creates a new data set named PROC12A. You do not need to issue a DDEF command for data sets created by a DATA command. By default, the data set organization is VS.	12, 14, 16
	LINE?	LINE? SOURCE.MAIN9, (1200,1400)	Causes printing of source lines 1200 to 1400 from the specified line data set.	9, 10, 16, 19
	MODIFY	MODIFY SETNAME= SOURCE.MAIN4	Permits you, with subsequent parameters, to insert, replace, review, or delete lines in a VISAM data set named SOURCE.MAIN4 containing FORTRAN source statements for your program MAIN4.	5

Table 1. Command Directory (cont.)

FUNCTION	COMMAND	SAMPLE USAGES	EFFECT	ILLUSTRATIVE EXAMPLES
Bulk Output	PRINT	PRINT DSNAME= LIST.MAIN2(0), ERASE=Y, PRTSP=EDIT	Causes the current generation of the listing data set LIST.MAIN2(0) to be printed on the high-speed printer.	2, 4, 5, 6, 8, 10, 13, 14, 19, 20
	PUNCH	PUNCH DSNAME= SOURCE.MAIN19, STARTNO=9, ENDNO=88	Causes the 9th through the 88th characters of each record of your source data set to be punched. The first eight characters are the line number and input key. Punching is done in nonconversational mode when system resources are available.	19
	WT	WT DSNAME=M22OUT	Causes the data set M22OUT to be written on magnetic tape for subsequent off-line printing.	22
Program Management	FTN	FTN NAME=MAIN2	Activates the FORTRAN compiler. You name the object module to be produced in this compilation MAIN2. The system will assign the name SOURCE.MAIN2 to the data set it creates containing your FORTRAN source statements. You have specified the default values for the remaining parameters by omitting them.	2, 3, 4, 5, 8, 13, 20
Program Control	AT	AT MAIN.17, MAIN.96(2)	Causes message to be printed on SYSOUT when execution of your program MAIN reaches statement numbered 17 and when it reaches the first executable statement after the one numbered 96.	10
	CALL	CALL MAIN4	Causes loading and execution of your program MAIN4 at the first executable statement.	4, 5, 7, 9, 11, 13, 14, 15, 17, 20, 21, 23
	DUMP	DUMP MAIN10#C, MAIN10#P	Causes a formatted dump of MAIN10's CSECT and PSECT. It will be written in the PCSOUT data set for later printing.	10
	GO	GO	Causes execution of your current program to be resumed from the point of interruption.	9, 10, 15
	IF	AT 101; IF A>B; STOP	Causes execution of your program to stop at location 101 if the expression A>B is true.	10
	DISPLAY	DISPLAY MAIN9.ALPHA, MAIN9.BETA	Causes printout on SYSOUT of the current contents of data fields ALPHA and BETA in program MAIN9.	9
	LOAD	LOAD BLKDATA8	Causes your block data subprogram to be transferred from your library to virtual storage.	8, 10
	QUALIFY	QUALIFY MNAME=MAIN9	Causes subsequent references to symbols and statement numbers to be qualified by the name MAIN9. You can now write AB instead of MAIN9.AB, or 105 instead of MAIN9.105.	9, 10
	REMOVE	REMOVE 2	Deletes previously issued AT commands, or PCS statements containing AT commands. Here you specify deletion of the statement to which the system assigned the number 2.	10
	SET	SET BETA=1.0	Sets value of BETA equal to 1.0.	9, 10
	STOP	STOP	Stops program execution and causes printing on SYSOUT of current instruction location and program status information.	9
	UNLOAD	UNLOAD MAIN15	Removes the object module MAIN15 from your virtual storage.	15, 21

Table 1. Command Directory (cont.)

FUNCTION	COMMAND	SAMPLE USAGES	EFFECT	ILLUSTRATIVE EXAMPLES
User Profile Management	DEFAULT	DEFAULT DSORG=VS	Sets the default value for the DSORG parameter of the DDEF command to virtual sequential (VS).	28
	PROFILE	PROFILE	Causes changes affected by DEFAULT and SYNONYM commands to become a permanent part of your user profile.	28
	SYNONYM	SYNONYM DOPROG=FTNPGM	Establishes a synonym for the name FTNPGM. This module can now be called by the name DOPROG.	28

Part II: Examples

Part II is devoted to examples in which the dialog between you and the system appears (along with explanatory comments) as it would at the terminal. They are typical examples of system use. Unlike the sample programs in Appendix I, the examples in this section have not been system-tested. You may, therefore, observe minor differences between an example's description in Part II and the printout you obtain if you run the example itself. Use the examples, therefore, only as a learning device, and as models for designing your own work.

Commands and concepts are presented in an ordered sequence: the most necessary and basic ones appear first, and are reviewed in subsequent examples. The examples are designed so that the beginner should read them in sequence. Those familiar with the commands and concepts can use the examples for reference.

FORTRAN programs are shown where they are necessary to clarify use of the commands. Only the relevant statements are included.

The system issues various types of messages at your terminal, as follows:

- Prompting Messages — request that you supply command operands or other information. You are prompted only for omitted parameters that have no default option.
- Response Messages — either inform you of actions the system has taken in executing a command or request additional information.
- Diagnostic Messages — inform you of errors and prompt you for correction.

In these examples, lines typed by the system are headed SYS, lines you enter are headed YOU. Lines in which both the system and you enter something are headed S,Y. Lines printed by your program are headed PGM, and cards entered from the terminal card reader and printed are headed CIP, for "card image printout."

Example 1: Initiating and Terminating a Conversational Task

In this example, you initiate a simple conversational task and then terminate it. The commentary explains the keyboard entries required to converse with the system.

To begin a conversational task, make sure that the terminal is properly prepared (refer to instructions provided by your installation or to the *Terminal User's Guide*). When you dial up the system or press the attention button for the first time in your task, the system assumes a log-on operation and responds with the current date and time. You then enter all the log-on operands.

During your dialog with the system, your commands are not entered into the system until you press the return key.

```
YOU:  (press the attention button or dial up system)
```

From this point on, pressing the attention button halts current activity in most situations. Consult Appendix F for the specific action taken in each situation.

```
YOU:  LOGON ADUSERID,MYPASS*,,ADACCT24,A
                                    9,A,,P
```

You must enter the entire LOGON command on a single line. While typing the LOGON operands, you realize that you have entered your charge number incorrectly. Therefore, you backspace three characters, move the paper up one line by hand to avoid overtyping, and reenter the corrected portion of the charge number. You then complete the LOGON operands. If you wanted, you could have cancelled the entire line by typing a pound sign (#) and immediately pressing the return key; then you would reenter the correct line.

```
SYS:  (responds with the current release-level of the system, the date, time, and task
      identification)
```

You can now communicate with the system by entering commands.

Explanation of LOGON Operands

ADUSERID

First Operand — User Identification

This operand is the full identification assigned to you when you were joined to the system.

MYPASS*

Second Operand — Password

This operand is an installation-assigned code that provides protection against unauthorized use of your user identification. In conversational mode, you must supply a password if one has been assigned to you.

Third Operand — Addressing

Specifies whether 24-bit or 32-bit addressing is to be used for this task. If you default this operand, the installation default value will take effect.

ADACCT29

Fourth Operand — Charge Number

This operand is the charge or account number that was assigned to you by your administrator. The first two characters of your charge number also identify your administrator.

A

Fifth Operand — Control Section Packing

This operand specifies whether control sections are to be packed (i.e., not placed on separate pages), and the manner of packing to be used. The codes and their meanings are:

Code	Meaning
A	Pack all control sections
P	Pack all prototype control sections (PSECTs)
O	Pack all control sections having neither public nor prototype attributes
X	Pack all control sections except prototype control sections
N	No packing

Sixth Operand — Maximum Auxiliary Storage

This operand specifies the maximum amount of auxiliary storage to be allocated to your task; you default this operand and use the installation default value.

P

Seventh Operand — Pristine Mode

This operand allows you to log on with only the system-supplied defaults, synonyms, procdefs, and Character and Switch Table. Since you specified this operand as P, your user library is defined; if you had specified it as X, your user library would not be defined.

S,Y KB

After logging you on, the system prints a single underscore and then backspaces; this is the standard signal that it is ready to receive your next command on the same line. Here you specify that you want folded mode; that is that certain lower case characters (as a-z and ! "¢) be translated by the system into their upper case equivalents (A-Z and $ # @, respectively). Thus, with KB, you no longer need to perform shifting operations.

When you initiate a conversational task, the system automatically assumes folded mode; hence in this example you need not have specified KB. However, there are other character control commands, such as KA, which invoke EBCDIC mode at the keyboard. Thus, if you specify KA and at a later time in your session wish to return to folded mode, you must enter KB.

Here you decide to conclude your session, so you logoff. Note that LOGoff translates to LOGOFF.

```
YOU:  LOGoff
SYS:
```

The system confirms your LOGOFF command.

Example 2: Compilation and Correction from the Terminal

In this example, you type in the source statements of a short program and correct several errors while compiling the program. The compiled object module is stored in your USERLIB. The listings you select are printed as a separate task, only if requested using the PRINT command. After logging on, you issue:

```
S,Y:  TIME  15
```

The TIME command establishes a period of time a task will be allowed to run in virtual storage. You decide that 15 minutes will be adequate for your task and wish to be alerted when this interval is exhausted. TIME is thus useful in controlling inadvertent loops and other abnormal actions occurring in programs.

```
S,Y:  FTN NAME=MAIN2
```

This command activates the FORTRAN compiler. A compiled program is called an object module. You name the object module to be produced in this compilation MAIN2. The system creates a source data set, naming it SOURCE.MAIN2, which will contain your FORTRAN source statements as you entered at the terminal.

Because SOURCE.MAIN2 is a line data set residing in public storage, it is automatically cataloged for you. Although you did not explicitly issue a DDEF command, there was an implied system issuance of DDEF associated with your FTN command.

The system also creates a list data set, named LIST.MAIN2, which will contain the listing of the object module. The NAME parameter is not defaultable, although you could enter the command as FTN MAIN2. It is permissible to omit the NAME keyword. Note, however, that when you omit the keyword and have several operands to enter, you must specify the operands in the order in which they are syntactically defined. In this example you specify the default values for the remaining parameters by simply omitting them.

```
S,Y:  0000100 READ (5,10) A, B
S,Y:  0000200 FORMAT (F6.2)
```

The system prints line numbers. After each line number, you skip a space and enter a FORTRAN statement. You do not have to follow the FORTRAN card format when entering source lines from the terminal. Skipping one space after the system prints the line number improves readability. Since the system regards any line with a C in column 1 as a comment line, skipping a space also prevents lines such as C = A*B from being treated as a comment. When you want a comment line, you should not skip a space, but enter the C in column 1.

```
SYS:  0000200 E *** FORMAT STATEMENT DOES NOT HAVE STATEMENT NUMBER.
```

The compiler examines each statement for syntactical errors as soon as it is received. 200 is the line number of the statement in error, E is an error level code, indicating a serious program error; the statement is ignored. Other error level codes are:

W A warning of a possible problem; the statement is compiled as written.
F Serious error; statement can only be partially compiled.
A Compilation cannot be continued.

See Appendix A for further details on compiler diagnostics.

```
SYS:  0000200 FORMAT (F6.2)
```

The system prints the line in error for your review.

```
S,Y:  #200,10 FORMAT (F6.2)
```

The system prints the number sign, #, after which you enter the line number of the line to be corrected, followed by a comma and the replacement line. There must be at least one space between the statement number (10) and the rest of the statement.

```
S,Y:  #(press return key)
```

Another correction or change or even insertion of an entirely new line could be made at this time. Since you wish to continue entering your program, you request the next line number by pressing the return key.

```
S,Y:  0000300 ATB = A * B
S,Y:  0000400 WRITE (6,20) A, B, ATB
S,Y:  0000500 STOP
S,Y:  0000600 END
SYS:  0000400 F *** 20 STATEMENT NUMBER USED AS FORMAT IS NOT DEFINED.
```

After the END statement has been entered, the compiler diagnoses global errors, which are errors that involve more than a single statement. In doing so, it found an error.

```
SYS:
```

The system invites you to modify your source statements.

```
YOU:  Y
```

You may reply yes (Y) or no (N). Here you reply yes and wait for the system to invite your modification.

```
S,Y:  #400, WRITE (6,10) A, B, ATB
S,Y:  #(press return key)
```

While you are entering modifications, no error checking is done; however, the compiler rescans the entire program when it recompiles after modifications are completed.

```
SYS:
```

The system continues compilation and informs you when finished.

```
S,Y:  PRINT LIST.MAIN2(0), ERASE=Y, PRTSP=EDIT
```

The system will establish a nonconversational task to print the current generation of LIST.MAIN2. The current generation is specified by the (0) immediately after the generation data group name. The PRTSP operand is specified as EDIT because the system supplies control characters to format the listing. The ERASE operand is included to eliminate the listing from the system after printing. Each listing is put into the list data set (the data set beginning with LIST.).

```
SYS:
```

The system ackowledges your PRINT command and informs you of the batch sequence number it has assigned to the printing task.
Now compilation is complete.

You are informed of the batch sequence number of the separate task created to print the listings produced by the compiler.

The compiled object module now resides on the library at the top of your program library list – in this case, your USERLIB.

```
S,Y:  LOGOFF
SYS:
```

The system will confirm your LOGOFF command.

Example 3: Compilation and Correction from the Terminal

In this example, you type in the same FORTRAN program as in Example 2, but this time all applicable parameters are shown. After logging on, you issue:

```
S,Y:  FTN NAME=MAIN3,STORED=N,VERID=A6/26,-
      ISD=N,SLIST=Y,OBLIST=N,CRLIST=N,STEDIT=N,MMAP=N,-
      BCD=N,PUBLIC=N,LISTDS=N,LINCR=(100,100)
```

This is the same FTN command as in Example 2, except that here all the FTN operands are entered with their keywords. Each operand is described below. When entering commands conversationally at the terminal, you may continue them on another line if necessary by entering a hyphen at the point where you wish to break the current line.

Explanation of FTN Operands

NAME= — ***Object Module Name***

You assign the name MAIN3 to the output object module to be created by the compiler. The source data set for this object module is named SOURCE.MAIN3; the listing data set is named LIST.MAIN3(0).

This is the only FTN operand that may not be defaulted.

STORED= — ***Prestored Source Data Set***

You specify N so that you may enter source statements from your terminal rather than compile from a prestored source data set.

VERID= — ***Object Module Version Identification***

You may assign a version identification to the object module in this case, A6/26. It appears on output listings of the named program and is stored in a special field in your object module. If you do not assign a version identification, you may distinguish the version of your object module by using the system supplied "time stamp." A time stamp is always produced by the system; it gives the current time and date at which compilation begins.

ISD= — ***Internal Symbol Dictionary***

This parameter permits you to create an Internal Symbol Dictionary (ISD) during compilation. An ISD is necessary for the fullest use of the program control system (PCS).

SLIST= — ***Source Listing***

The listings you request with this and the next four parameters will form your listing data set. (See Appendix A for a detailed explanation of these listings.) The system creates a name for this data set by prefixing "LIST." to the module name you supplied as the first assembler parameter (LIST.MAIN3), using generation data group logic.

The source listing shows the source input statements.

OBLIST= — ***Object Listing***

You indicate you do not want an object listing. The object listing shows the code generated by the compiler. This code is in the form of assembler language statements and hexadecimal machine language code. Ordinarily, it is not needed by FORTRAN programmers.

CRLIST= — ***Cross Reference Listing***

This listing shows where, in the source program, each statement number and symbol is defined or referred to. You have told the system not to produce this listing.

STEDIT= — ***Edited Symbol Table***

This listing indicates the characteristics and displacement for every symbol in the source program. You have indicated you do not want a listing of this table.

MMAP=

Memory Map

This listing contains summary information about the module, most of which is included on other listings. You have declined a listing of a memory map.

BCD=

Binary Coded Decimal

Since you are writing this at the terminal, the characters entered will be stored internally in the standard system EBCDIC form. If your source program were in the form of cards or tapes from a system using BCD, the BCD code could be used. In BCD mode, characters of either EBCDIC or BCD can be entered.

PUBLIC=

Private or Public CSECT Attribute

This parameter specifies whether the executable portion (not variables) of the object module is to have a public or private attribute. You have selected a private attribute.
Public means that the resulting object program can be shared by other users. Most FORTRAN users will want to take the default option (i.e., private).
For more detailed information regarding all FORTRAN compiler options, see Appendix A.

LISTDS=

Listing Destination

This parameter specifies whether the listings you request from the compiler are to be placed in a list data set or placed directly on SYSOUT; it is ignored in a conversational task.

LINCR=

Starting Line Number, Increment

The system creates a line number for each of your source statements. Although a part of the source data set being formed (SOURCE.MAIN3), line numbers are not an intrinsic part of the FORTRAN program itself and have no specific relationship to any statement numbers.

The starting line number and the increment number may contain three to seven digits, of which the last two must be 00. Thus in the case here illustrated, the system generated line numbers will be 100, 200, 300, etc.

```
SYS:
```

The system requests each input source line by typing out a line number to the terminal starting with 100. After you enter a source line, it is added to the source data set and processed by the FORTRAN compiler.

```
S,Y:  0000100 READ (5, 10) A, B
S,Y:  0000200 FORMAT (F6.2)
SYS:  0000200 E *** FORMAT STATEMENT DOES NOT HAVE STATEMENT NUMBER.
SYS:  0000200 FORMAT (F6.2)
```

The system prints the line in error for your review.
After the system prints the #, you correct the erroneous statement.

```
S,Y:  #200,10 FORMAT (F6.2)
S,Y:  #(press return key)
```

. . . and indicate that you have finished making modifications.
The session continues as in Example 2.

Example 4: Compile and Run

In this example you enter and compile a short test program without error and then execute it. You execute your task in conversational mode, using your terminal for both input and output. After logging on, you issue:

```
S,Y:  DDEF LIBDD,VP, SCRATCH, OPTION=JOBLIB
```

This command defines a job library and causes it to be placed at the top of your program library list. Object modules produced by compilations will be placed in it instead of in your USERLIB, which is now second on your library list.

A DDEF command defines a data set during the session in which the command appears. In general, every data set you use must be defined for the current session, even if it has been previously cataloged.

LIBDD is the data definition name (DDNAME) for the job library data set named SCRATCH. All libraries have virtual partitioned (VP) organization.

The OPTION indicates to the system that the data set you are defining is a job library.

The system automatically catalogs SCRATCH as a new catalog entry and assigns an "unlimited" (read/write) access qualifier to the library.

Your object module, MAIN4, will be placed automatically in your job library, SCRATCH, when compilation has satisfactorily completed.

```
S,Y:  FTN MAIN4,N,,,,,Y,,Y,,Y,,(100,100)
                      |||||||||||└─line numbers
                      ||||||||||└──listing data set
                      |||||||||└───public CSECT
                      ||||||||└────BCD
                      |||||||└─────storage map
                      ||||||└──────edited symbol table
                      |||||└───────cross-reference listing
                      ||||└────────object listing
                      |||└─────────source listing
                      ||└──────────ISD
                      |└───────────version identification
                      └────────────source prestored
```

Because no keywords were used in specifying which operands you desired, you must enter those operands in the order shown.

Only the first operand must be specified. The rest may be defaulted by including a comma where the operand would appear. You must supply commas for defaults prior to the non-defaulted parameter (e.g., the Y for public CSECT attribute), but you need not supply trailing commas.

The system automatically catalogs SOURCE.MAIN4 as a new catalog entry and assigns an "unlimited" (read/write) access qualifier to the library.

```
S,Y:  0000100      READ (5,10)A
S,Y:  000020010    FORMAT (F6.2)
S,Y:  0000300      ATC = A*3.14
S,Y:  0000400      WRITE (6,10)A,ATC
S,Y:  0000500      STOP
S,Y:  0000600      END
```

You type in your program statements following the line numbers printed by the system. You use a tab stop to space over 6 columns so that the statements have the appearance of the standard card format. Such tabbing is not required, but it is recommended as a visual aid to avoid errors. When entering source lines, a tab has the **logical** effect of a **single** blank character. Example 2 shows a source program entered in free form. Appendix A discusses the use of tabs and spaces in entering source statements.

```
SYS:
```

The system informs you of the satisfactory completion of the compilation.

```
S,Y:  PRINT LIST.MAIN4(0),PRTSP=EDIT
SYS:
```

The system acknowledges your PRINT command and informs you of the batch sequence number it has assigned to the printing task.

```
S,Y:  CALL MAIN4
```

The CALL command has two effects: it causes the loading of your object module and initiates program execution at the first executable statement. Note that the NAME keyword is omitted for the sake of brevity.
Since you gave no DDEF command for the data set reference number 5 in your READ statement, the system will assume you want to obtain input from SYSIN, which is the terminal when in conversational mode.

```
SYS:  (unlocks terminal keyboard)
YOU:  0.5
PGM:   0.50
       1.57
```

Since you gave no DDEF command for the data set reference number 6 in your WRITE statement, it will be defined as SYSOUT, which is also the terminal when in conversational mode.

```
PGM:   TERMINATED:  STOP
```

This message is printed when execution reaches your STOP statement (source line 500). You are now returned to command mode, indicated by the printout of the underscore.

```
S,Y:  ERASE SCRATCH
```

Before logging off you decide that you want to erase the job library data set, SCRATCH, containing the object module MAIN4, because you want to modify and recompile SOURCE.MAIN4 at a later date. You conserve public storage and increase the efficiency of the system by erasing all data sets not needed.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 5: Correcting and Recompiling a Prestored Source Program

In this example you modify and recompile the source program SOURCE.MAIN4 which, being on a public volume, was automatically cataloged for you in Example 4. You then run the new object module. After logging on, you issue:

```
S,Y:  MODIFY SOURCE.MAIN4
SYS:
```

You enter a MODIFY command to alter the source program entered in the previous example.

```
S,Y:  #
      R,100
```

The system prints a number sign to request each modification. You wish to review line 100 before modifying it, and enter the R (for review), a comma, and then the line number.

```
SYS:  0000100     READ(5,10)A
```

The system prints the line. When you entered the statements, you separated them from their statement number with a tab character.

The system prompts for modifications with the number sign.

```
S,Y:  #
      100,1       READ(10,5,END=80)A
```

You modify the line by typing, following the number sign, the line number, a comma, and then the modified line. The system then prints another number sign.

```
S,Y:  #
      450,        GO TO 1
```

You enter an entirely new line between 400 and 500.

```
S,Y:  #
      500,80      STOP
```

You add the label 80 as referenced in the READ statement.

```
S,Y:  #
      %E
```

You type these two characters to signal the end of modifications.

```
S,Y:  CATALOG SOURCE.MAIN4,STATE=U,ACC=U,NEWNAME=SOURCE.MAIN5
```

You use the CATALOG command to rename the current source data set SOURCE.MAIN5. At compilation time, its list data set will be named LIST.MAIN5(0) by the system. The first U indicates the updating of an existing catalog entry. The second U specifies unlimited access for the data set.

```
S,Y:  FTN MAIN5,Y,,Y
```

You enter the name and the rest of the FTN parameters you need: Y for prestored, the second comma after the first Y to default the version id parameter, and Y for ISD.

```
SYS:  0000100 F *** STATEMENT NUMBER USED AS FORMAT IS NOT DEFINED.
```

The compiler discovers an error in line 100. Note that this error was not detected during your use of the MODIFY command, since that command does no syntactical checking. You decide to correct the line.

```
SYS:  0000100 1       READ(10,5,END=80)A
```

The system prints the line that caused the diagnostic and asks whether you want to modify your source statements.

```
YOU:  Y
S,Y:  #100,1      READ(5,10,END=80)A
S,Y:  #     (press return key)
```

Having made the necessary correction, you signal that you are finished by pressing the return key. This is equivalent to the termination you indicated with %E during the MODIFY command. Then the compiler will rescan your source statements.

```
SYS:
```

The system informs you of the satisfactory completion of the compilation.

```
S,Y:  PRINT LIST.MAIN5(0),PRTSP=EDIT,ERASE=Y
SYS:
```

The system acknowledges your PRINT command and informs you of the batch sequence number it has assigned to the printing task.

The compiled object module is stored in your USERLIB. You now proceed to run the modified program.

```
S,Y:  CALL MAIN5
```

Since you gave no DDEF command for the data set reference number 5 in your READ statement, the system assumes you want to use the terminal for input.

```
SYS:  (unlocks terminal keyboard)
YOU:  2.0
PGM:   2.00
       6.28
```

Data set reference number 6 in your WRITE statement refers to the terminal for output.

```
SYS:  (unlocks terminal keyboard)
YOU:  5.0
PGM:   5.00
      15.70
SYS:  (unlocks terminal keyboard)
YOU:  1.0
PGM:   1.00
       3.14
SYS:  (unlocks terminal keyboard)
YOU:  %END
```

Satisfied that the program is now working correctly, you terminate execution by entering %END, which is the end-of-data indicator for SYSIN.

```
SYS:  TERMINATED:  STOP
```

Execution of MAIN5 being terminated, the system prints this message and then prompts for the next command.

```
S,Y:  ERASE USERLIB(MAIN5)
```

You plan to recompile your program later, so you erase its object module from your USERLIB. This will prevent name duplication in the future, and conserve public storage space.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 6: Writing a Data Set and Printing It

In this example, you run a program that writes a data set that is much too long to be conveniently printed at your terminal. You run the program, and then request printing of the output data set on the high-speed printer as a separate task. After logging on, you issue:

```
YOU:  (press attention or dial up system)
      LOGON ADUSERID,MYPASS*,,ADACCT29
SYS:  B001 LOGON TASKID=F206 12/15/69 10:12
S,Y:  DDEF DDNAME=FT07F001,DSORG=VS,DSNAME=M6OUT,-
      DCB=(RECFM=FA,LRECL=80),DISP=NEW
```

In preparation for the execution of your program, you define a cataloged data set (M6OUT) for data set reference number 7. You specify a virtual sequential (VS) data set.

You specify that your record format is to be fixed-length (F) and the records contain print control characters (A). Its records are to be 80 bytes long.

```
S,Y:  CALL MAIN6
```

The MAIN6 object module is stored in your USERLIB.

It ends with these statements:

```
      WRITE(7,10)ALPHA,BETA,GAMMA
   10 FORMAT(1H0,3F20.5)
      ENDFILE 7
      STOP
      END
```

The data set referred to in the WRITE7 and the ENDFILE7 statements is defined by the FT07F001 data definition.

```
SYS:   TERMINATED:  STOP
```

The system indicates the end of execution. The underscore on the next line indicates return to command made.

```
S,Y:  PRINT DSNAME=M6OUT,PRTSP=EDIT
```

To print your newly written data set, this command creates a separate task similar to the tasks that have printed your listing data sets. Only the first operand, DSNAME=, must be specified; the remaining operands may be defaulted.

Explanation of PRINT Operands

STARTNO=

First Byte Position

You want printing to begin with the first byte of each data set record. You can enter a number consisting of one to six digits.

ENDNO=

Last Byte Position

This parameter specifies at which byte in each data set record printing is to end. Since your records are shorter than the default length of 132, your printing will end at the last (80th) byte of each record.

PRTSP=

Spacing Option

Since you want line spacing to be controlled by the control character your program has supplied in each record, you choose EDIT. (The default would be 1.) Selecting EDIT requires that you default the next three parameters.

ERASE=

Erasure Option

This parameter is meaningful only if the data set being printed is cataloged. In that case, you can specify that the data set be erased after it is printed.

ERROROPT=

Error Option

This parameter applies only to data sets on tape. It specifies the action to be taken if an unrecoverable error is found while a data set record is being read.

```
        FORM=
```

Type of Printer Paper

Here you can specify the kind of printer paper you desire for your output. The operands for this keyword are determined by your installation.

```
SYS:
```

The system informs you that it has created a separate task to print your data set.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 7: Reading and Writing Cataloged Data Sets

In this example, you run a program that reads one data set and produces two other data sets as output, as well as printing some short messages at the terminal. After logging on, you issue:

```
S,Y:  DDEF FT11F001,VS,IN11
S,Y:  DDEF FT22F001,VS,OUT22A
S,Y:  DDEF FT22F002,VS,OUT22B
```

You give data definitions for the three data sets to be used.
A DDEF command remains in effect only for the session during which it was issued. Therefore, data definitions must be given even for data sets already cataloged. Data definition names for FORTRAN I/O have the standard form, FTxxFyyy, where xx is the data set reference number for an I/O statement, and yyy is the data set sequence number. You may use any data set name, as long as it is unique.

Because the first data set, IN11, was created previously, the system default for disposition is OLD. The next two data sets, OUT22A and OUT22B, are going to be created in this task, so they receive a system default disposition of NEW. Note that you do not have to include explicitly in the DDEF commands the parameter DISP=OLD for IN11, nor DISP=NEW for OUT22A and OUT22B.

The last two data definitions refer to the same data set reference number as in the FORTRAN WRITE statement, i.e., 22. Since an ENDFILE statement is given, and further WRITE statements are executed on the same data set reference number, two distinct data sets will be created. The second number in the data definition for the OUT22B data set name must be stepped from 1 to 2 to refer to the second data set written.

```
S,Y:  CALL MAIN7
```

You run your FORTRAN object module, which was stored in your USERLIB in a previous session. MAIN7 includes these statements:

```
7         FORMAT (2F20.3)
10        READ    (11,7,END=80)A,B
           .
           .
           .
          WRITE (22,7)A,B
           .
           .
          GO TO 10
80        ENDFILE 22
           .
           .
           .
          WRITE(22,20)E,F
           .
           .
           .
          ENDFILE 22
20        FORMAT(1X,2A4)
          WRITE (77,120)
90        STOP
120       FORMAT(26H FINISHED WRITING 2 FILES.)
          END
```

The last WRITE statement will produce a short message on the terminal.

```
PGM:  FINISHED WRITING 2 FILES.
```

Because you did not issue a DDEF command for data set reference number 77, the system assumes you want your output from the WRITE statement at the terminal.

```
SYS:   TERMINATED:  STOP
```

The system indicates the end of execution with this message. The underscore mark indicates return to command mode.

```
S,Y:  ERASE IN11
```

You erase the input data set that is no longer needed. Erasing a data set deletes its entry from your catalog and releases its storage space. You do, however, want to retain your two output data sets that were automaically cataloged for you at DDEF time.

```
SYS:  LOGOFF
```

The system confirms your LOGOFF command.

Example 8: Multiple Compilation Before Execution

In this example you enter a BLOCK DATA program, then compile prestored main and subprograms. You create a new JOBLIB, which you catalog. After logging on, you issue:

```
S,Y:  DDEF DDLIBA,VP,LIBA,OPTION=JOBLIB
```

With this data definition you create a new job library to hold the object modules from the three programs you are about to compile.

The system automatically catalogs LIBA as a new catalog entry and assigns an "unlimited" (read/write) access qualifier to the library.

```
S,Y:  FTN BLKDATA8
```

You activate the FORTRAN compiler and specify the module name (BLKDATA8) for your BLOCK DATA program. You will enter your source statements at the terminal.

The system automatically catalogs your source data set as SOURCE.BLKDATA8.

```
S,Y:  0000100     BLOCK DATA
S,Y:  0000200     DIMENSION AB(3),AC(3)
S,Y:  0000300     COMMON/XY/AB/EXTRA/AC, ANSWER
S,Y:  0000400     LOGICAL ANSWER
S,Y:  0000500     DATA AB(1)/.007/,AB(2)/71.1/,AB(3)/8200.0/,AC/3*.88/,-
                  .ANSWER/.TRUE./
```

The period preceding ANSWER is the continuation character and is therefore not part of the statement.

```
S,Y:  0000600     END
```

Your program initializes data for labeled common blocks XY and EXTRA.

```
SYS:
```

The system informs you of the satisfactory completion of the compilation.

```
S,Y:  PRINT LIST.BLKDATA8(0),PRTSP=EDIT
SYS:
```

The system acknowledges your PRINT command and informs you of the batch sequence number it has assigned to the printing task.

```
S,Y:  DEFAULT LPCXPRSS=Y
```

You indicate that you want the language processor "express mode" enabled. In express mode, several modules can be compiled in succession; the FTN command is issued for the first compilation, and only the module name is entered for succeeding compilations.

```
S,Y:  FTN MAIN8,STORED=Y
SYS:
```

The system informs you of the satisfactory completion of the compilation and requests the name of the next module to be compiled.

```
S,Y:  SUBR8
```

You enter the name of the next module to be compiled.

```
SYS:
```

The system informs you of the satisfactory completion of the compilation.

```
  Y:  _PRINT LIST.MAIN8(0),,,EDIT
SYS:
```

You enter a PRINT command preceded by a command system break character so that the system will interpret the line as a command. Express mode is turned off, and the system interprets the line as a command. The system acknowledges your PRINT command and informs you of the batch sequence number it has assigned to the printing task.

```
S,Y:  PRINT LIST.SUBR8(0),PRTSP=EDIT
SYS:  BSN=0569
```

The system acknowledges by issuing the batch sequence number of the PRINT job.

```
S,Y:  LOAD BLKDATA8
```

A block data subprogram is the only program you are required to load. Main programs and subroutines they refer to are automatically loaded when you issue the RUN command.

```
SYS:
```

The system informs you that it has loaded BLKDATA8.
You must load the block data program prior to executing the main program.

```
S,Y:  CALL MAIN8
```

Because you did not supply a DDEF for your WRITE statement in MAIN8, the output is received at your terminal.

```
PGM:  2048 VARIATIONS TRIED.
      ANSWER IS   F
SYS:   TERMINATED:  STOP
S,Y:  ERASE SOURCE.BLKDATA8
```

You decide to erase your source data set. You retain your cataloged job library, LIBA, containing the three new object modules.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 9: Use of PCS Immediate Statements

In this example, you are executing a program for the first time. Since the program control system (PCS) provides complete debugging capability at execution time, you have not included any debugging aids in your compiled program. Anticipating the use of PCS, you requested an ISD when the source program was compiled.

```
S,Y:  DDEF DEFJOB1,VP,JOB1,OPTION=JOBLIB,DISP=OLD
```

This command defines a job library JOB1, which contains the object module, MAIN9. JOB1 has been previously cataloged, but you must give this data definition to make it available. Note that you did not have to specify DISP=OLD explicitly because JOB1 was previously cataloged and the system defaults OLD in this case.

```
S,Y:  CALL MAIN9
YOU:  (press attention button)
```

You begin to run the program you wish to debug and then halt execution by pressing the attention button. The appearance of an exclamation mark indicates the system's readiness to accept new commands.

```
SYS:
YOU:  QUALIFY MAIN9
```

After issuing this command, you can refer to internal symbols without the qualifying module name; they will be qualified automatically by the prefix "MAIN9."

```
S,Y:  STOP
SYS:  STOP AT MAIN9.86(4) PSW 2 0 0 004A3C12
```

The STOP command displays the FORTRAN statement number where the interrupt occurred, or, if the statement is not numbered, the most recent number plus an increment. In this case the (4) indicates that the interrupt occurred during execution of the third executable statement after statement number 86. The rightmost field of the PSW gives the virtual storage address of the next instruction to be executed. See Appendix B for more PCS information.

```
S,Y:  LINE?  SOURCE.MAIN9,(1200,1400)
SYS:  0001200 7      ANGLEB=ANGLE1-ANGLE2
      0001300 86     ALPHA=COS(ANGLEA)
      0001400        BETA=SIN(ANGLEB)
```

You request a printout of source lines 1200 to 1400 which you believe include statement number 86. (Note the distinction between line numbers, which are not part of the program, and statement numbers, which are.) To obtain a printout of the current values of the variables ALPHA and BETA, you issue a DISPLAY command.

```
S,Y:  DISPLAY ALPHA, BETA
SYS:  ALPHA=+.17751984E+00
      BETA=+.00000000E+00
S,Y:  SET BETA=1.0
```

Since you previously issued a QUALIFY command for MAIN9, you specify only the internal names of the variables. Using this new information, you decide to change the value of a key variable to determine if the program will run to successful completion. You change the value of BETA and the system informs you of the new value.

```
S,Y:  GO
```

You next enter a GO command. It causes execution to resume from the point of interruption.

```
SYS:   TERMINATED:  STOP
```

The program runs to completion.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.
Alterations you made with PCS commands exist in your program only while it is executing in virtual storage.

Since PCS alterations do not affect your object module, permanent changes should be made by modifying the source statements and then recompiling.

Example 10: Use of PCS Dynamic Statements

In this example, you use some of the more powerful commands of PCS. PCS provides trace facilities, conditional program interruptions and modification of variables, and dumps. After logging on, you issue:

```
S,Y:  DDEF DDCURR,VP,CURRENT,OPTION=JOBLIB
```

This DDEF command causes your job library CURRENT to be placed at the top of your program library list. CURRENT has been previously cataloged and contains compiled object modules.

```
S,Y:  ERASE PCSOUT10
S,Y:  DDEF PCSOUT,VI,PCSOUT10
```

The DDEF command defines the data set that will be filled by the PCS DUMP command; the data set can later be printed. It requires the data definition name PCSOUT and virtual index sequential (VI) organization. You name the data set PCSOUT10. You precede the DDEF command with an ERASE command to ensure that PCSOUT10 does not contain any data before the DUMP command is issued.

```
S,Y:  LINE?  SOURCE.MAIN10,2100,2700,3200
SYS:  0002100      A=ATAN(Y)
      0002700 101  VAR=A**2
      0003200 210  GO TO(301,302,303,304),J
```

You decide to display three of your source statements in MAIN10, which has been previously compiled and cataloged. With the compilation, you had requested an internal symbol dictionary (ISD).

```
S,Y:  LOAD MAIN10
SYS:
```

The system informs you that it has loaded MAIN10.
In addition to its use for loading block data subprograms, you must use the LOAD command if you wish to enter a PCS statement before execution begins. Since the LOAD command does not initiate execution, you must eventually issue a GO or RUN command.

```
S,Y:  QUALIFY MAIN10
```

The QUALIFY command enables you to designate, before referring to a group of internal names, the module in which these names are defined; thereafter, you may refer to these names without explicitly qualifying them by module name.

```
S,Y:  AT 101; IF A>B & J=1; SET X=1.0
SYS:  00001
```

This AT command will cause a message to be printed on SYSOUT when execution of MAIN10 reaches statement number 101 and the IF condition is true. In addition, the IF and SET commands will cause the following: if A is greater than B at that time, and J is equal to 1, then X will be set to 1. Execution will then proceed.

The system assigns a number to each command containing an AT statement (here 1) that can be used later for removing the statement.

```
S,Y:  AT 210 STOP
SYS:  00002
```

You also request that execution be stopped when it reaches statement number 210. Without the QUALIFY command you would have had to write MAIN10.101 in the first AT and MAIN10.210 in this one.

```
S,Y:  MAIN10
SYS:  AT MAIN10.101 PSW 3 0 0 005F2AB0  1
      STOP AT MAIN10.210 PSW 4 0 0 0067D238 2
```

You execute the program. Your IF condition is fulfilled, X is set equal to 1, and your program stops at statement 210. If the IF condition were not satisfied, the SET would not be performed and you would not receive the X= printout. The number 1 appearing at the end of the PSW output is the PCS statement number assigned by the system.

```
S,Y:  DUMP MAIN10#C, MAIN10#P
```

You request a formatted dump of MAIN10's CSECT and PSECT. It will be written in the PCSOUT10 data set that you defined earlier.

```
S,Y:  RELEASE PCSOUT
```

If you wish to print the data set during this session, you must first issue a RELEASE command for its data definition. This causes the data set to be closed.

```
S,Y:  PRINT PCSOUT10,ERASE=Y
```

The data set will be erased after it is printed.

```
SYS:
```

The system acknowledges your PRINT command.

```
S,Y:  REMOVE 1,2
```

This command deletes the previously issued PCS statements that include AT commands.

```
S,Y:  GO
```

You now resume execution of your program.

```
SYS:   TERMINATED:  STOP
S,Y:  LOGOFF
```

The program runs to completion, and you logoff.

```
SYS:
```

The system confirms your LOGOFF command.

Alterations made to your program with the PCS commands (SET, AT) exist only in virtual storage. To make **permanent** changes to a program, reassemble from an altered source data set. This causes the changes to be incorporated into the object module, which you would then load.

Changes you make with the SET command remain in effect as long as the program is loaded. (By contrast, all AT commands in **any** of your programs are completely removed if you implicitly or explicitly unload a module that is referred to by any AT command.)

Logging off causes all of your programs to be unloaded from virtual storage.

Example 11: Input and Output on Tape

In the previous examples, all of your data sets resided on direct-access devices (disks) which were assigned to public storage. In this example, your data sets reside on tapes, which are always private volumes.

You will run a previously-compiled program that reads a data set from a labeled tape and processes the input data. Then it writes a new data set on another tape. After logging on, you issue:

```
S,Y:  DDEF FT01F001,PS,SAMPLE01
```

This command defines the data set that your program is to read. Since it is cataloged, you need enter only these parameters. Omitted information about the data set's characteristics (record format, record length, organization) will be obtained from the tape label that was created by the system when the data set was written. Information about the volume on which the data set resides (9-track tape, private, volume serial number, etc.) will be provided from the catalog entry.

```
SYS:
```

The system will inform you that the task is waiting for volume mounting. You will be informed by the system when the wait is over.

```
S,Y:  DDEF FT02F001,PS,RESULT01,-
      UNIT=(TA,9),LABEL=(,SL),VOLUME=(PRIVATE)
```

Here you define your output data set. It is not yet written, and is not cataloged, so you must supply all the necessary DDEF parameters.

Because it is not yet written, the disposition field is defaulted to NEW. The data set is to have physical sequential (PS) organization, is to reside on a 9-track tape, and is to be provided standard labels (SL) by the system.

By omitting the DCB field, you select the default options of variable length and unblocked records. You do not specify the volume serial number in the VOLUME field, so the system instructs the operator to choose a tape reel from the installation pool. (Refer to Appendix E for further details on specifying DDEF parameters.)

```
SYS:
```

The system will inform you that the task is waiting for volume mounting. Again you must wait until the tape is mounted.

```
S,Y:  CALL MAIN11
```

You execute your object program, which was stored in your USERLIB.

MAIN11 has the following significant I/O and related statements.

```
      .
      .
      .
      DIMENSION SAMPLE(250),RESULT(250)
10    FORMAT (250A4)
      .
      .
      .
100   READ (1,10,END=900, ERR=800)SAMPLE
      .
      .
      .
      CALL TRNFRM (SAMPLE,RESULT,250)
      .
      .
      .
```

```
      WRITE (2,10) RESULT
      .
      .
      .
      GO TO 100
800   .
      .
      .
      GO TO 100
900   ENDFILE 2
      STOP
      .
      .
      .
      END
```

SYS: TERMINATED: STOP

Your program concludes.

S,Y: CATALOG RESULT01,STATE=N,ACC=R

This command causes your output data set to be cataloged, thus recording its characteristics and volume serial number in the catalog. You will still have to issue a DDEF command in order to use this data set in a later session, but the system will retrieve its characteristics from the catalog, so at a later session, a DDEF of the following form will suffice:

DDEF ddname,,DSNAME=RESULT01

The N indicates that the catalog entry is new (data set not currently cataloged). You want to protect this new data set from accidental destruction in a later session so you restrict the access to read only (R).

S,Y: LOGOFF
SYS:

The system confirms your log-off request.
The private volumes (your two tapes) are demounted by the operator, and retained at the installation.

This example can be run only in conversational mode. To run it nonconversationally, you would omit from the LOGON command your password, which is only used conversationally, and add another command: SECURE (TA=2,9).

SECURE must appear immediately after the LOGON command. It would inform the system of device requirements (here, two 9-track tape units) prior to execution of the nonconversational task. Such tasks are described in later examples.

Example 12: Conversational Initiation of Nonconversational Tasks

It is often more convenient to have your programs run after you have left the terminal, that is, to have them run in nonconversational mode. Two ways of doing this after logging on are shown in this example.

In Part 1, you begin your task conversationally and then use the BACK command to switch its execution to the nonconversational mode.

In Part 2, you construct a nonconversational task and then use the EXECUTE command to cause it to be executed at a later time.

Part 1: The BACK Command

```
S,Y:  DATA PROC12A
```

With this command you build the SYSIN data set (named PROC12A) that will provide input to your task after you have switched to the nonconversational mode. You do not need to issue a DDEF command for the data set created by a DATA command. By default, the data set organization is VS.

```
S,Y:  #DDEF FT09F001,VS,SPRING
S,Y:  #CALL MAIN12
```

The system prompts (with #) for the first command to be executed in your nonconversational task. This DDEF command defines the new data set for data set reference number 9. It is to reside on public storage and is therefore automatically cataloged for you.

MAIN12 contains a "READ(1,m) list" and a "WRITE(9,n) list" statement. You omit a data definition for data set reference number 1 because you will provide input data in PROC12A, which will be used as SYSIN.

```
S,Y:  #(enter data to be read by MAIN12)
        .
        .
        .
```

The DATA command accepts each line as a string of characters. Any mistakes you make while creating this data set will not be detected until the BACK command is executed.

```
S,Y:  #%END
```

When %END is read from SYSIN, it indicates the end of data to your program.

```
S,Y:  #LOGOFF
S,Y:  #%E
```

With the %E you indicate that your data set is complete. Now you are prompted with an underscore.

```
S,Y:  BACK PROC12A
SYS:
```

The system informs you that your BACK command has been accepted.
Your BACK command has been accepted and the task will be continued immediately as a nonconversational task beginning with the DDEF command. (Note that DDEF commands for **private** volumes must be given prior to issuing the BACK command.) Should you wish to cancel the task you would issue a CANCEL command which specified the batch sequence number.

Now you can depart and let the task run, since PROC12A is now its SYSIN and includes a LOGOFF command for task termination. If you wish to initiate another task, you must log on again.

The BACK command may not complete its operation if the attention key is depressed shortly after issuing the command. The result is a nonconversational task still connected to a terminal. Wait a few seconds before initiating logon procedures.

```
S,Y:  DATA PROC12B
S,Y:  #LOGON ADUSERID,,,ADACC29
```

The LOGON command is the only difference between this and the PROC12A SYSIN data set created in Part 1. Since the task whose commands and data are stored in PROC12B will be run later instead of being continued, you must provide a LOGON command.

Note that a nonconversational LOGON omits the password. The remainder of PROC12B is the same as in Part 1.

```
S,Y:  DDEF FT09F001,VS,SPRING
S,Y:  #CALL MAIN12  (same program as in Part 1)
S,Y:  # (enter data to be read by MAIN12)
            .
            .
            .
S,Y:  #%END
S,Y:  #LOGOFF
S,Y:  #%E
S,Y:  EXECUTE PROC12B
SYS:
```

The system informs you that your EXECUTE command has been accepted.
Your request for a nonconversational task has been accepted by the system, and will be executed when system resources are available. The SYSOUT of this task will consist of system messages and any output to SYSOUT generated by your executing programs.

Because the terminal is active (you are still logged on) after an EXECUTE is issued, another command sequence can be entered. In fact, another sequence similar to the one illustrated could be issued to create other tasks.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 13: Preparing a Job for Nonconversational Processing

In this example, you put a series of commands and input data on cards. You will subsequently send them directly to the installation operator, who will store the information from the cards into a data set. The data set will then become the SYSIN for a nonconversational task (described in the cards) and will be queued for execution.

CARDS

```
  LOGON ADUSERID,,,ADACCT29
```

When entered on a card, the LOGON command must start in the **third** card column, and the first two columns must be blank. All the required LOGON parameters must be included in the same card. The password is not used.

```
DDEF   DDNAME=SCRATCH,VP,SCRATCH,OPTION=JOBLIB
```

The command will define a new JOBLIB on which to store the object module to be created by the compiler. SCRATCH will automatically be cataloged for you by the system.

```
FTN    MAIN13,LISTDS=Y
```

Here you use the LISTDS operand, which works only in nonconversational tasks. (If used in a conversational task, it is ignored.) By specifying LISTDS=Y, you cause the listing to be placed in the list data set, as in conversational tasks. If you did not specify LISTDS=Y, the listing would be printed automatically; then it would no longer exist in the system.

Your source statements follow. Note that the requirements for direct input of a FORTRAN source program at the terminal keyboard and on cards are not the same; here you must conform to FORTRAN source coding format. This is discussed more fully in Appendix A.

Your source program, SOURCE.MAIN13, will automatically be cataloged for you by the system.

```
       READ(5,10)A
10     FORMAT (F6.2)
       ATC=A*3.141
       WRITE(6,10)A,ATC
       STOP
       END
```

After compilation, the object module will reside on the library at the top of your program library list, in this case, the job library SCRATCH. You do not issue a PRINT command in this task. However, the listing data set procedure is retained as the latest generation of LIST.MAIN13, and you can later print it if you wish by issuing the following command: PRINT LIST.MAIN13(0),,, EDIT.

```
CALL MAIN13
```

This command will initiate execution of your newly compiled module.

```
099.70
```

This card contains your object time data.

```
%END
```

The %END will signal the end of the program data. The % character must be in column 1 of the card. This card must immediately follow the last input data card. This card activates the "END=" option on a READ statement, if you have used it in your program; if you have not, it initiates proper termination of the program execution when a READ is executed after the end of data has been reached. If your program depends on either of the above, and you have omitted the %END card, your program will read the subsequent commands as SYSIN data, producing abnormal results.

```
  LOGOFF
```

Enter LOGOFF beginning in column 3.

Three things in particular should be kept in mind when preparing a deck of cards for processing:

1. Although the positioning of characters when typed in directly can be "free form," the positioning on cards is more closely fixed.
2. Any errors in preparing the deck will probably terminate the task, since the system cannot prompt you for corrections.
3. The "modifications" and "continue" compilation prompts will not occur, so no Y or N responses should be specified.

Example 14: Storing DDEF Commands for Later Use

In Part 1 of this example you create a data set containing DDEF commands for frequently used data sets. In Part 2 you cause them to be issued with a CDD (call data definition) command. After logging on, you issue:

Part 1: Storing DDEF Commands

```
S,Y:  DATA DDPACK.MAIN14,RTYPE=I,BASE=1000,INCR=400
```

The DATA command can be used to store any kind of information that can be transmitted through the terminal. Here you are going to use it to store your DDEF commands in a data set you name DDPACK.MAIN14. The commands are stored as character strings but are interpreted as commands when they are later retrieved with the CDD command.

The I specifies that the data set is to be indexed. The first line number is to be 1000, and succeeding line numbers are to be incremented by 400. Default values for each of these parameters is 100.

The data set, DDPACK.MAIN14, is automatically cataloged for you by the system.

```
S,Y:  0001000 DDEF YOURLIB,VP,MAINPGMS,OPTION=JOBLIB
```

The system prompts you for each line with a line number. You enter the first DDEF to be stored. It is for the cataloged job library that contains your compiled program to be run, MAIN14.

The DDEFs do not have to be stored in any special order in the data set, but their ddnames must be unique.

```
S,Y:  0001400 DDEF FT01F001,VS,IN14
```

Data set reference number 1, input for MAIN14, has been cataloged in an earlier session under the name IN14.

```
S,Y:  0001800 DDEF FT09F001,PS,DATA,UNIT=(TA,9),LABEL=,-
S,Y:  0002200 (,SL),VOLUME=(,012170)
```

MAIN14 also expects input on data set reference number 9 from an uncataloged data set residing on tape 012170. Note the use of hyphen to continue the command on the next line.

```
S,Y:  0002600 DDEF FT51F001,VS,OUTPUT.MAIN14
```

Since MAIN14 output will be too large to be conveniently printed at the terminal, this cataloged data set is to be defined to hold it.

```
S,Y:  0003000 %E
```

The %E indicates that input to the DATA command is complete.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.
Your program, MAIN14, and its associated DDEF commands are ready for use. You now check them out, to be sure there are no errors.

Part 2: Retrieving Stored DDEF Commands

After logging on, you issue:

```
S,Y:  CDD DDPACK.MAIN14,YOURLIB
```

You cause the DDEF that defines your job library to be issued.

```
SYS:  0000, DDEF YOURLIB,VP,MAINPGMS,OPTION=JOBLIB
```

The system executes the specified DDEF command, prefixing four zeros to distinguish it on your SYSOUT listing from those DDEF commands entered directly through SYSIN. Any diagnostic would be printed at this point, as the system is now analyzing the character string as a DDEF command.

```
S,Y:  CDD DDPACK.MAIN14,(FT01F001,FT09F001,FT51F001)
```

This command causes it and all the remaining data definitions to be executed. You may enter any number of ddnames. Omitting this parameter causes all the DDEF commands to be executed.

```
SYS:  0000 DDEF FT01F001,VS,IN14
      0000 DDEF FT09F001,PS,DATA
      UNIT=(TA,9),LABEL=(,SL),VOLUME=(,012170)
SYS:
```

The system informs you that it is waiting for volume mounting.
You must wait until the operator mounts your tape.

```
SYS:
```

The system informs you that the task is now proceeding and the wait is over.

```
SYS:  0000 DDEF FT51F001,VS,OUTPUT.MAIN14
```

You begin execution of a program.

```
S,Y:  CALL MAIN14
SYS:  TERMINATED:  STOP
```

Execution of your program is complete. The output of MAIN14 went to the data set OUTPUT.MAIN14.

```
S,Y:  PRINT OUTPUT.MAIN14,PRTSP=EDIT
SYS:
```

The system acknowledges your PRINT command.

```
S,Y:  LOGOFF

SYS:
```

The system confirms your LOGOFF command.
The following card deck is all you need to run this task nonconversationally.

CARDS

```
LOGON ADUSERID,,,ADACCT29
SECURE (TA=1,9)
CDD DSNAME=DDPACK.MAIN14
RUN LOC=MAIN14
PRINT OUTPUT.MAIN14,PRTSP=EDIT
LOGOFF
```

Example 15: References to Subroutines

In this example you run two programs, MAIN15 and MAINXV, each having references to other programs. After MAIN15 is loaded, a diagnostic warns you of an undefined reference. You ignore it and execute anyway. After MAINXV is loaded, a diagnostic warns you of an undefined reference in a program called by MAINXV. In this case you resolve the reference before executing. After logging on, you issue:

```
S,Y:  CALL MAIN15
```

The CALL command causes the system to load the specified object module and to initiate its execution. During loading, the loader attempts to resolve any external references by searching the libraries in the program library list and loading those modules with definitions that satisfy the references. These new modules may in turn have references to other modules.

```
SYS:  *****UNDEFINED REF (ACLRTN) IN MODULE (MAIN15).ADDRESS FFFFF000 ASSIGNED
      F025 MAIN15 ERROR IN LOADING MODULE
      F002 STATEMENT REJECTED
```

Here a diagnostic is issued because the loader could not resolve a CALL for ACLRTN. It assigns an invalid address that will cause an interrupt if it is executed. Since you are certain that in this case the actual execution flow of MAIN15 will not go through the CALL on ACLRTN, you decide to go ahead and execute.

```
S,Y:  GO
```

You issue a GO command, but the system merely prints an underscore.

```
S,Y:  CALL MAIN15
```

You then issue the CALL command with the required module name. This must be done after the occurence of the F002 diagnostic.

```
SYS:  TERMINATED:  STOP
```

Your program runs to completion. ACLRTN was not called during execution. If it had been, an invalid address diagnostic would have appeared and an abnormal task termination would have followed.
Now you want to run MAINXV. You have to decide whether or not to unload MAIN15. If you don't unload it, any programs already loaded for MAIN15 that MAINXV also uses will not have to be reloaded, thereby saving some time. On the other hand, if the programs are not unloaded and then reloaded, the loader will not be able to check their references, and any unresolved references they might have will go undetected. To be safe, you unload MAIN15.

```
S,Y:  UNLOAD MAIN15
```

MAIN15 and any other modules that were loaded because of references from it are unloaded.

```
S,Y:  CALL MAINXV
```

Now you initiate the loading and execution of MAINXV.

```
SYS:  *****UNDEFINED REF (PRESSR) IN MODULE (THRUST44) .ADDRESS FFFF0000 ASSIGNED
      F025 THRUST44 ERROR IN LOADING MODULE.
      F002 STATEMENT REJECTED.
```

THRUST44 was loaded because of a CALL to it from MAINXV.
THRUST44 in turn contained a CALL to PRESSR, which could not be located after a search of all the libraries on the program library list. You remember that a job library named ROCKETS has an object module which contains a definition for PRESSR.

```
S,Y:  DDEF MYLIBE,VP,ROCKETS,OPTION=JOBLIB,DISP=OLD
```

You issue a DDEF for the library ROCKETS to put it at the top of the program library list.

```
S,Y:  UNLOAD MAINXV
```

Then you unload MAINXV from virtual storage.

```
S,Y:  CALL MAINXV
```

Reloading MAINXV causes the loader to search the libraries in the program library list again and it resolves the CALL to PRESSR from the newly defined library and loads the module containing the definition of PRESSR.

```
SYS:  TERMINATED:  STOP
S,Y:  LOGOFF
```

After execution is complete, you log off.

```
SYS:
```

The system confirms your LOGOFF command.

Example 16: Entering Data for Later Use

In this example, you create two data sets, one containing a source program for compilation in a later session, the other containing data to be read by the program stored in the first data set. After logging on, you issue:

```
S,Y:  DATA SOURCE.ORBIT,I,2000,200
```

SOURCE.ORBIT is the name of the data set you are about to create. When the DATA command is used, the system automatically supplies a data definition. The qualifier "SOURCE" is needed because this data set is intended to be used as input to the FORTRAN compiler. In earlier examples, where source statements were entered after a FTN command, the source data set was created automatically and the qualifier, SOURCE, was attached by the system.

The I specifies that the data set is to be indexed. The first line number is to be 2000, and succeeding line numbers are to be incremented by 200. Default values for each of these parameters is 100.

The source data set, SOURCE.ORBIT, is automatically cataloged for you by the system.

```
S,Y:  0002000C     ORBIT CALCULATIONS,HIGH ECCENTRICITY
```

The DATA command prompts for input by printing a line number. You enter a comment line (C in column 1). You may start typing immediately after the line number, or use a tab stop to format the terminal printing of your input. The tab stop may be set at this time. When setting your tab stop, you should issue a line cancellation (a pound sign at the end of the line) to cancel any of the spurious characters (tab, space, etc.) that were generated when you set your tab.

```
S,Y:  0002200       DIMENSION A(100,100),B(1000)
```

```
S,Y:  0002400       REED (5,10)A
```

You notice you made a mistake in line 2400.
Since the line has not yet been completed (you have not pressed the return key) you cancel the line by using the # sign. You then tab over and enter the correct line.

```
YOU:                READ (5,10)A
S,Y:  000260020     FORMAT (19H PERTUBAT
                                RBATION TABLE)
```

You make another error, but this time you correct only the part in error. You backspace 3 times, cancelling BAT, move the paper up once manually to avoid overtyping, and continue the line correctly.

```
S,Y:  0002800       CALL THRUST(A,B)
S,Y:  0003000%2200,      DIMENSION A(100,100),B(1000)
```

You notice another misspelling made earlier and decide to correct it by replacement. The percent sign in the first typeable position has a special meaning to DATA when of the form: %line number. It means that an insertion or replacement is to be made. If the line number specified already exists, a replacement by the character string following the comma will be made. If the line number falls numerically between two existing ones, an insertion will be made at that point.

In this correction and in the one after the next, the tab stop cannot be used because of the double line numbers. Therefore, to maintain uniformity for future printouts of your source data set, you enter six spaces between the comma and the source statement.

```
S,Y:  0003000       WRITE (6,10)B
```

The correction is made and you are again prompted for line 3000.

```
S,Y:  0003200%2700,30     FORMAT(E13.6)
```

Instead of entering a line for 3200, you insert a new line between 2600 and 2800.

```
S,Y:  0003200
          •
          •
          •
S,Y:  000700010 FORMAT (1X,2F10.6)
```

When entering your VS input data for your program via the DATA command (see below), the system places a keyboard-card character for internal use prior to each FORTRAN record. In this example, then, your FORMAT statement must include an X specification to skip one character for each record to be read so that your program will skip over the unwanted system character.

```
S,Y:  0007200%D,2600
```

The %D deletes line number 2600 from the data set. If a range of lines is to be deleted, two line numbers are specified; the first line number must be lower than the second.

```
S,Y:  0007200       END
S,Y:  0007400%E
```

The %E indicates to the DATA command that your data set is complete.

```
S,Y:  DATA TELEM001
```

You enter another DATA command, this time defaulting to no index, which means you will create a virtual sequential (VS) data set. This data is to be read by the program you just entered. Because this data set also resides on public storage, the system automatically catalogs TELEM001 for you at this time.

```
S,Y:  #099.900000-08.732460
S,Y:  #093.247650-01.178940
              •
              •
              •
```

When a sequential data set is specified, line numbers do not appear; instead the system prompts you for each line with the number sign. The tab key has not been used in entering this data because it would then not be compatible with the input FORMAT statement in ORBIT. Since a special character code is transmitted each time the tab is depressed, allowance for use of the tab key would have to be made when writing the FORMAT statement by using the X specification to skip one character for each time you planned to press the tab key.

```
S,Y:  #%E
S,Y:  RET TELEM001,PR
```

When a data set with virtual organization residing in public storage is automatically cataloged for you, the system creates a new catalog entry and assigns an access qualifier of "unlimited" (read/write) to the data set.

You wish to change the system assigned access qualifier because this data set contains important information which you do not want accidentally destroyed. You therefore issue a RET command giving the data set name TELEM001. The operand after the data set name specifiies the data set is to reside on permanent storage and have the read-only attribute.

```
S,Y:  LINE? SOURCE.ORBIT,(2000,7400)
```

To check on the corrections made while entering your source statements, you use this command to print the contents of the data set you have just created. You specify the first and the last lines to cause the printing of the entire data set.

```
SYS:  0002000 C     ORBIT CALCULATIONS, HIGH ECCENTRICITY
      0002200       DIMENSION A(100,100),B(1000)
      0002400       READ (5,10)A
      0002700 30    FORMAT(E13.6)
      0002800       CALL THRUST(A,B)
      0003000       WRITE(6,10)B
      0003200
                    .
                    .
                    .
      0007000 10    FORMAT(2F10.6)
      0007200       END
      D334 LAST LINE IN MEMBER OR DS IS 7200
      0007200       END
SYS:
```

The system informs you that the last line of the data set is line numbered 0007200. The space between the line numbers and the source statements is created by the system. It indicates that the lines were originally entered from a terminal keyboard. Lines entered from the terminal card reader are indicated by a C in that space.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Tab stops were used to make the terminal printout format resemble FORTRAN source card format. Note that, just because your terminal printout format looks like card images, it does not mean that cards punched from this data set can be used as FORTRAN source input. In this example they cannot. For a further discussion of punching source cards from a data set prepared at the terminal, see Appendix A.

Example 17: Data Set Considerations When Interrupting a FORTRAN Execution

In this example, you run a program that uses a data set on a private disk as input. When execution begins, you realize you have specified the wrong data set. To start over you release the data set and unload your program. You then run with the correct data set. After logging on, you issue:

```
S,Y:  DDEF FT11F001,VS,RESULT01,OLD
```

This command defines the data set that provides input to your MAIN17 program. DCB subparameters are not required for existing data sets on direct-access devices, since the data set characteristics were recorded with the data set itself when the data set was created.

```
SYS:
```

The system informs you that the task is waiting for volume mounting. You must wait for the operator to mount your disk.

```
S,Y:  DDEF FT05F001,VS,TABLE001
```

This command defines a new data set on public storage that is to contain some of your program output. It is automatically cataloged for you by the system.

```
S,Y:  CALL MAIN17
          .
          .
          .
```

You default data set reference number 1, which was referred to in MAIN17, to SYSOUT (terminal).

```
PGM:          FIRST RECORD OF TEST RESULTS SHOWS
                  DATE OF TEST — 11/17/69
                  LOCATION A
                ALTITUDE RANGE  20000.0 TO 30000.0
```

This is some of the output from MAIN17.

```
YOU:  (press attention button)
```

Realizing that you have specified the wrong data set and volume number in your DDEF command, you stop execution of MAIN17 by pressing the attention button.

```
SYS:
S,Y:  UNLOAD MAIN17
```

You make sure that all your data sets are closed. Remember that the data set TABLE001 was to be created during this run. If some output had gone to this data set before you pressed the attention button, and another RUN MAIN17 was issued without unloading, whatever had been written in TABLE001 would be left there after restart.

```
S,Y:  RELEASE FT11F001
```

This command releases the DDEF command previously issued. You must issue it before the FT11F001 data definition can be repeated for another data set.

```
S,Y:  DDEF FT11F001,VS,RESULT02,OLD
```

You define what you believe to be the correct data set.

```
SYS:
```

The system informs you that the task is waiting for volume mounting. After being notified that the operator has mounted disk number 012237, you again execute your program.

```
S,Y:  CALL MAIN17
            .
            .
            .
```

You default data set reference number 1, which was referred to in MAIN17, to SYSOUT (terminal).

```
PGM:            FIRST RECORD OF TEST RESULTS SHOWS
                    DATE OF TEST — 11/23/69
                    LOCATION  B
                  ALTITUDE RANGE  5012.9 TO 6492.3
```

Everything now appears to be all right, so you allow execution to proceed to the exit message and underscore.

```
SYS:  TERMINATED:  STOP
S,Y:  LOGOFF
```

The system confirms your LOGOFF command.

Example 18: Sharing Data Sets

This example shows how data sets can be shared by several users of the system. Part 1 shows a session during which another user makes one of his data sets available to you. Part 2 shows how you copy the data set so that you can make changes to it.

Part 1: Permitting Access to a Data Set

After logging on, user ABPALID issues:

```
S,U:  PERMIT DATA,USERID=ADUSERID,ACCESS=RO
```

He makes available to you his cataloged data set DATA with read-only access point.

```
S,U:  RET DATA,R
```

He changes his own access to DATA to read-only.

```
S,U:  DDEF FT01F001,VS,DATA
```

The user defines data set DATA for his new task; he now has read-only access to it.

```
S,U:  PROG1
```

He executes PROG1, a program that uses data set DATA.

```
USR:  LOGOFF
SYS:
```

The system confirms his LOGOFF command.

Part 2: Accessing a Shared Data Set

After logging on, you issue:

```
S,Y:  SHARE DATA,USERID=ABPALID,OWNERDS=DATA
```

An entry will be created in your catalog for data set DATA. This command would have been rejected if the owner had not previously granted you access with the PERMIT command.

```
S,Y:  DDEF FT03FT001,VS,DATA
```

You issue a DDEF command defining DATA for your task.

```
S,Y:  PROG9
```

You can now execute PROG9, a program that uses data set DATA.

Note: FORTRAN I/O opens all virtual storage data sets for OUTPUT unless the data set is read-only; read-only data sets are opened for INPUT. If a shared data set is opened for OUTPUT, an interlock is set that prevents other users from having access to the data set until it is closed.

```
YOU:  LOGOFF
```

You must remember that if the owner erases or deletes one of his data sets which you share, its entry in your catalog is not removed. To remove the entry from your catalog, you must issue a DELETE command.

```
SYS:
```

The system confirms your LOGOFF command.

Example 19: Manipulation of Several Forms of a Program

In this example, you examine a previously cataloged program. Then you remove all forms of it from the system. After logging on, you issue:

```
S,Y:  LINE? SOURCE.MAIN19,(1,5000)
```

You would like to eliminate from the system any forms of a program named MAIN19 that you no longer need. You want to punch the source data set on cards, but first you must determine whether such cards can be used as compiler input. So you issue this command in order to examine the source data set.

```
SYS:
```

The system informs you that the first line number in the data set is 000100. The system then proceeds with the actual listing.

```
SYS:
      0000100CC THRUST CALCULATIONS FOR MK.1 ENGINE
      0000200CC WITH STANDARD ATMOSPHERE.
      0000300C        DIMENSION ATBL(10,1000),FORM(10)
      0000400C10      FORMAT (10F10.6)
      0000500C20      FORMAT (10A4,2I4)
      0000600C        READ (3,20)FORM,I,J
      0000700C        READ (3,FORM) (ATBL((II,JJ),II=1,I),JJ=1,J)
      0000800C        WRITE (4,10)ATBL(I,
YOU:  (press attention button)
```

Satisfied that the program is what you want, you terminate the LINE? command. The C following the line numbers indicates the statements were originally entered via a card reader. This means that, if you punch the source data set, the cards can later be used for compiler input. (See Appendix A for a more detailed description of compiler input format requirements.)

```
S,Y:  LINE? SOURCE.MAIN19,9999999
SYS:
```

The system issues the last line in the data set as: 0013700C END
In order to determine the size of the data set, you request the maximum possible line number. This causes the last line of a line data set to be printed.

```
S,Y:  PRINT SOURCE.MAIN19
```

This command causes the creation of a nonconversational task that will print the source data, and issues a batch sequence number for the nonconversational task.

```
SYS:  PRINT BSN=0375
```

The system acknowledges your PRINT command and assigns it a batch sequence number (BSN).

```
S,Y:  PUNCH SOURCE.MAIN19,STARTNO=9,ENDNO=88,ERASE=Y
```

You request the punching of the 9th through 88th characters of each record in your source data set. The first eight characters are the line number and the input key. The system creates a separate task that will perform the punching when system resources are available.

You had to use the ERASE option in the PUNCH command, rather than a separate ERASE command following it. The system will reject an ERASE command if the data set referred to has an associated print or punch task pending. Most likely the two tasks will be executed in the same order as they were entered. It is possible, however, that they actually will be executed in reverse order. If so, the ERASE option will be delayed until after the PRINT task has been completed. You should not insert the ERASE option until the last print or punch data command in any sequence which refers to the same data set. It is possible that the first one, for example the PRINT above, could be executed in less time than it takes to type in the next command; therefore the ERASE option on the PRINT command could take effect before the PUNCH task could be executed.

```
S,Y:  CANCEL 0375
```

You now decide that a listing of the source data set is superfluous (since you will have a source deck), so you cancel the printing task, referring to it by the batch sequence number.

```
S,Y:  ERASE LIST.MAIN19(-1)
```

Here you erase the generation that contains the earlier version of MAIN19.

```
S,Y:  ERASE LIST.MAIN19(0)
```

Here you remove the latest generation of LIST.MAIN19 which you created and cataloged when the program was compiled in an earlier session.

```
S,Y:  ERASE USERLIB(MAIN19)
```

This command erases the last form of this program, the object module produced during compilation.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 20: Terminal Input of a Pre-Punched Program for Compilation and Running

In this example, you use a terminal that has a card reader. You switch back and forth between terminal keyboard input and card input as you compile and execute a program.

You place a deck in your terminal card reader. LOGON and LOGOFF command cards must begin in column 3, and their first two columns must be blank. All other commands may begin in column 1.

CARDS

```
      FTN MAIN20,ISD=Y,LISTDS=Y
      C     MATRIX I/O AND MULTIPLY
            DIMENSION A(20),B(20),C(20),FORM(10)
      10    FORMAT (10A4,I3)
      15    READ(7,10)FORM,I
      20    READ(7,FORM,END=30)(A(J),J=1,I),(B(K),K=1,I)
            CALL MATMPY(A,B,C,I,I,I)
            WRITE(17,FORM)(C(J),J=1,I)
            GO TO 20
      30    STOP
            END
      PRINT LIST.MAIN20(0),PRTSP=EDIT
      KB    Return to keyboard
```

Source Statements

After logging on, you issue:

```
S,Y:  CB (press reader start button)
```

This causes SYSIN to be switched to the card reader for one card. You can do this any time the system is waiting for keyboard input if the desired cards are ready in the card reader.

Since the terminal is in send-receive mode, each card image is printed on the terminal as if it had been typed in at the keyboard.

```
CIP:  LOGON ADUSERID,MYPASS*,,ADACCT29
```

This is the card image printout (CIP). You supply the LOGON command from the card deck.

```
S,Y:  CB (press reader start button)
S,C:  FTN MAIN20,ISD=Y,LISTDS=Y
```

The system prompts for source statements by issuing a line number. It then reads the statements from the card reader.

```
S,C:  0000100C      MATRIX I/O AND MULTIPLY
S,C:  0000200       DIMENSION A(20),B(20),C(20),FORM(10)
S,C:  000030010     FORMAT (10A4,I3)
S,C:  000040015     READ(7,10)FORM,I
S,C:  000050020     READ(7,FORM,END=30)(A(J),J=1,I),(B(K),K=1,I)
S,C:  0000600       CALL MATMPY(A,B,C,I,I,I)
S,C:  0000700       WRITE(17,FORM)(C(J),J=1,I)
S,C:  0000800       GO TO 20
S,C:  000090030     STOP
S,C:  0001000       END
SYS:
YOU:  Y
```

Even though you selected the card reader, these responses must be entered from the keyboard. The system will automatically revert to the card reader after these prompts.

```
SYS:
```

The system informs you that there were no errors.

```
CIP:  PRINT LIST.MAIN20(0),PRTSP=EDIT
SYS:
```

The system acknowledges your PRINT command and assigns it a batch sequence number (BSN). For this example, assume a BSN of 0137.

```
CIP:  KB
```

The KB card is encountered, which switches control to the keyboard. The system's underscore prompt for a command is followed by the KB card image printout. This results in another prompt for a command.

```
S,Y:  CANCEL 0137
```

Since you do not now want to see the listings produced by the compiler, you cancel the task created to print them. Note that LIST.MAIN20(0) is cataloged for you in case you want to print it later.

```
S,Y:  CB
```

The system prompts you for input of data by unlocking the terminal keyboard. You have the following deck ready in the card reader and switch to card input by entering CB at the keyboard.

Your READ statement refers to data set reference number 7. Since you did not supply a DDEF for FT07F001, you default for terminal input.

CARDS

```
      CALL MAIN20
      (3F10.6)                                        003
      +03.600000-04.723000+07.245000
      -04.200000+09.000000+03.400000
      +05.       - 6.       +07.800000
      +35.       +01.300000-04.200000
      -07.600000+03.700000+83.0
      +11.100000-13.140000+17.8
      %END
      KB
```

Your program reads its input data from the card deck.

```
CIP:  CALL MAIN20
CIP:  (3F10.6)    003
CIP:  +03.600000-04.723000+07.245000
CIP:  -04.200000+09.000000+03.400000
PGM:  25.999969-61.210037 93.89157
```

You default the data set reference number 17 so that your output will be printed at the terminal.

```
CIP:  +05.       -6.       +07.800000
CIP:  +35.       +01.300000-04.200000
PGM:  54.431976116.639954 44.063965
CIP:  -07.600000+03.700000+83.0
CIP:  +11.100000-13.140000+17.8
PGM:  64.799973-77.759964101.087952
SYS:  CHCIW STOP
S,C:  KB
```

Your program concludes. The KB card causes SYSIN to be switched to the keyboard. You then log off.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 21: Intra-Task Carryovers

In this example, you prepare a deck for nonconversational processing, taking into account carryover of data definitions and COMMON blocks within the task. Your LOGON and LOGOFF commands begin in column 3; all other commands may begin in column one.

CARDS

```
LOGON ADUSERID,,,ADACCT29
```

LOGON command parameters must all be on one card. A task for nonconversational execution must be accurately prepared because most errors will cause premature termination of the task or will make the results useless. Note that you do not enter a password in nonconversational tasks.

```
SECURE (TA=3,9),(DA=1,2311)
```

The SECURE command is needed in all nonconversational tasks that use private volumes, in order to secure devices on which to mount them. This command requests three 9-track tape drives and one 2311 disk unit. Only two tapes will be used simultaneously; the need for securing three will be explained later in this example. If this command is omitted or an insufficient number of units are reserved, your task will be terminated upon execution of the first DDEF command that requests a private device that is not secured.

```
DDEF MYDISK,VP,MYLIBE,OPTION=JOBLIB
```

Since the data set MYLIBE is cataloged, the only parameters needed are those shown here.

```
DDEF FT01F001,PS,MYDATA0A,UNIT=(TA,9),VOLUME=(,324010), LABEL=(,SL)
```

This DDEF command and the next one include the additional parameters needed for uncataloged data sets. The first command refers to an existing volume. Data set characteristics will be obtained by the system from the label that was created when the data set was first written on your private volume. You specify that standard labels exist. Note the – in card column 72 signifying a continued command on cards. The next card starts in column 16.

```
DDEF FT02F001,PS,MYOUT00B,UNIT=(TA,9),VOLUME=(PRIVATE),-
DCB=(RECFM=F,LRECL=80),LABEL=(,SL)
```

This DDEF command defines a new data set that is to reside on a private volume. By specifying PRIVATE but omitting the volume serial number on the VOLUME parameter you indicate that you want the operator to provide a tape from the installation pool. With the LABEL parameter, you indicate that you want the system to create standard labels.

```
CALL MAIN21A
```

MAIN21A contains a "READ(1,n)list" statement that reads input from the data set MYDATA0A. It creates the new data set, MYOUT00B, with a "WRITE(2,n)list" statement.

The data set reference numbers 1 and 2, in the READ and WRITE statements, respectively, appear in the data definition names (i.e., FT01F001, FT02F001).

```
UNLOAD MAIN21A
```

Unloading a program once you are through with it is often essential to successful program execution. For example, MAIN21A and MAIN21B both have an unlabeled (blank) COMMON block. You are not sure which COMMON block is larger. If MAIN21B contains a larger COMMON block than MAIN21A, then you **may** encounter problems when you run MAIN21B because the loader will not allocate virtual storage for a new COMMON block if there is one already loaded from the RUN MAIN21A command. Since the loader allocates each unlabeled COMMON block extra pages of virtual storage, the larger COMMON block in MAIN21B may fit. If it does not, MAIN21B will probably be terminated because of an invalid address reference. Unloading MAIN12 also ensures that the data sets it refers to are closed.

```
CATALOG MYOUT00B,N
```

In order to store the volume serial number in the catalog, this command must precede the RELEASE command below. Because this is a new private volume you cannot know the volume serial number in advance. By cataloging you cause the system to record the assigned volume serial number in the catalog. You can then define the data set for a future session by supplying only the minimum parameters in the DDEF command. Although failure to catalog MYOUT00B at this point would not have caused erasure of MYOUT00B, it would have made it inaccessible during the rest of this task. In conversational mode the assigned volume serial number is printed out and can be used in a DDEF command later in the same session.

```
RELEASE FT01F001
```

The next program to be run, MAIN21B, will read the data set MYOUT00B with a statement of the form READ(1,n)list. This read statement will also require a DDEF command with a data definition name FT01F001. If another DDEF command named FT01F001 were issued at this time an ambiguity would result, since the data definition FT01F001 would refer to two different data sets. The system would detect the error, reject the command, and print a diagnostic message. Therefore, you issue this RELEASE command to make the data definition name, FT01F001, available for use with MYOUT00B. Releasing the data definition name also releases the data set name and any secured devices it used. The RELEASE command in this example relinquishes one of the secured tape drives to the system, leaving you with two.

```
DDEF FT01F001,,MYOUT00B,OLD
```

You are, in effect, moving the data set name MYOUT00B from data definition FT02F001 to FT01F001. There is no ambiguity because the system will remove the data set name MYOUT00B from the data definition FT02F001. The system is also cognizant of the volume in which the data set MYOUT00B is resident and that MYOUT00B has already been mounted on a secured device for this task.

```
DDEF FT02F001,PS,FINALOC,UNIT=(TA,9),VOLUME=(PRIVATE),-
DCB=(RECFM=FBA, LRECL=50,BLKSIZE=500), LABEL=(,SL)
```

The FT02F001 data definition was left without a data set name and is thus available for use. This DDEF command now makes use of it to define a new data set named FINALOC. The third secured tape unit (unused until now) will be used to mount the necessary private tape volume.

```
RUN MAIN21B
```

A "WRITE(2,n)list" statement in MAIN21B will create the data set FINALOC.

```
CATALOG FINALOC,N
```

This command will catalog FINALOC so that you need specify only the minimum parameters when you issue a DDEF command for it in a future session.

```
  LOGOFF
```

Example 22: Survey of System Facilities and Some Housekeeping Methods

In this example you do some housekeeping, erasing unwanted programs, and transferring a source program from public storage to tape. After logging on, you issue:

```
S,Y:  PC?
```

This command is used to present the name, access, and, for shared data sets, the owner's identification for one or more cataloged data sets. Since you do not specify any data set names here, information about all your cataloged data sets is presented.

```
SYS:  DATA SETS IN CATALOG WITH QUALIFIER ADUSERID
          ADUSERID.JOBLIBA, ACCESS:RW
          ADUSERID.LIST.MAINTEST(0),ACCESS:RW
          ADUSERID.M220UT, ACCESS:RO
          ADUSERID.PROJECT.A, ACCESS:RO
          ADUSERID.PROJECT.B, ACCESS:RO
          ADUSERID.PROJECT.C, ACCESS:RW
          ADUSERID.PROJECT.C2, ACCESS:RO
          ADUSERID.SOURCE.MATRIX7, ACCESS:RW
          ADUSERID.SOURCE.TRIALX, ACCESS:RW
          ADUSERID.VERSION5, ACCESS:RO,OWNER:MICHAELB
```

```
S,Y:  DSS? SOURCE.MATRIX7
```

You want more information about one of your cataloged data sets, so you issue a DSS? command. This command presents more detailed information than does the PC? command. If DSS? is specified without an operand, detailed status information for all your cataloged data sets is presented.

```
SYS:  ADUSERID.SOURCE.MATRIX7
      ACCESS: RW
      VOLUME: 232323 (2311)
      DS ORGANIZATION: VI      PAGES: 002
      REFERENCE DATE: 257/68   CHANGE DATE: 257/68
      RECORD FORMAT: V         RECORD LENGTH: 00132
      KEY LENGTH: 00007        RELATIVE KEY POSITION: 00004
```

```
S,Y:  ERASE SOURCE.MATRIX7
S,Y:  ERASE LIST.MAINTEST(0)
```

You decide to erase two of the foregoing data sets. You would like to examine one other data set before deciding whether to erase it.

```
S,Y:  LINE? SOURCE.TRIALX
SYS:  0000100 C TRIALX IS BASED ON FORMER TUBE TEST ROUTINE.
YOU:  (press attention button)
```

The first line printed out is sufficient for you to recognize this as an old program that you no longer need. You halt further printing by pressing the attention button. You erase it and another data set of numerical data associated with it.

```
S,Y:  ERASE SOURCE.TRIALX
S,Y:  ERASE PROJECT
SYS:
```

The system gives you the option of erasing (E) or retaining (R) the individual data set cataloged under the generic name PROJECT, or erasing all of them (A).

You decide to erase all but PROJECT.B.

```
SYS:  PROJECT.A
YOU:  E
SYS:  PROJECT.B
YOU:  R
SYS:  PROJECT.C
YOU:  A
```

By typing A, you cause the system to erase PROJECT.C and those data sets whose names would follow if prompting continued in this case, just PROJECT.C2).

```
S,Y:  ERASE VERSION5
```

The underscore indicates the end of PROJECT data sets, and you tell the system to dispose of another obsolete data set.

```
SYS:
```

The system informs you that VERSION5 is not yours to erase, and ignores your command.
VERSION5 is a shared data set for which you do not have unlimited access, which includes the right to erase.

```
S,Y:  DELETE VERSION5
```

The DELETE will remove only your catalog entry for VERSION5 but will not affect the data set itself or the owner's catalog.

```
S,Y:  POD? USERLIB
```

Now you request a list of each object module on your USERLIB.

```
SYS:  ZCOX001 START PRESENT POD DUMP
      MAIN7
      MAIN10
      SUBMATRX
      END OF PRESENT POD DUMP
S,Y:  ERASE USERLIB(MAIN7)
S,Y:  ERASE USERLIB(SUBMATRX)
```

Individual members of partitioned data set can be erased in this way without erasing the entire data set, in this case your USERLIB.

```
S,Y:  POD? JOBLIBA
```

This command can be used to obtain information about a library or any other VP data set.

```
SYS:  ZCOX001 START PRESENT POD DUMP
      PROG14
      MAIN12
        .
        .
        .
S,Y:  ERASE JOBLIBA
```

An entire library data set can be erased. In addition to erasing the data set, the ERASE command also removes the catalog entry, thus having the effect for cataloged data sets of ERASE and DELETE.

```
S,Y:  DDEF DD1,PS,TAPE.M220UT
```

You define the copy of the data set that will reside on tape.

```
S,Y:  WT M220UT,TAPE.M220UT,ERASE=Y
```

This command requests a nonconversational task to write the data set M22OUT on tape. The data set must be cataloged or defined for the current session. Several optional parameters are defaulted such as blocking factor, line spacing, etc., described fully in the *Command System User's Guide*. ERASE specifies that the data set is to be erased after completion of the WT task.

```
SYS:
```

The system informs you that your request has been accepted.
Your request for writing the tape has been accepted and assigned a separate task. The system will also inform you of the number of the tape onto which it was written.

You conclude your task.

```
S,Y:  USAGE
```

You enter the USAGE command to inquire about the amount of system resources you have used. Two totals are presented: 1) the amount resources used since LOGON, and 2) the total amount of resources used since you were joined.

The following resources are accounted for: permanent storage, temporary storage, direct-access devices, magnetic tapes, printers, card reader-punches, bulk input, bulk output, TSS/360 tasks, total time that your terminal was connected to the system, and CPU time used.

```
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 23: Generation Data Groups

In this example you create a generation data group (GDG) to store related data sets. Data sets are stored and cataloged in a GDG with a common set of qualifiers, the order the data sets are stored being used to identify each data set. In the three parts of this example, you create a GDG and refer to generations of it by both *relative* and *absolute* references.

Part 1: Creating a GDG

After logging on, you issue:

```
S,Y:  DDEF MYDISK,VP,MYLIBE,UNIT=(DA,2311),-
      VOLUME=(,230001),OPTION=JOBLIB,DISP=OLD
```

You define a job library that resides on a private disk. It contains the object module that you will execute during this task.

```
SYS:
```

The system informs you that the task is waiting for volume mounting. You must wait for the operator to mount your disk.

```
S,Y:  CATALOG GDG=TESTRSLT,GNO=5
```

This command creates a generation data group catalog entry. All data sets in this group will have the name TESTRSLT as their leftmost qualifier. The second parameter specifies that five data sets are to be retained in one group. When more than the specified number has been reached, the oldest generation of the group is erased.

```
S,Y:  DDEF FT01F001,PS,TESTDATA,-
      UNIT=(TA,9),VOLUME=(,230002),DISP=OLD,LABEL=(,SL)
SYS:
```

The system informs you that the task is waiting for volume mounting. You must wait for the operator to mount your tape.
The data set TESTDATA contains the input to the program, MAIN23, which creates the first generation of your GDG.

```
S,Y:  DDEF FT02F001,VS,TESTRSLT(+1)
```

The dsname in this data definition is a relative reference. Zero (0) refers to the most recent member, minus one (−1) to the one just prior to the latest, minus two (−2) to the one before that, etc. Your positive, nonzero reference (+1) indicates a future generation about to be created.

When the system has completed automatically cataloging TESTRSLT(+1), TESTRSLT(+1) will be known as TESTRSLT(0); when a new generation is entered into a GDG, all of the relative generation numbers are reduced by one. If there were a prior generation at this time, it would become (−1).

A data set which was written and cataloged during a previous session can be added to this GDG. You would simply use the CATALOG command to change the data set name to TESTRSLT(+1).

```
S,Y:  CALL MAIN23
SYS:  TERMINATED:  STOP
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Part 2: Relative Reference to a GDG Member

After logging on, you issue:

```
S,Y:  DDEF MYDISK,VP,MYLIB2,OPTION=JOBLIB,DISP=OLD
SYS:
```

The system informs you that the task is waiting for volume mounting. You must wait for the operator to mount your disk.
You request a different job library, containing a different version of the MAIN23 object module. Although it is on a private volume you need only the four parameters shown because it was cataloged. No indication is seen here of a volume serial number but it is possible that this volume could be the same as the one in Part 1.

```
S,Y:  DDEF FT01F001,VS,TESTRSLT(0),DISP=OLD
S,Y:  DDEF FT02F001,VS,TESTRSLT(+1)
```

This version of MAIN23 will take its input from the last GDG generation, and then will create the next GDG generation. Thus, the first DDEF command above defines the input of MAIN23 and the second defines the output data set to be stored as a new generation in the GDG established in Part 1.

```
S,Y:  CALL MAIN23
SYS:  TERMINATED:  STOP
S,Y:  LOGOFF
SYS:
```

The system confirms your log-off request.

Part 3: Absolute Reference to a GDG Member

After logging on, you issue:

```
S,Y:  DDEF MYJOBL,VP,LIBE005,OPTION=JOBLIB,DISP=OLD
```

You request a job library that resides on a public volume. No waiting for volume mounting is necessary. A third version of MAIN23 will be used. This version also receives its input from one of the GDG data sets, defined by the next DDEF command.

```
S,Y:  DDEF FT01F001,VS,TESTRSLT.G0002V00,DISP=OLD
```

You refer to the GDG generation created in Part 2 by its absolute generation name. The general form of this name is

qualifier.GxxxxVyy

where xxxx is the absolute generation number and yy the version number. The name of the GDG is the qualifier. The generation number is automatically incremented as new generations are cataloged; the version number is not. If you wish to replace a GDG generation by another version of the same generation, you have to supply the version number by making it part of the absolute name you refer to. The absolute names of the two data sets created in Parts 1 and 2 are TESTRSLT.G0001V00 and TESTRSLT.G0002V00.

```
S,Y:  DDEF FT02F001,VS,TESTRSLT(+3)
S,Y:  CALL MAIN23
```

You supply a different relative generation number here. It will be added to the last absolute generation number, leaving a gap in the absolute sequence for possible later insertions (i.e., the absolute names TESTRSLT.G0003V00 and TESTRSLT.G0004V00 are omitted).

```
SYS:  TERMINATED:  STOP
S,Y:  LOGOFF
SYS:
```

The system confirms your LOGOFF command.

Example 24: Tape- and Disk Medium Transfers of Virtual Access Method Data Sets

In this example, you copy VAM data sets from one medium to another. Each of the following commands is illustrated: TV (TAPE to VAM), VT (VAM to TAPE), and VV (VAM to VAM). The data sets *to be copied* are assumed to exist, and are cataloged. After logging on, you issue:

```
S,Y:  DDEF DDVTOUT,PS,COPY1,UNIT=(TA,9),VOLUME=(PRIVATE)
```

You define the tape copy of the data set.

```
S,Y:  VT ORIGIN1,COPY1
```

Data set ORIGIN1 already exists as a VAM data set. COPY1 is the name assigned to the magnetic tape copy of this data set.

```
SYS:
```

When the data set is successfully copied, you will receive a message indicating the names of the input and output data sets, as well as the file sequence numbers and volume serial numbers used.

```
S,Y:  DDEF DDVTOUT,PS,COPY2,UNIT=(TA,9),VOLUME=(PRIVATE),LABEL=(2,SL)
S,Y:  VT ORIGIN2
```

Here the output data set name is defaulted, making necessary the preceding DDEF command. The output data set name will be ADUSERID.TA000001.COPY2, where TA000001 is an arbitrary number to assure uniqueness for the fully qualified data set name.

```
SYS:
```

A system message will inform you when the data set is successfully copied. Any failure to copy successfuly will result in a diagnostic message and cancellation of the command.

```
S,Y:  TV ADUSERID.TA000001.COPY2,COPYBACK
```

The data set just produced on a 9-track magnetic tape is copied on direct-access storage in VAM format.

```
SYS:
```

A system message will inform you of the success or failure of the copy operation.

```
S,Y:  VV ORIGIN3,COPY3
```

The data set named ORIGIN3 is copied into public storage and assigned the name COPY3.

```
SYS:
```

A system message will inform you of the success or failure of the copy operation.

```
S,Y:  DDEF PRIVDD,VI,COPY4,UNIT=(DA,2311),VOLUME=(,333333)
S,Y:  VV ORIGIN4,COPY4
```

You desire to copy the data set ORIGIN4 onto a private VAM volume #333333 and name the output data set COPY4.

```
SYS:
```

A system message will inform you of the success or failure of the copy operation.

```
S,Y:  LOGOFF
SYS:
```

You want to copy the data set ORIGIN4 onto a private VAM volume #333333 and The system accepts your LOGOFF request.

Example 25: The Text Editor Facility

In this example, you use the Text Editor to create and edit data sets. The example illustrates only the more basic features of the Text Editor facilities. After logging on, you issue:

```
S,Y:  DEFAULT REGSIZE=8
```

You enter a default value (in this example, 8 bytes) for the length you wish to allow for the names of regions within the data set you will edit.

```
S,Y:  EDIT EX25
```

You invoke the Text Editor and specify that data set EX25 is to be processed. Since no DDEF command was issued for EX25, and the value of the REGSIZE parameter is greater than zero, the system assumes that you wish to edit a region data set with the following data set attributes: virtual index sequential data set organization, format-V records, maximum logical record length of 256 bytes, a key length of 15 bytes (8-byte region name and 7-byte line number), and a relative key position of 4.

```
S,Y:  REGION REGION1
```

You specify a region name; you will be invited to enter text for the region indicated.

```
S,Y:  0000100 LINEONEE
S,Y:  0000200 LINETWO
S,Y:  0000300 LINETHREE
```

You enter the data lines you wish to be part of the region named REGION1. Each time you press the return key, the Text Editor prompts with the next line number.

```
S,Y:  0000400 _UPDATE
```

You decide to make a change to the previous entries. By preceding UPDATE with an underscore character (_), the Text Editor immediately executes the command.

```
SYS:  FOR EACH LINE ENTER LINE NUMBER AND DATA
YOU:  0000150 INSERT1
```

You add line number 150 to your data set.

```
YOU: _INSERT 0000400
```

You now want to continue entering data at the point where you left off earlier. You precede INSERT with an underscore character, since the system expects data and not a command following UPDATE.

```
S,Y:  0000400 LINEFOUR
S,Y:  0000500 LINEFIVE
S,Y:  0000600 _END
```

You terminate Text Editor processing. Since EX26 resides in public storage, and is VAM organized, it will be automatically cataloged.

```
S,Y:  EDIT EX25
S,Y:  EXCISE 200
```

Line number 200 from the current region REGION1 will be deleted.

```
S,Y:  INSERT 260,10
S,Y:  0000260 INSERT2
S,Y:  0000270 INSERT3
S,Y:  0000280 _END
```

Text Editor processing is terminated.

```
S,Y:  LOGOFF
```

You decide to terminate your conversational task.

```
SYS:
```

The system accepts the LOGOFF request.

Example 26: The Text Editor Facility

In this example, you make more extended use of the updating capabilities of the Text Editor. The example is probably more complex than you might expect for a single terminal session, but it will serve to portray the scope and flexibility of the editing commands that are available to you. After logging on, you issue:

```
S,Y:  DEFAULT REGSIZE=8
```

You enter a default value (in this example, 8 bytes) for the length you wish to allow for the names of regions within the data set you will edit.

```
S,Y:  EDIT EX26
```

You invoke the Text Editor and specify that data set EX26 is to be processed. Since no DDEF command was issued for EX26, the same data set attributes are assumed as for EX25 in the previous example.

```
S,Y:  REGION REGION2
```

You define a region name for EX26.

```
S,Y:  0000100 LINEA
S,Y:  0000200 LINEB
S,Y:  0000300 LINEC
S,Y:  0000400 LINED
S,Y:  0000500 LINEE
S,Y:  0000600 LINEF
S,Y:  0000700 LINEG
S,Y:  0000800 LINEH
S,Y:  0000900 LINEI
S,Y:  0001000 LINEJ
S,Y:  0001100 _END
```

You enter the lines for REGION2 of data set EX26. You then terminate Text Editor processing. Since EX26 is VAM organized and resides in public storage, it is automatically cataloged when the Text Editor is invoked.

```
S,Y:  EDIT EX25
```

You again invoke the Text Editor and specify that data set EX25, region REGION1, prepared in the previous example, is to be processed.

```
S,Y:  REGION REGION1
```

The system prompts you to enter a command.

```
S,Y:  NUMBER300,500,BASE=300,INCR=50
```

Lines 300, 400, and 500 are now numbered 300, 350, and 400.

```
S,Y:  DISABLE
```

This optional command makes the following data set changes provisional. These changes can be made permanent by issuing an ENABLE command, after you are satisfied all changes were entered properly.

```
S,Y:  EXCERPT EX26,REGION2,600,1000
```

You wish to excerpt lines 600 to 1000 from REGION2 of data set and insert these lines in the current data set EX25.

```
S,Y:  CONTEXT ,LAST,STRING1=LINE,STRING2=LINE NUMBER
```

The current region is searched for all occurences of the character string line. Wherever it is found, LINE NUMBER will replace the occurrence.

Note: This facility is useful for symbol replacement in source language data sets.

```
S,Y:  ENABLE
```

Up this this point, the revisions made since DISABLE was issued above were temporary. With the execution of the ENABLE command, these revisions are now permanent. A STET command, on the other hand, would have deleted all changes made since the DISABLE was issued.

```
S,Y:  CORRECT N1=100,SCOL=0
```

You now want to remove a single character from a line, starting with the first column (relative column ∅). Standard correction characters are assumed, by default.

```
SYS:  LINEONEE
YOU:  *      %
```

The result will be LINEONE.

```
S,Y:  EDIT EX26
```

You reopen the text editor for data set EX26.

```
S,Y:  REGION REGION2
```

The current region is now REGION2.

```
S,Y:  LOCATE ∅,LAST,LINEF
```

You want the entire data set EX26 to be searched for the character string LINEF.

```
SYS:  0000600 LINEF
```

The line in which LINEF is first discovered is displayed at the terminal.

```
S,Y:  LIST100,LAST
```

The current region (REGION2) will be displayed.

```
S,Y:  END
```

You terminate Text Editor processing.

```
S,Y:  LOGOFF
SYS:
```

The system accepts your LOGOFF command.

Example 27: Use of Procedure Definition (PROCDEF)

In this example, you create a procedure, tailored to your needs, to be called at a later time just as if it were a system-supplied command. After logging on, you issue:

```
S,Y:  PROCDEF FTNPGM
S,Y:  0000100 PARAM MODULE
S,Y:  0000200 FTN MODULE
S,Y:  0000300 PRINT LIST.MODULE(0),,,EDIT,ERASE
S,Y:  0000400 _END
```

You have defined a procedure which will now be available for calling by he name FTNPGM. It allows you to define a module name for compilation. By calling the established procedure, and giving a unique module name to use, both the compilation, and printing of the resulting listing data sets can be accomplished.

```
S,Y:  FTNPGM MYMOD
```

The procedure established above (via PROCDEF) will now be activated. The actual module name (MYMOD) will replace the dummy module name (MODULE) wherever it occurs.

```
S,Y:  PROCDEF SETUP
S,Y:  0000100 PARAM STORED=$1, ISD=$2, SLIST=$3, CRLIST=$4
S,Y:  0000200 DEFAULT STORED=$1, ISD=$2, SLIST=$3, CRLIST=$4
S,Y:  0000300 _END
```

This procedure will now be available to vary the default values for certain FTN parameters.

```
S,Y:  SETUP Y,N,Y,Y
```

Some FTN parameter default values have been adjusted to suit your requirements.

```
S,Y:  FTN MOD1
      .
      .
      .
```

You now proceed with the compilation of MOD1 with the adjusted default values.

```
S,Y:  PROCDEF ZLOGON
```

Here the operand (ZLOGON) for the PROCDEF command is shown without the use of a keyword.

```
S,Y:  0000100 DDEF STOREIT,VP,MYLIB,OPTION=JOBLIB
S,Y:  0000200 _END
```

You decide that each time you LOGON you would like a certain job library defined for any object modules you may produce. By assigning ZLOGON as the procedure name, you insure its automatic call as soon as LOGON is accepted. MYLIB is assumed to be an existing cataloged data set. Since PARAM was **not** used you **cannot change** any of the values in the DDEF command.

```
S,Y:  LOGOFF
SYS:
```

The LOGOFF command is accepted by the system.

Example 28: The User Profile Facility

In this example, you are shown how to manipulate your copy of the prototype user profile, made available to you at JOIN time. This prototype profile is a member of your user library (USERLIB). After logging on, you issue:

```
S,Y:  DEFAULT DSORG=VS
```

The data set organization field was originally defaulted by the system to VI (index sequential). You will now be using mostly VS organized data sets, so you set the default value (for the DDEF command) to virtual sequential (VS).

```
S,Y:  SYNONYM DOPROG=FTNPGM
```

The FTNPGM procedure named in Example 27 can now be invoked with either name: DOPROG or FTNPGM.

```
S,Y:  SYNONYM FINIS=DISPLAY 'TASK COMPLETED'
```

When FINIS is invoked, the message: TASK COMPLETED will appear on SYSOUT.

```
S,Y:  PROFILE
```

The above changes apply to your session profile only. You now decide to make the changes a permanent part of your user profile.

```
S,Y:  FINIS
SYS:  =TASK COMPLETED
```

Since the PROFILE command was invoked, FINIS may be used in all subsequent sessions to produce the same message.

```
S,Y:  LOGOFF
SYS:
```

The system accepts your LOGOFF command.

Part III. Appendixes

The appendixes give detailed information on the use of TSS/360 by the FORTRAN programmer; they contain the following information:

A. Use of the FORTRAN Compiler: describes source statement entry and correction and compiler diagnostics, output, and restrictions.

B. PCS and FORTRAN Object Programs: describes the use of PCS when debugging FORTRAN object programs at the source language level.

C. Programming Considerations: describes the programming techniques that yield more efficient programs, the effect of compiler optimization on the use of PCS, system naming conventions, library management, and several miscellaneous considerations.

D. Assembler Language Subprograms: describes the techniques and conventions of incorporating assembler-language subprograms into FORTRAN language programs.

E. Specification of Data Set Characteristics: describes the various record formats and data set organizations available to the FORTRAN user and explains how and when to specify these characteristics for a data set.

F. Attention Considerations: describes the system's response to the attention key, which is a function of the system's current activity.

G. Command Formats: describes the notation used to present commands and gives the general form of each of the TSS/360 users' commands.

H. Carriage and Punch Controls: lists the extended ANSI FORTRAN carriage control and punch control standard characters.

I. Sample Program: describes the sample program that is distributed with the TSS/360 FORTRAN IV compiler.

Appendix A. Use of the FORTRAN Compiler

This appendix discusses the following topics:

1. Entry and correction of FORTRAN source statements: the format of keyboard and card source statements, efficient source statement correction techniques, and entering lines from the keyboard that can later be punched and reentered as cards.
2. Compiler diagnostic action: the format and effect of diagnostic messages and error severity codes produced by the compiler.
3. Compiler options and listings produced: FTN parameters, listing options, indirect references to FORTRAN IV subprograms, and the destinations of all compiler output.
4. Compiler restrictions: simple and complex source program restrictions.

Entry and Correction of FORTRAN Source Statements

This section discusses the following topics:

1. The format of FORTRAN source statements entered at the terminal keyboard, at the terminal card reader, and at a card reader at the central computing facility.
2. Guidelines for efficient source statement correction techniques.
3. Techniques for entering FORTRAN source keyboard lines so that they can be punched and reentered in card form for compilation.

Format of Source Lines

A FORTRAN source *statement* is composed of one or more individual source *lines*. A source line consists of a single card or a single line of keyboard input. There are five types of lines:

1. Comment lines
2. Initial lines
3. Continued lines
4. Continuation lines
5. END lines

The following paragraphs describe each of these types of lines for both card and keyboard format.

For both card and keyboard statements, the maximum number of text characters that can be contained in a statement is 1320. Card input lines normally contain 66 text columns per card (columns 7-72); thus, an initial line and 19 continuation lines are allowed. The number of keyboard lines contained in 1320 characters depends upon the position of the first character in each line and the last character given prior to issuing a carrier return in each line.

Card Format Line (Both Nonconversational and Console Card Reader)

Comment lines are those lines with the letter C in column 1. The compiler ignores these lines, but includes them in the source listing. Comment lines may appear anywhere within the source program except immediately preceding a continuation line. *Initial* lines in card format are lines with the characters zero or blank in card column 6. An initial line is the first line of a FORTRAN statement. *Continued* lines are lines whose content does not complete the statement; that is, the statement is continued on the following line. In card format, a line is not known to be a continued line until the following line is inspected. A *continuation* line is a line in a statement other than the initial line, that is, a line whose content is a continuation of the preceding line. In card format, a continuation line must contain a character other than zero or blank in card column 6. An END line is a line containing the FORTRAN END statement. Every source module must terminate with an END line.

Character Sets — Card Format

The CA and CB commands transfer control to the 1056 card reader, and specify the character set to be used. CA is used to convert card input from 1057 card punch code to EBCDIC. CB specifies conversion from 029 keypunch code to EBCDIC.

Keyboard Format

Keyboard lines are different from card lines in two general ways: (1) the rigid column format of card lines is relaxed in keyboard format and (2) the maximum number of characters in a line is greater (as many as 130, depending upon the type of keyboard being used).

Keyboard *comment* lines are similar to card comment lines in that a keyboard comment line is identified by the letter C in the first typeable position, and may appear anywhere within the source program except immediately preceding a continuation line. Note that the statement C = 1.0, for example, if begun

in type position 1, would be treated as a comment line. A good general practice is to set tab stops and make use of the tab key. This practice will (1) ensure that a statement beginning with the letter C will not inadvertently be processed by the compiler as a comment line, and (2) provide a simple method for formatting the input program on the terminal paper — separating statement numbers from statement text, etc.; most examples in this appendix imply or expressly describe use of tabs. The compiler considers a tab the equivalent of *one* blank, when entering keyboard lines. Thus, when reference is made to blanks, tab *or* blank is implied, unless specifically stated otherwise.

Initial lines in keyboard format can contain a statement number, as in card format. This statement number can begin in any type position (hereafter referred to as position) and is distinguished from the text portion of the line by being numeric rather than having an alphabetic character as the first character. Statement numbers can be preceded by any number of blanks or tabs. A statement number can contain from one to five numeric characters, each of which can be preceded or followed by any number of blanks. A statement number is terminated when either five numeric characters have been encountered or a nonnumeric, nonblank character is encountered, whichever occurs first. A statement number cannot be contained on more than one line. Following the statement number is the line text. The text must be separated from the statement number by at least one blank, or by the character zero. (The user is warned that the entry of a terminal line with a statement number of 100, for example, immediately followed by the text of the statement — i.e., with no intervening blank — causes the second zero of the statement number to be treated as the character separating the statement number and the text, and the statement number will be considered by the compiler to be 10, not 100.) The text portion of a line is terminated either by a hyphen (-) followed by a carrier return (if the line is to be continued), or by a return preceded by a character other than a hyphen (if the line is not to be continued).

A keyboard *continued* line is one ending with a hyphen and a carrier return. The hyphen, of course, is not considered part of the text.

A keyboard *continuation* line is the line following a continued line. A continuation line cannot have a statement number. The text portion of a continuation line can begin in any position and can be preceded by any number of blanks; it must also be preceded by a single character other than blank or zero. This single character is equivalent to the column 6 continuation character of card lines and thus is termed a "floating continuation character." In effect, the first nonblank, nonzero character of a continuation line is treated as a continuation character. The floating continuation character, which is not considered part of the text, is useful for two reasons:

1. It allows the user to tab the continuation line (so that it will fall directly beneath the preceding line) without thereby causing a blank to be inserted in his text; blanks or tabs are ignored in continuation lines until the floating continuation character is encountered. This is an important consideration, for example, in cases where a line break must occur in the middle of a character string that does not permit embedded blanks.
2. If lines entered via the console are to be punched and later reentered in card format, the floating continuation character makes this possible (this is described later in this appendix).

A keyboard END line is a line containing the FORTRAN END statement. Every source module must terminate with an END line.

Character Sets — Keyboard Format

KA and KB are used to specify the character set to be used during keyboard input. KA specifies the full EBCDIC character set during input. KB indicates that the lower-case characters (a-z and ! " ¢) be translated into their upper-case equivalents (A-Z and $ # @ respectively).

It should be noted that KA is in effect only for the command during which it is issued. The system underscore (inviting a new command) reverts to the KB folded mode.

Mixed Card and Keyboard Input

FORTRAN source statements entered at the terminal may be from cards, from the keyboard, or from a mixture of the two. If the first line of a statement is from a card, all lines in that statement must also be on cards. If the first line in the statement is from the keyboard, the following lines may be from the keyboard or from cards. Once the source of a statement becomes cards, however, keyboard lines may no longer be included in that statement.

Once a line is entered at the terminal in either card or keyboard form, the source of the line (card or keyboard) is retained even though the line may be stored in a prestored data set and later presented to the compiler from that source. Thus the above mixed-input rules apply for both terminal input and later corrections to that input.

The procedure for changing sources is as follows. Keyboard lines will be expected by the system until

C, CA, or CB is entered at the keyboard. Once these characters have been entered, input lines are expected to be on cards. If a card containing K, KA, or KB is encountered, lines are once again expected from the keyboard. (See *Terminal User's Guide* for SYSIN device selection and data translation).

Examples: In these examples, the following notes apply:

1. The letter t represents depression of the tab key. The keyboard position at which the carrier is to be positioned as the result of a tab is implied by the position of the next nonblank character in the example. The following examples assume tab stops are set such that the first depression of the tab key causes the carrier to be positioned at type position 6 and the next depression causes positioning at type position 7.

EXAMPLE	FORMAT	CARD OR TYPE POSITION
		1 567
1	Card	C COMMENT
NOTE: Comment line.		
2	Card	50 Y=1.0
NOTE: Initial line with a statement number.		
3	Card	Y=2.0
NOTE: Initial and continued line, no statement number.		
	Card	X+B
NOTE: Continuation line.		
4	Key	C COMMENT
NOTE: Comment line.		
5	Key	9 Y=3.1416
NOTE: Initial line with a statement number.		
6	Key	100t tZ=1.0-(CR)
NOTE: Initial and continued line; tab to column 6, tab again to skip the continuation character position, then at position 7 type first text character.		
	Key	t X+3.0*B
NOTE: Continuation line; tab to position 6 for floating continuation character, with text beginning in column 7.		
7	Key	200t tY=1.0-(CR)
NOTE: Initial and continued keyboard line.		
	Key	CB
NOTE: To note a card line follows.		
	Card	X+3.0*B
NOTE: Continuation card line.		

2. The characters (CR) represent a carrier return.
3. The character (-) is used as the continuation character by system default.

Efficient Correction Techniques

Conversational correction of FORTRAN statements is normally made at one of two points in the compilation. The first, termed here *local* correction, occurs following the compiler's scan of the statement just entered and its printing at the terminal of any diagnostic messages associated with that statement. The second point at which corrections are normally made occurs when the entire program has been entered (i.e., when the END statement has been entered) and a message similar to, "MODIFICATIONS? ENTER Y OR N" has been typed at the terminal. Corrections made at this point are termed here *global* corrections. The distinction between global and local corrections (and between different types of local corrections) is important in that the user can minimize the amount of processing required for a given compilation by being aware of the effect corrections have on the compilation process. The following paragraphs describe efficient correction techniques in detail. Before proceeding to this detailed discussion, however, a general correction rule that applies in *most* cases can be given: the most efficient correction technique is to correct erroneous statements immediately after they are entered and the diagnostic is produced. This is the most natural time to correct an erroneous statement, and is a convenient guideline to use.

After all *global* corrections have been made, the entire source program is rescanned, beginning with the first source line of the program. When *local* corrections are made, reinitiation of the source scan may or may not be required, depending upon the type of correction made. It is desirable, of course, to minimize the number of source scans. For this reason, corrections noted below as reinitiating the source scan generally should *not* be made until the time for global corrections is reached. This rule does not apply where failure to make a correction would result in many other diagnostics, such as an error in entering variables in a DIMENSION list.

Discussion of compiler response to various types of local corrections can be quite complex if all possible combinations of conversational card and keyboard corrections are covered. This section does not discuss all possible types of corrections specifically, but gives sufficient descriptive material and examples so that the compiler response in any given case can be determined.

Discussion of compiler response to local corrections requires a definition of three terms:

1. Partial statement – a statement currently being entered. For card input, a statement is partial until a noncontinuation line is entered to terminate the statement. Keyboard statements are partial until a line is entered that is not a continued line or a comment line. An example of a partial keyboard statement is the following (i.e., the line is noted as being a continued line, but the continuation line has not yet been entered):

   X=A+B-(CR)

2. Tentative statement – the last *complete* statement entered to the compiler. A keyboard statement becomes tentative when the last line of the statement is not a continued line, causing the line to be scanned by the compiler. This statement will remain tentative until a new statement is completely entered. Thus a new statement may be begun without changing the tentative status of the previous statement, but once the new statement has been completely entered, the statement held in tentative status becomes committed (see below). Entry of comment lines does not affect the status of tentative statements. Such lines are included in the listing but otherwise ignored.
3. Committed statement – the statement preceding a tentative statement. The relation between a committed statement and a tentative statement is identical to the relation between a tentative statement and a partial statement: once a statement becomes tentative, the preceding statement becomes committed. In the following example, entrance of the (non-continued) second statement causes the second statement to become tentative and causes the first statement to become committed. Both are keyboard lines.

   X=A+B(CR)
   Y=X**2(CR)

Entry of comment lines does not affect the status of tentative or committed statements – such lines are included in the listing but otherwise ignored.

The relation between the above types of statements and compiler response to corrections is as follows:

1. Tentative and partial statements can be corrected without causing a reinitiation of the source scan.
2. Correction of committed statements causes reinitiation of the source scan from the beginning of the program.
3. Insertion of a new statement between a committed and a tentative statement does not cause a rescan of the entire program. Such an insertion causes a rescan of the tentative statement, however.

The above rules can be more easily understood by inspection of the following examples. In these examples, line numbers are seven digits with the last two digits zero, the format in which they are printed by the system A line number underneath a number sign, #, is a correction line. Such line numbers need not be seven digits long and need not have two trailing zeros. This notation is consistent with the system convention by which printing of a diagnostic is followed by printing a number sign soliciting a correction by the user. The correction line numbers are followed by a comma, also consistent with system conventions. Line numbers preceded by a percent sign (%), where the % is entered by the user, are unsolicited corrections – that is, corrections originated by the user and not arising from the system's diagnostic action.

Conversational corrections also affect the source listing, as follows:

1. Source statements and their associated diagnostics are not added to the source listing until the statements are committed. Thus, the terminal listing may contain many diagnostic messages, but the source listing contains only those diagnostics not corrected.
2. Corrections causing reinitiation of the source scan cause the source listing plus diagnostics associated with the previous source scan to be lost, since the results of the new source scan replace those of the previous scan.

Example 1.

LINE NO.	FORMAT	CARD OR TYPE POSITION 1 567
0000200	Key	Z=1.0
0000400	Key	Y=2.0
0000600	Key	DO 10 I=1,10

NOTE: In this example, all lines begin in type position 1, a dangerous practice as any lines beginning with a C are considered comment lines.

0000800	Key	X(I)=I

NOTE: Causes a diagnostic, as no DIMENSION (or equivalent) statement is included.

# 100,	Key	DIMENSION X(10)

NOTE: Making a correction prior to the committed statement (line 600) causes reinitiation of the source scan. Note that this statement could have been inserted at 700 rather than 100 without causing reinitiation of the source scan.

Example 2.

LINE NO.	FORMAT	CARD OR TYPE POSITION 1	567
0000100	Key	t	tZ=10.0(CR)
0000200	Key	t	tY=3.0-(CR)
0000300	Key	t	X=B-(CR)
0000400	Key	t	X+C-(CR)

NOTES:

The t indicates the tab key has been depressed, as discussed earlier.

The user is requested to enter line 500, but he realizes that line 300 must be corrected. When the correction of line 300 is made, the statement starting at line 200 is in partial status. This correction does not cause reinitiation of the source scan.

0000500%300, Key t X-B-(CR)

Note the use of floating continuation characters in lines 300 and 400.

0000500 Key t X+D(CR)

NOTE: Entry of line 500 completes the statement. The compiler then processes the composite statement Y=3.0−B+C+D.

Example 3.

LINE NO.	FORMAT	CARD OR TYPE POSITION 1	567
.			
.			
.			
0000400	Key		X=1(CR)
0000500	Key		B=2(CR)
0000600%400,	Key		X=2(CR)

NOTE: The user is requested to enter line 600. When line 500 was entered, the statement of line 400 became committed. The correction of line 400 thus causes reinitiation of the source scan.

Entry of Keyboard Source Statements for Later Punching and Recompilation

The entry of source statements such that they can be later punched out and reentered in card format is governed by the following considerations:

1. Source lines reside in a line data set in a format in which the initial input source line is *preceded* by eight characters — a 7-byte zoned-decimal key and a character specifying to TSS/360 that the source line was entered in card form or at the terminal keyboard.
2. A continued line (hyphen preceding the carriage return) when punched and reentered in card format retains the hyphen unless precautions are taken to remove it (see below).
3. Keyboard input positioning requirements are much more flexible than for card input.

Therefore:

1. Keyboard input lines must contain all statement numbers in columns 1-5.
2. Keyboard input lines must contain no tabs.
3. Keyboard input lines must contain all floating continuation characters in position 6.
4. Text must be contained between position 7 and a position not greater than 72, as source *card* lines cannot be scanned beyond column 72 for characters to be included in the text.
5. Continued lines must all contain the hyphen continue character in a column such that the PUNCH command (see below) will cause the hyphen *not* to be punched.
6. The column chosen in the PUNCH command for termination of punching must be such that no lines contain *text* beyond this column.

If input lines are prepared in accordance with the above rules, the line data set can then be punched, using the PUNCH command. The parameters supplied in the PUNCH command are: startno, the position in the source line as it resides in the line data set that will be punched as column 1 of the card; and endno, the position in the source line that will be last punched in the card. If the program contains no continuation lines (one line per source statement), good choices for startno and endno would be 9 (to skip 8 bytes — the 7-byte line number and the card or keyboard character) to 88 (to punch up to 80 columns of text from each source line — this choice assumes no source lines contain more than 80 columns of text).

The selection of 9 for startno will nearly always be the proper choice. The endno selection will vary, of course, depending upon position of text and continuation characters in the program source lines.

Compiler Diagnostic Action

This section describes the format of all diagnostic messages produced by the TSS/360 FORTRAN compiler. It includes a description of the error severity code and error level associated with each message, and describes the effect of error severity upon requests to execute the compiled program. Refer to *System Messages* for a description of each diagnostic and the source program errors that cause it.

The FORTRAN compiler issues diagnostic messages for source program errors, for violations of compiler space and size restrictions, and for apparent machine errors. These messages are included in the source program listing produced by the compiler if a listing

is requested; they are also printed at the terminal in conversational mode. (A detailed description of the destination of diagnostic messages for all combinations of input sources, options requested, etc., is given in Table 3 later in this appendix.)

Nearly all compiler diagnostic messages are printed on one line. The format of this line is:

number code *** text

(In the two-line messages, the second line follows the first and omits the number and code fields.)

The "number" parameter is the source program line number (*not a* FORTRAN statement number) of the first line of the statement to which the message applies. Messages concerning errors that the compiler does not associate with any specific statement carry the line number of the source program END statement.

The "code" parameter is a one-letter indicator of the severity of the error and the action taken by the compiler. The letters used, the severity of errors associated with each letter, and a brief description of compiler action taken are given in Table 2.

When a FORTRAN main program is to be executed using the CALL command, the module named in the CALL command and all modules called by this module are inspected during the loading process to see whether any have been compiled with level-2 errors (severity codes E or F). Any module containing an error level of 2 causes a diagnostic message naming the module and the error level to be printed on the user's SYSOUT.

The "text" parameter in diagnostic messages is a verbal description of the condition that caused the message. Names, statement numbers, etc., from the FORTRAN source program being compiled are included, where applicable. In addition to information to locate and identify the condition, often "text" specifies the actions taken by the compiler in F-code messages. Occasionally the object code listing must be inspected to determine the actual compiler action.

Occasionally, two or more identical messages are produced for a source program statement in which the erroneous situation appears to occur only once. This is due to the conjunction of two conditions: (1) the error is not serious enough to force the compiler to abandon processing the statement and (2) the statement is of a kind that requires more than one scan by the compiler. Examples of such conditions are (1) when an argument of a statement function is in error and the argument is used more than once in the statement function definition and (2) when certain types of errors are made in an I/O statement list.

The compiler does not attempt to make systematic checks for machine failure. However, in the course of processing, it may test for conditions that ought never to arise, according to the design of the compiler. If any such condition is detected, an A-code message is issued advising of machine or compiler error. These messages should be brought to the attention of system maintenance personnel.

Although the conversational user may know that a certain diagnostic is to appear at a particular place in

Table 2. Compiler Diagnostic Action

CODE	SEVERITY	DESCRIPTION	ACTION
W	Warning, Level-1 error	The message is a warning that the compiler has detected either a situation that may not be as the programmer intended or a use of a language feature that is acceptable to the TSS/360 FORTRAN compiler but is unacceptable to other implementations of IBM System/360 FORTRAN. In either case, the statement is compiled exactly as written.	Statement compiled as written
E	Serious, Level-2 error	The message is a notification that the compiler has detected a serious source program error. Compilation continues, completely ignoring the offending statement, and the object program is generated as if the statement had not occurred. (Although the offending statement is deleted from the compilation, the program is marked as containing a serious error if the offending statement is not replaced. The presence of a serious error causes a diagnostic message to be printed on the user's SYSOUT data set at load time.	Statement deleted
F	Serious, Level-2 error	This message is also a notification that the compiler has detected a serious error. The compilation continues by partially compiling the statement. The effect of F-code errors on the generated object program can frequently be determined from the text of the message, but occasionally examination of the object code listing is required. Object program execution is not recommended.	Statement partially compiled
A	Serious, Level-3 error	The message is a notification of a situation serious enough to prevent continuing the compilation. After issuing an A-code message, the compiler exits to the command-language level. These messages are concerned with violation of compiler size or space restrictions.	Compilation discontinued; no object module produced

his program, or he may recognize a diagnostic as it begins to appear at the terminal, he should not try to save time by pressing the attention key to prevent full diagnostic text printout. Little time can be saved, since a RUN command must be entered after an attention, and much time may be lost, since the compiler will reinitiate compilation with the first source line if certain of its diagnostics are so interrupted.

Compiler Options and Listings Produced

This section discusses three topics:

1. The parameters that must be supplied to the compiler when the FTN command is given.
2. The listings produced by the compiler when requested by user-supplied parameters.
3. A list of FORTRAN IV supplied subprograms which can be called by the compiler as a result of exponentiation, interrupt handling, I/O processing, or STOP or PAUSE statement usage.
4. The destination of all output from the compilation.

FORTRAN Parameters

After issuing a FTN command, the user must enter a parameter providing the module name for this compilation. A list of compiler parameters is given in Figure 7, and explained in detail following the figure. The notation used in Figure 7 is explained in Appendix G, "Command Formats."

Some of the compiler parameters listed in Figure 7 must be provided by the user; others may be left unspecified and default values will be chosen. In some cases the user will be prompted for missing parameters; in other cases he will not. Figure 8 shows the relation between parameter specification and the compiler conditions. In Figure 8 the terms "explicitly defaulted" and "implicitly defaulted" are used as discussed below:

Explicitly Defaulted

A comma is issued immediately following entrance of the preceding parameter, rather than entering a value for the new parameter followed by a comma. For example, module ALPHA, with prestored source lines, is to be compiled, explicitly defaulting the version identification, but supplying values for all other parameters. The proper parameter description is:

```
ALPHA, Y,,Y,Y,Y,Y,Y,Y,Y,Y
```

Implicitly Defaulted

In the example of the preceding paragraph, the user could depress the return key following entrance of the Y specifying an ISD is to be produced. This action causes all parameters following the ISD option to be implicitly defaulted.

The parameters shown in Figure 7 are described as follows:

NAME — specifies the name of the object module to be created. Prior to selecting the module name, the user should refer to Appendix C for a discussion of TSS/360 naming conventions, in order that a module name not be chosen using a reserved system name. The source data set for the module is named by appending a period and the module name to the characters SOURCE. For example, module ALPHA will have a source data set name SOURCE.ALPHA. The module name must be unique to the library that includes it (i.e., it must not be the same as any entry point, control section name, or module name in that library). Similarly, the module name must not be the same as any COMMON block, FUNCTION, SUBROUTINE or any variable name used within the program being compiled. The name consists of one to eight alphameric characters, the first of which must be alphabetic. It is recommended that module names be six or fewer characters, as discussed in Appendix C.

Default: None; a module name must be specified.

OPERATION	OPERAND
FTN	NAME=module name [, STORED= {Y / N}] [, VERID=version identification] [, ISD={Y|N}] [, SLIST={Y|N}] [, OBLIST={Y|N}] [, CRLIST={Y|N}] [, STEDIT = {Y|N}] [, MMAP={Y|N}] [, BCD={Y|N}] [, PUBLIC={Y|N}] [, LISTDS={Y|N}] [,LINCR=(first line number, increment)]

Figure 7. FORTRAN Parameters

Parameter	User Action	System Action	
		Nonconversational Mode	Conversational Mode
Module	Explicitly or implicitly defaulted	Task terminated	Prompting for parameter will occur
	Not defaulted	Processing continues with user-supplied parameter	
All other options	Explicitly defaulted	Default values selected	
	Implicitly defaulted	Default values selected	
	Not defaulted	Processing continues with user-supplied parameter	

Figure 8. Compiler Parameters Default and Prompting Description

STORED – specifies whether or not the source data set is prestored (if so, it must have been named SOURCE.module). The allowable values are Y or N.

Default: N.

VERID – specifies the version identification to be assigned. The version identification consists of one to eight alphameric characters.

Default: If a version identification is not assigned, the version of the object module may be determined by using the system supplied "time stamp." A time stamp is always produced by the system; it gives the current time and date at which the compilation begins. This time will be different from the time at which any other compilation begins, thus allowing positive identification of the compilation output. The compilation listing will contain an edit of the time stamp in the following format: MO/DD/YY HH:MM:SS giving the time of the compilation in month, day, year, hour, minute, and second.

ISD – specifies whether an internal symbol dictionary, which is required for extended use of PCS, is to be produced. The allowable values are Y or N.

An ISD should not be requested unless PCS is to be used with this compilation since the request for an ISD also inhibits compiler optimization. See Appendix C for a full discussion of this topic.

Default: Y.

SLIST – specifies whether a source program listing is to be produced. The allowable values are Y or N.

Default: Y.

OBLIST – specifies whether an object program listing is to be produced. The allowable values are Y or N.

Default: N.

CRLIST – specifies whether a cross reference listing is to be produced. The allowable values are Y or N.

Default: N.

STEDIT – specifies whether the symbol table is to be listed. The allowable values are Y or N.

Default: N.

MMAP – specifies whether a storage map is to be produced. The allowable values are Y or N.

Default: N.

BCD – specifies whether input includes BCD (binary-coded decimal) or EBCDIC form of special characters. The allowable values are Y for BCD or N. If Y (BCD) is chosen, either BCD or EBCDIC input may be used. Thus EBCDIC corrections may be made to BCD source lines. This option is included for compatibility with FORTRAN programs written for previous IBM systems. If the user is uncertain as to whether his program uses the BCD or EBCDIC form of special characters, the user should choose the Y option, thereby giving himself complete flexibility.

Note: If the EBCDIC option is selected, statement numbers passed as arguments must be preceded by an asterisk (&n). However, if the BCD option is selected, statement numbers passed as arguments must be preceded by a dollar sign ($n), and the $ character must not be used as an alphabetic character in the source module. (n represents the statement number.)

Default: N.

PUBLIC – specifies whether the executable part of the module (the CSECT, described below) to be created is to have a public or private attribute. Allowable values are Y or N; Y indicates public; N indicates private. If the public attribute is chosen, other programmers may use the same program if they are also given access to the library in which this module is stored. The means for so doing are described in Appendix C.

Default: N.

LISTDS – specifies whether the requested listings are to be placed in the list data set or on SYSOUT. Allowable values are Y or N. If Y is chosen, the listings are placed in the list data set and can be printed at any time with the PRINT command. If N is chosen, the listings are placed on SYSOUT; in other words, it is printed automatically but not kept in the system.

Default in conversational mode: **Y**.
Default in nonconversational mode: N.

LINCR(line) – specifies the line number to be assigned to the first line of the data set. The line number contains three to seven digits, of which the last two must be 00.

Default: 100.

LINCR(increment) – specifies the increment to be applied to develop successive line numbers. The increment may contain three to seven digits, of which the last two must be 00. It cannot be negative.

Default: 100.

Example: A user specifies the following parameters when issuing the FTN command:

```
COWBOY,N,V5,Y,Y,,,Y,,,,,
```

Thus, the name of the user's object module is COWBOY; the source data set is not prestored; the first line number of the data set is the default value of 100; subsequent line numbers are incremented by the default value of 100; the version identification is V5 (not a time stamp); an internal symbol dictionary is to be produced, a source listing is to be produced (this parameter could have been defaulted with the same result); an object listing and cross-reference listing are not to be produced (the default options); a symbol table edit is to be produced; no storage map is to be produced (the default option); no BCD special characters are to appear in the input (the default option); and the CSECT of the module to be created is to have the private attribute (the default option).

Structure and Description of Compiler Listings

The compiler will prepare a listing if one or more of the five listing options are requested. The five types of listings are: source program listing, object program listing, cross-reference listing, symbol table listing, and storage map listing. The listings produced vary somewhat, depending upon the combination of listing options chosen.

The figures that follow show the listings produced for a compilation requesting the default listing options (source listing only), a compilation requesting all five listings and a compilation requesting only a storage map listing. A description is given for all sample listings. This description includes both a general discussion of items contained in a particular listing and references to particular items in the listing. Where appropriate, a reference number in bold-face type will be given in the listing description, for example, **1**. Such numbers refer to the encircled numbers on the listing itself that correspond to the item being discussed.

```
(1) VERSION 07/10/67 OF THE TSS FORTRAN COMPILER ENTERED                                    PAGE  001
    THE MODULE NAME AND VERSION FOR THIS COMPILATION ARE COWBOY  ,V5
(4) OPTIONS--PUBLIC CSECT(N),BCD MODE(N),PRODUCE ISD(N).  LISTINGS--SOURCE(Y),OBJECT(N),CROSS REF(N),SYMBOL TABLE(N),MEMORY MAP(N).
```

Figure 9. Heading Page

```
(5)  (6)
COWBOY  ,V5                                                                 PAGE  002
     (7)
     100  C      EXAMPLE PROGRAM TO DEMONSTRATE TSS/360 FORTRAN COMPILER LISTINGS
     200         DIMENSION A(10),B(10)
     300         COMMON /NAME/C(5),D(5,2) /INDEX/L,M
     400         DATA A/10*0.0/,B/10*1.0/
     500         NAMELIST /NUM/L
     600       5 DO 10 I=1,2
     700         READ (5,NUM)
     800         DO 10 J=1,L
     900         READ (5,900) D(I,J)
    1000      10 CONTINUE
    1100         CALL COMPUT(A,B)
    1200  C      DELIBERATE DIAGNOSTIC FOR ILLUSTRATIVE PURPOSES.
    1300         X=A((1)
(8) 0001300 E *** ILLEGAL EXPRESSION IN SUBSCRIPT ON  A
    1400         IF(L.GE.M)GO TO 20
    1500         WRITE (6,910) (I,A(I),B(I),I=1,10)
    1600         GO TO 5
    1700      20 STOP
    1800     900 FORMAT(2E20.8)
    1900     910 FORMAT('1TEST PROGRAM SAMPLE OUTPUT FOLLOWS' /'0  I              A
    2000        X                    B'/(I6,E20.8,E20.8))
    2100         END
```

Figure 10. Source Program Listing

Heading Page

A heading page containing three lines is produced if any edits are requested. These heading lines describe: an identification of the version of the compiler being used **1**, the module name **2** and version (or time stamp, if version has been defaulted) for the compilation **3**, and a record of the options (other than verid) selected for the compilation **4**. An example of a heading page appears in Figure 9. In this example, the user supplied the module name COWBOY, version identification V5, and defaulted all other parameters.

Source Program Listing

If a source listing is requested, the first listing produced following the heading page is the source program listing. The source program listing will contain the diagnostic messages for each statement following the statement. A sample source program listing is shown in Figure 10. The first line of all listings contains the module name, **5**, and the version identification, **6**. All source lines are preceded by the system-assigned line number, **7**. A diagnostic message is included in the sample source listing **8**.

General Description of Output Module Listing

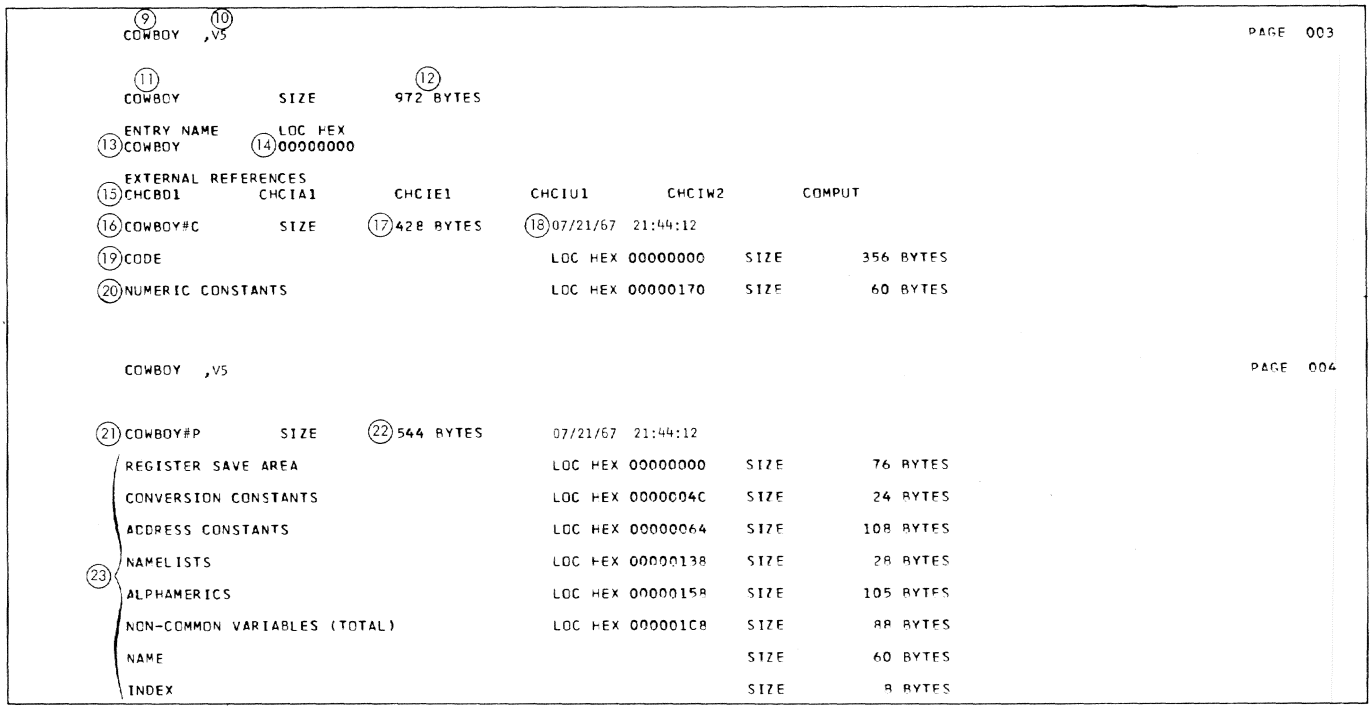
Following the source program listing, listings of the compiled object program module are given. In general, the listing of a TSS/360 FORTRAN output module follows the actual organization of the output module. For any FORTRAN source program other than a BLOCK DATA subprogram, the compiler generates an output module that consists of at least two control sections – a CSECT[1] and a PSECT. The CSECT contains executable code and other information that will not be changed during program execution. The name of the CSECT is derived from the user-supplied module name by appending the two characters #C to the module name, or its leftmost six characters. The PSECT is a prototype control section that contains a register save area, address constants (adcons), parameter lists, NAMELIST information, non-COMMON variables, and local and global temporary storage. The name of the PSECT is generated in the same manner as the name of the CSECT, the suffix for the PSECT being #P. If COMMON areas are defined, each COMMON (blank and any named COMMON) is represented by a common control section in the object program module.

The BLOCK DATA subprogram generates an output module that contains one or more common control sections. There is no CSECT or PSECT.

Default Option Listing

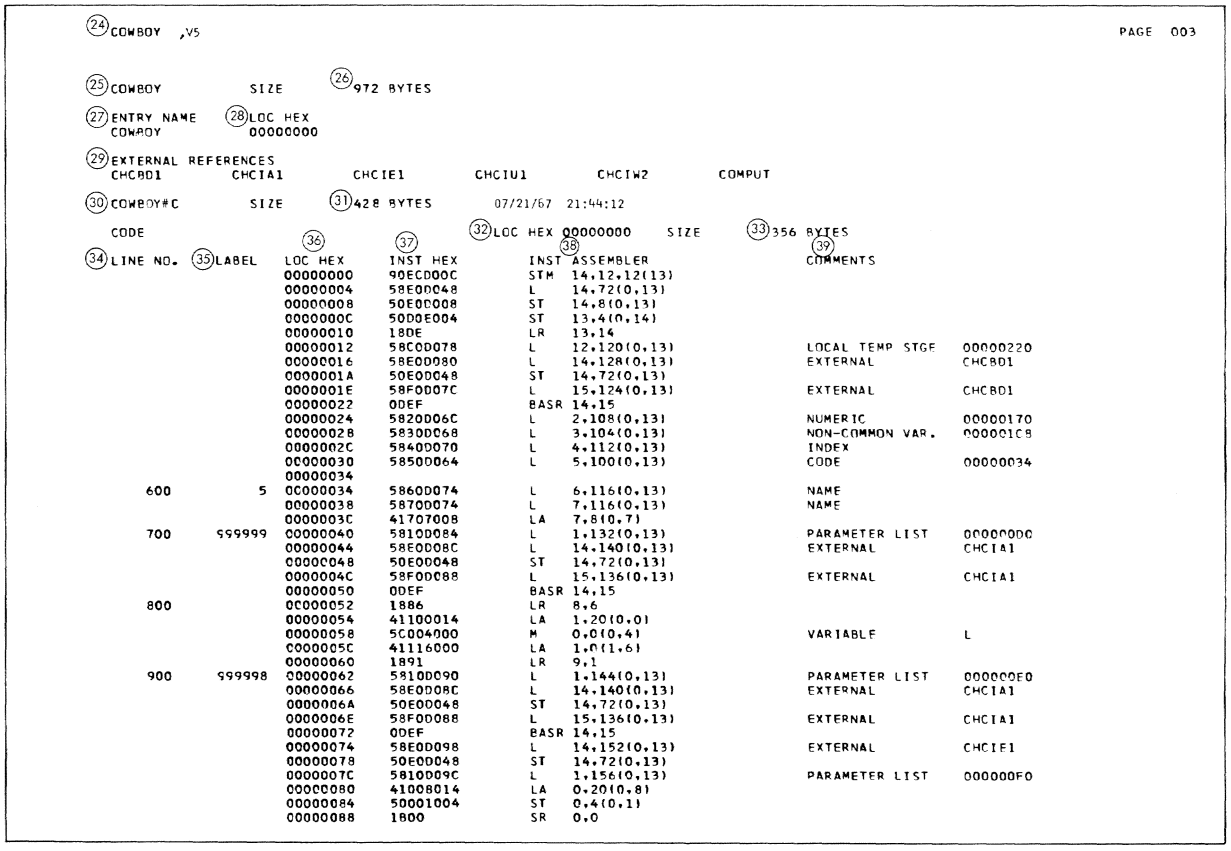
If the default options are chosen, an abbreviated description of the CSECT and PSECT is given. The sample shown in Figure 11 contains header information and

[1]The term "CSECT" generally refers to a control section other than a PSECT or a COMMON control section. In documentation or listings where compactness is necessary, the user may find CSECT referring to control sections in general.



```
(9)COWBOY  (10),V5                                                          PAGE  003

(11)COWBOY          SIZE        (12)972 BYTES

ENTRY NAME     LOC HEX
(13)COWBOY     (14)00000000

EXTERNAL REFERENCES
(15)CHCBD1     CHCIA1     CHCIE1     CHCIU1     CHCIW2     COMPUT

(16)COWBOY#C        SIZE     (17)428 BYTES    (18)07/21/67  21:44:12

(19)CODE                                      LOC HEX 00000000    SIZE       356 BYTES

(20)NUMERIC CONSTANTS                         LOC HEX 00000170    SIZE        60 BYTES


COWBOY  ,V5                                                                 PAGE  004

(21)COWBOY#P        SIZE     (22)544 BYTES    07/21/67  21:44:12

(23) REGISTER SAVE AREA                       LOC HEX 00000000    SIZE        76 BYTES
     CONVERSION CONSTANTS                     LOC HEX 0000004C    SIZE        24 BYTES
     ADDRESS CONSTANTS                        LOC HEX 00000064    SIZE       108 BYTES
     NAMELISTS                                LOC HEX 00000138    SIZE        28 BYTES
     ALPHAMERICS                              LOC HEX 00000158    SIZE       105 BYTES
     NON-COMMON VARIABLES (TOTAL)             LOC HEX 000001C8    SIZE        88 BYTES
     NAME                                                         SIZE        60 BYTES
     INDEX                                                        SIZE         8 BYTES
```

Figure 11. CSECT and PSECT Listings for Default Listing Options



```
(24)COWBOY  ,V5                                                             PAGE  003

(25)COWBOY          SIZE        (26)972 BYTES

(27)ENTRY NAME     (28)LOC HEX
    COWBOY          00000000

(29)EXTERNAL REFERENCES
    CHCBD1     CHCIA1     CHCIE1     CHCIU1     CHCIW2     COMPUT

(30)COWBOY#C        SIZE     (31)428 BYTES    07/21/67  21:44:12

    CODE                                      (32)LOC HEX 00000000    SIZE    (33)356 BYTES

(34)LINE NO.  (35)LABEL   (36)LOC HEX  (37)INST HEX  (38)INST  ASSEMBLER  (39)COMMENTS
                          00000000     90ECD00C      STM   14,12,12(13)
                          00000004     58E0D048      L     14,72(0,13)
                          00000008     50E0C008      ST    14,8(0,13)
                          0000000C     50D0E004      ST    13,4(0,14)
                          00000010     18DE          LR    13,14
                          00000012     58C0D078      L     12,120(0,13)          LOCAL TEMP STGE   00000220
                          00000016     58E0D080      L     14,128(0,13)          EXTERNAL          CHCBD1
                          0000001A     50E0D048      ST    14,72(0,13)
                          0000001E     58F0D07C      L     15,124(0,13)          EXTERNAL          CHCBD1
                          00000022     0DEF          BASR  14,15
                          00000024     5820D06C      L     2,108(0,13)           NUMERIC           00000170
                          00000028     5830D068      L     3,104(0,13)           NON-COMMON VAR.   000001C8
                          0000002C     5840D070      L     4,112(0,13)           INDEX
                          00000030     5850D064      L     5,100(0,13)           CODE              00000034
                          00000034
      600          5     00000034     5860D074      L     6,116(0,13)           NAME
                          00000038     5870D074      L     7,116(0,13)           NAME
                          0000003C     41707008      LA    7,8(0,7)
      700      999999     00000040     5810D084      L     1,132(0,13)           PARAMETER LIST    00000000
                          00000044     58E0D08C      L     14,140(0,13)          EXTERNAL          CHCIA1
                          00000048     50E0D048      ST    14,72(0,13)
                          0000004C     58F0D088      L     15,136(0,13)          EXTERNAL          CHCIA1
                          00000050     0DEF          BASR  14,15
      800                 00000052     1886          LR    8,6
                          00000054     41100014      LA    1,20(0,0)
                          00000058     5C004000      M     0,0(0,4)              VARIABLE          L
                          0000005C     41116000      LA    1,0(1,6)
                          00000060     1891          LR    9,1
      900      999998     00000062     5810D090      L     1,144(0,13)           PARAMETER LIST    000000E0
                          00000066     58E0D08C      L     14,140(0,13)          EXTERNAL          CHCIA1
                          0000006A     50E0D048      ST    14,72(0,13)
                          0000006E     58F0D088      L     15,136(0,13)          EXTERNAL          CHCIA1
                          00000072     0DEF          BASR  14,15
                          00000074     58E0D098      L     14,152(0,13)          EXTERNAL          CHCIE1
                          00000078     50E0D048      ST    14,72(0,13)
                          0000007C     5810D09C      L     1,156(0,13)           PARAMETER LIST    000000F0
                          00000080     41008014      LA    0,20(0,8)
                          00000084     50001004      ST    0,4(0,1)
                          00000088     1800          SR    0,0
```

Figure 12. CSECT Listing

a summary of PSECT *and* CSECT information. In the header information, a line is given containing the module name **9** and the version identification, **10**. Next, the module name is repeated, **11** and the size in decimal of the module (CSECT plus PSECT) is given, **12**. The name of the entry point follows, **13** with the location of this entry point relative to the CSECT, **14**. Next are listed all external references made by the compiled program, **15**. Only one of the external references listed (COMPUT) is also found in the source program. The other external names all begin with the three letters CHC, which identifies them as FORTRAN IV-supplied subprograms called by the object program. A list of all such programs, with their names, is given at the end of this appendix.

The name of the CSECT, **16**, and the number of storage locations in the CSECT, **17**, are then given. Also contained on this line is the time stamp associated with the CSECT, **18**. This time stamp is the same as that supplied for version identification, if the user defaulted this compilation parameter, or is obtained by the compiler for identification of the CSECT. Following this line is the size, **19**, and relative location, **20**, of the two types of information contained in the CSECT.

The next section gives a summary of the PSECT contents. The line containing the name, **21**, and size, **22**, of the PSECT is followed by the relative location and size of the seven principal areas in the PSECT, **23**.

Detailed Description of Output Module Listing

If an object code listing is requested, a detailed listing of the CSECT and PSECT (or COMMON control section, for BLOCK DATA subprograms) is given. Figures 12 and 13 contain examples of CSECT and PSECT listings, respectively. In addition, a listing of initialized variables is given. Figure 13A contains an example of the Table of Initialized Variables. The three listings are described below.

Header Information: Each page of the listing is headed by a line containing the user-specified module name, the version, and the page number, **24**. The next line in the listing contains the module name, **25**, and the module size in decimal, **26**. This size is the total number of bytes occupied by the CSECT and the PSECT, excluding COMMON control sections. This information is followed by a table of all entry names, **27**, and their locations (hexadecimal) relative to the base of the CSECT, **28**. The header information is completed by a list of all references to external routines, **29**.

Description of CSECT Listing: A line containing the name, **30**, and size, **31**, of the CSECT is printed immediately preceding the code. Next is a line giving the location of the executable code relative to the CSECT, **32**, followed by the size in decimal of the executable code, **33**. Following this line are six columns, described below.

1. *Line Number* **34**: The line numbers correspond to line numbers in the source data set. Each line number appears on the same print line as the first executable instruction of the respective source statement. Line numbers of nonexecutable statements (DIMENSION, COMMON, DATA, etc.) are omitted. However, CONTINUE statements are included in the listing.
2. *Label* **35**: Any entry name, statement number, or compiler-generated label is printed on the same line as the first instruction of the corresponding source statement that defines such a label. Compiler-generated labels indicate the destination of some compiler-generated branches. All compiler labels are six-digit numbers and are generated in a decreasing sequence starting with 999,999. (In some cases, the compiler-generated labels are not in descending sequence, and gaps may occur in the descending sequence due to compiler code optimization.)
3. *Hexadecimal Location* **36**: This column gives the location of the first byte of each instruction relative to the base of the CSECT.
4. *Instruction (Hexadecimal)* **37**: Each instruction is represented by its machine language (hexadecimal) configuration.
5. *Instruction (Assembly Type)* **38**: Each instruction is represented by its assembler language equivalent. All items in the operand field are decimal integers. No extended mnemonics are used except in conditional branches, where the operand field contains the label of the branch terminal.
6. *Comments* **39**: Whenever the operand (in storage) of an RX- or RS-type instruction can be meaningfully described, the description is printed in the comments column of the appropriate line.

   A referenced constant is commented by its value, which is printed in conventional FORTRAN representation, and by its location (hexadecimal) relative to the base of the CSECT. Each part — real and imaginary — of a complex constant is commented. Certain fixed binary constants can be commented upon with their values and storage locations, although the instructions do not actually refer to the constants but obtain them by other means (e.g., an SLL instruction).

   References to variables and elements of arrays contain the word "variable" followed by the variable or array name. No attempt is made to identify a reference to a specified subscripted array variable

```
COWBOY  ,V5                                                                                                    PAGE  004


LINE NO.     LABEL    LOC HEX     INST HEX       INST  ASSEMBLER                COMMENTS
                      0000008A    58F0D094       L     15,148(0,13)             EXTERNAL          CHCIE1
                      0000008E    0DEF           BASR  14,15
                      00000090    58E0D0A4       L     14,164(0,13)             EXTERNAL          CHCIU1
                      00000094    50E0D048       ST    14,72(0,13)
                      00000098    58F0D0A0       L     15,160(0,13)             EXTERNAL          CHCIU1
                      0000009C    0DEF           BASR  14,15
   1000         10    0000009E    41808014       LA    8,20(0,8)
                      000000A2    1989           CR    8,9
                      000000A4    4770502E       BNE   999998
                      000000A8    41606004       LA    6,4(0,6)
                      000000AC    1967           CR    6,7
                      000000AE    4770500C       BNE   999999
   1100               000000B2    5810D0A8       L     1,168(0,13)              PARAMETER LIST    000000F8
                      000000B6    58E0D080       L     14,176(0,13)
                      000000BA    50E0D048       ST    14,72(0,13)
                      000000BE    58F0D0AC       L     15,172(0,13)             EXTERNAL          COMPUT
                      000000C2    0DEF           BASR  14,15
   1400               000000C4    58604000       L     6,0(0,4)                 VARIABLE          L
                      000000C8    59604004       C     6,4(0,4)                 VARIABLE          M
                      000000CC    47B0511E       BNL       20
   1500               000000D0    5810D084       L     1,180(0,13)              PARAMETER LIST    00000100
                      000000D4    58E0D08C       L     14,140(0,13)             EXTERNAL          CHCIA1
                      000000D8    50E0D048       ST    14,72(0,13)
                      000000DC    58F0D088       L     15,136(0,13)             EXTERNAL          CHCIA1
                      000000E0    0DEF           BASR  14,15
                      000000E2    58E0D098       L     14,152(0,13)             EXTERNAL          CHCIE1
                      000000E6    50E0D048       ST    14,72(0,13)
                      000000EA    1873           LR    7,3
                      000000EC    41000001       LA    0,1(0,0)
                      000000F0    50003004       ST    0,4(0,3)                 VARIABLE          I
              999996  000000F4    5810D088       L     1,184(0,13)              PARAMETER LIST    00000110
                      000000F8    1800           SR    0,0
                      000000FA    58F0D094       L     15,148(0,13)             EXTERNAL          CHCIE1
                      000000FE    0DEF           BASR  14,15
                      00000100    5810D08C       L     1,188(0,13)              PARAMETER LIST    00000118
                      00000104    41007030       LA    0,48(0,7)
                      00000108    50001004       ST    0,4(0,1)
                      0000010C    1800           SR    0,0
                      0000010E    58F0D094       L     15,148(0,13)             EXTERNAL          CHCIE1
                      00000112    0DEF           BASR  14,15
                      00000114    5810D0C0       L     1,192(0,13)              PARAMETER LIST    00000120
                      00000118    41007008       LA    0,8(0,7)
                      0000011C    50001004       ST    0,4(0,1)
                      00000120    1800           SR    0,0
                      00000122    58F0D094       L     15,148(0,13)             EXTERNAL          CHCIE1
                      00000126    0DEF           BASR  14,15
                      00000128    41707004       LA    7,4(0,7)
                      0000012C    58603004       L     6,4(0,3)                 VARIABLE          I
                      00000130    41606001       LA    6,1(0,6)
                      00000134    50603004       ST    6,4(0,3)                 VARIABLE          I
                      00000138    5960201C       C     6,28(0,2)                        10    AT  0000018C


COWBOY  ,V5                                                                                                    PAGE  005


LINE NO.     LABEL    LOC HEX     INST HEX       INST  ASSEMBLER                COMMENTS
                      0000013C    47D05000       BNH   999996
                      00000140    58E0D0A4       L     14,164(0,13)             EXTERNAL          CHCIU1
                      00000144    50E0D048       ST    14,72(0,13)
                      00000148    58F0D0A0       L     15,160(0,13)             EXTERNAL          CHCIU1
                      0000014C    0DEF           BASR  14,15
   1600               0000014E    47F05000       B         5
   1700         20    00000152    5810D0C4       L     1,196(0,13)
                      00000156    58E0D0CC       L     14,204(0,13)
                      0000015A    50E0D048       ST    14,72(0,13)
                      0000015E    58F0D0C8       L     15,200(0,13)             EXTERNAL          CHCIW2
                      00000162    0DEF           BASR  14,15

(40) NUMERIC CONSTANTS          (41) LOC HEX 00000170    SIZE    (42) 60 BYTES

(43) TYPE        (44) LOC HEX     (45) CONTENTS HEX
     I*4         00000170         00000000
     I*4         00000174         00000001
     I*4         00000178         00000002
     I*4         0000017C         00000005
     I*4         00000180         00000004
     I*4         00000184         00000014
     I*4         00000188         00000006
     I*4         0000018C         0000000A
     I*4         00000190         00000008
     I*4         00000194         00000080
     I*4         00000198         00000020
     I*4         0000019C         000000C0
     I*4         000001A0         00000033
     I*4         000001A4         00000040
     I*4         000001A8         00000032
```

Figure 12. CSECT Listing, Continued

(element of an array). This information must be obtained by inspecting the D2, X2, and B2 fields of the instruction itself. As in the case of constants, references to complex variables are fully commented upon in both parts.

Subroutine calls are described by the word "external" followed by the name of the subroutine. In a number of subroutine calls there can be two such comments.

Arguments, or, specifically, adcons that contain the base register[1] for arguments at object time, are indicated by the word "argument" and the name of the argument. The actual arguments themselves are identified as "variable" followed by the argument name.

References to local or global temporary storage are printed as "local temp" and "global temp," respectively. Again, the location of the temporary storage item must be obtained from the operand field of the instruction.

Address constants are described by the names of the storage classes the adcons cover and the prerelocation values of such adcons (zero values are not printed). The following items can appear in the comments column in connection with adcon references:

CODE	Base register adcon for executable code
NUMERIC	Base register adcon for numerical constants
PARAMETER LIST	Adcon that contains the base register for the parameter list in a subroutine call
LOCAL TEMP STGE	Local temporary storage base register adcon
GLOBAL TEMP STGE	Global temporary storage base register adcon
NON-COMMON VAR.	Base register adcon for variables not declared in any COMMON
BLANK COMMON	Blank COMMON base register adcon
Name of a named COMMON	Base register adcon for that named COMMON

All numerical constants are listed at the end of the CSECT (after the listing of executable code), **40**. The relative location of the numerical constants in the CSECT is given, **41**, followed by the length in decimal of the numerical constants, **42**. Each constant is described by its type and length, **43**, location within the CSECT, **44**, and its internal representation, **45**. The types are:

I – fixed binary (integer)
R – floating binary (real)
C – floating binary (complex)

The length is given in bytes, thus, for example:

I*4 means an integer constant of 4-byte length.
C*16 means a complex constant (floating binary) with a *total* length of 16 bytes – 8 bytes for the real part and 8 bytes for the imaginary part.

Description of PSECT Listing

The information contained in the page heading line, **46**, and PSECT title line, **47**, is similar to that contained in the corresponding lines of the CSECT listing. Listed next is the relative location within the PSECT and the length of the areas.

A sample PSECT listing is shown in Figure 13.

1. *Register Save Areas* **48**: This area is used to preserve register contents upon executing a call to a subroutine.
2. *Conversion Constants* **49**: This area contains the necessary masks and working storage needed by some in-line conversions (e.g., fixed to floating).
3. *Address Constants* **50**, **51**: Each adcon is described by:
   a. The location of the adcon relative to the base of the PSECT.
   b. The contents (value) of the adcon prior to relocation.
   c. The control section referred to by the adcon or, in the case of arguments and external references, the item referred to by the adcon.
   d. The "storage class referenced" describes what part of the specified control section is covered by the adcon or what argument or external name corresponds to the adcon.

Following the description of the above three areas is a listing of the individual items contained in the PSECT. The first item in this listing is the address constants, **51**. The address constants are followed by six other groups of items, described below.

1. *Parameter Lists* **52**: The listing of items in the parameter list section of the PSECT is in a format identical to that of the adcon listing. A number of items may have no entries under "Control Section Referenced" and "Storage Class Referenced." This indicates that the contents of such parameters are not known at compile time and that the parameter is computed and stored in the indicated location upon execution of the program.
2. *NAMELISTs* **53**: This area contains the internal representation of NAMELIST information. Only the total size is printed.
3. *Alphamerics* **54**: Any alphameric constants, including contents of FORMAT statements, are listed by giving the starting byte of the character string followed by the string itself.

[1]The term "base register adcon" is used to refer to an address constant that is loaded into a base register.

```
(46) COWBOY   ,V5                                                                                    PAGE  006


(47) COWBOY*P          SIZE         544 BYTES        07/21/67  21:44:12

(48) REGISTER SAVE AREA                              LOC HEX 00000000    SIZE          76 BYTES

(49) CONVERSION CONSTANTS                            LOC HEX 0000004C    SIZE          24 BYTES

(50) ADDRESS CONSTANTS                               LOC HEX 00000064    SIZE         108 BYTES

(51) LOC HEX      CONTENTS HEX     CONTROL SECTION REFERENCED       STORAGE CLASS REFERENCED
     00000064      00000034      CSECT                            CODE
     00000068      000001C8      PSECT                            NON-COMMON VAR.
     0000006C      00000170      CSECT                            NUMERIC
     00000070      00000000      INDEX                            INDEX
     00000074      00000000      NAME                             NAME
     00000078      00000220      PSECT                            LOCAL TEMP STGE
     0000007C      00000000      EXTERNAL                         CHCBD1
     00000080      00000000      EXTERNAL                         CHCBD1
     00000084      00000000      PSECT                            PARAMETER LIST
     00000088      00000000      EXTERNAL                         CHCIA1
     0000008C      00000000      EXTERNAL                         CHCIA1
     00000090      000000EC      PSECT                            PARAMETER LIST
     00000094      00000000      EXTERNAL                         CHCIE1
     00000098      00000000      EXTERNAL                         CHCIE1
     0000009C      000000F0      PSECT                            PARAMETER LIST
     000000A0      00000000      EXTERNAL                         CHCIU1
     000000A4      00000000      EXTERNAL                         CHCIU1
     000000A8      000000F8      PSECT                            PARAMETER LIST
     000000AC      00000000      EXTERNAL                         COMPUT
     000000B0      00000000      EXTERNAL                         COMPUT
     000000B4      00000100      PSECT                            PARAMETER LIST
     000000B8      0000011C      PSECT                            PARAMETER LIST
     000000BC      00000118      PSECT                            PARAMETER LIST
     000000C0      00000120      PSECT                            PARAMETER LIST
     000000C4      0000012C      PSECT                            PARAMETER LIST
     000000C8      00000000      EXTERNAL                         CHCIW2
     000000CC      00000000      EXTERNAL                         CHCIW2

(52) PARAMETER LIST                                  LOC HEX 000000D0    SIZE         100 BYTES

     LOC HEX      CONTENTS HEX     CONTROL SECTION REFERENCED       STORAGE CLASS REFERENCED
     000000D0      0000017C      CSECT                            NUMERIC
     000000D4      00000197      CSECT                            NUMERIC
     000000D8      00000198      CSECT                            NUMERIC
     000000DC      00000138      NUM                              NAMELIST
     000000E0      0000017C      CSECT                            NUMERIC
     000000E4      00000197      CSECT                            NUMERIC
     000000E8      0000019F      CSECT                            NUMERIC
     000000EC      00000158      PSECT                            ALPHAMERICS
     000000F0      000001A3      CSECT                            NUMERIC
     000000F4      00000000
     000000F8      000001F8      PSECT                            NON-COMMON VAR.
     000000FC      00000100      PSECT                            NON-COMMON VAR.



     COWBOY   ,V5                                                                                    PAGE  007


     LOC HEX      CONTENTS HEX     CONTROL SECTION REFERENCED       STORAGE CLASS REFERENCED
     00000100      00000188      CSECT                            NUMERIC
     00000104      000001A7      CSECT                            NUMERIC
     00000108      0000019F      CSECT                            NUMERIC
     0000010C      00000160      PSECT                            ALPHAMERICS
     00000110      000001AB      CSECT                            NUMERIC
     00000114      000001CC      PSECT                            NON-COMMON VAR.
     00000118      000001A3      CSECT                            NUMERIC
     0000011C      00000000
     00000120      000001A3      CSECT                            NUMERIC
     00000124      00000000
     00000128      00000000
     0000012C      0000012B      PSECT                            PARAMETER LIST
     00000130      00000000

(53) NAMELISTS                                       LOC HEX 00000138    SIZE          28 BYTES

(54) ALPHAMERICS                                     LOC HEX 00000158    SIZE         105 BYTES

     LOC HEX      ALPHA
     00000158     (2E20.8)
     00000160     ('1TEST PROGRAM SAMPLE OUTPUT FOLLOWS'/'0  I             A                   B'/(I6,E20.8,E20.8))

(55) NON-COMMON VARIABLES (TOTAL)                    LOC HEX 000001C8    SIZE          88 BYTES

     LOC HEX      VARIABLE         TYPE
     000001C8      J               I*4
     000001CC      I               I*4
     00000100      B               R*4
     000001F8      A               R*4

(56) NAME                                                                SIZE          60 BYTES

     LOC HEX      VARIABLE         TYPE
     00000000      C               R*4
     00000014      D               R*4

     INDEX                                                               SIZE           8 BYTES

     LOC HEX      VARIABLE         TYPE
     00000000      L               I*4
     00000004      M               I*4
```

Figure 13. PSECT Listing

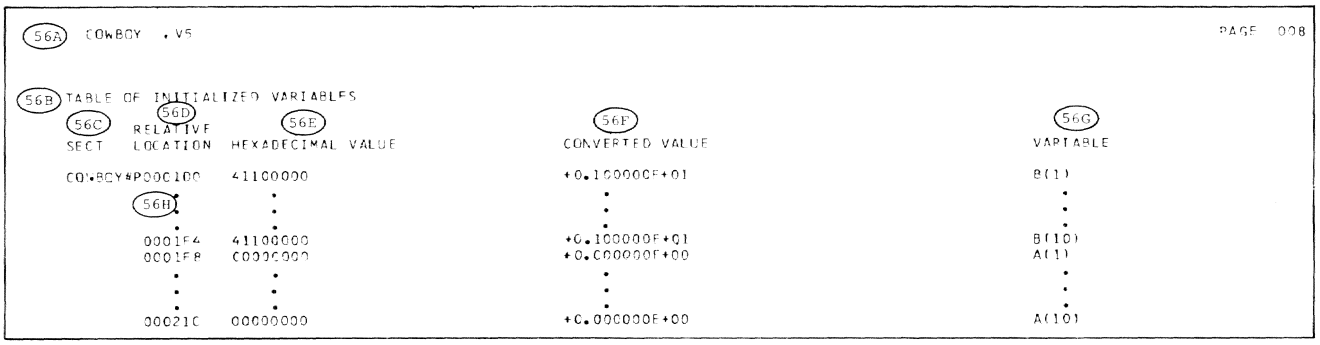


Figure 14. Table of Initialized Variables

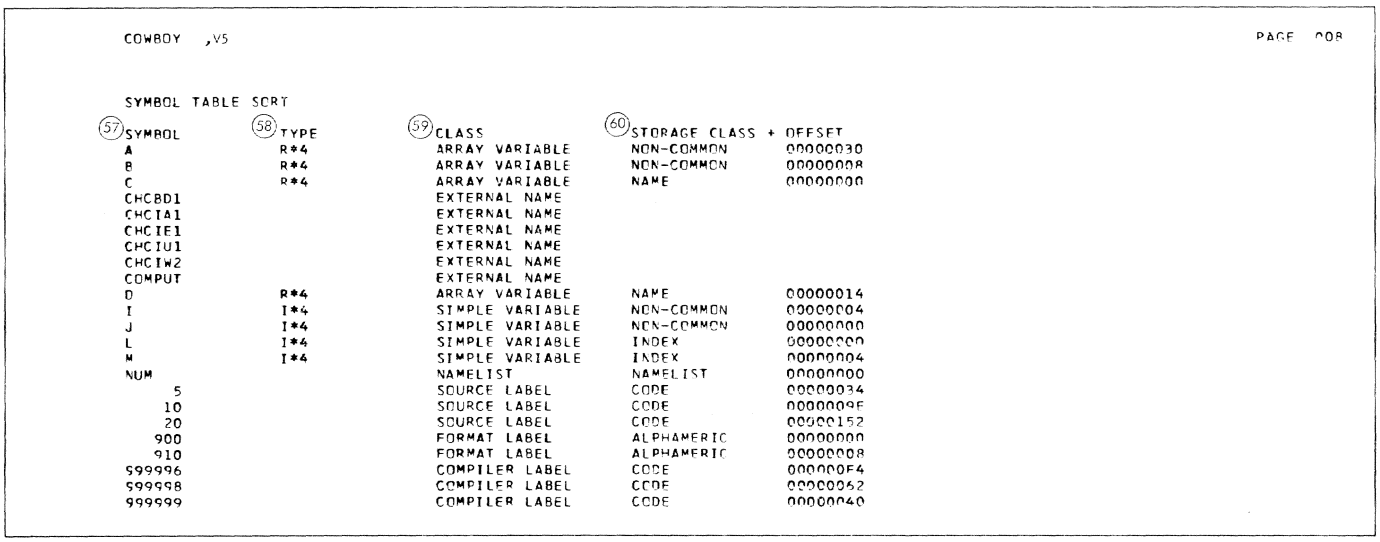


Figure 15. Symbol Table Listing

4. *Temporary Storage:* As in the case of NAMELIST, local and global temporary storage blocks are identified on the listing by their starting locations (relative to the PSECT's base) and their respective sizes. The example contains no temporary storage blocks.
5. *Non-COMMON Variables* **55** : The listing of the PSECT is completed by information about non-COMMON variables. The starting location of the non-COMMON variable block and its total size are given. Each variable (or array) is described by its location with respect to the base of the PSECT, the name, and the type-length code. The type-length codes have the same meanings as described under constants.
6. *Common Control Sections Listing* **55** : Any COMMON block — blank or named — is identified by its name and the total size in bytes. All variables contained in a COMMON block are listed in the same format as non-COMMON variables. The locations are relative to the base of the respective COMMON block.

Description of Table of Initialized Variables

The page heading line, **56A** , is identical to the heading on the CSECT and PSECT listings. The next line in the listing contains the listing title, **56B** , followed by the column headings. The information contained in the five columns is described below.

1. *SECT* **56C** : This column contains the module name specified by #P if a main program. If a BLOCK DATA subprogram is compiled, the name of the COMMON block will print. If more than one page of listing is required, the name will be repeated on the first line of data on each page.
2. *Relative Location* **56D** : This column gives the hexadecimal value of the displacement of the variable within the section.
3. *Hexadecimal Value* **56E** : This column gives the hexadecimal value of the preset variable as it appears in the text.
4. *Converted Value* **56F** : This column contains the preset value converted according to type of con-

stant. These types are: hexadecimal, integer, real, complex, logical, and literal.

5. *Variable* **56G** : The variable name with subscript, if applicable, prints in this column. Variables are listed in order by displacement within section.

Columns 2-5 may also contain a "3-dot" notation, **56H** , if the repetition factor of a preset value exceeds 5. In this case, only the first and last values of the range print on the listing.

Description of Symbol Table Listing

The symbol table listing (symbol table sort) contains an alphamerically sorted listing of symbols — names of variables, entry points, external references, labels, etc. Each symbol is printed on a line and is described as follows.

The name of the symbol, **57** , is followed by its type-length code, **58** . The code has a meaning for the item represented by the given symbol. Entries under "class" further describe the item, and they are self-explanatory, **59** . "Storage class + offset," **60** , identifies the storage class to which a given symbol belongs and the location within such storage class. Under "storage class" there can be references to blank COMMON, code, alphameric, name of a named COMMON, etc. External names are not part of the compiled module; therefore, no information can be given for storage class + offset.

A sample Symbol Table Listing is shown in Figure 15.

```
   COWBOY   ,V5                                                          PAGE  009

(61)SYMBOL CROSS-REFERENCE LIST
   SYMBOL    DEFINITIONS (62)          (63)REFERENCES
   A                                   200  400  1100  1500
   B                                   200  400  1100  1500
   C                                   300
   CHCBD1                              0
   CHCIA1                              700  900  1500
   CHCIE1                              900  1500
   CHCIU1                              900  1500
   CHCIW2                              1700
   COMPUT                              1100
   COWBOY                              0
   D         900                       300
   I         600  1500                 900  1500  1500  1500
   INDEX                               300
   J         800                       900
   L                                   300  500  800  1400
   M                                   300  1400
   NAME                                300
   NUM                                 500  700


   COWBOY   ,V5                                                          PAGE  010

(64)LABEL CROSS-REFERENCE LIST
   LABEL     DEF(65)    REFERENCES(66)
   00005     600        1600
   00010     1000       600  800
   00020     1700       1400
   00900     1800       900
   00910     1900       1500
```

Figure 16. Cross-reference Listing

Description of Cross-reference Listing

The cross-reference listing is divided into two sections: a listing of names (symbols), **61**, followed by a listing of labels, **64**. Both sections list the corresponding items in alphamerically sorted sequence. Line numbers, as defined in the source listing, are printed under "definitions," **62** and **65**, and "references," **63** and **66**, for each item. Whenever an item is defined (e.g., label of a labeled statement or variable name on the left side of an assignment statement), the corresponding line number is printed in the "definitions" column. Any reference to an item causes an entry under "references." Multiple entries for any item are sorted in order of increasing line numbers. Multiple references to the same item in the same source line result in multiple printing of the same line number for that item. Compiler-generated labels are not included in the listing.

A sample cross-reference listing is shown in Figure 16.

Description of Storage Map Listing

If an object code listing or both an object code listing and a storage map listing are requested, the listing produced will be as described in the detailed description of the output module listing above. If a storage map listing is requested and no object listing is requested, the resultant listing will contain summary information for the module, **67**, CSECT, **68**, and for the PSECT, **69**. This information includes the CSECT and PSECT sizes, external definitions and references, the location relative to the CSECT of all FORTRAN statement numbers, the size in the CSECT of the numeric constants area, the relative location and the size of the principle PSECT areas, and the location in the PSECT of all variable names.

A sample storage map listing is shown in Figure 17.

```
        COWBOY   ,V5                                                                    PAGE  003


(67)    COWBOY          SIZE        972 BYTES

        ENTRY NAME      LOC HEX
        COWBOY          00000000

        EXTERNAL REFERENCES
        CHCBD1      CHCIA1      CHCIE1      CHCIU1      CHCIW2      COMPUT

(68)    COWBOY#C        SIZE        428 BYTES       07/21/67  21:44:12

        CODE                                        LOC HEX 00000000    SIZE        356 BYTES

        LINE NO.    LABEL   LOC HEX
                            00000034
            600             00000034
            700     999999  00000040
            800             00000052
            900     999998  00000062
           1000         10  0000009E
           1100             00000082
           1400             000000C4
           1500             000000D0
                    999996  000000F4
           1600             0000014E
           1700         20  00000152

        NUMERIC CONSTANTS                           LOC HEX 00000170    SIZE         60 BYTES



        COWBOY   ,V5                                                                    PAGE  004


(69)    COWBOY#P        SIZE        544 BYTES       07/21/67  21:44:12

        REGISTER SAVE AREA                          LOC HEX 00000000    SIZE         76 BYTES

        CONVERSION CONSTANTS                        LOC HEX 0000004C    SIZE         24 BYTES

        ADDRESS CONSTANTS                           LOC HEX 00000064    SIZE        108 BYTES

        NAMELISTS                                   LOC HEX 00000138    SIZE         28 BYTES

        ALPHAMERICS                                 LOC HEX 00000154    SIZE        105 BYTES

        NON-COMMON VARIABLES (TOTAL)                LOC HEX 000001C8    SIZE         88 BYTES

        LOC HEX     VARIABLE        TYPE
        000001C8    J               I*4
        000001CC    I               I*4
        00000100    B               R*4
        000001F8    A               R*4

        NAME                                                            SIZE         60 BYTES

        LOC HEX     VARIABLE        TYPE
        00000000    C               R*4
        00000014    D               R*4

        INDEX                                                           SIZE          8 BYTES

        LOC HEX     VARIABLE        TYPE
        00000000    L               I*4
        00000004    M               I*4
```

Figure 17. Storage Map Listing

Compilation Completed Message: Following production of requested listings, the page is restored and the message COMPILATION COMPLETED is written.

Destination of Compiler-Produced Listings

The destinations of compiler-produced listings depend on whether the task is conversational or nonconversational, and on the value of the FTN command's LISTDS operand.

Conversational Tasks

In conversational tasks, all compiler-produced listings are placed in the list data set unless the LISTDS operand of the FTN command specifies SYSOUT.

Printing of the list data sets prepared by the compiler is not automatic. Each time a unique module name is encountered, a generation data group is established, containing two generations. Each time the limit (two generations) is reached, the oldest generation is erased. The user may print only when he wants the output listings, using: PRINT LIST.module-name followed by the relative or absolute generation. The *Command System User's Guide* presents a complete explanation of the language processor listing data set maintenance process.

Since a pending BULK/IO task will be established when the PRINT command is issued for the language processor listing data set, the user must not attempt to erase the data set (or otherwise remove it from the system) unless the BSN is canceled first.

Nonconversational Tasks

In nonconversational tasks, the system automatically puts compiler-produced listings on SYSOUT and prints them. After printing, the listing no longer exists in the system.

This system action can be overridden, however, by the LISTDS operand of the FTN command. If you specify LISTDS=Y, the system puts the listing in the list data set and maintains it exactly as in a conversational task.

You can have the listing put in the list data set and printed immediately by specifying LISTDS=Y and following the compiler source statements with an appropriate PRINT command.

Note that if you use a PRINT command in a nonconversational task initiated from the terminal, you can always cancel the printout by issuing a CANCEL command. However, the CANCEL command does not prevent printing of a listing, or any part of a listing, that is already waiting in the SYSOUT data set.

FORTRAN IV Library Subprograms: Indirect References

Most FORTRAN IV library subprograms are referred to in a compiled program directly — i.e., by the same name used in the source program; the statement

$$X = SIN(Y)$$

for example, leads to a call on the SIN program, and SIN will be listed under external references in an object code listing. Certain other FORTRAN library subprograms are referred to by names created by the compiler. These programs are listed as follows, with their names.

CHCBGA	Raises an I*4	number to an I*4 power
CHCBGB	Raises an I*2	number to an I*2 power
CHCBGC	Raises an I*2	number to an I*4 power
CHCBGD	Raises an I*4	number to an I*2 power
CHCBHA	Raises an R*4	number to an I*4 power
CHCBHB	Raises an R*4	number to an I*2 power
CHCBIA	Raises an R*8	number to an I*4 power
CHCBIB	Raises an R*8	number to an I*2 power
CHCBJA	Raises an R*4	number to an R*4 power
CHCBJB	Raises an I*2	number to an R*4 power
CHCBJC	Raises an I*4	number to an R*4 power
CHCBKA	Raises an R*8	number to an R*8 power
CHCBKB	Raises an I*2	number to an R*8 power
CHCBKC	Raises an I*4	number to an R*8 power
CHCBKD	Raises an R*4	number to an R*8 power
CHCBKE	Raises an R*8	number to an R*4 power
CHCBMA	Raises a C*16	number to an I*4 power
CHCBMB	Raises a C*16	number to an I*2 power
CHCBCA	Raises a C*8	number to an I*4 power
CHCBCB	Raises a C*8	number to an I*2 power
CHCBD1	Initialize interrupt processing.	
CHCIA1	Initialize for an I/O call.	
CHCIE1	Transmit an I/O value.	
CHCIU1	Terminate an I/O call.	
CHCIV1	DUMP program	
CHCIV2	PDUMP program	
CHCIW1	EXIT program	
CHCIW2	STOP program call.	
CHCIW3	PAUSE program call.	
CHCIW5	Called if FORTRAN subprograms are erroneously entered at their standard entry point.	

Reference To Subroutines

Special considerations must be made when a FORTRAN main program makes references to subprograms. If a main program and its associated subprograms are compiled together, and an error is detected in one of the subprograms, that subprogram must be recompiled. The recompiled output module may be placed in the same program library as the original or in a different one. Depending on which method is chosen, the results will vary.

If the recompiled module is placed in the same program library, the user is asked if the module is a replacement. If it is, (the default condition) the system tries to unload any module in the user's virtual

storage that has the same name. The unloader will find a module but will not be able to unload it because of outstanding references. Unless the user explicitly issues an UNLOAD command for his main program, he will not get his new copy of the subprogram.

If the user defines a new program library, he will not be asked if the module is a replacement. Consequently, if he reruns the program, he will use the old copy since it is still loaded.

The simplest solution is for the user to unload the main program before he starts recompilation. He can also unload modules that have references to the new module, but this might not work since the modules he tries to unload might satisfy references in other modules. If the user unloads his main program, he avoids getting diagnostics from the loader during compilation and ensures that the latest level of the module is being used.

Destination of Output

Table 3 shows the destination of all output from any compilation variation.

Compiler Restrictions

Limitations of virtual storage available to the compiler and the object programs generated by it impose a number of restrictions on the size of a source program capable of being compiled. These restrictions are categorized according to complexity. The first category, simple source program restrictions, can easily be applied to individual source statements or particular types of source statements. Simple source program restrictions are listed in Table 4.

The term "file" is used in this section to refer to compiler work areas.

The second category, complex restrictions, is composed of restrictions that generally are too complex to anticipate in advance of compilation (e.g., the storage requirements of the various tables internal to the compiler are, in many cases, extremely difficult to compute accurately, as the table sizes are complex functions of the source program). Very few programs are of such a size or configuration that these complex restrictions can be met. Therefore, the FORTRAN user may not wish to concern himself with the complex restrictions until he receives a diagnostic message; then he can proceed to remedy the situation. Complex source program restrictions are listed in Table 5.

Should the user wish to more accurately determine the number of entries that can be made in the files listed in Table 5, the following paragraphs provide information allowing him to do so. For each file listed in Table 5, either a formula, an absolute number, or an average number is given as a measure of the number of storage locations (bytes) in the file.

Symbol Table	*Storage Locations*
Variable or function-name	28
Four-byte constant	16
Eight-byte constant	20
Sixteen-byte constant	28
Label	20
Adcon	16

Program Representation File (PRF)	*Storage Locations*
Equation	16
Unconditional GO TO	16
IF	28
CALL	20
DO	64
Average I/O Statement (Five list elements, two of them subscripted)	74
Average Label Definition	12

Expression File (EF)	*Storage Locations*
Average Equation (Ten variables and operators)	80
Unconditional GO TO	0
Average IF (Arithmetic IF)	80
Average CALL (One simple argument)	80
Average DO	0
Average I/O Statement (Five list elements, two of them subscripted)	100
Average Label Definition	0

Storage Specification List (SPL)	*Storage Locations*
Average COMMON (Three variables, arrays, or block names)	20
Average EQUIVALENCE (Three variables)	30

Cross Reference Table (CRL)

CRL size = (number of occurrences of statement numbers + number of occurrences of names) x 8

Preset Data Table (PDT)	*Storage Locations*
The PDT size is estimated from the relation: PDT size = CRL size (described above) + NAMELIST size (described below) + total for the following four types of statements.	
Average DIMENSION (Two arrays of three dimensions each)	24

Table 5. Complex Source Program Restrictions

Table 5. Complex Source Program Restrictions

Item (Storage limit[1])	Overflow Cause	Comments	Associated Diagnostic Message(s)	Corrective Action[2]
Symbol Table (limited to 20 pages; 81,920 bytes)	Too many names, constants, and statement numbers in the source program.		SYMBOL TABLE OVERFLOW, SPLIT PROGRAM AND COMPILE PARTS SEPARATELY SYMBOL TABLE OVERFLOW, TOO MANY NAMES, CONSTANTS, AND FORMATS SYMBOL TABLE OVERFLOW IN PHASE 2. RETURN IS TO hex location	
Program Representation File and Expression File (limited to 60 pages; 245,760 bytes)	Source program too large.	Excessive use of nested statement function references and multidimensioned subscripted variables (whose subscripts cannot be resolved at compile time) may contribute significantly to the size of this area.	FILE OVERFLOW. TOO MANY EXECUTABLE STATEMENTS	
Storage Specification List (limited to 60 pages; 245,760 bytes)	Too much COMMON or EQUIVALENCE information.		TABLE OVERFLOW. TOO MUCH COMMON AND EQUIVALENCE INFORMATION	
Cross Reference Table (see Preset Data Table)	Defining and referencing too many variables and statement numbers.		CROSS-REFERENCE TABLE OVERFLOW	Do not request a Cross Reference Listing.
Preset Data Table (Preset Data Table plus Cross Reference Table limited to 32 pages; 131,072 bytes)	Too many initial values, name lists, and formats.	In programs containing a large number of entries in DATA statements, Preset Data Table storage requirements may be reduced by use of repeat constants whenever possible.	TABLE OVERFLOW. TOO MANY INITIAL VALUES, NAME-LISTS, AND FORMATS	Use Block Data subprograms to preset initial values.
Statement Function Expression File (limited to 110,480 bytes)	The cummulative size of statement function definitions is too large.		TABLE OVERFLOW. TOO MANY STATEMENT FUNCTIONS	Use function subprograms to define the larger functions.
Non-COMMON Variable Storage	Too many non-COMMON variables in the source program.		STORAGE ASSIGNMENT TO NON-COMMON VARIABLE name IS TOO LARGE	
COMMON Variable Storage	Too many COMMON variables in the source program.		STORAGE ASSIGNMENT TO COMMON VARIABLE name IS TOO LARGE	
Program File (limited to 60 pages; 245,760 bytes)	Source program too large.		PROGRAM FILE OVERFLOW IN PHASE 3	
Code File (limited to 60 pages; 245,760 bytes)	Source program too large.	Excessive use of deeply nested statement functions, multi-dimensioned subscripted variables, and complex arithmetic may contribute significantly to the size of this area.	CODE FILE OVERFLOW. SPLIT PROGRAM AND COMPILE PARTS SEPARATELY.	
Adcon Page (4096 bytes)	Source program too large.	Total of all statement numbers in assigned GO TO statements, the number of input/output lists, and the number of function references contribute significantly to the size of this area.	ADCON PAGE OVERFLOW. SPLIT PROGRAM AND COMPILE PARTS SEPARATELY.	
Phase 2 Internal Table	Too many non-COMMON variable names and/or too many names in EQUIVALENCE statements.	The available space for sorting non-COMMON variables to determine storage assignments, or for solving EQUIVALENCE relationships, has been exceeded.	INTERNAL TABLE OVERFLOW IN PHASE 2. RETURN IS TO hex location	
Optimization Table (limited to 16,384 bytes)	Source program too large.	Contributors to this table are primarily related to the size of the source program, particularly the number of DO loops and the extent of subscripted variable storage.	WORKING STORAGE OVERFLOW IN PHASE 3.	
Program Module Dictionary (limited to 6 pages; 24,576 bytes)	Source program too large.	The amount of storage specified in DIMENSION statements, the number of subprogram references, and the number of I/O statements contribute significantly to the size of this area.	PROGRAM MODULE DICTIONARY TABLE OVERFLOW	
Name Table (External Name List) (limited to 2 pages; 8,192 bytes)	Too many ENTRY statements.		NO. OF ENTRY OR COMMON NAMES HAVE CAUSED A NAME TABLE OVERFLOW	Reduce the number of ENTRY statements or named COMMON names.
Internal Symbol Dictionary (limited to 10 pages; 40,960 bytes)	Too many variables and source statements.		INTERNAL SYMBOL DICTIONARY OVERFLOW	Do not request an Internal Symbol Dictionary.
Object Program Module (limited to 42 pages; 172,032 bytes)	Source program too large.		OBJECT PROGRAM MODULE EXCEEDS ALLOCATED SIZE	
Name List (common and removed expression table)	There may be only 4095 distinct expressions (including sub-expressions) recognizable as common or removable from loops.		NAME LIST DEPLETED IN PHASE 3.	
Number of terms in the internal linear form of a subscript is limited to 184 divided by (the number of dimensions + 1)	The maximum number has been exceeded.		TABLE OVERFLOW. SUBSCRIPT EXPRESSION IS TOO BIG	Use an assignment statement to compute all or part of the subscript prior to its use as a subscript.
The maximum number of formal arguments in a function or subroutine subprogram is limited to 126.[3]	The maximum number has been exceeded, but see comments.	In certain cases the maximum is somewhat less than 126: The Preset Data Table, the Cross Reference List (CRL), and the Formal Argument Adcon List (FAAL), share a common work area of 32 pages. The space allotted to the FAAL is only that not needed by the other two. Omitting the CRL option will leave more space for the FAAL.	FORMAL ARGUMENT ADCON TABLE OVERFLOWED IN PHASE 3.	Do not request a Cross Reference listing.
Number of primitives (function names, constants, and variables, including constants and variables that appear in subscripts and as arguments to function references) in an expression may not exceed 2500. Generally there is a one-to-one correspondence between the elements of an expression in the source statement and the internal representation. There are two cases where this is not true, and where the internal representation may become quite large: 1. Statement function references. 2. Subscripts.	1. Statement function references are expanded inline; therefore, the use of deeply nested statement functions may contribute significantly to the size of the internal representation of the expression. 2. Variable subscripts, and subscripts with variable dimensions, are expanded to a linear form to be computed during object program execution. The use of many multidimensioned subscripted variables may contribute significantly to the size of the internal representation of the expression.		EXPRESSION TOO BIG	Divide the statement into several smaller statements.

[1] Where an explicit limit is not given, the limit is a complex function of other limits.

[2] General corrective action is to divide the program into a main program and one or more subprograms, and compile the parts separately. Other corrective actions are noted in the "Corrective Action" column, and may in some cases be implied from information in previous columns.

[3] This restriction is listed here as well as in Table 4 as in certain cases the restriction may be a complex one.

Table 3. Destination of Compiler Output

COMPILER VARIATION	OUTPUT			
	OBJECT MODULE	SOURCE	LISTINGS	COMPILER DIAGNOSTICS
Conversational – Input from terminal keyboard or card reader.	Latest job library defined in task, or USERLIB.	Data set named SOURCE. module-name, created by system.	To list data set member named LIST.module. To SYSOUT when user issues appropriate PRINT command.	To terminal, and to list data set if listings requested.
Conversational – Prestored data set.		Data set named SOURCE. module-name, will be updated to reflect modifications.		
Nonconversational – Prestored data set.			To list data set if requested; otherwise to SYSOUT.	To SYSOUT data set if no listings requested; otherwise, to list data set only.
Nonconversational – Input after FTN.		Data set named SOURCE. module-name, created by system.		

Average COMMON (Three variables, arrays, or block names)	24
Average Explicit Type Statement (Three variables, arrays, or function names, each with one initial data value)	72
Average DATA Statement (Four variables, each with one value)	64

Statement Function Expression File	*Storage Locations*
Average equation (Ten variables and operators)	80

Non-COMMON Variable Storage

The storage assignment for any variable may not exceed 2^{24}-1 relative to the assignment of the first non-COMMON variable assigned. The assignment of this variable is independent of its own length (save for at most 15 bytes of padding which might be necessary for proper internal alignment), but depends upon the assignments made by the compiler to earlier processed variables and upon the additional effect of an EQUIVALENCE statement which might involve this variable.

COMMON Variable Storage

The storage assignment for any variable may not exceed 2^{24}-1 relative to the origin of the COMMON block within which it is to be assigned. If this variable appears in a COMMON statement, then the sum of the lengths of the variables and arrays that were declared previously in the same COMMON block is 2^{24} or greater. If the variable has been given EQUIVALENCE to a COMMON variable, then the EQUIVALENCE relationship is such as to make the assignment of the variable exceed 2^{24}-1.

Table 4. Simple Source Program Restrictions

ITEM	MAXIMUM NUMBER OR SIZE	ASSOCIATED DIAGNOSTIC MESSAGE
Number of arguments in a statement function	25	ILLEGAL NUMBER OF ARGUMENTS USED FOR FUNCTION name
Number of nested statement function references	24	STATEMENT FUNCTION CALLS NESTED TOO DEEP
Number of levels of nested DO loops (both explicit and implicit)	55	DO LOOPS NESTED TOO DEEP
Number of statement numbers in a computed or assigned GO TO	255	NUMBER OF STATEMENT NUMBERS EXCEEDS 255
Number of named COMMON blocks	118	TOO MANY COMMON BLOCKS
Number of significant characters[1] in a source statement	1320	MORE THAN 1320 CHARACTERS THIS AND FOLLOWING CONTINUATION LINES WILL BE IGNORED
Total size of an array	2^{24}-1 bytes	ARRAY name IS TOO BIG
Number of characters in a character string	255	CHARACTER STRING TOO LONG
Maximum number of arguments in a subprogram reference[2]	126	FORMAL ARGUMENT ADCON TABLE OVERFLOWED IN PHASE 3
Maximum number of dimensions in an array	7	variable HAS MORE THAN SEVEN DIMENSIONS
Maximum number of preset variables	510	WORK AREA OVERFLOW – INCOMPLETE TABLE OF INITIALIZED VARIABLES

[1]See "Format of Source Lines" for the rules to determine the number of significant characters in a source statement.
[2]See also the more detailed discussion of this restriction in Table 5.

Program File (PF)

Estimated from the relation:

PF size = (PRF size + EF size) x 0.9

Code File (CF)

Estimated from the relation:

CF size = PF size x 0.5

Adcon Page

The adcon page contains certain address constants required by the compiled program. The particular address constants included in this page are implied by the items listed below as contributing to space required in the page.

The size of the adcon page can be estimated from the relation:

(number of pages of constants referred to
+ number of pages of common or non-common variables or arrays referred to
+ number of pages of generated code estimated and referred to
+ number of pages of local temporary storage referred to
+ number of pages of global temporary storage referred to
+ number of literal occurrences of statement numbers in assign statements
+ number of formal parameters
+ number of pages relative to a formal parameter referred to except the first page
+ number of literal occurrences of external function references or external subroutines referred to with at least one actual argument
+ number of list elements) x 4
+ (number of distinct external subprograms referenced) x 8
+ 8 if there are any I/O statements
+ 16 if any I/O statement has a list

Phase 2 Internal Table

The following relation gives an upper bound on the size of entries in the table. Areas in the table are reused frequently.

Internal Table size = (number of occurrences of variables excluding common, equivalence, and formal arguments
+ number of variables in equivalence statements
+ number of groups of variables in equivalence statements
+ number of occurrences of a variable common between groups of variables in equivalence statements) x 8
+ (number of DO statements − 1 + number of branches into and out of DO loops) x 4

Optimization Table (Triad Table)

If NO ISD requested, estimated size of optimization table = number of executable statements x 36

If ISD requested, estimated size of optimization table = number of executable statements x 72

Program Module Dictionary

Estimated from the relation:

PMD size = (number of COMMON statements + 2) x 84
+ (number of ENTRY statements) x 28
+ (number of I/O statements) x 44
+ (number of CALL statements
+ (number of CALL statements + number of external subprogram arguments which are any of: variable or array name that is not a formal parameter; expression; constant; function name that is not a formal parameter) x 8 + 88

Name Table or External Name List (ENL)

ENL size = (number of COMMON statements + number of ENTRY statements + 3) x 8 + 4

Internal Symbol Dictionary (ISD)

Estimated from the relation:

ISD size = (number of COMMON statements + 2) x 16
+ (number of executable statements) x 8
+ (number of variables + number of COMMON statements + 2 + number of FORMAT statement numbers) x 24[1] + 24

Object Program Module (Text)

Estimated from the relation:

OPM size = (number of statements) x 24

NAMELIST

NAMELIST size = (number of names in NAMELIST statements) x 2

The restrictions listed in Tables 4 and 5 are implementation restrictions; they apply only to this particular implementation of the FORTRAN language. They are a supplement to the language restrictions given in the publication *IBM FORTRAN IV*. Other than restrictions specifically stated in Tables 4 and 5, the only implementation restrictions placed upon the language are the limit of source statement size and maximum number of dimensions in an array.

[1]Assuming average of one dimension per variable.

Appendix B. PCS and FORTRAN Object Programs

General

This appendix discusses the use of the program control system (PCS) for debugging object modules produced by the FORTRAN compiler. *Command System User's Guide* contains a complete description of the PCS language components. This appendix discusses the elements of the language as it pertains to the FORTRAN user who is debugging at the source language level.

PCS is a part of the command system and can be used, along with other commands, whenever a user program is loaded. PCS provides the user complete control over the execution of the program he is debugging. He can start and stop execution at selected points, and he can examine and modify variables before, during, or after execution.

PCS commands are not part of the compiled module and are never saved as a part of the module. In this sense, PCS is an object-time checkout language and not a compile-time checkout language. The only connection between the compiler and PCS is via the Internal Symbol Dictionary (ISD), which is produced by the compiler when the user selects the ISD option in the FTN parameters. The ISD contains information about all FORTRAN statements and local and common variables in the module. The availability of an ISD allows the user to check out his program using the same names and statement numbers as those in the source program without concern for the actual location of his program in virtual storage. In addition, when the ISD is selected at compilation time, the compiler inhibits the optimization of the object code generated, so that the user has available the complete facilities of PCS. Appendix C describes more fully the object code optimization performed by the compiler and its effect on PCS usage. The discussion here generally assumes that an ISD is available for the module and that references in the checkout statements to data and FORTRAN statements are made symbolically.

This appendix contains sections describing the following:

- The general function of each PCS command and the combining of commands to form PCS statements.
- The use of PCS in relationship to the task and the execution of the user's program.
- The notation used in forming PCS commands.
- The form of each command, including restrictions and considerations for its usage.
- PCS diagnostics.

Commands and Statements

PCS commands have the following functions:

DISPLAY	To display the contents of variables or arrays on SYSOUT.
DUMP	To dump the contents of a variable or array into the PCSOUT data set for later printing.
SET	To modify the contents of an array or variable.
CALL, GO, BRANCH	To begin, continue, or alter program execution.
STOP	To stop program execution.
AT	To predefine a point (a FORTRAN statement) at which some action is to be performed when the statement is reached during program execution.
IF	To define a condition that must be "true" to activate other PCS commands in the statement.

Two or more of the above commands can be combined in a prescribed manner to form PCS statements. The IF command must always be combined with another command; it cannot be used alone. The format of a PCS statement is as follows:

```
[AT] . . .; [IF]; [DISPLAY] . . .; [DUMP] . . .;
                                  [SET] . . .; [ {BRANCH} ]
                                               [ { STOP } ]
```

The following two commands are always entered individually:

QUALIFY	To designate the module in which the statements and variables to be used in PCS statements are defined.
REMOVE	To delete previously entered PCS statements containing the AT command.

Sequence of Operation

PCS statements can be entered before, during, or after module execution. In conversational mode, if reference is made to an external symbol that has not been loaded, the user is prompted to indicate whether or not a module satisfying the reference is to loaded. When a PCS statement is entered, the action requested can be performed at one of two times. If the statement contains no AT command, the actions are performed immediately, and the terminal is returned to command mode (in a nonconversational task, the

next command is read from SYSIN). If the statement contains an AT command (termed a dynamic statement), the actions are performed when the FORTRAN statement number given in the PCS statement is reached during program execution. He can then enter any commands he wishes, including dynamic statements that are to be effective during execution. The CALL command, when used without an operand, executes the last module referred to by the system. If an object module is loaded after the main program is loaded, the name of the main program should be specified as the operand of the CALL.

During execution, statements can be entered whenever execution is interrupted, which can be the result of a PAUSE statement or of the entry, prior to the CALL, of a dynamic PCS statement containing a STOP command. The conversational user can also interrupt the execution of a program by pressing the attention button. The STOP command can then be entered to obtain the symbolic location in the program that is to be executed when the GO command is used to resume execution. (Refer to Appendix F for considerations in the use of the attention button.)

Checkout operations can be continued following execution until any module referred to by a dynamic statement is unloaded, at which time all PCS statements are removed from the user's object program modules.

Associated with each dynamic PCS statement is a counter that is incremented by one for each occurrence of the events specified in the statement. This counter can be referred to by the special character %. The value of the counter can be displayed or dumped and can be used in forming expressions. The counter (%) referred to is always the one associated with the statement in which it is referenced.

Since % is not a user's variable, it cannot be changed by a SET command.

Conversational Mode

PSC commands entered at the user's terminal (SYSIN) are immediately checked for valid syntax. References to variable names and statement numbers are checked in the appropriate module's ISD. Syntax errors and references to undefined symbols are reported to the user via diagnostic messages.

All PCS output is printed at the user's terminal (SYSOUT), except for the DUMP command output, which is written on the PCSOUT data set.

Nonconversational Mode

PCS can be used in nonconversational mode with the following differences:

1. Erroneous PCS commands produce a diagnostic on the task's SYSOUT data set, and the commands are ignored.
2. No prompting is performed, and incorrectly entered commands are ignored.
3. PCS output goes to the task's SYSOUT; it is interspersed with user and system responses. DUMP command output is written on the PCSOUT data set.
4. If object program execution is interrupted by a STOP, the next command is taken from the task's SYSIN.

Notation

PCS commands consist of directives, operators, symbols, and constants. In a PCS statement, these elements are delimited by blanks. That is, blanks cannot be embedded in variables or constants, but they can be used following a comma, semi-colon, and around arithmetic, relational and logical operators, and parentheses used for grouping.

The character set is:

1. The letters A-Z (upper or lower case) and $ # @.
2. The digits 0-9.
3. The special characters + − , > < ¬ | = . * ( ) ; ' / & % : blank.

Directives

The PCS directives are AT, DISPLAY, DUMP, IF, QUALIFY, REMOVE, BRANCH, CALL, GO and STOP. Each directive designates a PCS command.

Operators

Operators used to form arithmetic and logical expressions are:

TYPE	OPERATOR	MEANING
Arithmetic	+	Addition
	−	Subtraction
	*	Multiplication
	/	Division
Logical	¬	Logical inversion or negation (NOT)
	&	Logical intersection (AND)
	|	Logical union (OR)
Relational	>	Greater than (GT)
	<	Less than (LT)
	=	Equal to (EQ)
	>=	Greater than or equal to (GE)
	<=	Less than or equal to (LE)
	¬=	Not equal to (NE)
	¬>	Not greater than (LE)
	¬<	Not less than (GE)

Symbols

Symbols refer to variable names, array names, and statement numbers. They are referred to in PCS with the same names and numbers used in the FORTRAN module.

PCS recognizes two kinds of symbols: external and internal.

FORTRAN external symbols are:

- Module name
- CSECT name (the module name suffixed with #C)
- PSECT name (the module name suffixed with #P)
- COMMON block names
- FUNCTION subprogram names
- SUBROUTINE subprogram names
- ENTRY names in subprograms

Internal symbols are those defined within a single compilation. FORTRAN statement numbers and FORTRAN variable or array names are internal symbols. Internal symbols can be referred to only if an ISD was requested when the module was compiled. Further, each internal symbol must be qualified to specify the program name in which the symbol was defined.

Certain names that appear in a FORTRAN source program are not available for use in PCS statements. These are names whose *only* occurrences in the source program are as any of the following:

1. As a formal argument in a SUBROUTINE, FUNCTION, or ENTRY statement.
2. As a dummy argument in a statement function.
3. As a type statement component without dimensions or initial values.

Names used only in these ways are ignored by the compiler. No storage is allocated for them, and no ISD entries are made.

Symbols can be qualified explicitly or implicitly. The internal symbol A is qualified explicitly as follows:

```
MAIN.A
```

An internal symbol is qualified implicitly as follows:

```
QUALIFY MAIN
   .
   .
   .
DISPLAY   A
```

If a module has been link-edited, internal symbols can only be used if an ISD has been requested as a linkage editor option and in addition, an ISD was requested at compile time for the module defining the internal symbol. Each internal symbol in a link-edited module, when referred to in a PCS statement, must be qualified by both the module name originally assigned at compilation time, and the name assigned to the link-edited output module. For example, if object module MAIN was link-edited into an output module name TOTAL, the internal symbol A in MAIN is explicitly qualified as:

```
DISPLAY   TOTAL.MAIN.A
```

To use implicitly qualified internal symbols, both object module names must be specified in the QUALIFY:

```
QUALIFY   TOTAL.MAIN
DISPLAY   A
```

The QUALIFY remains in effect until another QUALIFY is given. Explicitly qualified symbols can still be entered at any point.

The special symbol %COM can be used to refer to blank common; %COM can be used as either an external or internal symbol.

PCS commands can refer to dummy arguments to subprograms. The values of the arguments used are those established at the most recent execution of the subprogram when the PCS action is performed. Dummy arguments should not be referred to if the action requested in the command is to be performed prior to entry to the subprogram.

FORTRAN Statement Numbers

FORTRAN statement numbers are those written by the user in the original source program and should not be confused with the line numbers that are assigned to each source line by the compiler. Statements must be referred to by their statement numbers, not line numbers. Executable statement numbers used as internal symbols can be incremented to refer to unnumbered statements. The increment must be an integer greater than zero, enclosed in parentheses, and immediately following the statement number. The increment (1) refers to the numbered statement itself. Therefore, 86(1) refers to numbered statement 86; 86(2) refers to the next *executable* statement following numbered statement 86.

Executable statements are arithmetic and logical assignment statements, control statements, and input/output statements. Nonexecutable statements are specification statements and subprogram statements. Nonexecutable statements should not be incremented. For example, in the following statements:

```
10   READ (1,20)A
20   FORMAT (F6.2)
     B=A*3.14
     WRITE (2,20)A,B
     GO TO 10
```

to refer to the third statement (B = A*3.14), .10(2) must be used; the FORMAT statement cannot be incremented since it is not executable.

Statement numbers refer to a statement's first line, plus any continuation lines; therefore, continuation lines need not be considered when using incremented statement numbers.

If the first executable statement in a program is unnumbered, the integer zero can be used to refer to it. In the above example, if the READ statement were unnumbered, 0 could be used to refer to it; 0(2) would then be used to refer to the second executable statement (i.e., B = A*3.14).

Subscripted Symbols

Internal symbols that refer to arrays can be subscripted to refer to elements of their arrays. A subscript can be any integer arithmetic expression that does not itself include a subscripted symbol. The subscript is enclosed in parentheses, following the internal symbol naming the array. One subscript expression must be used for each dimension; multiple subscripts are separated by commas.

An array that is a dummy argument to a subprogram can be subscripted. The dimensions of the array are as defined in the subprogram. When an array has adjustable dimensions, both the array and the dimension values used are those established at the most recent execution of the subprogram.

Constants

Five classes of constants can be used to form expressions in PCS commands: integer, real, hexadecimal, character, and address constants. There are no complex constants.

1. Integer constants are expressed in the same manner as FORTRAN constants. For example: 9327, −642, +1066, −67.
2. Real constants are expressed in the same manner as FORTRAN constants. For example: 5764.1, 7.0E3, 16.9D−03, +0. .
3. Hexadecimal constants are written with one or more hexadecimal digits (0-9 and A-F), preceded by an X, and enclosed by apostrophes. For example: X'76543210', X'FFFFFFFF', X'AC7', X'9FEC3', X'00FF'. A hexadecimal constant is either truncated on the left or filled with zeros on the left if its length is inappropriate for the expression in which it appears.
4. Character constants can contain all letters, decimal digits, and special characters. Those remaining unused combinations (of the 256 card punch combinations) that can be designated in a character constant entered on cards are described in *Terminal User's Guide*. A character constant is enclosed in apostrophes. If an apostrophe is desired as a character in a character constant, it must be represented in the written statement by a pair of apostrophes, although only one apostrophe will appear in storage. For example: '$3.98', 'HOW ARE YOU?', 'I' 'M FINE'. If the length of the constants is not appropriate for the context in which it occurs, the constant is truncated or filled with blanks on the right.
5. Address constants consist of the character A followed by a symbol enclosed in apostrophes. The allowable symbols are: external symbol with or without offset, internal symbol with or without offset, and subscripted variable. The length of an address constant is always four bytes; its value is the address assigned to the symbol. Address constants are evaluated at the time they are used. The current value of any variable referenced as a subscript is used in computing the value of the address constant. As a result, the value of an address constant that contains a subscripted symbol may vary during program execution. For example: A'NAME', A'ARRAY(I,J)'.

Expressions

Arithmetic Expressions

Arithmetic expressions in PCS are similar in most respects to FORTRAN expressions. They can be used as subscripts, as value to which variables are to be set, or as values to be compared in logical expressions.

The special character (%) can be used in an arithmetic expression to refer to a counter incremented by arrivals at the control point(s) specified in an AT command (or a PCS statement that includes one or more AT commands).

There is no exponentiation or function evaluation in PCS expressions.

The rules for formation of an arithmetic expression are as follows:

1. Any arithmetic expression can be enclosed in parentheses.
2. Arithmetic elements or expressions can be connected by arithmetic operators to form other arithmetic expressions, provided that no two arithmetic operators appear in sequence and no arithmetic operator is assumed to be present.
3. An arithmetic element or expression preceded by a sign (either + or −) is permitted, whereas the operators * and / must be enclosed by elements and/or expressions.
4. All constants in an arithmetic expression must be of the same type. Similarly, all variables in an arith-

metic expression must be of the same type. Mixed-mode arithmetic should not be attempted.

When division is performed in an integer arithmetic expression, the integral part of the quotient is retained and the fraction is discarded.

Logical Expressions

A logical expression is used in an IF phrase and can take any of the following forms:

1. A single logical variable.
2. Two or more logical variables, connected by the logical operators & or |, denoting logical AND and logical OR.
3. Two arithmetic expressions of the same type, connected by a relational operator.

The rules for constructing logical expressions are:

1. A logical expression that contains a relational operator has the logic value "true" if the condition expressed by the operator is met when the expression is evaluated. Otherwise, the expression has the value "false."
2. The ¬ logical operator must be followed by a logical expression or term. Similarly, the operators & and | must be enclosed by logical expressions to form more complex expressions.
3. Any logical expression can be enclosed in parentheses. Any logical expression containing two or more variables to which the ¬ operator is to apply *must* be enclosed in parentheses.

Logical expressions that do not contain parenthetical terms are evaluated in the following order: terms connected by relational operators are evaluated, then terms connected or modified by logical operators. When parenthetical terms are included in a logical expression, evaluation is performed in the order indicated above on the terms within parentheses, then on the reduced logical expression (reduced in that the parenthetical terms have been assigned a single logical value) in the same order. Logical expressions are evaluated by PCS in the same manner as FORTRAN. The major difference is the notation used for relational and logical operators, as illustrated in the following table:

FORTRAN OPERATOR	PCS OPERATOR
.GT.	>
.GE.	>=
.LT.	<
.LE.	<=
.EQ.	=
.NE.	¬=
.NOT.	¬
.AND.	&
.OR.	|

Ranges

The DISPLAY, SET, and DUMP commands may have as an operand two internal symbols separated by a colon (:), thus indicating a range of variables and arrays to be displayed or dumped. For example:

```
DISPLAY MAIN.I: MAIN.A
```

Commands

The following section describes, for each PCS command, the format of the command and its operands, and some examples of how it might be used in checking out a program.

QUALIFY Command

The QUALIFY command allows the user to enter implicitly qualified internal symbols, which are all defined in a single source program, after he has issued this command with the appropriate defining program name.

Example:

```
QUALIFY     FTNPGM
```

where FTNPGM is the name of the compiled module. If the compiled object module has been link-edited, both the compiled object module name and the link edit output module name must be specified. An ISD must be available in order to use this command. When an object module has been link-edited, an ISD must have been requested for the output object module in addition to the one requested at compile time. Only one QUALIFY is in effect at a time, and each successive one overrides the previous one.

AT Command

The AT command causes control to be passed to PCS when the named FORTRAN statement is reached but before it is executed. Other actions (if any) in the PCS statement are performed prior to resuming execution.

The system assigns a PCS statement number to each statement containing an AT command.

Each time the statement specified in the AT command is reached during execution, a standard output is presented to the user except where the statement contains an IF condition that is found to be false. This output includes the FORTRAN statement number at which the command became effective, certain program status information, and the PCS statement number. The program status information includes the virtual storage location of the instruction being executed and the settings of several internal indicators.

Unless the PCS statement containing the AT command also contains a STOP, execution of the user's program

is automatically resumed following the actions requested. Only CALL, DISPLAY, DUMP, IF, SET, GO, BRANCH, and STOP can follow an AT. BRANCH and STOP must be the last in the dynamic statement. A GO command is meaningless in an AT statement and will be ignored.

Two or more operands, each separated by commas, can be specified in an AT command, but each must be the statement number of an executable statement.

Given the following statements in a source program named MAIN1:

```
      IF (A) 10, 20, 30
      .
      .
      .
10    X = 1
      GO TO 40
20    X = 2
      GO TO 40
30    X = 3
40    IF (A . GT. B) GO TO 50
      GO TO 60
      .
50    .
      .
60    STOP
```

The flow through the IF statements could be traced with the PCS command.

```
QUALIFY MAIN1
AT 10, 20, 30, 40(2), 50
```

The counter referred to by the special character % is incremented by one each time the executing program arrives at a statement designated in an AT command. The counter is incremented even when the AT command is included in a PCS statement that contains an IF phrase that is evaluated as false.

DISPLAY Command

The DISPLAY command is used to print the contents of specified variables or arrays. The format of the output is determined from the type and length of the data.

The DISPLAY can have a list of operands, each separated by a comma. In addition to simple variables, the following can be displayed:

Arrays — When the operand of a DISPLAY is an array name without a subscript, the entire array is printed.

Ranges — When the first and last variable names, separated by a colon, are specified, a series of arrays and variables can be displayed. The user must be aware of the storage locations assigned by the compiler, since the last variable to be displayed must be in a higher storage location than the first variable. The storage assignments made by the compiler can be determined from the storage map optionally selected at compilation time.

Control Section — When the name of a COMMON block is specified, the entire contents of the area is displayed. The entire PSECT containing all non-common variables can be displayed by specifying the PSECT name. If the name of the COMMON block or PSECT is qualified by the module name (i. e., specified as a qualified internal symbol), each variable or array in the area is identified and formatted according to its data type. When the name is not qualified by the object module name (i. e., the external symbol form is used), the contents of the area are displayed in hexadecimal. This method can be used if an ISD is not available for the object module, but, again, a storage map should be available for locating the variables in storage.

Module Name — When a module name is specified as an operand, a control section map is formatted. The map contains such information as: the name, location, and length of each control section; the version of the module and each control section; and the entry point and save area location of the module.

Dummy Arguments — Arguments to subprograms cannot be displayed until the subprogram has been entered and they have been replaced by the actual argument values.

If the user is operating in conversational mode, he can terminate the action of the DISPLAY command by pressing the attention button at his terminal.

If a FORTRAN subroutine named SUBR consists of the following statements:

```
      SUBROUTINE SUM (A, N, M)
      COMMON B, C, D
      REAL*8 A(N, M)
      DO 20 J = 1, M
      DO 10 I = 1, N
10    C = C+A(I, J)
20    CONTINUE
      RETURN
      END
```

Then the following would be valid DISPLAY commands:

```
QUALIFY SUBR
```

DISPLAY C,I,J	to cause each variable in the list to be formatted and printed.
DISPLAY A	to cause each element in the array to be displayed. This statement is equivalent to DISPLAY A(1,1):A(N,M)
DISPLAY B:D	to cause the contents of B, C and D from the unnamed COMMON to be printed.

DUMP Command

The DUMP command is used to cause the contents of specified variables or arrays to be written in the PCSOUT data set.

The DUMP command provides exactly the same results as the DISPLAY command. DUMP should be used when there are large amounts of data and/or when an offline output of data is desired. The operand of the DUMP command is identical to that of the DISPLAY command.

The DDEF command must be used to define the PCSOUT data set before the DUMP command is issued. If no definition has been given, the conversational user is prompted to issue it. In a nonconversational task, if the DDEF is not entered prior to the DUMP, the task is terminated. The organization of the PCSOUT data set is VI.

The user is prompted at log-off time as to whether or not he wishes to catalog the data set. Since DUMP output is not interspersed with SYSOUT output, the user should provide a means of correlation if one is required.

Using the sample source program from the DISPLAY command description, the user might enter the following commands:

```
DDEF   PCSOUT, VI, DSNAME=name
DUMP   SUBR. %COM        This command would cause the
                         contents of the unnamed COM-
                         MON block (in this case, vari-
                         ables B, C, and D) to be format-
                         ted and placed in the PCSOUT
                         data set.
DUMP   SUBR. SUBR#P      This command would cause the
                         contents of the subroutine's
                         PSECT to be formatted and
                         placed in the PCSOUT data set.
                         Included would be variables I
                         and J plus miscellaneous con-
                         stants generated by the compiler
                         as needed for program execution.
```

IF Command

The IF command is used to specify a logical expression that must be true in order for any other commands in the statement to be performed.

If the PCS statement containing the IF also contains one or more AT commands, the logical expression is evaluated when the statements specified in the AT command are reached. For example, the following statements appear in a source program named CALC:

```
 5  DO 10 I = 1, 5000
    CALL SUB(ANS)
    IF (ANS) 20, 10, 10
10  CONTINUE
20  STOP
```

If it is discovered that the upper limit of the DO loop (5000) has been set too high, the following PCS statement could be entered.

```
QUALIFY CALC
AT 10;IF I=1000;STOP
```

Then, once execution starts, each time control passes to statement 10, the value of I is tested for equality to 1000. If I reaches the value of 1000 before going to 20, the PCS STOP command is performed.

The counter associated with a PCS statement containing the AT commands, referred to by the special character %, is incremented by one whether or not the logical expression in the IF is true.

The % counter can be useful in controlling loops in source programs and in controlling the effectiveness of PCS commands. For example, the above PCS statement could be replaced with:

```
QUALIFY CALC
AT 10;IF %=1000;STOP
```

In the last statement, rather than testing the value of the variable I, a count is incremented each time control passes to statement 10. The STOP is activated when the count reaches 1000.

Other uses of the % counter can be seen from the following examples:

```
QUALIFY CALC
AT 10;IF %=1;DISPLAY ANS
```

The DISPLAY would be performed only on the first arrival at statement 10

```
QUALIFY CALC
AT 10;IF %=(%/10)*10;DISPLAY ANS
```

The DISPLAY would be performed every tenth time statement 10 is reached. This example shows that the fraction is discarded in integer division.

REMOVE Command

The REMOVE command permanently cancels all dynamic PCS statements whose numbers are specified as operands. PCS produces a statement number following entry of each statement containing an AT command. These statement numbers are used in the REMOVE command to specify the PCS statements to be canceled.

Taking the following source statements as an example:

```
C   PROGRAM MAIN
10  READ (1, 20)A
20  FORMAT (F6. 2)
    IF (A) 10, 30, 30
30  B = A*3.14
    WRITE (2, 20)A, B
    GO TO 10
```

then the following statements could be entered to check the progress through the program:

```
LOAD MAIN
QUALIFY MAIN
AT 10(2); DISPLAY A
AT 30(2); DISPLAY B; STOP
CALL
```

When control reaches the IF statement, the value of A is displayed; when the WRITE statement is reached, the value of B is displayed. The STOP causes the next command to be read. The user might then decide that the program is executing correctly, and wish to continue running without the checkout statements. He could then enter:

```
REMOVE 1, 2
GO
```

In this example, the numbers 1 and 2 are the PCS statement numbers that have been assigned to each AT command. They are printed immediately following entry of the statement either at the user's terminal if in conversational mode or on the SYSOUT data set if in nonconversational mode.

CALL, GO, BRANCH Commands

These commands can be used either as a separate command or as part of a PCS statement. The effect of these commands is to transfer system control of a task from command mode to program execution mode.

The commands have three forms: CALL, GO, BRANCH.

1. CALL [module-name]

   The CALL command loads the module named in the operand (unless it is already loaded) and initiates execution at the beginning of the program. Only main programs should be referenced by the CALL command; otherwise, the results are unpredictable.

2. GO

   There is no operand. This command is used when the user wishes to resume execution following a PCS STOP command, a FORTRAN PAUSE statement, or an attention interrupt.

3. BRANCH [module.stmnt-no]

   This is used when the user wishes to change the flow of a program; it is equivalent to a GO TO statement in the original source program. The object module must be loaded and executing prior to issuing the BRANCH. This form cannot be used in initiation of program execution or in situations that are illegal in the FORTRAN language (e.g., illegal entry into loops). The statement number must be an executable statement.

   For example, if the following statements appear in a source program:

```
C    PROGRAM MAIN1
      .
      .
      .
10   X = A
     GO TO 20
20   X = B
      .
      .
      .
30   CALL SUBR(X)
      .
      .
      .
```

and the user discovers that the GO TO statement has the wrong statement number, he can temporarily correct the invalid GO TO with the following PCS statement, so that the rest of the program can be debugged.

```
QUALIFY MAIN1
AT 10(2);BRANCH 30
```

Note that the BRANCH command combined with an AT cannot be used to insert a missing GO TO statement without bypassing the statement referred to in the AT. In the above example, if the GO TO had been missing from the source program, the BRANCH command would have to be made effective at statement 10. In this case, the assignment statement X = A would be bypassed, so that a SET comand would be necessary to achieve the same results.

SET Command

The SET command is equivalent to an assignment statement in the original source program. It enables the user to change the contents of any variable or array element. It has the form:

```
SET a=b
```

where a is any simple variable or subscripted array element, and b is any logical or arithmetic expression. A list is allowed; for example:

```
SET a=b, c=d, e=f
```

When the SET is performed, the new value of the variable is displayed on SYSOUT in the same format as if the name had appeared in a DISPLAY command if LIMEN=1. This output is produced from the changed field and reflects the results of conversions and expression evaluation.

In a SET command, all variables and constants must be of the same type. The permissible lengths vary with the type. Real variables or constants must be 4 or 8 bytes in length, integer 2 or 4, and logical 1 or 4.

If the expression is a character constant that is not the same length as the variable, the character constant is either truncated or filled out on the right with blanks. If the expression is a hexadecimal constant that is not the same length as the variable, the hexadecimal constant is truncated or filled on the left with zeros.

In the example given for the CALL, GO, and BRANCH commands, the missing GO TO statement could be effectively inserted by the following PCS statement:

```
AT 10;SET X = A;BRANCH 30
```

The SET command is useful in setting variables to some initial value, in correcting erroneous assignment statements, and in inserting missing assignment statements. It should not be used in a situation that is invalid in the original FORTRAN program. For example, in the following statements:

```
 5  DO 10 I=J, K
    L(I)=L(I)+M
10  CONTINUE
```

the values of I, J and K cannot be changed by a dynamic SET command that may be activated at statements 5(2) or 10. The SET command could be used at statement 5, however, to initialize the values of J and K. For example:

```
AT 5;SET J = 1, K = N/2
```

The SET command, like DISPLAY and DUMP, can refer to dummy arguments to a subprogram once the subprogram has been entered.

A complex variable can be SET to the value of another complex variable, but it cannot be SET to a constant value, nor can complex arithmetic be performed with SET. For example, if a FORTRAN program had the following specification statement

```
COMPLEX*16 A, B, C(10, 10)
```

the following SET commands would be valid:

```
SET A = B
SET C(1,1) = C(2, 1)
```

A SET command cannot refer to the control section containing instructions generated by the compiler. The virtual storage assigned to this control section by the system is protected so that its contents cannot be changed.

STOP Command

The STOP command halts execution of a module and prints the current instruction location and program status information. STOP does not have an operand. Execution of the module can be resumed with a RUN or GO command; if execution is not resumed, any data sets that the module has left open should be closed with the CLOSE command.

PCS Diagnostics

PCS, like the FORTRAN compiler, examines each statement for validity and issues diagnostics alerting the user to errors.

Diagnostics usually are issued immediately upon reading the command. The conversational user can reenter the statement with the necessary correction made. The nonconversational user has no chance to correct errors; a diagnostic message is issued and the PCS statement is ignored.

Certain errors are not detected until execution has begun. These errors are the result of some action that has been requested in a dynamic PCS statement (i.e., one containing an AT command). In a conversational task, after the diagnostic is issued, the terminal is placed in command mode. The user can then *remove* the erroneous statement, reenter it correctly if he desires, and continue execution with a GO. If he wishes to perform the corrected statement immediately, he must use the statement number in the AT operand of the BRANCH. In a nonconversational task, the diagnostic is written on the SYSOUT data set and the next command is read from SYSIN. This may result in prematurely terminating program execution.

The errors described below are those that are not detected until execution has begun.

Dimension Errors

Each time the user refers to a subscripted array in a PCS command, the subscript values are checked against the dimensions of the array as declared in the FORTRAN program. Since the values of variable subscripts may vary during execution, the error is not detected until the command containing the invalid reference is performed. Constant subscripts that are in error are detected when the statement is first read, and the user is informed immediately. If an array is a dummy argument, subscript errors are not detected until the command is performed, since both the dimensions of the array and the subscripts may be variable.

Range Errors

A DISPLAY or DUMP command may have as its operand a range of symbols. These symbols, which represent the starting and ending storage locations to be printed, must be in sequential order. When both symbols are subscripted arrays, the subscripts must be evaluated to determine the particular element being referred to. To illustrate:

```
QUALIFY MAIN1
AT 10;DISPLAY A(I):A(J)
```

If, when control reaches statement 10, the value of I is higher than the value of J, the range would be invalid.

Program Interruption

Program interruptions can occur any time an expression must be evaluated in a PCS command. Five such interruptions are recognized:

1. Fixed-point overflow exception
2. Fixed-point divide exception
3. Exponent-overflow exception

4. Exponent-underflow exception
5. Floating-point divide exception

When any of these interruptions occurs, a warning message is issued to the user and the requested action is not performed. These interruptions are *not* processed by the interruption handling module provided by the compiler; therefore, any CALL OVERFL or CALL DVCHK statements do not recognize the interruption. (Refer to Appendix C for more details on program interruptions.)

Dummy Arguments

When dummy arguments are referred to in a PCS command, the subprogram in which they are declared must be entered prior to the point where the command is activated. Dummy arguments must not be used to form a range of variables to be displayed or dumped. There are also those conditions under which dummy arguments are not defined in the ISD for the subprogram.

Appendix C. Programming Considerations

This appendix addresses a number of topics that can assist the TSS/360 FORTRAN programmer in achieving efficient and trouble-free execution of his object program. The sections of this appendix discuss:

1. Object-time efficiency through compiler optimization, optimal use of source statements, and use of the linkage editor and dynamic loader.
2. Effect of compiler optimization on the use of the program control system (PCS), describing conditions under which the user may want to inhibit optimization by the compiler of the object code.
3. Multiple executions, to alert the user to possible problems when executing more than one program between a LOGON and a LOGOFF.
4. Library management.
5. System naming rules that prevent the user from inadvertently choosing a subprogram or other external name such that a conflict would occur between this name and a system name.
6. Executing commands from within a FORTRAN program.
7. Miscellaneous programming considerations.

Object Time Efficiency

Object Code Optimization

Efficient object code can be achieved by optimizations performed by the compiler, by optimal ordering of source statements by the programmer, or both.

Compiler Optimization

This section describes optimization of the user's program normally performed by the compiler. The section "Effect of Compiler Optimization on PCS Usage" discusses the relation between compiler optimization and use of the program control system (PCS).

A considerable amount of the compiler's effort is devoted to producing an efficient object program. This processing is called "optimization." The effects of the compiler's optimization can be seen by examining the optional object code listing. It can be observed that the instructions to perform certain computations are sometimes not located where one would expect to find them. This is due to the action of two optimization processes: (1) recognition of "common" expressions and (2) removal of expressions from DO loops.

Two occurrences of the same expression in a FORTRAN program are "common" if there is no possibility of any of the operands receiving a new value between the occurrences and if program control cannot reach the second occurrence without having passed the first occurrence. In this situation, the compiler often generates code to evaluate the expression only at the first occurrence and to reuse this value at the second and later occurrences.

If an expression occurs in a DO loop and if none of its operands can have different values for different repetitions of the loop, the expression is "removable." The compiler generates code to evaluate such an expression before entering the loop and to use the computed value where needed inside the loop.

These processes can contribute much to the efficiency of the object program, but there is an important side effect. If the program is testing for such conditions as arithmetic overflow and divide check, the operations giving rise to these conditions may not occur at the expected place or with the expected frequency. A related optimization process is the computation by the compiler of all quantities whose operands are constants instead of the generation of instructions to carry out the computation in the object program. If the values of the constant operands are such as to cause overflow, the overflow will take place during compilation (causing a diagnostic message) rather than during execution of the object program.

Compiler optimization can also cause register contents to be used at points quite remote from the point of loading. In some cases, frequently used address constants may be loaded into general registers only at the beginning of the program and kept there permanently for use as needed. Other addresses, subscript expressions, etc., may be held in registers across the range of a DO loop or nest of loops. Even where such "global" register assignments are not made, the contents of any register, once established, is remembered and may, under the proper conditions, be used later without reloading.

Subscript expressions, especially those involving DO loop variables, receive extensive manipulation, and their evaluation may be spread over several levels of a DO loop nest. In such instances, an occurrence of a loop variable multiplied by other factors is evaluated by initialization at the top of the loop and addition of an increment at the bottom just before returning for another iteration.

If the most recent value of a DO loop variable is always stored in its assigned location each time through the loop, the DO loop variable is said to be "materialized." In many DO loops, there is no computational need for the value of the loop variable and it may not be materialized. Instead, a subscript expression involving the loop variable will be tested to determine the current number of repetitions of the loop. A feature of the FORTRAN language is that no assumption can be made about the value in the storage location assigned to a DO loop variable after the loop has been executed due to completion of the proper number of repetitions. (This does not apply to other exits from the loop, since the existence of such exits as a GO TO statement causes the compiler to materialize the loop variable.)

Examination of the optional storage map of the object program produced by the compiler can show that the storage assignments for non-COMMON variables are not made in the order of declaration or appearance in the source program. Rather, these variables are assigned by the compiler in an order intended to minimize the number of distinct address constants and subscripts needed in the object code. Undimensioned variables are placed first, followed by arrays in order of increasing size and dimensionality. Variables whose assignments are controlled by EQUIVALENCE relations are placed after those that are not in EQUIVALENCE.

The purpose of EQUIVALENCE is to permit overlays to reduce object-time storage use. It is not intended to permit intermingled references to the same storage locations by two different names. If X and Y are assigned to the same storage location by EQUIVALENCE, and a value is given to X, there is no guarantee that a subsequent reference to Y in the same program will use this value. The compiler's optimization processes do not recognize the relationship between X and Y.

Efficient Use of FORTRAN Statements

The above section described optimization performed by the *compiler* on FORTRAN programs. Further optimization of the object code can sometimes be achieved by the FORTRAN user's being aware of uses of the FORTRAN language leading to more efficient object code. Such uses are described here. Under no circumstances, however, is the user required to program in accordance with the guidelines presented here.

The compiler's optimization is limited in various ways, such as lack of freedom under the rules of the FORTRAN language (e.g., the compiler cannot rearrange variables in a COMMON block) or lack of information (e.g., the compiler cannot make any assumptions about the behavior of external subprograms).

In laying out user-controlled storage (COMMON and EQUIVALENCE), the user can find it worthwhile to align the storage locations for all variables to the proper byte boundaries for their arithmetic or logical type: doubleword, fullword, or halfword quantities should be assigned to locations that are multiples of eight, four, or two storage locations, respectively, from the beginning of the area being laid out. This permits access to these quantities by machine load and store instructions rather than by subroutines accessed as the result of specification exceptions. (See the discussion of object program interruption provisions in the Miscellaneous Programming Considerations section below.)

If the user, when ordering a COMMON block, follows the same criteria used by the compiler in laying out non-COMMON variable storage, the same benefits accrue. Placing scalars first, then small arrays, etc., tends to improve the address coverage in the object code and obviates the need for object-time boundary alignment.

Since each COMMON block must be covered by its own address constants, the use of a large number of small COMMON blocks leads to less efficient addressing than a few large blocks.

In passing information to a subprogram, explicit arguments are more expensive than implied arguments in COMMON. Not only must each individual argument have its own address cover in a subprogram, but instructions in the subprogram prologue must be executed to move the address in from the calling sequence. A group of arguments in a COMMON block, however, can all be addressed with the same address constant and need no initialization.

The compiler's manipulation of expressions is restricted by the FORTRAN language requirement that the source program associations (both explicit associations determined by parentheses and those implied by left-to-right order) be respected. A+B+C must be treated by the compiler as (A+B)+C. Common expressions, removable expressions, and constant expressions can be recognized only if the associativity permits. Therefore, the efficiency-minded user writes expressions in such a way as to permit optimization. For example, in A*(2./3.), the division of constants is done by the compiler; in (A*2.)/3. it is not. If K1 and K2 are unchanging in a DO loop on I, the sum K1+K2 is computed outside the loop if K1+K2+I occurs; it is not removed from I+K1+K2, or K1+I+K2.

The compiler is unaware of the properties of subprograms external to a program being compiled. Even for FORTRAN IV-supplied subprograms such as SIN, the user is free to substitute his own subprogram for the library routine. Therefore, the compiler does no op-

timization on external function calls. If the user wants to save execution time by eliminating redundant calls on the same function with the same arguments, he must do this himself in his FORTRAN program. Only the user has the necessary knowledge of whether or not a function uses or changes variables in COMMON, changes its arguments, performs I/O, runs internal counters, etc. (The function routines supplied in the FORTRAN IV-supplied subprograms do none of these things.)

The use of mixed arithmetic types in expressions and across the equal sign in assignment statements leads to the execution of conversion functions, the most expensive of which are those converting REAL to INTEGER and vice versa. Unnecessary use of mixed types thus diminishes efficiency.

Although the compiler may remove expressions from DO loops, it does not remove complete statements. For example, every assignment statement occurring in a loop results in at least a storing of a value into the left-side variable on each repetition of the loop. For efficiency, statements that are entirely invariant within a loop should not be placed inside the loop.

Much normal optimization is inhibited for DO loops with extended range (i.e., a branch out of the loop to execute some remote statements, followed by a branch back into the loop). This programming practice reduces the efficiency of those DO loops in which it is used.

Computed GO TO statements with three or less destinations produce less efficient code than equivalent arithmetic IF statements.

At the time of writing his program, a user thinks in terms of virtual storage, of which he has a very large amount available. During execution of the program, the system maps this virtual storage onto the much smaller actual main storage of the computer, using a page (4096 storage locations) as the basic unit. Each page of virtual storage referred to in the program must be made available in main storage before the reference can be successfully made. Two attributes of a program can decrease the efficiency of TSS/360 in carrying out this task, resulting in a loss of system performance. These attributes are references to a number of different pages in rapid succession and a large number of total pages required. Some simple programming and operating practices can alleviate both problems.

When indexing a large multi-dimensional array, it is better to vary the left-most subscript the most rapidly. This causes the array elements to be accessed in order of their location in storage rather than out of order. For example:

```
      DO 24 J=1, 50
      DO 24 I=1, 80
24    A(I, J)=1.0
```

is better than

```
      DO 24 I=1, 80
      DO 24 J=1, 50
24    A(I, J)=1.0
```

from the point of view of page utilization.

In coding a subprogram, it may be worthwhile to move the value of an argument into the subprogram by setting a local variable equal to it, if the argument is referenced frequently but is not an output argument of the subprogram. For example:

```
FUNCTION F(X)
XLOCAL=X
  .
  .
  .
Y=XLOCAL/Z
  .
  .
  .
(and other references to XLOCAL, rather than X)
```

is better than

```
FUNCTION F(X)
  .
  .
  .
Y=X/Z
  .
  .
  .
(and other references to X)
```

since in the latter case the actual argument presented for X in a call on the subprogram is located in some other module and, hence, probably on a page that would otherwise not need to be accessed during the execution of the program F.

The user can also minimize the number of pages referred to, where the executable code generated for his FORTRAN statements exceeds one page or extends over many pages. The general rule for attaining minimum page references for such programs is to place infrequently used statements in a separate subprogram. If this is inconvenient, the infrequently-used statements could be placed in a separate area of the program, near the end perhaps, while grouping together those areas of the program that will be executed most frequently. Since calls on subprograms are in general references to separate pages (unless link editing is performed, as discussed below), it may be more efficient to minimize the number of subprogram calls within areas where optimum efficiency is desirable.

Use of Linkage Editor to Improve Object-Time Efficiency

Linkage editing is a valuable process for reducing the total number of pages required for execution of a pro-

gram using many subprograms and for obtaining better utilization of allocated storage. Object program loading time can also be reduced by linkage editing to package the control sections together and thus produce a dense packing of virtual storage. The order in which programs are packed should be such that as few references as possible are made by code in one page to code in other pages. Maximum efficiency can therefore be achieved if the packing is done following a study of relation between programs and between different parts of large programs.

Use of Dynamic Loader to Improve Object-Time Efficiency

Explicit unloading (using the UNLOAD command) of modules that are no longer of interest to the user in a session is a good practice if:

1. these modules referred to a great many different pages of virtual storage; and
2. no further references will be made to these pages.

Use of Control Section Packing to Improve Object-Time Efficiency

To allow the system to function more efficiently when executing object program modules, a dynamic method is provided for combining more than one control section into a single page of virtual storage at *execution time*. Fewer pages will thus be referred to, reducing system paging requirements. Control sections of like attributes within a module will be allocated contiguous storage, with the secondary control sections aligned on doubleword boundaries. You elect the type of control section packing to be used (if any) in your LOGON command.

Effect of Compiler Optimization on PCS Usage

Appendix B contains a description of the use of PCS with FORTRAN programs. In Appendix B it is stated that the FORTRAN user should select the ISD option to ensure that the PCS statements operate correctly. The following paragraphs explain why the PCS user should generally request an ISD, and under what conditions he need not request an ISD.

Due to the optimization method, use of PCS with optimized FORTRAN programs might easily lead to erroneous results. For example, consider the following program:

```
 50  DO 200 I=1, N
100  X(I)=A(I) + (B+1 . 0)
200  CONTINUE
       .
       .
       .
```

The sum of (B+1.0) is in no way affected by the fact that a loop is occurring in which the sum is required, so the compiler computes the sum once, outside the loop, and uses this value inside the loop. Suppose now that the user wants to change the value of B at statement 100 using the PCS SET statement. A fully optimized object program would not be aware that B has been reset, as (B+1.0) would not be recomputed within the loop; thus, the user's intent would not be accomplished.

A second example of compiler optimization leading to problems when PCS is used would be where, in the above example, the FORTRAN user wants to use the PCS DISPLAY command to determine the current value of the loop variable I. The object code would have no need for I except for counting passes through the loop and indexing into the X and A arrays, so no code would be generated to save the current value of I in the storage location assigned to I. (Indeed, no storage location may have been assigned to I.) Thus a DISPLAY of I would not produce the desired results.

It is clear that such complex restrictions on PCS usage as implied by the compiler optimization procedures would not be desirable. For this reason, the FORTRAN user may request that the compiler modify its generation of the object program in such a manner as to allow complete use of PCS facilities on FORTRAN object programs. The user requests such modification of object code generation by specifying, following his entrance of the FTN command, that he wishes an Internal Symbol Dictionary (ISD). Such a request:

1. Inhibits optimization as required to allow all PCS capabilities to be available
2. Produces an ISD, which allows the FORTRAN user easy reference to all symbols within the FORTRAN subprogram

A user can still use PCS, of course, even if he does not request an ISD. To do so, however, he must have extensive knowledge of his object code to be assured that his PCS requests will give the desired result.

There is one type of PCS usage in which the FORTRAN user must exercise considerable care, even if an ISD is requested. This use of PCS can be described with the aid of the following program:

```
       .
       .
       .
     DO 10 I=1, M
     M=M+1
  5  L(I)=L(I)+M
 10  CONTINUE
```

The statement M=M+1 is clearly illegal, as it violates a FORTRAN language rule (and the compiler produces a diagnostic message). Just as it is illegal in

the original FORTRAN program, it should not be simulated by compiling a program without the M=M+1 statement but directing PCS to add one to M at statement 5. Similarly, in the following example, the use of PCS to specify that at statement 100 the program should transfer control inside the DO 200 loop (using the PCS RUN directive) is not legal, as this would violate a language rule were it replaced by a GO TO 200 in the original FORTRAN program.

```
      .
      .
      .
100
      .
      .
      .
      DO 200 I=2, 10
      A(I)=A(I+1)/A(I-1)
200   CONTINUE
```

However, it is legitimate in the following program, at statement 100, to direct the object code to RUN at statement 200, as this is equivalent to a GO TO 200 at source statement 100, a legitimate branch.

```
 50   READ (5, 9, END=200) A, B
      X=A**2+A/3.1416-A**B
100   WRITE (6, 9)A, B
      GO TO 50
200   STOP
  9   FORMAT (2E20. 7)
      END
```

Multiple Executions

"Multiple executions" refers to executing more than one program between logging on and logging off.

Data Definition Considerations

A DDEF command provides the linkage between the data set reference number used in the FORTRAN program and the actual data set. Once a DDEF has been entered, it remains in effect until LOGOFF unless the definition is released or redefined.

If two programs are executed in succession, the following conditions could arise:

1. Both programs refer to the same data set with the same data set reference number. One DDEF command issued prior to the execution of the first program is sufficient for both executions if the data set is read in both programs or written in the first and read in the second. If, however, the data set is written in both programs and not rewound in the first, the data is not automatically concatenated. Data written in the first execution would be destroyed by the write operation in the second execution. If the user does not want this to occur, he must take the steps outlined in item 3.
2. Both programs refer to the same data set with different data set reference numbers. Each execution must be preceded by a DDEF command giving the ddname as appropriate for the data set reference number. Since the second DDEF contains the same dsname as the first, effectively redefining it, the first definition need not be released.
3. Each program refers to a different data set with the same data set reference number. Each execution must be preceded by a DDEF command giving the dsname for the ddname. In addition, since the second DDEF has the same ddname, the first definition must be released prior to the second DDEF. When a data set on a private volume is released, the input/output device is also released unless another defined data set resides on that same volume. In a nonconversational task, if a device is freed by a RELEASE command, the user must account for this when specifying the SECURE command. For example, if two programs read different data sets on separate private volumes and both are referred to by data set reference number 1, the following procedure is necessary:

a. SECURE	Two devices — even though only one device is needed at any one time
b. DDEF	For first data set
c. CALL	First execution
d. RELEASE	First data set
e. DDEF	For second data set
f. RUN	Second execution

Linking COMMON Between Multiple Executions

When executing a series of programs in sequence, if a prior module is not unloaded before the execution of the next program, any external symbol reference in the second module will be resolved, if possible, by definitions of that symbol in the first module. This may or may not be desirable. If this is not desirable, an UNLOAD command should be issued after the first main program has completed execution, causing any blank or named COMMONS to be removed from the task's allocated storage. Any subsequent module that is loaded containing a COMMON block would have storage allocated as if it were the first usage.

When the user does want to pass the same COMMON block from one execution to the next, the UNLOAD command should not be entered. In this case, the references to COMMON in the second execution would be to the COMMON that was allocated storage with the first execution, if both are unnamed or have the same name.

Program Libraries

Program Library List Control

A program in TSS/360 can consist of one or more object modules. All programs in TSS/360 are stored in object module form in program libraries, which are partitioned data sets. A program consisting of only one object module is stored entirely within one library; however, if a program consists of several object modules, those modules may reside in different libraries, depending on how the user has stored them. During link editing and execution, the system can automatically retrieve all object modules required, if the user has defined the libraries containing those object modules. The method for doing this is described in the following paragraphs.

There are four categories of program libraries:

1. System library (SYSLIB)
2. User library (USERLIB)
3. User-defined job libraries
4. Other user-defined libraries

TSS/360 does not allow a library to contain more than one declaration of *any* external symbol, except those control sections that have no content (e.g., named or blank COMMON from a FORTRAN main or subprogram).

The system library contains some service routines provided by the installation. It also includes the FORTRAN supplied subprograms.

The user library is the private library assigned to each user when he is joined to the system. This library is automatically defined for him and made a part of his catalog by the system. His user library is thus available each time he logs on. If the user does not specify job libraries in a task, the object modules resulting from his use of the language processors are placed in his user library.

The user may want to restrict his user library to object modules that he executes frequently or that he uses frequently in the buildup of other object modules. The system's library list facilities make it possible for the user to control the contents of his user library.

The program library list is a defined hierarchy of program libraries. It is initialized at log-on time and consists of the user library and SYSLIB.

The library at the top of the list automatically receives all object modules resulting from language processing. As noted above, if no job libraries are defined, the library at the top of the list is always the user library. However, the user can specify that a job library be added to the program library list to receive the output of the language processors. He does this by issuing a DDEF command defining that job library and containing the operand OPTION=JOBLIB. When this command is executed, the name of that job library is added to the top of the program library list. That library then receives all subsequent module output of the language processors until another job library is defined (and is thus at the top of the list) or until a RELEASE command is issued for that job library. A job library must always have a VP data set organization; it can be defined on public *or* private volumes.

In addition to using the program library list to store object modules, the system uses this list to control its order of search when looking for object modules that must be loaded at execution time. The library at the top of the list is searched first, then the next-to-the-top library, etc. until finally, the user library and SYSLIB are searched.

In summary, the user has the following basic library setups for handling the object modules by the language processors.

- User library — As this is always available and is always searched, the user may want to reserve it for frequently used checked out programs. All user's USERLIBs are kept in public storage and, hence, are always mounted on system devices.
- Session JOBLIB — By issuing a DDEF command for a new library at the beginning of a session, a user can create a library to contain all modules assembled or compiled during the session.
- Cataloged Private Volume JOBLIB — A user can direct output to and retrieve it from a library of infrequently used modules by issuing a DDEF command for a cataloged job library that resides on a private removable disk pack. When using private job libraries in a nonconversational task, the user must request (via SECURE) a device for that job library. Modules can be entered in such a library:
  - Automatically if the library is the latest defined one in the session.
  - By link-editing it from his USERLIB, session job library, or public device job library and specifying to the linkage editor the desired private device job library as the output destination.
  - Cataloged libraries on private volumes can also be shared among users.
- Cataloged Public Volume JOBLIB — This type of library can be useful in setting up (and using) a library of frequently used programs whose names and external symbols conflict with other programs in USERLIB. For example, versions of frequently used programs can be set up with one USERLIB and another in a job library. All job libraries re-

siding on public volumes are automatically cataloged at DDEF time and may be shared among users.

During linkage editing, the program library list can also be used to define to the system:

- The library that is to receive the link-edited object module.
- The sequence in which libraries are to be searched if the system must find other object modules to define references in the linkage-edited object module.

The fourth category of libraries may be defined by a DDEF command with the JOBLIB operand omitted. Such libraries may be referred to by a linkage editor INCLUDE statement, but are not listed in the program library list, and hence are not included in the automatic library search, nor are they available to the dynamic loader. Refer to *Linkage Editor* for an explanation of linkage editor program libraries.

Since one library may not contain more than one definition of any external symbol, different versions of the same program must be kept in different libraries. For example, a user has a checked-out program in his USERLIB and wants to recompile the program with modification but retain his original version until the new version has been checked out. A DDEF with a JOBLIB option causes the new module to be stored on the job library rather than USERLIB. The user can continue after compilation with his checkout of the new version, since any subsequent LOAD or RUN command in the task naming the module retrieves the new version from the job library. If, when the new version has been successfully tested, the user wants to replace the old version with the new version, he can linkage-edit the new version onto his USERLIB. Link-editing can be used to copy a program module from one library to another. If the user does not want to retain the new version, he must either erase the module on the job library or release the job library. Releasing the library removes it from the program library list and automatically causes subsequent retrievals of that module to revert to USERLIB. Erasing the module does not remove the job library from the program library list, but any subsequent references to that module are resolved from USERLIB after the job library has been searched unsuccessfully.

The PDS command facilitates the orderly maintenance of programs within various job libraries and USERLIB. PDS enables the user to obtain on SYSOUT a list of the member names (and optionally the alias names and other member-oriented data) of individual members of cataloged VPAM data sets.

Substituting FORTRAN IV-Supplied Subprograms

All IBM-supplied subprograms are stored on the system library (SYSLIB). Any subprogram can be effectively replaced by storing a user's version (with the same name or entry point) on one of his own libraries, since the system library is always the last one searched. If the user stores his version on his user library, then all of the user's programs, when executed, refer to his version of the subprogram. If the user wants to refer selectively to either version, he should store his version on a job library, so that it is selected in a given task only if he has issued a DDEF for that job library.

When object modules are loaded by the dynamic loader, any substitute modules should be explicitly loaded (using the LOAD command) prior to issuing a RUN command for the main program. This guarantees that the desired modules will be used.

Note that, if a module is loaded explicitly, it will not be unloaded when the calling module is unloaded, i.e., it must be unloaded explicitly using the UNLOAD command.

When object modules are link-edited, references to modules on the system library are left for dynamic linking at LOAD time. If, however, the user has his own version of a subprogram on a job library in the program library list during the linkage edit run, this version is automatically included as part of his output module. He cannot then attempt to select either version of the subprogram during subsequent executions.

Sharing Libraries

A user can allow another user to share (i.e., access) one or more of his cataloged job libraries. When the owner permits access to his job library, all of the object modules on that data set are usable by the sharer. This does not imply that if the owner and/or one or more sharers use the same program at the same time they are sharing (co-using) the same copy in main storage. This aspect is controlled by the public option declaration at compile time.

The data set owner isues a PERMIT command to designate the other users who can share his job library and to indicate the level of access for those users.

- Read-only access — the sharer can use the object modules on the library but cannot add, replace, or erase a module.
- Read-and-write access — the sharer can use any object module on the library and can add or replace modules. He cannot use the ERASE command to delete a module from the library.
- Unlimited access — the sharer, in effect, can treat the library as his own; thus he can even erase modules from it. However, when any user with un-

limited access, including the sharer, attempts to erase a shared VI or VP data set, the system will first check to see if there are any active users of that data set. If there are active users, the system issues a diagnostic and disregards the command. If there are no active users, the system executes the ERASE command.

To gain access to a data set for which he has been previously authorized, the sharer must issue a SHARE command, which places an entry for the owner's data set name in the sharer's catalog. The sharer can then enter a DDEF command for the data set (with the JOBLIB option) in each task where he wants to include the library in his program library list.

Table 6. Shared Data Set Commands

	BY OWNER	BY SHARER
PERMIT	Must be issued prior to the SHARE command by the sharers.	Not allowed. A user cannot permit access to a data set that he does not own.
SHARE	Not allowed.	Must be issued prior to any other references to the data sets. Once issued, the sharer may access the data set until he issues an ERASE or DELETE. The SHARE command places an entry in the sharer's catalog, so that a further CATALOG command is not necessary.
ERASE	The owner can only erase a member (object module) from his job library or erase the entire library when no sharer is accessing that member at the time the ERASE command is issued. If he erases the job library, the entry in the sharer's catalog is not removed. The sharers must issue a DELETE command to remove the entry from their own catalog.	A sharer can erase only if he has been granted unlimited access. If he then erases an object-module, neither the sharer's or owner's catalog is affected. If he erases the entire job library, both his catalog entry and the owner's are removed.
DELETE	The owner can delete a library or group of libraries from his catalog. An object module alone cannot be deleted. When the owner deletes a shared job library the sharer's catalog entry is not removed.	A sharer can delete his catalog entry for a job library without affecting the owner's catalog. The sharer must reissue a SHARE command if he again wants to refer to the data set that has been deleted.
CATALOG	The owner can catalog a fully qualified data set name. If that name is a component of a partially qualified name that the owner has permitted to be shared, all sharers have immediate access to the newly cataloged data set. If an owner changes the name of a single data set to which he permitted access using a fully qualified name, each sharer must delete his catalog entry and reissue the SHARE command with the owner's new name.	A sharer that has been granted unlimited access can change or add entries to the owner's catalog. If he is permitted to share a group of data sets, he can catalog a new data set into the group, but he must include as part of the name the partially qualified name that he used in the SHARE command. If he changes the name of one of the data sets in the group, the new name must still contain the partially qualified name. A sharer who has been granted unlimited access to an individual data set can never change the data set name.

Groups of job libraries with names having common higher-order components can be specified by using partially qualified names when the PERMIT is issued. For example, an owner of two job libraries named TRACK.SUB1 and TRACK.SUB2 can allow sharing of both libraries by using the partially qualified name TRACK in the PERMIT command. In this case, the sharer *must also* use the partially qualified name (as the $dsname_2$ parameter) in the SHARE command, even though he wants to access only one of the job libraries.

Table 6 lists the commands applicable to shared data sets and the effect of the command on the user's catalog.

Recovering from Errors When Dynamically Loading

The dynamic loader takes all of the external references in a module that is explicitly loaded or run and resolves them by searching the program library list. While the loader is linking the object modules into the user's virtual storage, diagnostics may be issued indicating any of several error conditions that can affect the eventual execution of that program.

- Name to be loaded or run not found in library — Either the user has specified the wrong name in the LOAD or CALL command or the job library containing

the object module has not been defined in the task and, therefore, is not in the program library list. In the latter case, the conversational user can merely enter the DDEF defining the job library and reissue the command.

- Unresolved references — If an object module refers to a FUNCTION or SUBROUTINE that cannot be located in any of the libraries in the program library list, a diagnostic is issued specifying the name that was used in the reference. Further linking of other object modules is not suspended, however, so that the main program and possibly other subprograms have been placed in the user's virtual storage. If the error occurs in a RUN command, execution of the program is not initiated.

  If the user wants to execute his program regardless of the error, he can reissue the CALL command. He must, however, repeat the name of the module specified in the original CALL command. This is necessary to define the point at which execution is to be initiated.

  If the user anticipates that an object module will have unresolved references, he should first issue a LOAD command naming the module, followed by a CALL command with the same operand. This procedure is recommended for a nonconversational task, since the user can be assured that execution will be initiated regardless of unresolved references.

  If the user does not want to CALL the version of the program that has been put into his storage, he must issue an UNLOAD command. If he wants, he can then enter a DDEF defining a job library that was missing in the first LOAD attempt. A LOAD or CALL issued at this point causes the entire linking procedure to be redone.

- Duplicate entry points — This condition can only occur when two or more object modules are being linked from different libraries. For example, a user might LOAD a main program from a library which calls a subroutine on another library. If in this case, the subroutine had an ENTRY statement which duplicated the main program name or an ENTRY in the main program, a diagnostic would be issued indicating the error and the duplicated entry point name. The second entry point is disregarded by the loader, so that as the loading process continues all references to that entry point are resolved by the first definition — in this case, the definition in the main program rather than the subprogram. Subsequent execution of the program could give erroneous results if the references were incorrectly resolved. The user should take some corrective measures before attempting to LOAD or CALL again. (A possible correction might be to change the ENTRY name by linkage-editing the object modules onto another job library. To avoid the possibility of such duplications when working with a new library, the POD? command can be used to list the directory of the library. The user can then circumvent the problem by setting up an appropriate program library list before he attempts to load his program.

Shared Code (PUBLIC) Considerations

The system recognizes a control section as being either private or sharable. Normally, both the PSECT and the CSECT of the output module are marked by the compiler as private. However, if the public option is selected in the FTN parameters, the CSECT is marked as public. If the library containing such a module is a shared data set (i.e., PERMIT and SHARE commands have been issued), the CSECT is considered sharable.

Each task is allocated its own copy of a private CSECT; however, allocation of public CSECTs occurs in such a way as to make the same physical copy of the CSECT available to all tasks which have allocated the CSECT to their respective virtual storages.

Sharing object code enhances the efficiency of the system. Paging is reduced since only one copy need be in main storage or on the paging device; in addition, shared routines can be executed simultaneously by more than one CPU.

Any user-written FORTRAN program can be made sharable by specifying the PUBLIC option in the FTN parameters.

Prior to compiling the module, a DDEF must be issued defining the job library where the object module is to be stored. Once the module is compiled, the user must grant access to the job library by issuing a PERMIT. This, of course, is not necessary if the object module is stored on a job library previously being shared.

Each user who has been permitted access must then issue a SHARE command, to make the appropriate entry in his catalog for the library. Again, this is not necessary if the user is already sharing the data set. Each time the sharer wants to use the shared program, he must issue a DDEF for the job library prior to loading the object module. The object code is only truly shared (only one copy in main storage) when each user loads the public control section from the same shared job library. A sharer who linkage-edits a public control section onto another library receives a private copy each time the object module is loaded from that library.

The owner of a data set may PERMIT any level of access he wants regardless of the access designator

in the owner catalog. For example, if the owner catalog is marked "read only," the owner may not write into his own data set, but he may PERMIT a higher level access (read/write or unlimited) to a sharing user. Because of this flexibility, the data set owner should be very cautious with critical data sets that he has entered into the system.

Note: A program requiring more the 256 shared pages of storage cannot be loaded in public storage. The program will instead be loaded on private pages, and each user sharing it will receive a private copy.

System Naming Rules

User-Assigned Names

The following names resulting in external symbols are supplied by the user in his FORTRAN source program or during compilation:

- Module name (required)
- SUBROUTINE subprogram name
- FUNCTION subprogram name
- ENTRY names in subprograms (optional)
- Names of labeled COMMON

Names resulting in external symbols that are assigned in any single compilation must be distinct from each other. In addition, since the system does not allow any one library to contain more than one definition of a particular external symbol, each name (except names of COMMON blocks) must be distinct from any other symbol contained on the library that is going to receive the object module. It is valid to have the same names on different libraries. Since a named or blank COMMON is not listed in the directory of the library as an external symbol associated with this module, the name of the COMMON area does not have the preceding restriction. Also, since this name is not listed in the directory, it cannot be explicitly referred to by name (i.e., it cannot be loaded by its COMMON name).

The POD? command can be used to list external symbols in a library, thus assisting the user in avoiding duplication.

Reserved Names

External Symbols

The user can never assign an external name beginning with the characters SYS. Names beginning with these letters are reserved for certain system programs. Any module stored on the user library or a job library starting with these symbols can never be retrieved by that name for execution, since resolution of SYS symbols for loading and running is always attempted from the system library. In addition, a diagnostic is issued if a module loaded by another name contains an external symbol beginning with SYS.

The user should be careful to avoid accidentally duplicating the names of IBM-supplied subprograms. Generally, he should avoid the use of all external symbols starting with the characters CHC or any FORTRAN-supplied subprogram entry point name (i.e., SIN, COS, etc.) unless he specifically wants to substitute for such a subprogram one of his own.

Reserved Names Associated with Data Sets

The following list contains the reserved names that are assigned to system functions:

RESERVED DDNAMES	RESERVED DSNAMES
SYSLIB	USERLIB
SYSULIB	SYSLIB
SYSIN	
SYSOUT	
PCSOUT	

Compiler-Assigned Names

For each FORTRAN program compiled, the compiler makes the following name assignments resulting in external symbols:

- CSECT name — The module name (truncated to six characters if greater than six characters) is suffixed with #C to form the CSECT name.
- PSECT name — The module name (truncated to six characters if greater than six characters) is suffixed with #P to form the PSECT name.

NOTE: Since a BLOCK DATA program has neither executable instructions nor program variables, a CSECT or PSECT name is not assigned.

It is the user's responsibility to ensure that the first six characters of the module name are unique from others on the library receiving the object module. Since characters following the first six are truncated to form the CSECT and PSECT names, FORTRAN user may want to follow the practice of limiting the module names of compiled programs to six characters.

In addition to the CSECT and PSECT names, the following names are assigned to the compiler output data sets:

SOURCE.module — is the data set name assigned to the line data set of source statements constructed during the compilation. For example, a source program with module name COWBOY will be assigned the data set name SOURCE.COWBOY. If the input to the compilations was from a prestored data set, then the user must assign the name SOURCE.module to the data set prior to the FTN command.

LIST.module — is the data set name assigned to the data set created for all listings optionally selected by the user. Note that this is the index name of a generation data group.

Executing Commands from Within a FORTRAN Program

You can execute a command from within a FORTRAN program by calling module CGCDB at entry point SYSOBF. (CGCDB is a nonprivileged module residing in SYSLIB.)

Code the CALL statement with these three arguments:

First argument: The command length. (The number of characters in the command, not including the scratch byte in the second argument. Count double apostrophes — like those in the example below — as one character.

Second argument: The command itself. Place this argument in single apostrophes. The first character of this argument must be a scratch byte that should not be counted in the command length.

Third argument: The name of the area in your program where you want the return code placed.

For example:

```
CALL SYSOBF (26,'_DISPLAY""AT STATEMENT 500"",IRC)
```

In this example, an underscore is used as the scratch byte.

Miscellaneous Programming Considerations

Floating-Point Computations

It must be kept in mind that, unlike integer arithmetic, floating-point computations (types REAL and COMPLEX) are not in general exact, due to roundoff, which may cause the low-order bits of a result to be different from the expected value. This consideration is especially important when writing FORTRAN relations or arithmetic IFS; exact equality of two floating-point quantities which are the results of computation is not to be expected. For example, consider:

```
Y = 0.1*X
IF (10.0*Y-X) 1, 2, 3
```

The zero branch to statement number 2 will probably never be taken, since roundoff in the two multiplications, and the fact that 0.1 cannot be represented exactly in a binary computer, will cause at least the low-order bit of 10.0* Y to be different from that of X, so the subtraction does not give a true zero.

Object Program Interrupt Provisions

This section contains descriptions of the procedures followed when the user's program is temporarily interrupted due to certain types of interruptions. An interruption is a computer-originated break in the flow of processing. Program interruptions are those resulting from improper specification or use of instructions and data. The term "exception" is used to refer to these types of interruptions.[1] Six such exceptions occur frequently enough during normal FORTRAN programming to warrant special treatment. These are:

1. Fixed-point overflow exception
2. Significance exception
3. Exponent-overflow exception
4. Exponent-underflow exception
5. Floating-point divide exception
6. Specification exception

The procedure for handling the above exceptions is as follows. The compiler generates code at the beginning of all *main programs* that calls an interruption-handling module.[2] In this module the following operations are performed:

1. Initialization is performed such that the fixed-point overflow and significance exceptions will be ignored.
2. Initialization is performed such that a control will be passed to an entry in an interruption-handling module if any of the following four exceptions occur:

   a. Exponent overflow
   b. Exponent underflow
   c. Floating-point divide
   d. Specification

   At the first three of these entries, flags are set for later interrogation by programs called as a result of the CALL OVERFL (if exponent overflow or underflow occurred) and CALL DVCHK (if divide check occurred) statements. The contents of registers following an overflow or underflow is:

   Exponent Overflow: The sign of the result is unpredictable and the result characteristic is set to 127. In short precision, the high-order 24 bits of the fraction are set to one, leaving the low-order 32 bits unchanged. In long precision, all 56 bits of the fraction are set to one.

   Exponent Underflow: The sign, characteristic and fraction of the result are set to zero, yielding a true-zero result. (In short precision, the contents of the low-order 32 bit positions of the fraction remain unchanged.)

[1]For more detailed information, see *IBM System/360 Principles of Operation*, Form A22-6821.

[2]For a more detailed description, see *FORTRAN IV Library Subprograms.*

A specification exception will occur when a variable is not on a proper word boundary. This condition may exist in a FORTRAN program by forcing such misalignment through the use of a COMMON and/or EQUIVALENCE statement. The compiler issues a warning diagnostic if the user has forced such a misalignment, but such a misalignment does not prevent him from executing the program. An installation option specifies that one of two courses of action is to be taken if a specification interruption occurs:

1. Terminate the task.
2. Transfer control to a program that will perform the desired operation, using instructions that will not cause an exception due to the incorrect boundary alignment, followed by continuation of the user's program. This procedure is extremely inefficient, and thus should be employed as little as possible.

STOP/PAUSE/RETURN Differences

Table 7 summarizes the use of the FORTRAN STOP, PAUSE, and RETURN statements in both conversational and nonconversational mode.

Table 7. STOP/PAUSE/RETURN Differences

FORTRAN STATEMENT	EFFECT IN CONVERSATIONAL MODE	EFFECT IN NONCONVERSATIONAL MODE
PAUSE n or PAUSE 'message'	1. Prints the message "PAUSE n" or "PAUSE message" at the users terminal. 2. Prints an underscore at terminal requesting a command.	PAUSE n or 'message' prints on SYSOUT data set; execution continues with the statement following the PAUSE.
PAUSE n or PAUSE 'message' (cont)	3. Program may be continued at the statement following the PAUSE by entering the RUN command.	PAUSE n or 'message' prints on SYSOUT data set; execution continues with the statement following the PAUSE.
STOP n or RETURN (in main program)	1. Prints "STOP n" at the user's terminal. 2. Prints an underscore at terminal requesting a command.	1. Prints STOP n on the SYSOUT data set. 2. Reads the next command from the SYSIN data set.

Link-Editing FORTRAN Programs

The standard entry point assigned to a link-edited module is the first byte in the first control section that is linkage-edited if no main program is included. If a main program is included, the standard entry point is the first byte in the first control section of the main program. This procedure imposes the following rules when linkage-editing FORTRAN modules:

1. If a task requires a BLOCK DATA subprogram, this subprogram must be included prior to any module containing a COMMON block for the same areas defined in the BLOCK DATA subprogram.
2. A linkage-edited module does not retain the module names of those modules included in the linkage editing. Thus the module name in a CALL command must be the name assigned to the linkage-edited module; execution will begin at the standard entry point of the module.

Use of CALL Command and CALL Statement with FORTRAN Subprogram Module Names

It is not good practice to use the CALL command to run FORTRAN subprograms or linkage-edited subprograms without a main program. If this is attempted, some interruption-handling mechanisms will be missing, and the subprogram's execution may be terminated abnormally. A FORTRAN program must not attempt to call a subprogram by its module name.

Initial Content of FORTRAN Variables

FORTRAN programmers should never assume that the value of any variable is known unless the variable has been set by an assignment statement or by a Type or DATA statement in which initial values are specified.

Appendix D. Assembler Language Subprograms

A FORTRAN program can call assembler-language subprograms; similarly, an assembler language program can call a FORTRAN subprogram. This appendix discusses both types of calls. The reader is also referred to *Assembler Language*, GC28-2000; *Assembler User Macro Instructions*, GC28-2004; and *IBM FORTRAN IV Library Subprogram*, GC28-2026. The reader of this appendix must be familiar with the assembler language.

This appendix is divided into the following sections:

1. *FORTRAN Object Program Structure:* general characteristics of FORTRAN-compiled object programs.
2. *Subprogram References:* register use, save areas, and related information.
3. *Types of FORTRAN Calls:* a general description of the manner in which compiler programs call-by-name, call-by-value, and pass subprogram names in a parameter list.
4. *Linkage between FORTRAN and Assembler Language Programs:* Detailed examples for FORTRAN programs calling assembler language subprograms and vice versa.

FORTRAN Object Program Structure

There are certain conditions of which assembler-language users writing code to link to or from FORTRAN object code should be aware:

1. FORTRAN object code is reenterable.
2. A single CSECT and an associated PSECT are generated for each compiled program not containing COMMON.
3. Standard type-I linkages (described below) are compiled for subprogram references.
4. FORTRAN main programs, but not subprograms, issue a call on the CHCBD1 entry to module CHCBD prior to any other operations. This call causes the following (see Appendix C for a more complete discussion):
   a. Bits are set in the PSW such that fixed-point overflow and significance exceptions are ignored.
   b. Initialization is performed such that four types of exceptions cause control to be passed to the system modules CHCBD or CHCBE, at which point a flag is set for later interrogation. The four exceptions and the FORTRAN statements that test the flag are:

Exponent-overflow	CALL OVERFL
Exponent-underflow	CALL OVERFL
Floating-point divide	CALL DVCHK
Specification	See below

   A specification exception occurs where a variable is not on a proper word boundary. This condition can occur in a FORTRAN program when a misalignment is forced through the use of the COMMON and/or EQUIVALENCE statements. The compiler issues a warning diagnostic if the user has caused such a misalignment, but program execution will be permitted. When a specification exception occurs, an entry in FORTRAN IV-supplied subprogram CHCBE is entered. According to the option chosen by the installation when the system was generated, CHCBE either terminates the program or causes the requested operation to be performed as if no exception has occurred.

   c. Clears any pointers to entries in the DCB table.

If an assembler-language main program calls a FORTRAN subprogram and arithmetic overflow and boundary alignment problems are to be handled, the user must either call CHCBD1 as a part of his initialization procedures in his main program or provide assembler-language coding to accomplish this end. CHCBD1 issues SIR, DIR and SPEC macro instructions with the default priority.

Subprogram References

This section gives general information concerning subprogram references by both FORTRAN and assembler-language programs. The following section gives specific examples for both types of references.

The FORTRAN program can refer to a subprogram in two ways: by a CALL statement or by a function reference within an arithmetic expression. For example, the statements

```
CALL  SUBR(X, Y, Z)
I=J+K+FUNC(L, M, N)
```

refer to a subroutine subprogram SUBR and a function subprogram FUNC, respectively.

For every subprogram reference, the compiler generates a type-I linkage. Similarly, FORTRAN subprograms expect to be called by a type-I linkage.

Associated with type-I linkage conventions are three areas of concern; these are:

1. Register usage
2. Parameter lists
3. Save areas

Proper Register Usage

TSS/360 has assigned roles to certain registers used in generating a linkage. The function of each linkage register is illustrated in Table 8. Note that registers 2 through 12 are not assigned and, thus, are always available to the user for other purposes.

It is the responsibility of the *called* module to maintain the integrity of general registers 2 through 12 so that their contents are the same at exit as they were at entry to the called program. It is the *calling* program's responsibility to maintain the floating-point registers and program mask around a call. General registers 0, 1, and 13 through 15 must conform to the indicated conventions; 0 and 1 may be destroyed by the called module.

Table 8. Linkage Registers

GENERAL REGISTER	USAGE
0	Integer Result Register (FORTRAN-supplied subprograms).
1	Parameter List Register — contains the address of a list of pointers to input parameters.
13	Save Area Register — contains the address of the calling module's save area.
14	Return Register — contains address in calling module at which execution resumes upon return.
15	Entry Point Register — contains address of the entry point in the called module; also Return Code Register — contains return code set by called module.

By convention, general register 0 is used by a FORTRAN FUNCTION statement subprogram to return the resultant value computed in the subprogram when the resultant value is an integer. When the resultant value is a floating-point number, floating-point register 0 is used. Complex numbers are returned in floating-point registers 0 (real part) and 2 (imaginary part).

Reserving a Parameter Area

If a called module requires input parameters, the calling module must supply the called module with the location of a parameter list in general register 1. Each entry in the parameter list must be on a fullword boundary and represents the address of a parameter being passed to the called module. If the parameter list is variable in length, the length is specified as a count of the number of addresses that compose the list. This count is located one word before the first word in the parameter list. Regardless of whether the parameter list is of fixed or variable length, the parameter list register points to the first word of the parameter list. The CALL macro instruction can be used to generate the parameter list, as well as to link to the called module. The FORTRAN CALL statement does not generate a variable length parameter list count.

Reserving a Save Area

It is the responsibility of the calling module to supply a 19-word area to be used by the called module. Figure 18 shows the layout of the save area and briefly describes the information saved in the area by the calling and called module. Of particular interest in this save area (for trace purposes) are the following two words:

Word 2 — The "backward pointer." This word always points to the save area of the module that called the module whose save area is being inspected.

Word 3 — The "forward pointer." This word contains the address of the save area of the module last called by the program whose save area is being inspected. The low-order bit of this word is set to zero as the called program is entered and set to 1 upon exit if the T option in the RETURN macro instruction is used. (The FORTRAN RETURN statement also causes this bit to be set). This bit is useful in determining the flow of control during program execution.

SAREA → (word 1)	Contains the length of the save area in bytes, a minimum of 76.
SAREA + 4 → (word 2)	The address of the calling module's save area. This field is set by the called module in its own save area.
SAREA + 8 → (word 3)	The address of the next save area; that is, the save area of the called module. This field is set by the called module.
SAREA + 12 → (word 4)	The contents of register 14 containing the address to which return from the called module is made. This field is set by the called module in the calling module's save area.
SAREA + 16 → (word 5)	The contents of register 15, containing the address to which entry into the called module is made. This field is set by the called module in the calling module's save area.
SAREA + 20 → (word 6)	The contents of register 0. Value in register 0 set by calling module and saved by called module.
SAREA + 24 → (word 7)	The contents of register 1.
SAREA + 28 → (word 8)	The contents of register 2.
SAREA + 32 → (word 9)	The contents of register 3.
	Eight words containing the contents of registers 4-11.
SAREA + 68 → (word 18)	The contents of register 12.
SAREA + 72 → (word 19)	The address of the PSECT of the called module. This field must be set by the calling module, by storing the R-value of the called entry point in it.

Figure 18. Save Area Format and Content

Variable-Length Parameter Lists

FORTRAN will not provide a TSS/360 variable-length parameter list (except to the DUMP/PDUMP programs),

nor can any TSS/360-supplied subprograms except DUMP and PDUMP process a variable parameter list passed to them.

Types of FORTRAN Calls

A FORTRAN program can call a subprogram with two basic types of parameters.

The first type is one in which a parameter is the name of a variable, the value of which is to be operated on in assignment statements, transfer of control statements, etc. (This is the usual use of parameters in a subprogram reference.) An example of this use follows:

```
C    PROGRAM MAIN
     CALL SUBR(A, B)
     .
     .
     .
     SUBROUTINE SUBR(X, Y)
     .
     .
     .
     END
```

The call of SUBR in program MAIN above results in MAIN passing to SUBR in a parameter list the addresses of A and B; both A and B, in this example, lie within MAIN. SUBR references to its dummy arguments X and Y will result in references to A and B within MAIN, as SUBR uses the parameter list passed at the CALL to obtain the location of X and Y.

The above type of calls is referred to as "call-by-name." Some compilers also have implemented "call-by-value." Although the TSS/360 compiler treats this type of call identically with a call-by-name, a brief discussion of call-by-value is given here to note the differences.

In a call-by-value linkage, references to X and Y are treated differently. Rather than referring to the values of X and Y stored in MAIN (and known to MAIN as A and B), a call-by-value causes SUBR to obtain the current values of A and B from MAIN and store them within SUBR. All references to X and Y in SUBR will then refer to the locally stored (i.e., within SUBR) values, rather than the values in MAIN. The values are identical, of course, so the end result is the same.

The second basic type of call is one in which the passed parameter is the name of a subprogram. An example of such a linkage is:

```
C    PROGRAM MAIN
     .
     .
     .
     EXTERNAL FUNC
     .
     .
     .
     CALL SUBR(A, FUNC)
     .
     .
     .
     END
     SUBROUTINE SUBR(X, BETA)
     .
     .
     .
     Y=BETA(U, V, W)
     .
     .
     .
     RETURN
     END
```

In this example, program MAIN does not pass the location of FUNC, as FUNC is not a variable name but is the name of a function type subprogram. In this case, MAIN passes the location of a parameter list, containing the V and R-values for FUNC (rather than the location of a variable, as is the normal case), and SUBR uses this information when referring to the function that SUBR knows as BETA.

Linkage Between FORTRAN and Assembler Language Programs

This section describes the linkage between calling and called programs for calls in which the name of a variable and the name of a subprogram are arguments of the call.

CALL Where the Argument Is a Variable Name

In the following example, showing the FORTRAN-assembler language interface, a FORTRAN main program MAIN calls an assembler-language subroutine, ASUBR, which calls a FORTRAN subroutine named FSUBR.

The source statements for the FORTRAN main program are given below, where the leftmost numbers are the system-assigned line numbers, used for reference.

```
0000100C  MAIN PROGRAM FOR INTERFACE EXAMPLE
     .
     .
     .
0000700   CALL ASUBR (A ,B)
0000800   STOP 'END OF EXAMPLE'
0000900   END
```

The CALL statement at line 700 generates object code equivalent to the following:

```
     LA      13, MAIN#P    Caller's PSECT and save
                           area base register
     LA      15, ASUBVR    V-and R-values for
                           ASUBR
     LA      1, PLIST      Parameter list
     L       14, 4(15)     R-value
     ST      14, 72(13)    To PSECT 19th word
     L       15, 0(15)     V-value for ASUBR
     BASR    14, 15        Call ASUBR
     .
     .
     .
```

```
MAIN#P  PSECT                    Caller's PSECT
        DC      F'76'            Save area
        DC      18F'0'
ASUBVR  DC      V(ASUBR)         V-and R-values for called
                                 program
        DC      R(ASUBR)
PLIST   DC      A(A)             Parameter list
        DC      A(B)
        .
        .
        .
        END
```

The purpose of subroutine ASUBR is to exchange the values of A and B.

```
ASUBRP  PSECT
        ENTRY   ASUBR            Required for R-value
                                 linking
        DC      F'76'            Save area
        DC      18F'0'
ASUBRC  CSECT
        USING   ASUBR, 15
ASUBR   SAVE    (14, 12)         Save registers in caller's
                                 save area
        L       14, 72(13)       Get R-value from caller's
                                 PSECT
        ST      14, 8(13)        Save in caller's PSECT
                                 for later tracing of calls,
                                 if desired
        ST      13, 4(14)        Save address of caller's
                                 save area (PSECT) in
                                 ASUBR save area
                                 (PSECT) for later
                                 tracing of calls
        LR      13, 14           13 now has address of
                                 PSECT
        USING   ASUBRP, 13
        LR      12, 15
        DROP    15               Use register 12 as base
                                 register, as CALL below
                                 destroys register 15
        USING   ASUBR, 12
        LM      6, 7, 0(1)       Addresses of A and B
        L       2, 0(6)          Value of A
        L       3, 0(7)          Value of B
        ST      2, 0(7)          A stored in B
        ST      3, 0(6)          B stored in A
        .
        .
        .
        (Call
        FSUBR,
        shown
        later)
        .
        .
        .
        L       13, 4(13)        Restore 13 to caller's
                                 PSECT
        RETURN  (14, 12)         Restore registers and
                                 return
        END
```

The call by assembler-language program ASUBR on FORTRAN subroutine FSUBR is described next.

```
ASUBRP  PSECT
        .
        .
        .
FSUBRVR ADCON IMPLICIT,EP=FSUBR
FSAB    DS      F                Address of A (in MAIN)
        DS      F                Address of B (in MAIN)
ASUBRC  CSECT
        .
        .
        .
        LM      6, 7, 0(1)       Address of A, B
        STM     6, 7, FSAB       To parameter list
        .
        .
        .
        LA      15, FSUBRVR
        CALL    (15), MF=(E, FSAB)
```

Many forms of the CALL macro instruction can be used. In the form of the CALL macro instruction used above, the generated code is:

```
        LA      1, FSAB          Point to parameter list
        L       14, 16(15)       R-value
        ST      14, 72(13)       To save area
        L       15, 12(15)       V-value
        BASR    14, 15           CALL
```

The above CALL of the FORTRAN subroutine FSUBR uses a V-and-R-value pair in the linkage. This type of linkage is required, as FSUBR (like all FORTRAN-compiled programs) is reenterable; thus, the called program must include a PSECT. Note also that a program calling a FORTRAN subprogram must provide the address of a 19-word save area in register 13, and the FORTRAN subprogram called modifies the contents of this save area by storing registers in it. Generally, the first 19 words of the caller's PSECT are reserved for this save area, but it is legitimate to point to a save area elsewhere in the program.

CALL Linkage Where the Argument Is a Subprogram Name

An example was given earlier of a main program passing the name of a function FUNC to subroutine SUBR. The FORTRAN statements were:

```
C   PROGRAM MAIN
    .
    .
    .
    EXTERNAL FUNC
    .
    .
    .
    CALL SUBR (A, FUNC)
    .
    .
    .
    END

    SUBROUTNIE SUBR (X, BETA)
    .
    .
    .
```

```
      Y=BETA (U, V, W)
      .
      .
      .
      RETURN
      END
```

The code generated in MAIN for this example is the equivalent of the following:

```
(Program MAIN CSECT)
        .
        .
        .
              L          15, SUBRVR
              LA         1, PARAM
              CALL       (15)
(Program MAIN PSECT)
        .
        .
        .
SUBRVR  ADCON            IMPLICIT,EP=SUBR
PARAM   DC               A(A)
        DC               A(VRPAIR)
              .
              .
              .
VRPAIR  DC               V(FUNC)
        DC               R(FUNC)
```

When referring to FUNC (known to SUBR as function BETA), subprogram SUBR does not generate for BETA, but uses the V- and R-values passed in the parameter list.

Using Data in COMMON

Both named and blank COMMONS in a FORTRAN IV program can be referred to by an assembler-language subprogram. To refer to named COMMON, the V-type address constant

```
name  DC  V(name of COMMON)
```

is used.

A blank COMMON may also be defined (by the COM instruction) in an assembler-language program. After the first program containing a blank COMMON is loaded, all blank COMMONS in subsequently loaded programs are rejected; any references to the blank COMMON are tied to the already loaded one, thus making data in the first blank COMMON accessible to more than one program.

Referring to Variables in an Array

For an array, the address of the first variable in the array is placed in the parameter list. An array (for example, a three-dimensional array C(3,2,2)) appears in this format in main storage:

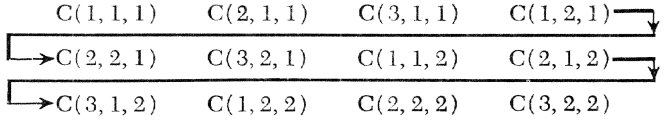


Table 9 shows the general subscript format for arrays of 1, 2, and 3 dimensions.

Table 9. Dimension and Subscript Format

ARRAY A	SUBSCRIPT FORMAT
A(D1)	A(S1)
A(D1, D2)	A(S1, S2)
A(D1, D2, D3)	A(S1, S2, S3)
D1, D2, and D3 are integer constants used in the DIMENSION statement. S1, S2, and S3 are subscripts used with subscripted variables.	

The address of the first variable in the array is placed in the list. To retrieve any other variables in the array, the displacement of the variable (that is, the distance of a variable from the first variable in the array) must be calculated. The formulas for computing the displacement (DISPLC) of a variable for one-, two-, and three-dimensional arrays are

```
DISPLC=(S1-1)*L
DISPLC=(S1-1)*L+(S2-1)*D1*L
DISPLC=(S1-1)*L+(S2-1)*D1*L+(S3-1)*D2*D1*L
```

where

L is the length of each variable in the array.

For example, the variable C(2,1,2) in the main program is to be moved to a location ARVAR in the subprogram. Using the formula for displacement of variables in a three-dimensional array, the displacement (DISP) is calculated to be 28. The following instructions can be used to move the variable:

```
LA    6, 8(13)
LA    8, DISP
L     9, 0(6, 8)
ST    9, ARVAR
```

Appendix E. Specification of Data Set Characteristics

This appendix discusses eight topics associated with defining and processing data sets with FORTRAN object programs. The first of these, "Data Set Creation and Structure," gives a description of the format, creation, and structure of data sets written and read by FORTRAN-compiled modules.

Next, the section "Operation on Data Sets," describes techniques for: creating new data sets, print and punch output, processing data card input, and reading data sets created by other TSS/360 FORTRAN programs or OS/360 FORTRAN programs. Also included are discussions of: exception handling (I/O errors and end-of-data-set handling); use of REWIND, ENDFILE, and BACKSPACE statements; and execution I/O error messages.

The next section, "SECURE Requirements for Nonconversational Tasks," includes considerations in determining the number of private devices needed during processing of a nonconventional task.

"Guide to DDEF Commands" describes in detail how to write DDEF commands for all allowable FORTRAN object-time processing. This section is divided into a description of the basic DDEF command, which may satisfy all normal user requirements; the default of DDEF commands, which discusses SYSIN/SYSOUT I/O; and the full DDEF command, describing extended processing facilities.

The section "Sample DDEF Commands" presents and explains a variety of DDEF command uses. The final three sections of this appendix are "Error Messages for the DDEF Command," "Data Definition Rules for Language Processing," and "Data Definition Rules for TSS/360 Commands."

Data Set Creation and Structure

This section describes the format, creation, and structure of data sets written and read by FORTRAN-compiled modules.

In creating and using data sets, the user is concerned with two things: the logical record format and the data set organization. A *logical record* is the unit of information processed by the user's program – that is, the specific number of contiguous bytes of information that is to be read or written by a FORTRAN program. TSS/360 recognizes three formats for logical records:

1. Format F, for logical records of a fixed length.
2. Format V, for logical records of varying length.
3. Format U, for logical records of undefined format.
4. Format D, for ASCII tape records.

Detailed descriptions of these three formats are given later in this section.

The data set organizations are spoken of in terms of the TSS/360 *access methods* used to manipulate them; that is, the particular set of system routines that are used to transfer data records between virtual storage and a data set in external storage that is organized in a particular way. The TSS/360 access methods are described below.

Access Methods

Data set records are transferred to and from I/O devices and virtual storage by system programs known as access methods. There are two primary access methods.

1. *Virtual Access Method (VAM):* The access method used in TSS/360 unless the data sets must be interchanged with programs running in the IBM System/360 Operating System or the Model 44 Programming System, or the data set is to be written on magnetic tape.
2. *Basic Sequential Access Method (BSAM) and Queued Sequential Access Method (QSAM):* Used to read and write records that can be read and written with programs running under control of the IBM System/360 Operating System or the Model 44 Programming System, or when the data set is to be written on magnetic tape.

The choice of access methods and record formats (see below) are originally determined by the parameters in the DDEF command. A later section of this appendix contains a complete discussion of how DDEF commands are written.

Virtual Access Method

Users create, read, and process virtual access method (VAM) data sets on the basis of logical records. The system, however, blocks these records by pages (4096 bytes) and uses the page as the unit of transfer between the direct-access device and the user's virtual storage. The system also ensures that only those pages of a data set that are actually required are resident in virtual storage.

Virtual storage data sets can be classified as:

1. Virtual sequential (VS)
2. Virtual index sequential (VI)
3. Virtual partitioned (VP)

VAM data sets *must* reside on direct-access volumes (not tape) that are specifically formatted for TSS/360. Labels and other related tables pertaining to the data set for VAM are not the same as those in an OS/360-generated direct-access data set. Therefore, data sets written with VAM cannot be read with a program running under the IBM System/360 Operating System or the Model 44 Programming System.

For FORTRAN, format-U records in any VAM data set are created as format-F with a record length of 4096 bytes.

Virtual Sequential (VS): In a virtual sequential (VS) data set, the order of the logical records is determined by the order in which they are created. VS permits logical records up to 1,048,576 bytes (256 pages) in length.

Most FORTRAN programs read and write logical records using VS in format V. This access method, with this format, is sufficient to handle nearly every application, and only when records are specially formatted will the user have to use some other combination of access method and record format.

Virtual Index Sequential (VI): Virtual index sequential records are similar to virtual sequential records with the addition of an extra field called the key.

In VI data sets, it is only possible to have format-V or -F records; format-U records are not permitted. Logical record length is limited to 4000 bytes; key length cannot exceed 255 bytes, but keys can be anywhere in the record.

The records in the data set are ordered by ascending sequence of the key field. A FORTRAN program can read any VI data set sequentially and records are presented in ascending key order. FORTRAN cannot read VI records by key – that is, nonsequentially. When reading a VI record, the user must account for the key in his FORMAT statement since the key is considered part of the record and must be maintained by the user. An assembler-language subprogram may be used to read records nonsequentially. Writing a VI data set with a FORTRAN program can be done sequentially; however, the key field in the record is checked and used by data management. Therefore, the user must lay out the logical records so that an ascending key, according to the System/360 8-bit code, appears in the same place on every record. For example, the following FORTRAN statements could be used to write a VI data set which contains a 6-character ascending key at the beginning of each logical record.

```
      DIMENSION DATA (40)
      KEY = 0
       .
       .
       .
   10 KEY = KEY + 1
      WRITE (7, 200) KEY, DATA
  200 FORMAT (I6, 40F5. 1)
       .
       .
       .
      GO TO 10
```

To summarize, since TSS/360 FORTRAN does not have random access capability, VI records are of limited use to the FORTRAN user. VI would be used primarily to construct records that are to be read by non-FORTRAN programs, and in writing these records it is the responsibility of the user to supply the KEY in the record.

Virtual Partitioned (VP): Partitioned data sets may contain both VI or VS data set organization. Logical records are grouped into named subdivisions so that processing can take place on any one of them, called a *member* of the partitioned data set. Each member can be treated as an individual data set.

To create and operate on a member of a partitioned data set, the user writes a DDEF command to (1) indicate a DSORG of either VSP or VIP in the subfield of the DCB parameter and (2) append a member name (in parentheses) to the DSNAME. Only one DDEF command can be issued for the partitioned data set at one time; hence, only one member may be processed at any one time.

Physical Sequential (PS)

Physical Sequential (PS) data sets are written by the basic sequential access method (BSAM), and queued sequential access method (QSAM). However, this is normally done only to communicate with the IBM System/360 Operating System or the Model 44 Programming System, or if the data set is to be written on magnetic tape.

BSAM can support any of the record formats – F (blocked and unblocked), V (blocked and unblocked), U (unblocked only), and D (blocked and unblocked). If the user wants to process blocked records with BSAM, he must perform all deblocking first. If the user needs to process blocked records, FORTRAN I/O will automatically perform the deblocking function.

QSAM, on the other hand, supports both blocked and unblocked records. In the case of blocked records, QSAM will automatically provide the deblocking function of the user.

PS data sets are built around physical blocks that contain one or more logical records in format F, V, or U. Format-U records are considered unblocked.

PS data sets may be written either on magnetic tape or direct-access devices. To read a PS data set the user

must first ensure that it is available to the system on the correct device and then indicate to the system the data set's special characteristics. These two functions are performed by special parameters in the DDEF command. (These are described in a later section of this appendix.)

Data Set Records

A logical record is a specified number of contiguous bytes of information that is to be read in or written out by a program.

1. *Format F:* If a data set is made up of records that are all of the same length, it is format F, for fixed length. There are no special restrictions on the contents of a format F logical record; however, different access methods set limits on record size (see Figure 18).
2. *Format V:* If a data set is made up of records that are of varying length, it is format V, for variable length. Again, the different access methods set limits on record size.
3. *Format U:* A third class of record is format U, for undefined length. For records on VS data sets, format U records are always considered to be format F with a record length of 4096 bytes or a multiple of 4096; for records on PS data sets, the record length is determined by some physical boundary that is recognized by the device that reads the record.
4. *Format D:* If a data set contains ASCII records, format D must be specified. Format-D records are variable in length.

The above considerations for using format-F records with FORTRAN programs do not apply to unformatted READ or WRITE records.

	VS	VI	PS	
Record Format			Unblocked	Blocked
F	1,048,576	4000	32760	32760
V	1,048,572	4000	32756	32756
U	4096*		32760	
D			32760	32760
*All U-format records are multiples of 4096.				

Figure 19. Maximum Record Lengths (Bytes)

Variable-Length Format

1. *Record Lengths:* VS format-V records can contain from 1 to 1,048,572 bytes of data. VI format-V records can contain from 1 to 3096 bytes of data. PS format-V records can contain from 1 to 32,752 bytes of data.

   The record length is indicated at the start of each record. PS records (blocked and unblocked) have a two-byte binary number followed by two bytes reserved for system use. VI and VS blocked records have a four-byte binary number. FORTRAN-written programs can read PS data sets and write them on VI or VS and vice versa.
2. *Reading and Writing:* FORTRAN I/O processes input and output format-V records exactly as if they were format F (i.e., the record-length bytes are not transmitted into user storage nor do they need to be constructed by the user before issuing a WRITE). No padding of output records ever takes place. All unformatted FORTRAN records are written as format V with spanning control bits in either the first byte of a VI or VS record or the third byte of a PS record; again this special byte is handled by the system.

Both format-V and -F records can occur in any of the different data set organizations, although they cannot be mixed in any one data set. The organization to be used for an output data set is specified in the DDEF command. The organization used for an input data set can be determined from the data set standard labels, from information in the system catalog, or from the DDEF command.

FORTRAN I/O always writes format V records unless otherwise instructed by the DDEF command.

The user's source program need never be concerned whether format-V or -F records are being read or written, since FORTRAN will construct the records properly and transmit them to the I/O device as instructed. The same is true for format-U records, but their use should be restricted to PS data sets, since VAM generates very large records for format U.

Figures 20, 21, and 22 show the various records formats under different data set organizations.

Fixed-Length Format

1. *Record Lengths:* VS format-F records can be any length from 1 to 1,048,576 bytes. VI format-F records can be any length from 1 to 4,000 bytes. PS format-F records can be any length from 1 to 32,760 bytes. Unblocked records less than 13 bytes in length are rejected if a reading error occurs (i.e., no recovery attempt is made). Therefore, unblocked records of less than 13 bytes are not recommended. Blocked records are automatically at least 13 bytes long.
2. *Blocking format-F records:* Any specification of block size (in the DDEF command) is ignored for blocking of format-F records in VAM data sets. The block size of format-F records in PS data sets must be an integral multiple of the record size.
3. *Writing:* If a data set is defined as containing format-F records, any short records written by a FOR-

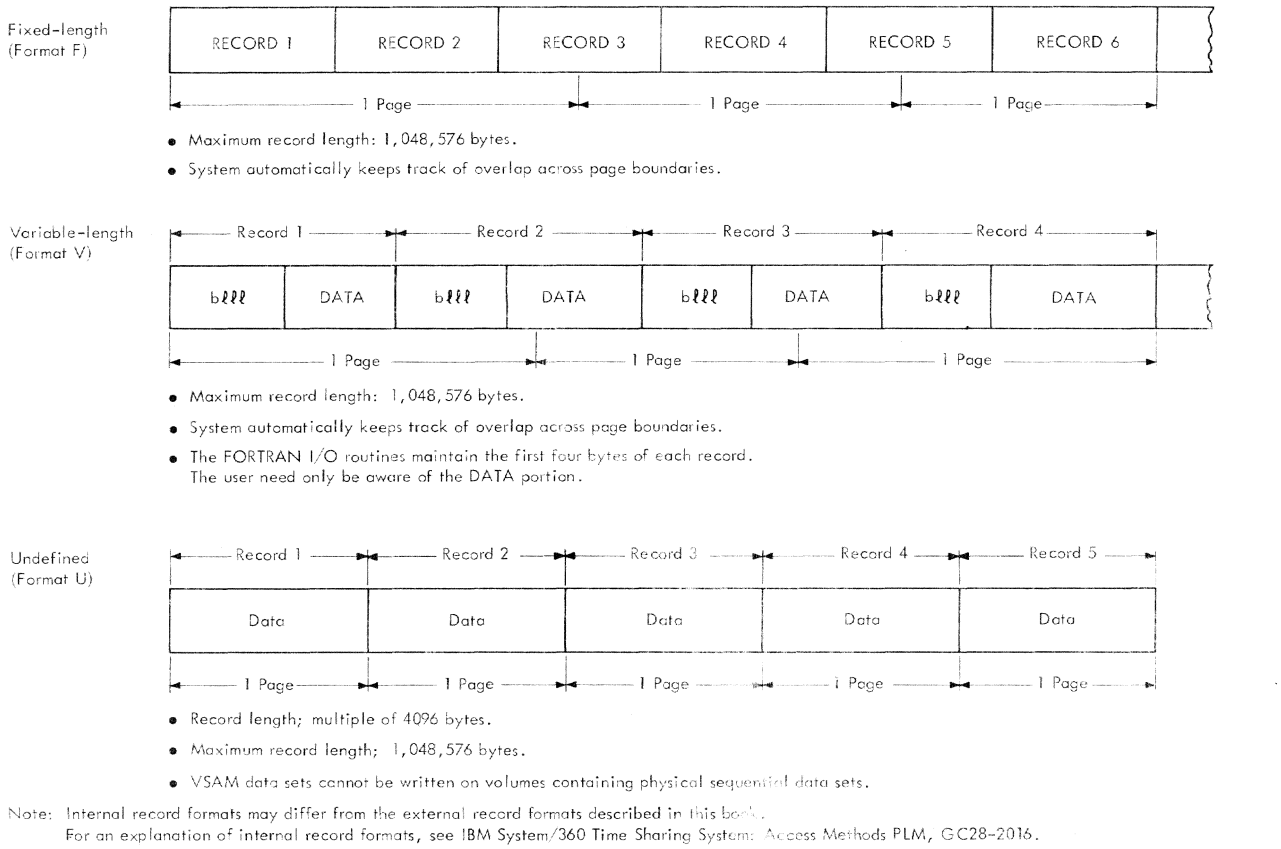


Figure 20. Record Formats — Virtual Sequential

TRAN program are padded with trailing blanks or binary zeros to the required size. Attempts to write logical records greater than the size specified will cause diagnostics and the record will be split.

4. *Reading:* Unused portions of an input record cause no error indication and are simply ignored. Attempts to read logical records longer than the size of the format-F records causes a diagnostic and the next logical record will be read to fulfill the request.

FORTRAN Records

Within the four classes of logical records (i.e., F, V, U or D), the FORTRAN I/O routines construct three different types of records, depending on the FORTRAN language statements used to write the records. These three types of records are formatted, NAMELIST, and unformatted.

Formatted Records

A FORTRAN program most commonly reads or writes logical records whose length is defined by the FORMAT statement and the list. Thus:

```
FORMAT (15H RESULTS ARE  )
```

can be referred to in a WRITE statement without list in order to write a single logical record of 15 bytes. Alternatively:

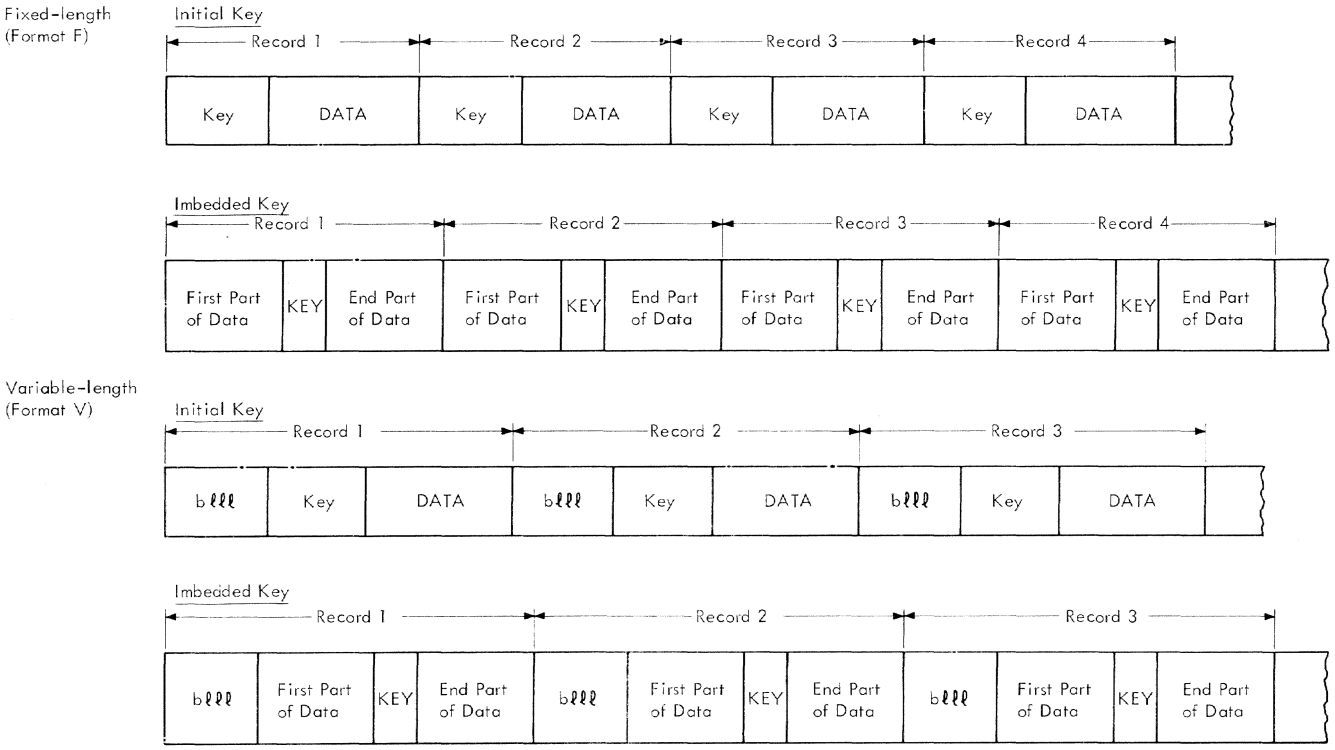
```
FORMAT (15H RESULTS ARE  , 5I5)
```

produces a logical record of 20 bytes if the WRITE statement has a single (simple) variable name in the list, 25 bytes for two names, etc., up to 40 bytes for five names in the list. If there are more than five simple variables in the list, a number of additional records are written, all of which (except possibly the last) are 40 bytes in length, since the FORMAT specification specifies 40-byte records.

When FORTRAN I/O has built up a logical output record according to the rules specified by the FORTRAN IV language, it incorporates the resulting record into any data set format, adding a length indicator, if required for format-V records, and making up a block for F format blocked records.

If the user has requested format-F or -V records for an output data set (in a DDEF command), none of the generated logical records should exceed the maximum permitted logical record length specified in the DDEF. Two or more data set records are generated in such a case, and a diagnostic is issued.

If an attempt is made to read a logical record longer than the one on the input data set, a diagnostic mes-



- Maximum logical record length: 4000 bytes.
- Maximum number of records per data page: 1300.
- Maximum key length: 255 bytes.
- Maximum number of data pages: 65,000.
- Maximum number of overflow pages: 240.
- Maximum number of records per overflow page: 255.
- No limit to the number of directory pages.
- User responsible for Key and DATA parts of each record.
- FORTRAN I/O maintains first four bytes of format-V records.

Figure 21. Record Formats — Virtual Index Sequential

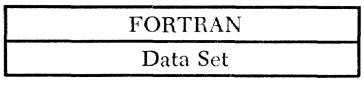
sage is issued and the next record will be read to fulfill the READ.

Parameters in the DDEF command that differ from those of an input data set override the latter, and will cause errors.

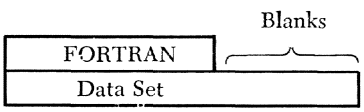
A summary of formatted FORTRAN records is as follows:

1. FORTRAN logical record of X bytes written on a data set with format-F records with a logical record length (LRECL) of Y bytes:

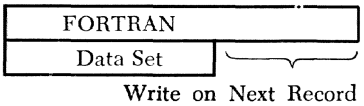
(a) X = Y



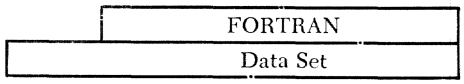
(b) X less than Y



(c) X greater than Y (error)



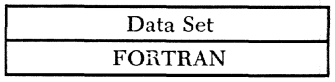
2. FORTRAN logical record of X bytes written on a data set with format-V records. LRECL is unimportant, provided it is not set to less than X.



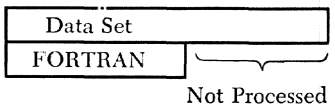
X+4(VAM)
X+8(PS)

3. FORTRAN logical record of X bytes read from a data set with format F records with an LRECL of Y bytes:

(a) X = Y



(b) X less than Y



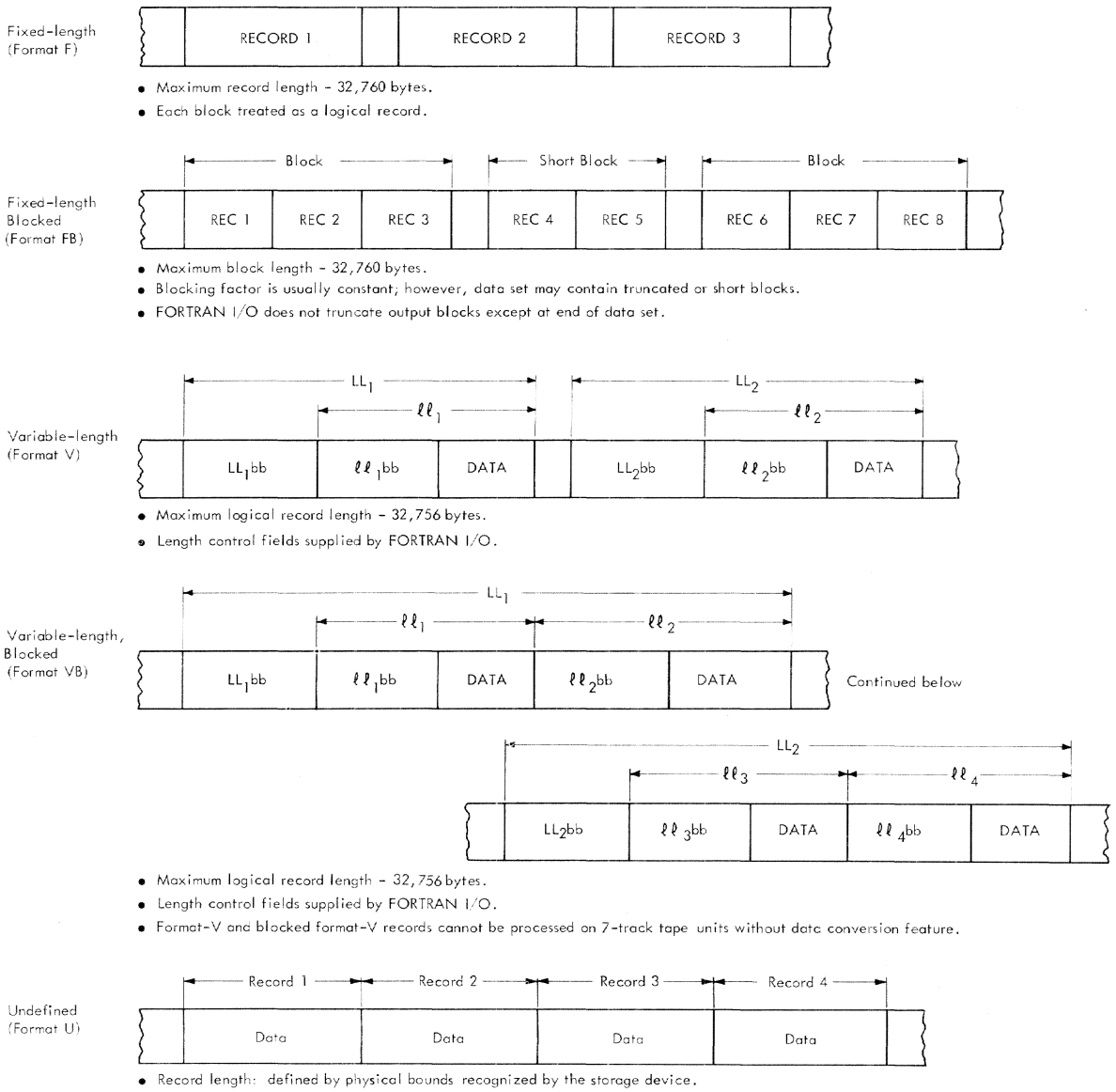
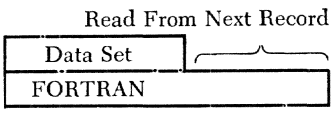


Figure 22. Record Formats — Physical Sequential

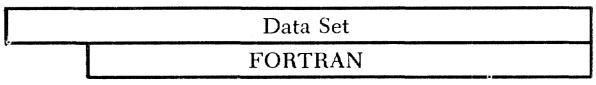
(c) X greater than Y (error)



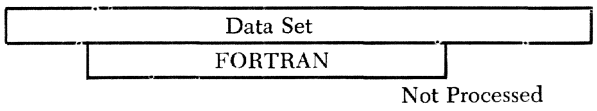
4. FORTRAN logical record of X bytes read from a format V data set logical record with a data length of Y (data set LRECL in the DDEF command is unimportant unless it is deliberately set smaller than maximum likely Y):

(a) X = Y

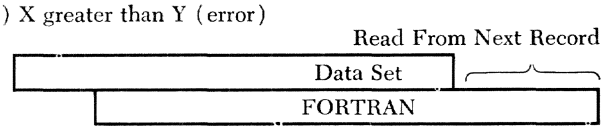
Y+4(VAM)
Y+8(PS)



(b) X less than Y



(c) X greater than Y (error)



NAMELIST Records

FORTRAN NAMELIST records are written based on a NAMELIST variable list that provides a NAMELIST designator name followed by a number of variable or array names.

This results in the generation of at least three logical records:

1. A record containing only the NAMELIST designator name preceded by an ampersand (&), which starts in character 2 of the record
2. One or more records containing items of the form variable-name = integer, real, complex, or logical number
3. A final record containing &END, which starts in the second character of the record.

The user has no control over the spacing or size of items in the second class of record; this depends on the size of the number field required to represent the variable. Typical output might appear as:

```
&NAME1
A=47. 00000, I=5, N=-76709,XXX=-0. 1234567E-07
&END
```

If format V is specified, records of different lengths are written, but none exceeds 120 bytes.

If format F is specified, the specified logical record length in the DDEF is used. The logical record length can be set to 120 to facilitate subsequent printing of the data set.

If format U is specified (with a data set organization of PS), unblocked records (format V) are directed to the output device.

If the DDEF command for a NAMELIST output data set is defaulted, output is directed to SYSOUT as variable-length records of up to 120 bytes. It is either written conversationally at the user's terminal or stored on a system data set (SYSOUT) for subsequent printing.

Since key information cannot be maintained within NAMELIST records, NAMELIST records with a data set organization of VI are not permitted.

If NAMELIST input is from SYSIN, the terminal entries for conversational input should be exactly the same as would be punched on a data card. A prompting message requesting NAMELIST input is printed.

Unformatted Records

Unformatted FORTRAN logical records are written only under the control of a list with no FORMAT statement. Data is transferred to the output data set in internal representation copied from virtual storage.

All unformatted output is made up into format-V records using, if necessary, a standard pair of bits indicating that a given record is incomplete and extends into the next record. For VSAM records, the first two bits of the first byte in the record length field are used. For BSAM records, the last two bits of the third byte in the block length field are used. The bits of this byte are given the following meaning:

	VSAM	BSAM	Meaning
Bit	0 (first)	6	This record spans into the next record.
Bit	1	7 (last)	This record spans from the last record.

Unformatted records written by the IBM System/360 Operating System with PS organization are processed correctly by TSS/360.

When the DDEF command for an output data set is defaulted and unformatted records are written, they are converted to hexadecimal and appear in this form at the terminal or in the listing. The spanning indicator and record length are printed. When the DDEF command for an input data set is defaulted and unformatted records are to be read, the prompting message reminds the user that hexadecimal data should be entered. The user is not required to enter hexadecimal data for the length field and spanning indicator. If one line of input is not enough to fill the elements of the list, additional requests are made for more lines until enough data is received. Invalid hexadecimal characters cause a request for a new line of data. A blank in the input line is treated as marking the end of hexadecimal data, and any further characters in the line are ignored.

Summary of FORTRAN Data Set Formats

Table 10 summarizes the allowable data set organizations and logical record structure for data sets created or processed by FORTRAN object programs.

FORTRAN Operations on Data Sets

Generation of New Data Sets

A FORTRAN program can write an output data set to be used as intermediate data, print or punch output, or to be processed later by other programs.

1. *Intermediate Output:* This requires use of the simplest form of DDEF described under basic DDEF command. Default characteristics are suitable for all applications and for any combination of READ, WRITE, and control statements.
2. *Print or Punch Output:* The default parameters of the basic DDEF command are acceptable. Unformatted records should not be interspersed with formatted. The PRINT or CATALOG command should be issued for the data set before LOGOFF. In conversational operation, defaulting the DDEF command will cause the output to be printed at the terminal.
3. *Output Retention Within TSS/360:* The simplest form of DDEF command can be used, and the data set will be cataloged since new data sets defined by the basic DDEF command reside on public storage. The data set may reside on either a public or private volume.

Table 10. Data Set Format Summary

DATA SET ORGANIZATION	RECORD FORMAT	LOGICAL RECORD LENGTH (LRECL) NOTES	(DISP=NEW) REQUIRED PARAMETERS IN DDEF	NOTES
VS	F[2]	1. Max length = 1,048,576 2. Default length = 133 3. Padding occurs if output less than specified 4. Error if output greater than specified	1. FTxxFyyy, VS 2. DSNAME= 3. RECFM=F 4. LRECL=	1. Records are always blocked. 2. Do not use for unformatted I/O. 3. No tapes.
VS	V[1]	1. Max length = 1,048,572 2. Default length = 4092 3. No padding if output less than specified 4. Error if output greater than specified	1. FTxxFyyy, VS 2. DSNAME=	1. Records are always blocked. 2. Can be used for *formatted, unformatted* and NAMELIST logical records. 3. 4-byte length indicator at beginning of each logical record, not transmitted to user's storage. 4. No tapes.
VI	F	1. Max length = 4,000 2. Default length = 133 3. Padding occurs if output less than specified 4. Error if output greater than specified	1. FTxxFyyy, VI 2. DSNAME= 3. RECFM=F 4. KEYLEN= 5. RKP=[3]	1. Records are always blocked. 2. Do not use for unformatted I/O. 3. User must supply key in the record. 4. No tapes.
VI	V[1]	1. Max length = 4,000 2. Default length = 4,000 3. No padding of logical records 4. Error if output greater than specified	1. FTxxFyyy, VI 2. DSNAME= 3. KEYLEN= 4. RKP=[3]	1. Records are always blocked. 2. Can be used for *formatted* logical records (and *unformatted* using core in the key). 3. User must supply key in the record. 4. 4-byte length indicator at beginning of each logical record, not transmitted to user's storage. 5. No tapes.
PS	F	1. Max length = 32,760 2. Default length = 133 3. Padding occurs if output less than specified 4. Error if output greater than specified	1. FTxxFyyy, PS 2. DSNAME= 3. RECFM=F 4. LRECL=	1. Records are unblocked. 2. Volume may be tape. 3. Do not use for unformatted I/O. 4. IBM System/360 Operating System volumes can be written/read.
PS	FB	1. Max length = 32,760 2. Default length = 133 3. Padding occurs if output less than specified 4. Error if output greater than specified	1. FTxxFyyy, PS 2. DSNAME= 3. RECFM=FB 4. LRECL= 5. BLKSIZE=	1. Maximum block length is 32,760. 2. Default block length is 3990. 3. Block length must be a multiple of LRECL. 4. Can be used for *formatted* logical records only. 5. Volume may be tape. 6. IBM System/360 Operating System volumes can be written/read. 7. Cannot be specified for ASCII data sets.
PS	V[1]	1. Max length = 32,756 2. Default length = 4092 3. No padding 4. Error if output greater than specified	1. FTxxFyyy, PS 2. DSNAME=	1. Maximum block length is 32,760. 2. Default block length is 4096. 3. Block length must be a multiple of LRECL. 4. Can be used for *formatted, unformatted* and NAMELIST records. 5. Volume may be tape. 6. IBM System/360 Operating System volume can be written/read. 7. 4-byte length indicator at beginning of each logical record, not transmitted to user's storage.

[1]IBM-supplied default parameter
[2]Format-U records are treated as Format F with length of 4096 in VS
[3]RKP must allow for the 4-byte indicator

If the data set is to be used subsequently by others, a PERMIT command must be issued for the data set so that those who wish to use it can SHARE it.

4. *Output Retention Outside TSS/360:* A data set to be used on another TSS/360 system is treated as if it were to be used on the same system, but a private volume must be requested. However, if the data set is to be used on another system (not a TSS/360 system), a full DDEF command is required for one of the PS data set types on either direct-access storage or tape. The data set should be on a private volume. All tapes should have standard labels, so that they can be processed on TSS/360 and most other systems) with a minimum of DDEF command parameters.

Reading Existing Data Sets

A FORTRAN object program may use input data sets from a number of different sources and with different characteristics.

From Outside TSS/360

1. *Card decks.* Card decks may be placed in a terminal card reader and read directly by FORTRAN when the DDEF command for the input data set is defaulted. Another method is to submit to the TSS/360 operations center the card deck made up as input to a system program that generates VAM data sets from card decks. The card deck is set up for a nonconversational task in one of two ways:
   a. The deck contains a LOGON card and command cards that CALL a specified FORTRAN porgram. The data cards follow the CALL card; the last data card is followed by a card with %END in columns 1-4, by additional system command cards, and finally by a LOGOFF card. The entire deck causes FORTRAN execution similar to that in a batch environment. The resulting VAM data set serves as SYSIN but cannot be cataloged or retained in the system. (See Example 13 in this manual.)
   b. A data descriptor card immediately precedes the first data card. The data descriptor card is described in *Command System User's Guide.* Following the last data card is a card with %ENDDS starting in column 3. The resultant data set is cataloged and is accessible to FORTRAN programs by means of the basic DDEF command.
2. *Magnetic Tapes.* If the tape is to be used frequently, the system operator should be requested to make a VS data set from the tape using a program similar to that mentioned above for bulk input from cards.

The operator will create a standard cataloged VS data set that is accessible to the user for any session.

The alternative approach is to treat the tape as a private volume, request it on DDEF commands with DSORG set to PS, and specify the additional parameters as discussed in "Full DDEF Command" in this appendix. When the tape has no labels, a number of DDEF command parameters must be specified that are normally obtained from the tape label. However, if the data set is cataloged (CATALOG command following DDEF command), it again be comes possible to use the basic DDEF command.

3. *Direct-Access Volumes (Not VAM).* To use direct access volumes from outside TSS/360, supply appropriate DDEF commands for DSORG of PS with the parameters given in this Appendix. Issuing a CATALOG command following the DDEF command will make PS-type direct-access volumes more convenient to process in future sessions.

From Other Than FORTRAN Programs on TSS/360

FORTRAN I/O can be used to process most input VAM data sets created under TSS/360. The basic DDEF command is used. Any input logical record that can be represented as a print line can be processed by a FORTRAN program having the right FORMAT statement.

If a non-FORTRAN program has written a non-VAM data set such as a tape or direct-access volume on TSS/360, the user should proceed as if the volume had originated outside TSS/360.

From FORTRAN Programs on TSS/360

There are no special considerations when exchanging data sets between TSS/360 FORTRAN programs.

Exception Handling

If a READ statement is being executed and it contains the optional specification of END= or ERR=, and an end or error condition exists, control transfers to the user program without error message or interruption.

If an end-data-set condition exists and END= causes continued execution, further READS on the same data set cause a search for another DDEF command (e.g., one with a DDNAME of FT01F002 instead of FT01F001).

If an error condition exists, the user can attempt to backspace and read again as many times as he wants.

If DSORG is PS for magnetic tape, the system's error recovery procedures are applied to read or write errors unless suppressed by the IMSK option in the DDEF command. If the error is unrecoverable, the program terminates (system EXIT is called by the I/O routines) unless a READ with the ERR option is being processed. If the IMSK option has been used to sup-

press one or more of the standard error procedures, this suppresses either termination of the program or transfer to the ERR location.

If DSORG is PS for direct access, the system's error recovery procedures attempt to use alternate tracks. Thus, when a track is found to be defective, the system assigns the next available alternate track. The FORTRAN user has no control over this action and is not aware of its taking place except that in the event that no alternate track is available for a WRITE, the program will be terminated.

Positioning Statements and Sequence Rules

When operating with VAM or PS-type data sets, the system attempts to interpret and execute each FORTRAN positioning statement in accordance with the organization of the data set in question.

1. For SYSOUT and SYSIN, all positioning statements are ignored unless they violate rules 2 through 5.
2. An attempt to use ENDFILE on a data set that has so far only been used as input causes an error message and execution is terminated.
3. When ENDFILE is used on an output data set, subsequent WRITE statements relate to a different ddname (i.e., another DDEF command), such as FT01F002 instead of FT01F001.
4. The sequence of statements WRITE-ENDFILE-READ cause an error message and program termination. The sequence WRITE-ENDFILE-REWIND-READ is acceptable.
5. An initial REWIND has no meaning for VAM data sets that are always accessed starting at the first record; hence, it is ignored. The sequence READ-REWIND-READ is acceptable and causes a return to sequential processing starting at the first record of the first data set associated with the data set reference number. Also READ-READ-BACKSPACE-READ is acceptable. Attempts to BACKSPACE when positioned at the first record of a data set are ignored.

Execution I/O Error Messages

All FORTRAN I/O error messages are directed to SYSOUT; that is, they appear at the terminal during conversational mode or are listed after a nonconversational task is complete.

All messages except those that cause a system pause start with a five-character name that identifies the I/O routine issuing the message. The names always start with the four letters CHCI and end in one of the letters A through Y.

Most messages consist of a fixed portion, usually 40 bytes in length, followed by a variable portion of about 20 bytes that contains the variable information associated with the message.

When a FORTRAN PAUSE statement is executed, the user is permitted to enter any command other than LOAD, UNLOAD, or CALL name, and then to continue execution of the program with GO. In nonconversational mode, the PAUSE message is written on SYSOUT and program execution continues.

Certain error conditions do not permit further execution of the program, such as an end-data-set condition from a READ statement with no END= specified. This causes the printing of a message; then control is transferred to the system termination routine, EXIT. Any data sets that the program has left open can be closed with the CLOSE command.

SECURE Requirements for Nonconversational Tasks

Nonconversational tasks are enqueued until the system is able to fill the requirements for private devices. This list of requirements is made available to the system by means of a SECURE command which the user must include in the task's command procedure as the first command after LOGON. Then as each DDEF is read and processed, the required devices are allocated from those that have been secured for the nonconversational task. Any attempt to allocate more than are available will cause the task to be terminated.

In determining the number of devices needed in a task, the following points should be considered:

- The number of devices should be at least equivalent to the number of data sets on different private volumes which are opened at any one time. Two or more data sets residing on the same private volume may require only one device (the exception is described below).
- If two different data sets residing on separate volumes are used in sequence (i.e., the first is closed before the second is opened) the system can be directed to allocate the same device to both by including the UNIT=AFF option in the second DDEF along with the DDNAME of the first DDEF command. When the UNIT=AFF option is selected, the device types of both data sets must be compatible, and neither should be new data sets residing on direct-access devices.
- If two different data sets on the same or different private volumes are defined by the same DDNAME, the UNIT=AFF option may not be selected, regardless of whether the references are in the same module or not. If the same data set reference number is used in different programs in a multiple execution task, then the first data set must be released prior to the second DDEF; thus, two devices must be secured for

the data sets even though both data sets are not open at the same time. If both data sets are processed serially in the same program (i.e., the end of the data set is reached, followed by a READ on the same data set reference number) then two DDEF commands are necessary with the same data set reference number in their DDNAME and with successive data set sequence numbers. In this case, one device is sufficient because the unit affinity option may be used.

If several data sets are to be serially processed with unit affinity specifed, each data set may have unit affinity with only the most recently processed data set. Note that unit affinity may only be specified for physical sequential data sets.

If, however, the data sets are not processed serially in the same program, the first data set must be released prior to the second DDEF. Therefore, two devices are necessary since the RELEASE command removed the device from the task's allocation prior to the second DDEF command.

Guide to DDEF Commands

This section discusses:

1. Basic DDEF Commands — describing the general form of the basic DDEF command and its uses.
2. Default of DDEF Commands — describing the conditions where DDEF commands are defautable and subsequent system action.
3. Full DDEF Command — describing the general form of the full DDEF command for the FORTRAN user. Included is a table illustrating for each type of data set, the required and optional DDEF parameters.

The DDEF command is used to establish a data set in the system and describe its characteristics. In general, any data set required by a FORTRAN object program during execution must be specified in a DDEF command.

A DDEF command can be issued at any time within the session prior to the CALL command for the program in which the data set is to be used. Each DDEF command is valid only during the task in which it is issued; previously defined data sets must be redefined at every task that refers to them. A DDEF command that has been entered can be canceled by a RELEASE command.

Normally, FORTRAN users require only basic DDEF commands, defaulting almost all of the operand fields. In some cases, DDEF commands themselves can be defaulted, in which case the SYSIN or SYSOUT data set for input and output respectively is chosen. More complex DDEF commands can be used if the data formats require it.

Input/output statements, such as READ, WRITE, REWIND, BACKSPACE, and ENDFILE, apply to collections of data that are referenced within a FORTRAN program as integer numbers:

READ (23)A OR WRITE (J)B

Since the reference is to the data rather than any specific device, this number is called the *data set reference number.*

The data set reference number used within a FORTRAN program must be associated with a data set name or DSNAME before the system can read or write it. This relationship is established by reference to a DDEF command that links a data set reference number, a data definition name (DDNAME), and a data set name (DSNAME).

Command format specification conventions are listed in Appendix G.

Basic DDEF Command

The basic DDEF commands may be used for *any* cataloged input data set except those on unlabeled tapes. For a new data set it specifies public volume residence, a virtual sequential (VS) data set organization, and variable length records (format VA). Data sets defined with this basic DDEF command must be cataloged by the system. The basic DDEF command is shown in Figure 23.

Operation	Operand
DDEF	DDNAME=data definition name, [DSORG={VI|VS|VP}], DSNAME=data set name

Figure 23. Basic DDEF Command

DDNAME=FTxxFyyy

The DDNAME parameter must be of the following format:

FTxxFyyy

where xx is the data set reference number used within the program and must be two integer digits in the range 00-99; for example, a program containing the FORTRAN statement READ (5, 60)A requires a DDEF command with DDNAME parameter FT05F001. The yyy is the three integer digits 001, except as noted below. The yyy portion of the DDNAME permits operations on multiple data sets with the same data set reference number. For example, when a READ (5, END=40) is used and an end-of-data-set condition occurs, successive READ statements applying to data set reference num-

ber 5 take place on DDNAME FT05F002; therefore, two DDEF commands should be supplied, one for FT05F001 and the other for FT05F002. Similarly, when a WRITE (5) statement is followed by ENDFILE 5, successive WRITE (5) statements take place on DDNAME FT05F002; therefore, two DDEF commands should be supplied, one for FT05F001 and the other for FT05F002.

If a DDNAME with yyy higher than 001 is used, DDEF commands for all yyy between 001 and the higher number must be provided. The various data sets using the same data set reference number may have completely different characteristics and may be stored on the same or different devices.

DSORG=

Specifies the data set organization. In the basic DDEF command, this should be specified as VS (virtual sequential). Other data set organizations and their use are described later in this appendix in "Full DDEF Command."

DSNAME=

The DSNAME parameter description DSNAME=name specifies the name of the data set. This is the name under which the data set is to be cataloged or referred to by other commands during the session. It contains one or more simple names, each simple name having one to eight alphameric characters, the first of which must be alphabetic. A period is used as separator between simple names. The maximum number of characters, including periods, is 35. The maximum number of simple names is 18.

For many cases the DSNAME will consist of only one simple name such as:

```
DDEF   FT06F001,VS,DSNAME=OUTPUT,DISP=NEW
```

A DSNAME may be of value in describing the contents of the data set. Thus, a program that generates a table of random numbers and a table of square roots with the data set reference numbers 1 and 2, respectively, might employ the DDEF commands:

```
DDEF   FT01F001, VS, TABLE.RANNUM
DDEF   FT02F001, VS, DSNAME=TABLE.SQRROOTS
```

A simple means of obtaining unique meaningful DSNAMES is to use the program module name as the first simple name and the DDNAME as the second simple name. Therefore, a program called EXSMOOTH that writes its output on data set reference number 10 might be given DDEF command parameters:

```
DDEF   FT10F001,VS,DSNAME=EXSMOOTH.FT10F001.OUTPUT
```

Use of partitioned data set member names and relative generation numbers are for a special kind of data set discussed in detail in this appendix under "Full DDEF Command," but their effect on DSNAMES is described briefly below.

The DSNAME may continue one of two additional kinds of simple names. The first is written within parentheses and is *not* preceded by a period. The second is a simple name of the form GxxxxVyy, where xxxx is a 4-digit numeric generation number and yy is a 2-digit numeric version.

If a simple name is not separated from the previous name by a period and is within parentheses at the end of a DSNAME, it may be the name of a member of a partitioned data set (first character must be alphabetic) or a relative generation number (zero or a signed integer).

Examples:

MATHLIB(SQRT)	Means the SQRT member of the partitioned data set MATHLIB
PAYROLL(0)	Means the most recent generation of PAYROLL
PAYROLL(−1)	Means the last generation of PAYROLL
PAYROLL(+1)	Means the next generation of PAYROLL
PAYROLL.G0005Y00	Fifth absolute generation

If a DSNAME is to contain generation names, the DSNAME proper is limited to 26 characters, including periods.

Default of DDEF Commands

When an I/O statement is encountered during the execution of FORTRAN programs and the data set reference number is one that has not already been used, the I/O routines make a search of user DDEF commands issued so far. This search is based on the appropriate ddname constructed from the data set reference number according to the convention FTxxFyyy. If no such command is found, the terminal is defaulted.

Conversational

Running conversationally with a defaulted DDEF command means that any WRITE statements in the program cause data to be printed at the terminal. Unformatted WRITE statements result in the printing of hexadecimal data. Formatted or NAMELIST WRITE statements lead to the output of print lines identical to those that would appear on a line printer except that the page skip carriage control character is treated as a triple space and, if the terminal has a print line size shorter than a generated FORTRAN logical record, two or more lines are output (up to a maximum permitted

logical record length of 256 bytes). The first character in the record does not appear but is handled as a carriage control character.

Running conversationally with a defaulted DDEF command means that any READ statement requires input from the terminal.

The expression %END is needed to indicate the end of data to be read by the user's object program from SYSIN. It can be punched on a card for nonconversational processing (or entry through the terminal card reader) or entered through the terminal keyboard. The FORTRAN I/O subroutines detect the end of input by an end-of-data set condition. The system recognizes the expression, %END, and generates an end-of-data set indication, which is transmitted to the FORTRAN subroutines. When a command sequence which has data lines or cards included with it is stored as a SYSIN data set for processing (see Examples 11, 12, and 16), the %END must follow the last line of data.

It is possible to include any number of %END cards in an input deck if the user wishes to section his deck. If the END=option is used in a FORTRAN read statement each %END would then indicate the end of a section of data.

I/O control operations such as REWIND, ENDFILE, and BACKSPACE are ignored when the corresponding DDEF command has been defaulted conversationally.

The I/O statements READ (with no data set reference number) and PRINT lead to automatic default to terminal I/O without prompting for DDEF commands.

Nonconversational

When an I/O statement is encountered during execution of FORTRAN programs in nonconversational mode and the data set reference number has not already been used, a search for the DDEF is made. If no DDEF with the proper data set reference number is found and the I/O operation is WRITE, then output is directed to the system-assigned output data set, SYSOUT. The user receives a listing of SYSOUT, but the data set is not cataloged for subsequent use. If the I/O operation is READ, an attempt is made to read from the SYSIN data supplied by the user when the task was submitted. It should contain data following the RUN command if READ statements without corresponding DDEF commands are to be executed. The characteristics of this data set depend on how it, in turn, was created; it can be either VS or VI and normally contains fixed-length 80-character records. When reading from SYSIN, a record consisting of the characters %END is assumed to be an end-data-set indicator, which causes either termination or transfer to the END=location specified in the READ statement. If the SYSIN data set is exhausted, (i.e., there is no %END on SYSIN) the same action takes place, but errors will arise if the LOGOFF command has been read as FORTRAN data.

Therefore, data sets and multiple data sets can be read from SYSIN, but it is the user's responsibility to guard against reading commands as if they were data. Further, the user should read all data on SYSIN to avoid that data being interpreted as commands.

I/O control operations such as REWIND, ENDFILE, and BACKSPACE are ignored when the corresponding DDEF command has been defaulted nonconversationally. The I/O statements READ (with no data set reference number) and PRINT lead to automatic default to SYSIN and SYSOUT.

Once a data set has been defaulted to SYSOUT (i.e., a WRITE has been executed where no DDEF was supplied), a subsequent attempt to READ the same data set reference number will cause execution to be terminated.

Full DDEF Command

Those portions of a DDEF command that are applicable to determine or specify the characteristics of a data set operated on by FORTRAN programs are presented in Figure 24. Other parameters and options of the general DDEF command, as described in the publication *Command System User's Guide*, are not given because they are ignored or overridden by the FORTRAN I/O routines.

Specification of DDEF commands for peripheral devices of the CPU is also described in the publication *Command System User's Guide*.

The DDEF command that defines a cataloged data set is brief and simple. The only required operand fields are DDNAME and DSNAME. Other operand fields are unnecessary since other information about the data set is described in its catalog entry. For a cataloged data set if SPACE, UNIT, LABEL, or VOLUME operands are entered, diagnostics will be displayed as appropriate. However, the associated fields will be taken correctly from the existing catalog entry.

DDEF commands that define uncataloged data sets can be divided into two groups: (1) those defining new data sets (data sets that are to be generated during the run but do not yet exist) and (2) those defining old (already existing, but uncataloged) data sets. These old, uncataloged data sets can exist only on private volumes.

To define a new data set that is to be written on a public volume, the user can use the DDNAME, DSNAME, SPACE, DSORG, and LABEL operand fields. Exactly which fields he uses other than DDNAME and DSNAME, which are required, depends on the character of his partic-

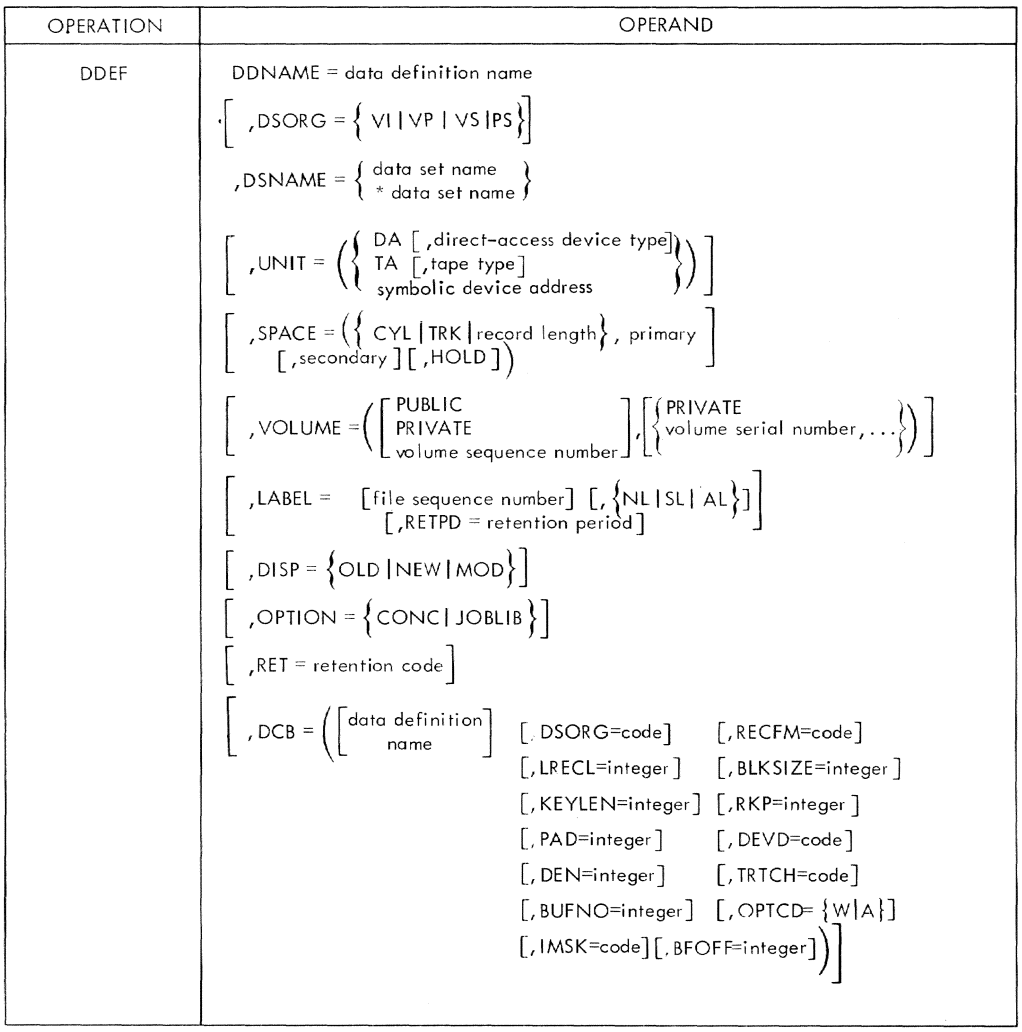


Figure 24. Full DDEF Command for the FORTRAN User

ular data set. To define a new data set that is to be written on a private volume, the user must give DDNAME, DSNAME, UNIT, and VOLUME operands. If he wants, he can also furnish DSORG, SPACE, LABEL, and DISP fields as well.

The user defines an old, uncataloged data set by specifying the DDNAME, DSNAME, VOLUME, UNIT, and DISP fields. The remaining fields can be defaulted for all data sets except unlabeled tapes.

The description of the basic DDEF command given previously in this appendix also applies to the full DDEF command. If DISP=OLD, the full DDEF command can be used to override data set specifications already given in the standard label; however, the user is cautioned that to do this may cause errors in processing the data.

When DISP=NEW, data sets can be defined that differ radically from the standard data set resulting from the basic DDEF command. In particular, the user can define output data sets to be made compatible to other systems.

DDNAME

This operand is used exactly the same way as in the basic DDEF command. Refer to "Basic DDEF Command" in this appendix.

DSORG

In the basic DDEF command this is virtual sequential (VS). The other options are virtual index sequential (VI), virtual partitioned (VP),[1] and physical sequential (PS).

[1]The DSORG parameter is also present within the DCB sublist of the full DDEF command. This distinguishes between the different forms of VP, namely virtual index sequential partitioned (VIP) and virtual sequential partitioned (VSP), and identifies the organization of the partitioned data set member to be processed.

The PS option must be used for tapes or disks that originate outside the TSS/360 environment and for tapes or disks that are to be written under TSS/360 and then transferred to other systems for processing.

The data set organization options other than the standard VS are available for the benefit of the FORTRAN user who wants to process index sequential or partitioned data sets, either to take advantage of their special features or to communicate with assembler language programs.

Each member of a partitioned data set is treated as an independent data set, and the FORTRAN user need not be aware of whether it is a member of the data set or not. However, only one DDEF command can be issued for a VP data set and, therefore, only one member can be processed during a single FORTRAN execution.

Virtual index sequential can be used only if there is no NAMELIST input/output for the data set and if the user takes the responsibility (for output data sets) of making certain that all logical records contain a sequential key in a specified location. The location and length of this key are given as RKP= and KEYLEN= within the DCB sublist of the full DDEF command. NAMELIST output cannot be placed on a VI data set because there is no way for the user to ensure a sequential key in a given location in every record.

DSNAME

The previous description in this appendix under Basic DDEF Command on this subject applies to the full DDEF command.

If DSORG is VP, a member name must be specified as part of the DSNAME. No more than one member of a partitioned data set can be processed at one time.

The *data set name option of the full DDEF command is needed only when processing tape or disk data sets written by the IBM System/360 Operating System with 44-character data set names. Therefore, this option is used only with a DSORG of PS. Subsequent references to the name do not include the asterisk prefix.

UNIT

This operand is only required when DSORG is PS. It can be defaulted even in that case if the data set is cataloged.

UNIT=(DA,{2311|2314})

Specifies direct-access (either a 2311 Disk Storage Drive or a 2314 Multi-disk Storage Drive).

UNIT=(TA,{7|7DC|9})

Specifies that a tape unit (7-track, 7-track with data conversion, or 9-track) is required for the data set. If given, it should agree with the DEVD parameter in the DCB field.

UNIT=(symbolic device address)

Specifies the symbolic device address of a non-standard device.

SPACE

The SPACE parameter is never required for existing data sets. It can be used for new virtual storage data sets (DSORG is VI, VS, or VP) to request an initial allocation of public storage that is different from that specified at system generation time. Its function in this respect is of interest only if the expected size of the data set is either much larger or much smaller than the standard system allocation. In these cases, it permits somewhat greater efficiency in storage allocation. Even if the storage required is greater than the standard allocation, additional storage is automatically issued so that the SPACE parameter is never required for virtual storage data sets.

Form 1

SPACE=(, primary [, secondary] [, HOLD])

This form is used to request allocation parameters for virtual storage data sets that differ from the system standard. Primary and secondary allocation are in space units of 4096 bytes (pages). Primary specifies the number of initial space units to be allocated to the data set. It is one to three digits. Secondary is the number of space units to be allocated each time the space allocated to the data set has been exhausted and more data is to be written. This allocation consists of a one- to three-digit decimal number.

The HOLD option within the SPACE parameter specifies that unused storage assigned to the data set is not to be released when the data set is closed.

Form 2

SPACE=({TRK|CYL|record length},primary [,secondary] [, HOLD])

This form is used for direct-access devices where DSORG is PS. It allocates space in units defined by the first subparameter, namely tracks, cylinders, or record lengths.

VOLUME

Form 1

VOLUME=({PRIVATE | , volume serial number [, . . .]})

The VOLUME parameter is required for old, uncat-

aloged data sets that reside on private volumes. It can also be supplied for new data sets that are to reside on private volumes. Volume serial numbers can be one to six alphameric characters and should uniquely identify a particular disk pack or tape reel that is to be mounted. If PRIVATE is specified and DISP=NEW, the system obtains an available volume and informs the user of the volume selected.

In general, therefore, this form of the VOLUME field is needed only for data sets that are not cataloged. It applies mainly when DSORG is PS and a disk pack or tape generated by the IBM System/360 Operating System is to be read.

Form 2

VOLUME=(volume sequence number)

Where a data set extends over more than one volume, specifies the sequence number of the first of the data set to be read or written. This consists of a one- to four-digit number. It is meaningful only if the data set has PS organization, is cataloged, and its earlier volumes are not to be processed.

Form 3

VOLUME=PUBLIC

This form is used for a new public data set if the user specifies a device type in the UNIT parameter. If PUBLIC is specified, the volume serial number is not recognized. PUBLIC is also assumed if the VOLUME parameter is not specified.

LABEL

This parameter applies only when the data set organization is PS. It is generally used only when magnetic tapes are to be processed, since all data sets on direct-access volumes have labels known as Data Set Control Blocks (DSCBS). The RETPD subparameter, however, is applicable to all PS data sets.

If the entire LABEL field is defaulted, the labeling conventions specified by the installation are assigned. However, if the data set is cataloged, label information is retrieved from the catalog.

Form 1

LABEL=(file sequence number)

The file sequence number (one or two decimal digits) specifies the number of a data set on a tape volume containing multiple data sets. By specifying LABEL, the user can skip over other data sets and the tape is positioned to the data set he wants. If the user subsequently issues a REWIND instruction, the tape will be positioned to the beginning of the data set he is using (not necessarily to the beginning of the tape).

Form 2

LABEL=(, [NL|SL|AL], RETPD=days)

The options shown are NL for no labels, SL for standard labels and AL for ASCII labels. The exact meaning of standard labels is installation dependent. The NL option should not be used for FORTRAN output data sets unless a definite reason exists, since a tape data set without labels requires a more complicated DDEF command when read back by a FORTRAN program than one with labels.

RETPD specifies the number of retention days and applies to output tapes with standard labels and to direct-access output.

If defaulted, RETPD is set to zero to permit immediate rewriting of any tape or direct access data set.

DISP

$$\text{DISP} = \left\{ \begin{matrix} \text{OLD} \\ \text{NEW} \\ \text{MOD} \end{matrix} \right\}$$

DISP=OLD and DISP=NEW do not affect a data set's status. Their only function is to guard against use of the wrong data set.

If DISP=NEW is explicitly specified, the system verifies that the DSNAME does not duplicate one that is already in the user's catalog or one that has been found in a previous DDEF command in the same task. If a duplication occurs in conversational mode, the system issues an error message. In nonconversational mode, the task is terminated.

If DISP=OLD is explicitly specified, the system searches for an existing data set with the same DSNAME. If it cannot find such a data set, it issues an error message; in nonconversational mode, the task is terminated.

If the user does not specify DISP, and if the system finds a data set with the specified DSNAME, it assumes that it is to use that data set. If it cannot find such a data set, it creates a new data set with that DSNAME.

DISP=MOD applies only when the data set organization is PS and a private volume is being processed. This option causes logical positioning after the last record of the data set. Additional WRITE statements are then possible to expand the data set. This option applies mainly to magnetic tapes.

OPTION

OPTION=CONC

Specifies that a data set is being added to the concatenated data set named as DDNAME. The order of concatenated data sets is the same as the order in which they are defined. *Only existing* PS *data sets can be concatenated.*

OPTION=JOBLIB

Specifies that the data set is to be used as a job library. The data set name specified in the DSNAME field is entered into the program library list. The data set organization must be VP.

RET

The RET parameter allows the owner of a virtual storage data set to specify the storage type, and deletion and access attributes of a data set:

RET=([P|T] [C|L] [U|R])

The storage types are:

P – permanent storage

T – temporary storage
- if neither is specified, permanent storage (P) is assumed.

The access attributes are:

C – delete at CLOSE

L – delete at LOGOFF
- if not specified, deletion at LOGOFF (L) is assumed for a temporary (T) data set.
- a permanent data set (P) is not deleted automatically.

The access attributes are:

U – read/write

R – read-only
- if neither is specified, read/write (U) is assumed.

DCB

A data control block (DCB) is one of the major control tables used for communication between TSS/360 data management and any program requiring control of a data set. For every distinct data set reference number, the FORTRAN input/output routines build a DCB as it is encountered in executing the object program. The DCB is initially void, but can be filled from information in the DDEF commands, by the I/O routines after the DDEF command has been examined, or by the input data set labels. Therefore, any required information not in the DDEF command is entered from one of these sources; in particular, record format (RECFM) and logical record length (LRECL) take on values determined by the characteristics of an existing data set (DISP=OLD) or by FORTRAN input/output standards for RECFM=VA where LRECL is not required. The only DCB parameters of critical interest to the FORTRAN user are RECFM and LRECL, and the only time these affect him is when LRECL is smaller than a logical input or output FORTRAN record defined within the program. This condition will cause an error message.

Aside from LRECL and RECFM, the remaining DCB parameters can be grouped into those related to a DSORG of VI (KEYLEN, RKP, and PAD) and those related to a DSORG of PS (DEVD, DEN, TRTCH, OPTCD, BLKSIZE, and IMSK).

DCB Parameters – RECFM, LRECL, and BLKSIZE: RECFM specifies the format or character of the records in the data set:

$$\text{RECFM} = \left\{ \begin{array}{l} \text{U[T][A|M]} \\ \text{V[B|T][A|M]} \\ \text{F[B|T|BT][A|M]} \\ \text{D[B]} \end{array} \right\}$$

Where the record format is:

U – undefined-length records
- if DSORG is VS or VI, this means record size is 4096 bytes
- if DSORG is PS, this means records have physical boundaries (on a tape) and can vary in length, also known as blocksize.

V – variable-length records (EBCDIC)
- each record contains in the first four bytes a binary count of the number of bytes in the record
- maximum data byte limit is:
  - 1,048,572 bytes for VS
  - 4,000 bytes for VI
  - 32,756 bytes for PS
- maximum data byte limit for formatted records with VS is 4092 bytes.

F – fixed-length records
- maximum record length is:
  - 1,048,576 bytes for VS
  - 4,000 bytes for VI
  - 32,760 bytes for PS
- maximum formatted record length with VS is 4092 bytes.

D – variable-length records
- for ASCII tapes only
- can be specified only as a DCB subparameter of DDEF command.

Where the physical attributes are:

B – blocked records (meaningful only for PS); the maximum blocksize is 32,760 bytes
- BLKSIZE must be an integral multiple of logical record length for format-F records

T – track overflow employed
- applies only to disk data sets with DSORGPS
- may cause errors if omitted when track overflow is to be used for writing very long records.

LRECL must be 4 bytes greater than the largest *formatted* logical FORTRAN record that is to be read or written. If defaulted for format-V records, it is assumed to be 4096 for VS and 4000 for VI. If larger VS records are anticipated, it must be specified by the user. Format-V records with a DSORG of PS are processed with an assumed LRECL of 4096, which can also be raised by the user.

When using VSAM, the FORTRAN BACKSPACE statement may not be used to backspace a data set of undefined format (RECFM=U).

The A or M options under RECFM relate to whether extended ANSI FORTRAN control characters or machine code control characters appear as the first byte of every record. The A option (default value) is usually preferred, since most formatted FORTRAN records make use of extended ANSI FORTRAN control character conventions. If NAMELIST records are written, the A can be specified (or chosen by default) since all records start

with a blank. The M option should not be specified unless the user has coded hexadecimal data into the first byte of every record. This option can be ignored by most users.

BLKSIZE is required only if RECFM is FB (fixed-length blocked records) and this option, in turn, is meaningful only if DSORG is PS. In this case, it must be a multiple of LRECL. Otherwise, any value given is ignored and replaced by LRECL.

Examples of how to use the RECFM, LRECL, and BLKSIZE parameters are shown below (they are not complete DDEF commands; only the DSORG and DCB portion is shown).

VS, DCB=(RECFM=F, LRECL=80)	VS 80-character fixed-length records
VS, DCB=(RECFM=V)	VS variable-length records (standard)
VS, DCB=(RECFM=FA, LRECL=133)	VS data set for listing
VI, DCB=(RECFM=V, RKP=4, KEYLEN=4)	VI variable-length records with 4-byte key in initial position (after 4-byte control word)
PS, DCB=(RECFM=FB, LRECL=100, BLKSIZE=1000)	PS fixed-length blocked with 10 records per block

DCB Parameters — VI Associated: If DISP=NEW and DSORG is VI, the user must specify record key position (RKP), key length (KEYLEN), and optionally padding percent (PAD). The relative key position (RKP) specifies the displacement of the key field from the first byte of the logical record. Since VISAM records cannot exceed 4000 bytes, any value between 0 and 3999 can be specified. The first four bytes of a format-V logical record are reserved for length information. Therefore, if RECFM=V, RKP must be four bytes higher ($4 \leq$ RKP ≤ 3999) than for the same data set with RECFM=F. KEYLEN is the length in bytes of the key associated with a record. The maximum value is 255.

PAD specifies the percent of space (to a limit of 50 percent) to be left available within the pages of a VI data set, thus providing for insertions within pages. The FORTRAN user can use VI data sets as output provided he ensures that the specified key field is maintained with appropriate data in collating sequence (ascending) from record to record. This is most easily done by specifying an integer output field as in the following example of a FORTRAN program for reading input records and copying them to a VI data set.

```
1  FORMAT (1X, I5, 6A4)
2  FORMAT (6A4)
   DIMENSION A(6)
   I=0
3  READ (1, 2, END=4) A
   I=I+1
   WRITE (2, 1) I, A
   GO TO 3
4  STOP
   END
```

DDEF commands are:

```
DDEF FT01F001, , DSNAME=INPUT, DISP=OLD
DDEF FT02F001, VI, DSNAME=OUTPUT,
      DCB=(RKP=1, KEYLEN=5, RECFM=F,
      LRECL=30), DISP=NEW
```

The user cannot write NAMELIST records on a VI data set. The user should exercise caution in maintaining the key when writing unformatted records on VI data sets.

DCB Parameters — PS Associated: If DSORG is PS, a large number of DCB parameters can be used that otherwise have no meaning. As previously discussed, the BLKSIZE parameter is required if RECFM=FB. In addition, the parameters listed below apply.

1. *DEVD:* Specifies the device on which the data set resides. It is not required for cataloged data sets; it can be one of the following:
   a. DA specifies direct-access (disk formatted in accordance with IBM System/360 Operating System conventions). In this case KEYLEN has a special meaning since it specifies how many of the initial bytes of each record are to be written on the disk (or read from it) as a key. This condition has no connection with VI and the key cannot be used for random access by the FORTRAN user. If all processing is to be done on TSS/360, it is not necessary to use it. However, if a data set is to be written on a disk pack for the purpose of being processed on another IBM system (e.g., IBM System/360 Operating System), the use of KEYLEN may be required.
   b. TA specifies magnetic tape. If 7-track tape is specified in the UNIT parameter, DEN is given a value of 0, 1, or 2 for recording density of 200, 556, or 800 bytes, respectively. If 7-track tape is to be read, TRTCH can be given as C for data conversion, E for even parity, and T for BCDIC to EBCDIC conversion. The defaults are odd parity and no translation.
2. *BUFNO=1:* Physical sequential I/O normally takes place with two buffers. The user can reduce space allocation requirements by specifying the number of buffers as only one. Any other value given to BUFNO is disregarded.
3. *OPTCD=W:* Applies only for direct-access output, causes additional checking of all write operations. This will increase execution time. OPTCD = A is specified for an ASCII tape.

4. *IMSK*=code: Specifies a 4-byte hexadecimal number whose bit pattern indicates the system's error-handling procedures to be invoked. If FFFFFFFF is written, the system is to apply all optional error recovery procedures. This is the default condition. If 00000000 is written, the system is to apply none of its optional error recovery procedures. If any other 4-byte hexadecimal number is written, the system applies its error-recovery procedures wherever a bit is set to one in IMSK which corresponds to an error condition. The first two bytes correspond to the first two bytes of the channel status word, and the other two correspond to the first two sense bytes. Bit positions in each byte for specification of system error recovery procedure are in the following format:

XXXXXXXB XCXXXXXD YEFGHIYY YYYYYYYY

where a 1-bit in a given position indicates that the system is to handle the associated error condition.

X = System never tests this bit to determine entry to retry routines
Y = Device-dependent conditions
B = Unit exception
C = Incorrect length
D = Channel chaining check
E = Intervention required
F = Bus-out parity
G = Equipment check
H = Data check
I = Overrun

DDEF Summary

Table 11 shows, for each type of data set the required and optional parameters for the DDEF command. The major category is device type (direct-access or tape), followed by disposition (new or old) for direct-access device. Data sets residing on magnetic tape are grouped as cataloged (CAT) or uncataloged (UNC), and labeled (LAB) or unlabeled (UNL).

Sample DDEF Commands

Commands are presented here in increasing order of complexity and decreasing order of likely applicability.

1. DDEF FT01F001,VS,SCRATCH

Can apply to a program containing such statements as WRITE (1), READ (1), REWIND 1, etc., on a temporary (scratch) data set.

The first parameter, FT01F001, is built according to the skeleton FTXXFyyy, where xx is the data set reference number used in the program (01 in this case) and yyy is a sequence number (generally 001).

VS indicates virtual sequential.

The DSNAME can be any valid name made up of eight-letter components connected with periods.

2. DDEF FT03F001,,DSNAME=SCRATCH.ONE
DDEF FT04F001,,DSNAME=SCRATCH.TWO

Illustrates the use of two scratch data sets, distinguished by having different DSNAMES.

3. DDEF FT05F001,VS,DSNAME=SCRATCH,DISP=NEW

This may be used if the data set named SCRATCH is either not yet in existence or has not been cataloged.

4. DDEF FT06F001,VS,DSNAME=SCRATCH,DISP=OLD

This may be used if the data set named SCRATCH is already in existence and has been cataloged.

5. DDEF JLIB,VP,DSNAME=OWNER.JOBLIB,OPTION=JOBLIB

This would never be used with object time I/O but can be applied when the user wants to compile programs onto a job library other than the standard USERLIB that LOGON supplies.

DISP is defaulted to NEW only on the first use of the data set OWNER.JOBLIB. Subsequent action (compiling new members, etc) requires the same DDEF command but DISP is defaulted to OLD. (Job libraries are described in Appendix C.)

6. DDEF FT07F001,VS,DSNAME=OUTPUT.F120,DCB=(RECFM=F,LRECL=120)

Creates a new VS data set with fixed-length records of 120 bytes. The DSNAME can be anything; a suggested technique is to incorporate information defining the kind of data set.

The DCB parameters appear within parentheses and consist of RECFM, meaning record format, and LRECL, meaning logical record length.

If DISP=NEW and no DCB parameters are given, it is assumed that DCB=(RECFM=V, LRECL=4096). If DISP=OLD, the data set characteristics that appear in the data set label are used.

The above DDEF command should *not* be used with DISP=OLD, since the DCB parameters may not be correct.

7. DDEF FT08F001,VS,DSNAME=OUTPUT.F120,DISP=OLD

This is the correct way to read back the data set created by the last example.

8. DDEF FT09F001,VS,DSNAME=DATA.V,DCB=(RECFM=V,LRECL=4096)

This has the same effect as DDEF FT09F001,,DSNAME=DATA.V, since V and 4096 are the default values supplied for RECFM and LRECL by the FORTRAN I/O routines.

9. DDEF FT10F001,VI,DSNAME=LIST.VIF80,DCB=(RECFM=F,LRECL=80,RKP=0,KEYLEN=5)

VI indicates virtual index sequential. This can be omitted if the installation-defined option is VI.

Table 11. DDEF Parameter Requirements by Data Set Type

		Direct Access												Tape									
		New Data Set						Old Data Set						Old						New or Old UNC UNL			
		VS			VI		VP	PS			CAT any dsorg	UNC VS VI VP	UNC PS	CAT LAB	CAT UNL			UNC LAB					
DDNAME		X			X		X	X			X	X	X	X	X			X			X		
DSORG		VS			VI		VP	PS			10	X	PS					PS			PS		
DSNAME		X			X		X	X			X	X	X	X	X			X			X		
DCB	DSORG						VIP	VSP															
		F	V	U	F	V			F	V	U										F	V	U
	RECFM	X	*	X	X	*			X	X	X							X	X	X	X	X	X
	LRECL	X	7		X	8			X	2								X	2		X	2	
	BLKSIZE								1									1			1		
	KEYLEN				X	X			4	4	4			4									
	RKP				X	X																	
	PAD				0	0	S	S															
	BUFNO						A	A	0	0	0			0	0	0	0	0	0	0	0	0	0
	OPTCD						M	M	0	0	0			9									
	DEVD						E	E	DA	DA	DA			DA				TA			TA	TA	TA
	DEN																	0			0	0	0
	TRTCH						A	A										C			0	0	0
	IMSK						S	S	0	0	0			0	0	0	0	0	0	0	0	0	0
UNIT									X	X	X			X				X			X	X	X
SPACE		0	0	0	0	0	V	V	9	9	9												
VOLUME		3	3	3	3	3	I	S	X	X	X		X	X				X			X	X	X
LABEL									6	6	6							5			5	5	5
DISP									*	*	*		X	X	X	X	X	X			X	X	X
OPTION														0	0	0	0	0					
RET		0	0	0	0	0																	

Notes:
1. Required for RECFM=FB. BLKSIZE must be a multiple of LRECL.
2. Specify largest V type record expected. Default values are as described in this appendix.
3. Specify only if private volume desired.
4. Refer to "DCB Parameters - PS Associated" in this appendix.
5. Specify NL for unlabeled data sets. A file sequence number may be specified.
6. Only retention period (RETPD) may be specified.
7. Default is 4092 bytes.
8. Default is 4000 bytes.
9. Only meaningful if existing data set being extended.
10. Required for nonVAM data sets.

Legend: Shaded - Field not required in DDEF command
X - Field required in DDEF command
0 - Field optional
* -IBM-supplied default

The additional DCB parameters define a new data set having a sequential key in every record in the first five bytes. The user must make sure that the key is in ascending sequence (e.g., by using a format such as FORMAT (I5, . . .) and incrementing the key in the output list before each write).

RKP means record key position relative to the first byte of the record. KEYLEN means key length in bytes.

10. DDEF FT11F001,VI,DSNAME=LIST.VIV,DCB=(RECFM=V,RKP=4,KEYLEN=5)

This differs from sample 9 only in that it is for variable-length records. LRECL can be omitted or set as high as 4000, which is the maximum possible value for VI.

RKP=4 because each logical record has a four-byte length field that is *not* maintained by the user but supplied automatically by the FORTRAN I/O routines; it is followed by a five-byte sequential key that *is* maintained by the user.

11. DDEF FT12F001,VI,DSNAME=LIST.VIF80
DDEF FT13F001,VI,DSNAME=LIST.VIV

The above DDEFs might be used to read back the data sets created by 9 and 10, respectively.

Note how characteristics are defaulted. They will

be filled in from the catalog and input data set labels. Note also that DISP in this case is defaulted to OLD.

12. DDEF FT19F001,PS,DSNAME=TAPE.OS360,DCB=(RECFM=FB,LRECL=80,BLKSIZE=800,DEVD=TA),UNIT=(TA,9),VOLUME=(PRIVATE),LABEL=(,SL,RETPD=50)

A DDEF such as this might be used to instruct the operator to mount a scratch tape on a 9-track drive (the volume identification is sent to the user after entry of the DDEF command). It is written with blocked 80-character records, at 10 records per block. The density, DEN, and TRTCH DCB subparameters do not apply since 9-track tape is specified.

Assuming the volume serial number assigned is 00896, the next DDEF may be used to read the tape back into a FORTRAN program.

13. DDEF FT20F001,PS,DSNAME=TAPE.OS360,VOLUME=(,000896),UNIT=(TA,9)

DCB parameters are not needed if the installation default for LABEL is (,SL) which has been assumed in this example.

14. DDEF FT20F001,PS,DSNAME=TAPE.OS360

This assumes that when 12 was created it was cataloged. The act of cataloging a data set makes it much easier to write DDEF statements for retrieving it.

15. DDEF FT21F001,VS,DSNAME=PRIVATE.VAM,VOLUME=(PRIVATE)

VAM data sets may be written on private volumes, provided the volumes are correctly formatted. The actual identification of the volume used is sent back to the user. Data set characteristics by default will be RECFM=V,LRECL=4096.

16. DDEF FT22F001,VS,DSNAME=PRIVATE.VAM

This reads back the data set created by 15. It is assumed that it has been cataloged.

17. DDEF FT23F001,PS,DSNAME=DISK.OS360,DCB=(RECFM=FB,LRECL=40,DEVD=DA,BLKSIZE=400),UNIT=(DA,2311),VOLUME=(PRIVATE),SPACE=(400,500,20)

A data set is to be written on a PS-formatted direct-access volume to be mounted for private use. Space is to be reserved for 500 blocks of 400 bytes each, each block containing 10 logical records of 40 bytes. Each secondary allocation is to be 20 blocks of 400 bytes each. The device type is 2311.

18. DDEF FT24F001,PS,DSNAME=DISK.OS360

This reads back the data set created in 17. It is assumed that it has been cataloged.

19. DDEF FT25F001,PS,DSNAME=DISK.OS360
VOLUME=(,05789),UNIT=(DA,2311)

This is the same as 18, but is used if the data set had not been cataloged. The operator must be informed of the volume identification and device type. All other data set characteristics will be obtained by the system from standard direct-access labels, which must be present on all direct-access volumes.

20. DDEF FT26F001,PS,DSNAME=BADSYS.TAPE,DCB=(RECFM=F,LRECL=80,DEVD=TA),UNIT=(TA,9),LABEL=(,NL),VOLUME=(PRIVATE)

This is not recommended unless the tape is to be used by another system that cannot process standard tape labels.

A tape reel is to be mounted and the user informed of its identification. Since no labels are written, the characteristics of the data set and its name are not apparent to any program reading the tape back.

21. DDEF FT27F001,PS,DSNAME=BADSYS.TAPE,DCB=(RECFM=F,LRECL=80,DEVD=TA),UNIT=(TA,9),LABEL=(,NL),VOLUME=(009876)

This is needed to read back the tape made by 20 (assuming that volume 009876 was assigned to it). Only DISP=OLD can be defaulted since there are no tape labels and it was not cataloged.

22. DDEF FT28F001,PS,DSNAME=BADSYS.TAPE,DCB=(RECFM=F,LRECL=80),DISP=OLD

This is needed to read back the tape made by 20, provided it has been cataloged. DCB parameters are still needed, but VOLUME, UNIT, DEVD, and LABEL parameters are supplied from the system catalog.

23. DDEF FT29F001,VS,DSNAME=MULTIPLE.PART1
DDEF FT29F002,VS,DSNAME=MULTIPLE.PART2
DDEF FT29F003,VS,DSNAME=MULTIPLE.PART3

The three DDEF statements apply to a program that executes the following sequence of statements:

WRITE(29) . . . ENDFILE 29 . . . WRITE(29) . . . ENDFILE 29 . . . WRITE(29)

24. DDEF FT30F001,VS,DSNAME=MULTIPLE.PART1.V
DDEF FT30F002,VS,DSNAME=MULTIPLE.PART2.F,DCB=(RECFM=F,LRECL=100)
DDEF FT30F003,VI,DSNAME=MULTIPLE.PART3.VIF80,DCB=(RECFM=F,LRECL=80,RKP=0,KEYLEN=5)

This is similar to 23, except that the three data sets have different characteristics.

25. DDEF FT31F001,,DSNAME=MULTIPLE.PART1
DDEF FT31F002,,DSNAME=MULTIPLE.PART2
DDEF FT31F003,,DSNAME=MULTIPLE.PART3

This is similar to 23, but applying to a program that reads the three data sets back as follows:

```
1  READ (31, END=2)
   .
   .                          [Process MULTIPLE.PART1]
   .
   GO TO 1
2  READ (31, END=3)
   .
   .                          [Process MULTIPLE.PART2]
   .
   GO TO 2
3  READ (31, END=4)
   .
   .                          [Process MULTIPLE.PART3]
   .
   GO TO 3
4  STOP
```

Error Messages for the DDEF Command

The user's replies to diagnostic messages issued for his DDEF command should be guided by the following:

1. If the diagnostic message calls for reentering an element within a given operand field, only that element should be reentered. Preceding and/or following delimiters are unnecessary. Default is acceptable.
2. If the diagnostic message calls for reentering a complex operand field, the whole field should be reentered, including keyword and equal sign. Default is acceptable.
3. If the diagnostic message calls for reentering an operand field that consists of only one element in addition to the keyword, the reply may be either the element alone, or the keyword, equal sign, and element.
4. If the diagnostic message calls attention to an inconsistency and asks the user to (re)enter one of two or three specified operands, the reply must be a complete operand field. Default is acceptable only if so stated in the message.

The user is informed if the DDEF command cannot be completed. This can occur for one of the following reasons:

1. Invalid punctuation in the operand string.
2. User's volume(s) cannot be mounted.
3. Sufficient space cannot be allocated.
4. More than three logical inconsistencies were detected in the DDEF command.

Whenever possible, correction and completion of the command is attempted. But if diagnostic messages indicate that an operand has been misunderstood because of a punctuation error in the operand string, the user should interrupt the operation (by pressing the attention key) and reenter the corrected command.

The user must never reenter an operand or part of an operand that has not been requested.

If a keyword is missing or invalid, the pertinent element following it must be reentered after the corrected keyword and equal sign are typed.

If an operand occurs twice in the operand string, the second occurrence is preferred. All elements belonging to the earlier occurrence are erased.

DDEF prompting messages are issued according to the operand information already supplied. Unnecessary prompting is kept to a minimum.

If the user's problem program is being executed in conversational mode and an undefined DDNAME is referenced, prompting messages for DDEF operands are issued to the user.

Data Set Definition Rules for Language Processing

Table 12 provides information relating to the organization of and DDEF requirements for data sets involved in assembly, compilation, and linkage editing.

Data Set Definition Rules for TSS/360 Commands

Table 13 provides information relating to the structure of and DDEF requirements for data sets processed by TSS/360 commands.

Table 12. Data Set Definition Rules for Language Processing

COMMAND	RELATED DATA SETS	DATA SET DEFINITION RULES	DSORG
FTN (FORTRAN)	Source program data set	Source program data sets: If supplied as part of SYSIN data set, these data sets do not require any further data set definition. If supplied as prestored data set, they must be cataloged. No DDEF is required for these commands.	VI
	Object module		
	Listing data set		
ASM (ASSEMBLER)	Source program data set	Object module: The module is placed in library at top of program library list. If job library is to receive object module, DDEF command is required to define library.	VP
	Object module		
	Listing data set	Listing: No DDEF command required.	VI
LNK (LINK EDITOR)	Source program data set	Same rules as for FTN and ASM.	
	Libraries that are to supply object modules	Each library referred to by INCLUDE statements except USERLIB and each job library used by automatic call must be defined by a DDEF command.	VP
	Library to receive output object module	If library at top of program library list is to receive output object module, no additional DDEF in this task. If another library is to receive output, it must be defined by previous DDEF command and be specified by its DDNAME to linkage editor.	VP
	Listing data set	No DDEF command required.	VI

Table 13. Data Set Definition Requirements for Commands

COMMAND	RELATED DATA SETS	DSORG	DATA SET DEFINITION
BACK	New SYSIN data set that is to control completion of this task in nonconversational mode.	VS, VI	New SYSIN data set must be cataloged, or defined by previous DDEF command in conversational portion of this task.
CATALOG	Data set to be cataloged.	PS	Data set to be cataloged must be defined by previous DDEF command in this task, unless UPDATE option specified.
CDD	Data set containing only DDEF commands.	VI	Data set must be cataloged, or defined in current task.
CDS	Data set to be copied: existing data set or member of partitioned data set.	VS, VI	Data set to be copied must be cataloged or defined by previous DDEF command in this task.
	Copy data set: can be data set or member of partitioned data set.	VS, VI	Copy data set is defined by this command.
DATA (See Note 2)	Data set to be entered.	VS, VI	No DDEF command is required if the data set is to reside on public storage; data follows this command in input stream. If the data set is to reside on private storage, a DDEF must be issued before the command.
DEFAULT	User profile data set in USERLIB.	VP	Data set must be defined in current task.
DELETE	Data set whose name is to be removed from catalog.	any	No DDEF command required for this command.
DSS?	Data sets whose status is desired.	any	Each data set whose status is to be presented must be cataloged; no DDEF command required for this command.

Table 13. Data Set Definition Requirements for Commands (continued)

COMMAND	RELATED DATA SETS	DSORG	DATA SET DEFINITION
DUMP	Data set to be printed as a reult of program control command DUMP.	VI	DDEF command whose DDNAME is PCSOUT must be defined prior to execution of DUMP command.
EDIT (See Note 1)	Data set to be processed by the Text Editor.	VI	Data set must be cataloged, defined in current task, or defined by this command.
END (See Note 2)	Data set being processed by the Text Editor, or indicates PROCDEF Command completion.	VI	No DDEF command required for this command.
ERASE	Data set to be erased.	VS, VI, VP	Data set to be erased must be cataloged.
EVV	Data sets whose names are to be entered in the catalog.	VS, VI, VP	No DDEF command required by this command.
EXECUTE	SYSIN data set for nonconversational task set up by this command.	VS, VI	Data set must be cataloged; no DDEF command required by this command.
LINE?	Line data set containing lines to be presented.	VI	Line data set must be cataloged or defined by previous DDEF command in this task.
LOAD { FTN, ASM, LNK, User-written problem program }	Object module to be loaded.	VP	Object module to be loaded is identified by external name specified in this command; it must be in a library in the current program library list.
MODIFY	Data set to be changed.	VI	Data set must be cataloged or defined by previous DDEF command in this task.
PC?	Data sets whose status is desired.	any	Each data set whose status is to be presented must be cataloged; no DDEF command required for this command.
PERMIT	Data sets for which sharing is permitted.	any	Data sets for which sharing is permitted must be cataloged; no DDEF command required for this command.
POD?	Virtual partitioned data set for which information about its members is given.	VP	Virtual partitioned data set must be cataloged, or defined by previous DDEF command in this task.
PRINT	Data set to be printed.	PS, VS, VI	Data set must be cataloged or defined by previous DDEF command in this task. Data sets on unlabeled tapes must be defined by a DDEF command.
PROCDEF	Data set which consists of other commands, to become a user-written procedure.	VI	Data set must be defined in current task.
PROFILE	User profile data set in USERLIB, session profile in task virtual storage.	VP	Data sets must be defined in current task.
PUNCH	Data set to be punched on cards.	VS, VI	Data set must be cataloged or be defined by previous DDEF command in this task.
REGION (See Note 1)	Data set to be processed by the Text Editor.	VI	Data set must be cataloged, or defined in current task.
RELEASE	Data set to be released.	any	Data set to be released must be defined in previous DDEF command in this task.
RET	VAM data set whose data set descriptor is to be changed.	VS, VI, VP	Data set must be cataloged.

Table 13. Data Set Definition Requirements for Commands (continued)

COMMAND	RELATED DATA SETS	DSORG	DATA SET DEFIN'TION
SHARE	Data sets for which sharing is requested.	any	Data sets for which sharing is requested must be cataloged; no DDEF command required by this command.
SYNONYM	User profile data set in USERLIB, session profile in task virtual storage.	VP	Data sets must be defined in current task.
TV	Physical sequential data set (from a VT operation) to be written on a VAM volume.	PS	Data set (input) must be cataloged, or defined in current task.
VT	VAM data set to be copied to magnetic tape as a physical sequential data set.	VS, VI, VP	Data set (input) must be cataloged or defined in current task.
VV	VAM data set to be copied into direct access storage.	VS, VI, VP	Data set (input) must be cataloged, or defined in current task.
WT	Data set to be recorded on magnetic tape in print format.	VS, VI	Data set must be cataloged or defined by previous DDEF command in this task.

Note 1: These are the basic directive commands of the Text Editor. See *Command System User's Guide* for details concerning the data manipulation commands of this facility.

Note 2: If the DATA command was used to create the data set within the current task, then the data set is defined as if a DDEF command had been issued by the user directly. If the data set is also VAM organized and resides in public storage, it is automatically cataloged.

Appendix F. Attention Considerations

Interrupting Execution

Pressing the ATTENTION button on the terminal lets the user interrupt the execution of programs within his task. The effect of the ATTENTION interruption depends upon the privilege class of the interrupted module, the nature of the module (some privileged modules are sensitive to attention interruptions and some are not), and even the language in which the source program is written.

Interrupting Privileged Commands

If ATTENTION is pressed during the execution of a privileged command imbedded within a command string (one or more commands in one sysin line), the system responds by printing an asterisk (*) at the terminal, meaning "more commands remain to be processed." To display a list of remaining commands, the user responds by issuing STRING (see Table 14). All commands processed during or before the attention interruption can be assumed to have successfully executed if the system issues no diagnostic message. To resume execution of the remaining commands, the user may press RETURN, or he may ignore the remaining commands by issuing new commands unrelated to the interruption.

If ATTENTION is pressed during the execution of a singly issued privileged command, or during execution of the last command in a command string, the command will normally complete execution and prompt the user to enter another command. If the ATTENTION interruption prevents the command from completely executing, however, the system issues a diagnostic message.

Interrupting Nonprivileged Commands and User Programs

If ATTENTION is pressed during the execution of a nonprivileged command (all language processors, for example, are nonprivileged), or during the execution of a user's program (including FORTRAN library subprograms), the system responds by printing an exclamation point (!) at the terminal. The user may invoke PCS commands to display critical fields and modify values (see "Using the Program Control System," in this appendix), or, to resume processing at the point of interruption, he may issue GO (or press the RETURN key).

Attention Levels

When a user stops program execution by pressing ATTENTION, the status of the interrupted program is saved and can be restarted later at the point of interruption by issuing the GO command. Privileged commands cannot be restarted, however.

Nonprivileged commands (FTN or EDIT, for example) and user-written programs coded in assembler language or in PL/1 can be interrupted and saved at 10 levels: each time a nonprivileged program or command is interrupted by ATTENTION, its status is saved so that it can be restarted later.

As many as 10 such programs can be interrupted and saved for later execution (10 ATTENTION levels). ATTENTION interruptions of more than 10 nonprivileged programs (that is, a request for more than 10 ATTENTION levels) will cause the status of the earliest-saved level to be lost.

FORTRAN programs interrupted by ATTENTION can be saved, too, but only one FORTRAN program can be saved: calling a second FORTRAN program will cause a FORTRAN program previously saved at any level to be lost.

Using The Program Control System (PCS) with ATTENTION

User-written programs may be interrupted during execution by pressing the ATTENTION key. The interrupted program and all related data sets are frozen when the attention interruption is received. Using PCS commands, the user can inspect any portion of the object module, he can display or modify the values of variables, registers, or object code, and resume execution using the values he has modified.

See Appendix B, "PCS and FORTRAN Object Programs," in this book, for further information about using the Program Control System. For complete information about using PCS commands, see *Command System User's Guide.*

Responding to Attention Interruptions

Table 14 shows how the user can make full use of the multi-level ATTENTION handling capability of TSS/360.

Table 14. Responding to Attention Interruptions

When the ATTENTION key is pressed, the system responds with one of three condition symbols:

By these actions, the user calls for the system reaction listed in the block under the corresponding condition symbol:	! (to denote the interruption of nonprivileged programs or commands)	* (to denote the interruption of an unfinished, privileged command string)	_ , or user's command prompt (denotes completion of program or command string)
By issuing the GO command . . .	the current user program is resumed	the most recently interrupted user program is resumed and intervening command strings are cancelled	
By issuing any command . . .	the command is executed	the command is executed and the current command string is cancelled	the command is executed
By pressing the RETURN key . . .	the current user program is resumed	the current command string is resumed	the system prompts the user to enter a command
By pressing the ATTENTION key . . .	the system returns an exclamation point (nothing is changed)	the system returns an asterisk (nothing is changed)	the system prompts the user to enter a command
By entering STRING to list remaining commands in an interrupted string . . .	the system displays the unexecuted command string, if it exists	the system displays unexecuted commands in the current command string	the system returns a diagnostic message
By entering STACK to list names of active nonprivileged programs (in the order in which they may be retrieved). . .	the system displays the names of active user programs at every ATTENTION level		
By entering EXIT to end the currently active program . . .	ends the currently active program, resumes command string if it exists	ends the most recently interrupted program and resumes its associated command string, cancelling subsequent command strings	
By entering RTRN to cancel command strings and user programs at every attention level . . .	command strings and user programs are cancelled by the system at every ATTENTION level		
By entering PUSH to save the status of the currently active program	the system saves the status of the currently active program in ISA Long Save 1 (ISALS1)		

Appendix G. Command Formats

This appendix explains the notation used in command descriptions and presents the general form of each TSS/360 user's command.

The command language statements given in this appendix and in Appendixes A and E use the conventions given below in their notation.

Operands

A positional operand is represented by:

value-mnemonic or operand-name

In the first case, the user writes *only* a value of one of the forms specified by the value mnemonic. In the second case, the operand name is merely a means of referring to the operand in the format description; the hyphen simply separates elements of the operand description and is not written in the actual operand.

A keyword operand is represented by:

KEYWORD=value-mnemonic or KEYWORD=operand name

The user first writes the keyword and the equal sign, and then either a value of one of the forms specified by the value mnemonic, or an operand name, as required.

The following general rule applies to the interpretation of operand representations in a format description: when the operand is written, anything shown in upper-case letters must be written exactly as shown; anything shown in lower-case letters is to be replaced with a value provided by the user. Thus, in the case of a keyword operand, the keyword and equal sign are written as shown, and the value mnemonic is replaced. In the case of a positional operand, the entire operand representation is replaced.

Some operands are not represented in format descriptions by operand names or value mnemonics. Instead, they are represented by one or more upper-case character strings that show exactly how the operand should be written. These character strings are called coded values, and the operands for which they are written are called coded value operands.

A coded value operand results in either a specific value parameter or a specific sequence of executable instructions.

When a positional operand can be written as only one coded value, the operand is shown simply as the coded value; an additional lower-case operand name is not used. For example, a positional operand could be represented by:

MYDATA

A keyboard operand could be represented by:

KEYWORD=MYDATA

If a positional operand can be written as any one of two or more coded values, an additional lower-case operand name may or may not be used. The choice of which is done is determined by whether or not a name can be meaningfully used to refer to all values of the operand. For example, a positional operand could be shown as either of the following:

{NL|SL}

mode-{NL|SL}

In both of the above examples, the braces indicate that the coded values are grouped together in one operand representation, and the vertical stroke indicates that either one of the coded values can be written. The braces and vertical strokes are metasymbols.

Metasymbols

Metasymbols are symbols that convey information to the programmer, but are not written by him. They assist in showing the programmer how and when an operand should be written. The metasymbols used in this publication are:

1. | This is a vertical stroke and means "or." For example, A|B means either the character A or the character B. Alternatives are also indicated by being aligned vertically (as shown in the next paragraph).
2. {} These are braces and denote grouping. They are used most often to indicate alternative operands. For example:

   {NL|SL}

   $\left\{\begin{matrix}\text{NL}\\ \text{SL}\end{matrix}\right\}$

   The two examples above are equivalent; either NL or SL must be written.
3. [] These are brackets and denote options. Anything enclosed in brackets can be either omitted

or written once in the command. For example:

[NL]

[NL|SL]

[NL]
[SL]

The second and third examples above are equivalent; NL or SL or neither can be written. The underlining indicates that, if neither is written, SL is assumed. Braces used for grouping inside brackets are redundant.

4. . . . This is an ellipsis. It denotes occurrence of the preceding syntactical unit one or more times in succession. A syntactical unit is any combination of operand representations, commas, parentheses, and metasymbols, enclosed in braces. For example:

{symbol,} . . .

The above example indicates that a symbol followed by a comma can be written any number of times, but it must be written at least once. The braces denote grouping, and are the extremities of the syntactical unit to which the ellipsis refers.

General Forms

Each of the TSS/360 user's commands is shown below in its general form. Detailed specifications for these commands are given in *Command System User's Guide;* this list is intended for quick reference only. Note that only the basic form of the DDEF command is given; the full form appears in Appendix E.

OPERATION	OPERANDS
ABEND	

OPERATION	OPERANDS
ABENDREG	

OPERATION	OPERANDS
ASM	NAME=module name [,STORED={Y|N}] [,MACROLIB=({data definition name of symbolic portion, data definition name of index portion} [, . . .])] [,VERID=version identification] [,ISD={Y|N}] [,SYMLIST={Y|N}] [,ASMLIST={Y|N}] [,CRLIST={Y|N}] [,STEDIT={Y|N}] [,ISDLIST={Y|N}] [,PMDLIST={Y|N}] [,LISTDS={Y|N}] [,LINCR=(first line number, increment)]

OPERATION	OPERANDS
AT	instruction location [, . . .]

OPERATION	OPERANDS
BACK	DSNAME=data set name

OPERATION	OPERANDS
BEGIN Note: For MT/T use only	application name [application parameters]

OPERATION	OPERANDS
BRANCH	INSTLOC=instruction location

OPERATION	OPERANDS
BUILTIN	NAME=command name, [,EXTNAME=BPKD macro instruction name] [,DSNAME = data set name]

OPERATION	OPERANDS
C	

OPERATION	OPERANDS
CA	

OPERATION	OPERANDS
CALL	[NAME= {entry-point name / module name} [,module parameters]]

OPERATION	OPERANDS
CANCEL	BSN=batch sequence number

Form 1

OPERATION	OPERANDS
CATALOG	DSNAME=current data set name [,STATE={N|U}] [,ACC={R|U}] [,NEWNAME=new data set name]

Form 2

OPERATION	OPERANDS
CATALOG	GDG=generation data group name, GNO=number of generations [,ACTION={A|O}] [,ERASE={Y|N}]

OPERATION	OPERANDS
CB	

OPERATION	OPERANDS
CDD	DSNAME=data set name [, {data definition name / (data definition name, . . .)}]

OPERATION	OPERANDS
CDS	DSNAME1=input data set name [(member name [,...])] ,DSNAME2=Copy data set name [(member name)] [,ERASE={Y|N}] [, {COPYBASE=first line number [COPYINCR=increment] {REPLACE={R|I}}]

OPERATION	OPERANDS
CLOSE	[DSNAME=data set name] [,TYPE=T] [,DDNAME=data definition name]

OPERATION	OPERANDS
CHGPASS	[password]

OPERATION	OPERANDS
CONTEXT	[N1=starting position] [,N2=ending position], STRING1=search string [,STRING2=replacement string]

OPERATION	OPERANDS
CORRECT	[N1=starting line] [,N2=ending line] [,SCOL=first column] [,CORMARK=correction markers] [,CHAR={C|M|H}]

OPERATION	OPERANDS
DATA	DSNAME=data set name [,RTYPE={ FTN CARD S {I {LINE} [,BASE=first line number, INCR=increment] }]

OPERATION	OPERANDS
DDEF	DDNAME=data definition name [,DSORG={VI|VS|VP}] ,DSNAME=data set name

OPERATION	OPERANDS
DDNAME?	[JOBLIB={Y|N}]

OPERATION	OPERANDS
DEFAULT	{operand=[value]} [,...]

OPERATION	OPERANDS
DELETE	[DSNAME=data set name]

OPERATION	OPERANDS
DISABLE	

OPERATION	OPERANDS
DISPLAY	{data field or expression [, . . .]} {ID? data field name }

OPERATION	OPERANDS
DMPRST	FROMDEV={2311|2314|2400}, FRVOLID={volid|(volid [,volid])}, TODEV={2311 2311|2400} [,TOVOLID=}volid|(volid[,volid)|PRIVATE}] [,NEWVLID=volid] [,WRITCHK={YES|NO}] [,LABEL={RETAIN|NO}] [,],RUNMODE={BACK|FORE}

OPERATION	OPERANDS
DSS?	[NAMES= {data set name }] {(data set name, . . .)}

OPERATION	OPERANDS
DUMP	{data field or expression [, . . .]} {ID? data field name }

OPERATION	OPERANDS
EDIT	DSNAME=data set name [(member name)] [, RNAME=region name] [,REGSIZE=region name length]

OPERATION	OPERANDS
ENABLE	

OPERATION	OPERANDS
END	

OPERATION	OPERANDS
ERASE	[DSNAME=data set name]

OPERATION	OPERANDS
EVV	DEVICE=device type, VOLUME=(volume serial number[, . . .]

OPERATION	OPERANDS
EXCERPT	DSNAME=data set name [(member name)] [,RNAME=region name] [,N1=starting line [,N2=ending line]]

OPERATION	OPERANDS
EXCISE	[N1=starting line] [,N2=ending line]

OPERATION	OPERANDS
EXECUTE	DSNAME=data set name

OPERATION	OPERANDS
EXHIBIT	OPTION = {BWQ [, TYPE={ALL|BSN-number}] / UID [, TYPE={ALL|CONV|BACK|UID userid}]}

OPERATION	OPERANDS
EXPLAIN	[{MSGID / ORIGIN / {word / TEXT / RESPONSE / MSGE / MSGS} [,message identification]}]

OPERATION	OPERANDS
FTN	NAME=module name [,STORED={Y/N}] [,VERID=version identification] [,ISD={Y|N}] [,SLIST={Y|N}] [,OBLIST={Y|N}] [,CRLIST={Y|N}] [,STEDIT={Y|N}] [,MMAP={Y|N}] [,BCD={Y|N}] [,PUBLIC={Y|N}] [,LISTDS={Y|N}] [,LINCR=(first line number, increment)]

OPERATION	OPERANDS
GO	

OPERATION	OPERANDS
IF	condition

OPERATION	OPERANDS
INSERT	[N1=preceding line] [,INCR=increment]

OPERATION	OPERANDS
JOBLIBS	DDNAME=data definition name

OPERATION	OPERANDS
K	

OPERATION	OPERANDS
KA	

OPERATION	OPERANDS
KB	

OPERATION	OPERANDS
KEYWORD	[COMNAME=command name]

OPERATION	OPERANDS
LINE?	DSNAME=data set name [, {line number | (first line number, last line number)} [,...]]

OPERATION	OPERANDS
LIST	[N1={starting position|CLP|LAST}] [,N2={ending position|LAST}] [,CHAR={C|H|M}]

OPERATION	OPERANDS
LNK	NAME=module name [,STORED={Y|N}] [,LIB=data definition name of library] [,VERID=version identification] [,ISD={Y|N}] [,PMDLIST={Y|N}] [,LISTDS={Y|N}] [,LINCR=(first line number, increment)]

OPERATION	OPERANDS
LOAD	[NAME=entry-point name]

OPERATION	OPERANDS
LOCATE	[N1=starting position] [,N2=ending position] [,STRING=character string]

OPERATION	OPERANDS
LOGOFF	

OPERATION	OPERANDS
LOGON	user identification, [password] , [addressing] , [charge number] , [control section packing] , [maximum auxiliary storage] , [pristine], [user IVM]

OPERATION	OPERANDS
MCAST	[ECB=end-of-block character] [,CONT=continuation character] [,CLP=break character] [,TRP=transient statement prefix character] [,RCC=concatenation character] [,SSM=system scope mask] [,USM=user scope mask] [,KC=keyboard/card reader character] [,RS=carriage return supression character] [,CP=command-prompt string]

OPERATION	OPERANDS
MCASTAB	[INTRAN={Y|N}] [,OUTRAN={Y|N}]

OPERATION	OPERANDS
MODIFY	SETNAME=data set name [,CONF=R] [,LRECL=record length, KEYLEN=keylength, RKP=key displacement, RECFM={V|F}] [,FTN={Y|N}]

OPERATION	OPERANDS
NUMBER	[N1=starting line] [,N2=ending line] [,NBASE=base number] [,INCR=increment]

OPERATION	OPERANDS
PC?	$\left[\text{NAMES}=\begin{Bmatrix}\text{data set name}\\(\text{data set name},\ldots)\end{Bmatrix}\right]$

OPERATION	OPERANDS
PERMIT	DSNAME={data set name|*ALL} [,USERID={(user identification[,...])|*ALL}] [,ACCESS={R|RO|RW|U}]

OPERATION	OPERANDS
PLI	[NAME=module name] [,PLIOPT=compiler option list] [,PLCOPT=language controller options] [,SOURCEDS=source data set name] [,MERGELST=converter input list] [,MERGEDS=converter input data set] [,MACRODS=intermediate data set name] [,PRVDS=data set name]

OPERATION	OPERANDS
POD?	[PODNAME=data set name] [,DATA=Y] [,ALIAS=Y] $\left[,\text{MODULE}=\begin{Bmatrix}\text{name}\\\text{ALL}\end{Bmatrix}\right]$

OPERATION	OPERANDS
POST	

OPERATION	OPERANDS
PRINT	DSNAME=data set name [,STARTNO=first byte position] [,ENDNO=last byte postion] [,PRTSP= {EDIT | {1|2|3} [,HEADER=H] [,LINES=lines per page] [,PAGE=P]}] [,ERASE={Y|N}] [ERROPT={ACCEPT|SKIP|END}] [,FORM=paper form] [,STATION=station identification]

OPERATION	OPERANDS
PRMPT	MSGID=message identification [,{INSERTn=inserted characters} [, . . .]]

OPERATION	OPERANDS
PROCDEF	NAME=procedure name [,DSNAME=data set name]

OPERATION	OPERANDS
PROFILE	CSW={N|Y}

OPERATION	OPERANDS
PUNCH	DSNAME=data set name [,,STARTNO=first byte position] [,ENDNO=last byte position] [,STACK={1|2|3|EDIT}] [,ERASE={Y|N}] [,FORM=card stock]

OPERATION	OPERANDS
QUALIFY	MNAME=[link-edited module name.] object-module name

OPERATION	OPERANDS
REGION	[RNAME=region name]

OPERATION	OPERANDS
RELEASE	DDNAME=data definition name [,DSNAME=data set name] [,{SCRATCH|HOLD}]

OPERATION	OPERANDS
REMOVE	{statement number [, . . .]} {ALL}

OPERATION	OPERANDS
RET	DSNAME=data set name ,RET={P|T} {L|C} {U|R}

OPERATION	OPERANDS
REVISE	[N1=starting line] [,N2=ending line] [,INCR=increment]

OPERATION	OPERANDS
RUN	[LOC=entry point name]

OPERATION	OPERANDS
SECURE	{(TA=number of devices, [type of device])} {(DA=number of devices, [type of device])} [, . . .]

OPERATION	OPERANDS
SET	{data location=value} [, . . .]

OPERATION	OPERANDS
SHARE	DSNAME=data set name, USERID=owner's user identification] [,OWNERDS={owner's data set name|*ALL}]

OPERATION	OPERANDS
STET	

OPERATION	OPERANDS
STOP	

OPERATION	OPERANDS
SYNONYM	{term=[value] } [, . . .]

OPERATION	OPERANDS
TIME	[MINS=minutes]

OPERATION	OPERANDS
TV	DSNAME1=tape data set name [,DSNAME2=VAM data set name]

OPERATION	OPERANDS
UNLOAD	[NAME=entry-point name]

OPERATION	OPERANDS
UPDATE	

OPERATION	OPERANDS
USAGE	

OPERATION	OPERANDS
VT	DSNAME1=VAM data set name [,DSNAME2=tape data set name]

OPERATION	OPERANDS
VV	DSNAME1=current data set name [,DSNAME2=new data set name]

OPERATION	OPERANDS
WT	DSNAME=current data set name [,DSNAME2=tape data set name] [,VOLUME=tape volume number] [,FACTOR=blocking factor] [,STARTNO=first byte position] [,ENDNO=last byte position] [,PRTSP={1|2|3|EDIT}] [,HEADER=H] [,LINES=lines per page] [,PAGE=P] [,ERASE={Y|N}]

OPERATION	OPERANDS
ZLOGON	

Appendix H: Carriage and Punch Controls

The carriage and punch controls shown in Tables 15 and 16 are recommended as standard; four of them are standard FORTRAN control characters. *They are installation variable, however, depending upon system output routines and, for carriage control, the printer's carriage control tape.

In conversational mode where SYSOUT is the user's terminal rather than an offline printer, all carriage control characters other than 0 and 1 cause a single line skip to occur prior to printing of the line. The carriage control character 0 causes an additional line skip prior to printing of the line, as with offline printer processing. The carriage control character 1 causes three lines to be skipped prior to printing of the line.

Table 15. Carriage Control Characters

FUNCTION	CHARACTER
*Skip no line before printing	+
*Skip 1 line before printing	blank
*Skip 2 lines before printing	0
Skip 3 lines before printing	-
*Skip to channel 1 before printing	1
Skip to channel 2 before printing	2
Skip to channel 3 before printing	3
Skip to channel 4 before printing	4
Skip to channel 5 before printing	5
Skip to channel 6 before printing	6
Skip to channel 7 before printing	7
Skip to channel 8 before printing	8
Skip to channel 9 before printing	9
Skip to channel 10 before printing	A
Skip to channel 11 before printing	B
Skip to channel 12 before printing	C

*Standard FORTRAN control characters.

Table 16. Punch Control Characters

FUNCTION	CHARACTER
Select punch pocket 1	V
Select punch pocket 2	W

*As used in this book, "FORTRAN control characters" refers to the control characters defined by American National Standard FORTRAN, ANSI X3.9-1966.

Part One — Nonconversational

In part one of this appendix, a user enters a program, CONV, to read matrix A and matrix B as input. The product, matrix C, is then computed and all three matrixes are printed as output. The matrices are real and stored a column at a time (i.e., the leftmost subscript varying most rapidly) in order to minimize the amount of storage "paging" required. The card listing for CONV is shown in Figure 25. The program compiles without error and is executed.

After the compilation has been completed, the user receives a compilation listing, shown in Figure 26, and a SYSOUT listing, shown in Figure 27, which includes the commands, system messages, and three matrices A, B, and C.

```
   LOGON ADUSERID,ADACCT29
   FTN NAME = CONV, ISD = N

C          MATRIX MULTIPLICATION EXAMPLE
           DIMENSION A(8,8),B(8,8),C(8,8)
           DATA C/64*0.0/
           READ(2,1) L,M,N
           DO 10 J=1,M
 10        READ(2,2) (A(J,I),I=1,L)
           DO 20 J=1,N
 20        READ(2,2) (B(J,I),I=1,M)
           DO 30 K=1,M
           DO 30 J=1,N
           DO 30 I=1,L
 30        C(I,J)=C(I,J)+A(I,K)*B(K,J)
           DO 40 J=1,M
 40        WRITE(3,3) (A(J,I),I=1,L)
           WRITE (3,4)
           DO 50 J=1,N
 50        WRITE(3,3) (B(J,I),I=1,M)
           WRITE (3,5)
           DO 60 J=1,N
 60        WRITE(3,3) (C(J,I),I=1,L)
           STOP
 1         FORMAT (3I2)
 2         FORMAT (8F10.0)
 3         FORMAT (' ',8F10.3)
 4         FORMAT (14X,'X')
 5         FORMAT (14X,'=')
           END


    RUN CONV
 3 3 3
         3.0         11.0         19.0
         5.0         13.0         23.0
         7.0         17.0         29.0
        31.0         43.0         59.0
        37.0         47.0         61.0
        41.0         53.0         67.0
 $END
    LOGOFF
```

Figure 25. Card Listing for CONV

```
VERSION 07/10/67 OF THE TSS FORTRAN COMPILER ENTERED                                                    PAGE  001
THE MODULE NAME AND VERSION FOR THIS COMPILATION ARE CONV     ,V5
OPTIONS--PUBLIC CSECT(N),BCD MODE(N),PRODUCE ISD(N).  LISTINGS--SOURCE(Y),OBJECT(N),CROSS REF(N),SYMBOL TABLE(N),MEMORY MAP(N).


CONV     ,V5                                                                                            PAGE  002
    100  C         MATRIX MULTIPLICATION EXAMPLE
    200            DIMENSION A(8,8),B(8,8),C(8,8)
    300            DATA C/64*0.0/
    400            READ(2,1) L,M,N
    500            DO 10 J=1,M
    600    10      READ(2,2) (A(J,I),I=1,L)
    700            DO 20 J=1,N
    800    20      READ(2,2) (B(J,I),I=1,M)
    900            DO 30 K=1,M
   1000            DO 30 J=1,N
   1100            DO 30 I=1,L
   1200    30      C(I,J)=C(I,J)+A(I,K)*B(K,J)
   1300            DO 40 J=1,M
   1400    40      WRITE(3,3) (A(J,I),I=1,L)
   1500            WRITE (3,4)
   1600            DO 50 J=1,N
   1700    50      WRITE(3,3) (B(J,I),I=1,M)
   1800            WRITE (3,5)
   1900            DO 60 J=1,N
   2000    60      WRITE(3,3) (C(J,I),I=1,L)
   2100            STOP
   2200    1       FORMAT (3I2)
   2300    2       FORMAT (8F10.0)
   2400    3       FORMAT (' ',8F10.3)
   2500    4       FORMAT (14X,'X')
   2600    5       FORMAT (14X,'=')
   2700            END


       CONV     ,V5                                                                                        PAGE  003


       CONV             SIZE       2204 BYTES

       ENTRY NAME       LOC HEX
       CONV             00000000

       EXTERNAL REFERENCES
       CHCB01        CHCIA1        CHCIE1        CHCIU1        CHCIW2

       CONV#C           SIZE        908 BYTES       07/13/67  14:23:15

       CODE                                         LOC HEX 00000000    SIZE        864 BYTES

       NUMERIC CONSTANTS                            LOC HEX 00000360    SIZE         44 BYTES



       CONV     ,V5                                                                                        PAGE  004


       CONV#P           SIZE       1296 BYTES       07/13/67  14:23:15

       REGISTER SAVE AREA                           LOC HEX 00000000    SIZE         76 BYTES

       CONVERSION CONSTANTS                         LOC HEX 0000004C    SIZE         24 BYTES

       ADDRESS CONSTANTS                            LOC HEX 00000064    SIZE        124 BYTES

       ALPHAMERICS                                  LOC HEX 000001B0    SIZE         43 BYTES

       LOCAL TEMPORARY STORAGE                      LOC HEX 000004F8    SIZE         24 BYTES

       NON-COMMON VARIABLES (TOTAL)                 LOC HEX 000001E0    SIZE        792 BYTES


CONV     ,V5                                                                                            PAGE  005
COMPILATION COMPLETED
```

Figure 26. Compilation Listing for CONV

```
LOGON ADUSERID,ADACCT29
FTN NAME=CONV

CONV
    3.000     11.000     19.000
    5.000     13.000     23.000
    7.000     17.000     29.000
              X
   31.000     43.000     59.000
   37.000     47.000     61.000
   41.000     53.000     67.000
              =
 1279.000   1653.000   2121.000
 1579.000   2045.000   2629.000
 2035.000   2637.000   3393.000
LOGOFF
```

Figure 27. SYSOUT Listing for CONV

Part Two — Conversational

In this part, a user writes and compiles a program to solve the same problem as solved in part one. He then runs it on-line. He uses his console for both input and output, switching it to become the equivalent of SYSIN and SYSOUT, i.e., the standard system input and output, as shown in Figure 28. A sample SYSOUT listing is shown in part one.

```
USR:  (presses attention button or dials up system)
      LOGON ADUSERID,MYPASS*,,ADACCT29
SYS:  B001 LOGON TASKID=FFF9 07/25/68
S,U:  FTN NAME=CONV
S,U:      0000100C      MATRIX MULTIPLICATION EXAMPLE
S,U:      0000200       DIMENSION A(8,8),B(8,8),C(8,8)
S,U:      0000300       DATA C/64*0.0/
S,U:      0000400       READ(2,1) L,M,N
S,U:      0000500       DO 10 J=1,M
S,U:      0000600 10    READ(2,2) (A(J,I),I=1,L)
S,U:      0000700       DO 20 J=1,N
S,U:      0000800 20    READ(2,2) (B(J,I),I=1,M)
S,U:      0000900       DO 30 K=1,M
S,U:      0001000       DO 30 J=1,N
S,U:      0001100       DO 30 I=1,L
S,U:      0001200 30    C(I,J)=C(I,J)+A(I,K)*B(K,J)
S,U:      0001300       DO 40 J=1,M
S,U:      0001400 40    WRITE(3,3) (A(J,I),I=1,L)
S,U:      0001500       WRITE (3,4)
S,U:      0001600       DO 50 J=1,N
S,U:      0001700 50    WRITE(3,3) (B(J,I),I=1,M)
S,U:      0001800       WRITE (3,5)
S,U:      0001900       DO 60 J=1,N
S,U:      0002000 60    WRITE(3,3) (C(J,I),I=1,L)
S,U:      0002100       STOP
S,U:      0002200 1     FORMAT (3I2)
S,U:      0002300 2     FORMAT (8F10.0)
S,U:      0002400 3     FORMAT (' ',8F10.3)
S,U:      0002500 4     FORMAT (14X,'X')
S,U:      0002600 5     FORMAT (14X,'=')
S,U:      0002700       END
SYS:      The system asks whether it should continue processing.
```

Figure 28. Conversational SYSIN-SYSOUT for CONV

```
USR:      Y
SYS:      The system informs the user that it found no errors.
S,U:      PRINT LIST.CONV(0),,,EDIT,ERASE
S,U:      CALL CONV
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:      3 3 3
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:            3.0       11.0       19.0
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:            5.0       13.0       17.0
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:            7.0       17.0       29.0
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:           31.0       43.0       59.0
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:           37.0       47.0       61.0
SYS:      The keyboard unlocks indicating the system will accept input data.
USR:           41.0       53.0       67.0
PGM:            3.000     11.000     19.000
                5.000     13.000     23.000
                7.000     17.000     29.000
                          X
               31.000     43.000     59.000
               37.000     47.000     61.000
               41.000     53.000     67.000
                          =
            1279.000   1653.000   2121.000
            1579.000   2045.000   2629.000
            2035.000   2637.000   3393.000
SYS:      CHCIW  STOP
USR:      ERASE SOURCE.CONV
S,U:      LOGOFF
S,U:      The system acknowledges log-off.
```

Figure 28. Conversational SYSIN-SYSOUT for CONV (continued)

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79-80
117-118

A change to the text is indicated by a vertical line to the left of the change.

Summary of Amendments

- The description of the effect of a level-2, severity code "E" error diagnostic has been modified.
- Errors in the description of the parameters required by SYSOBF have been corrected.

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