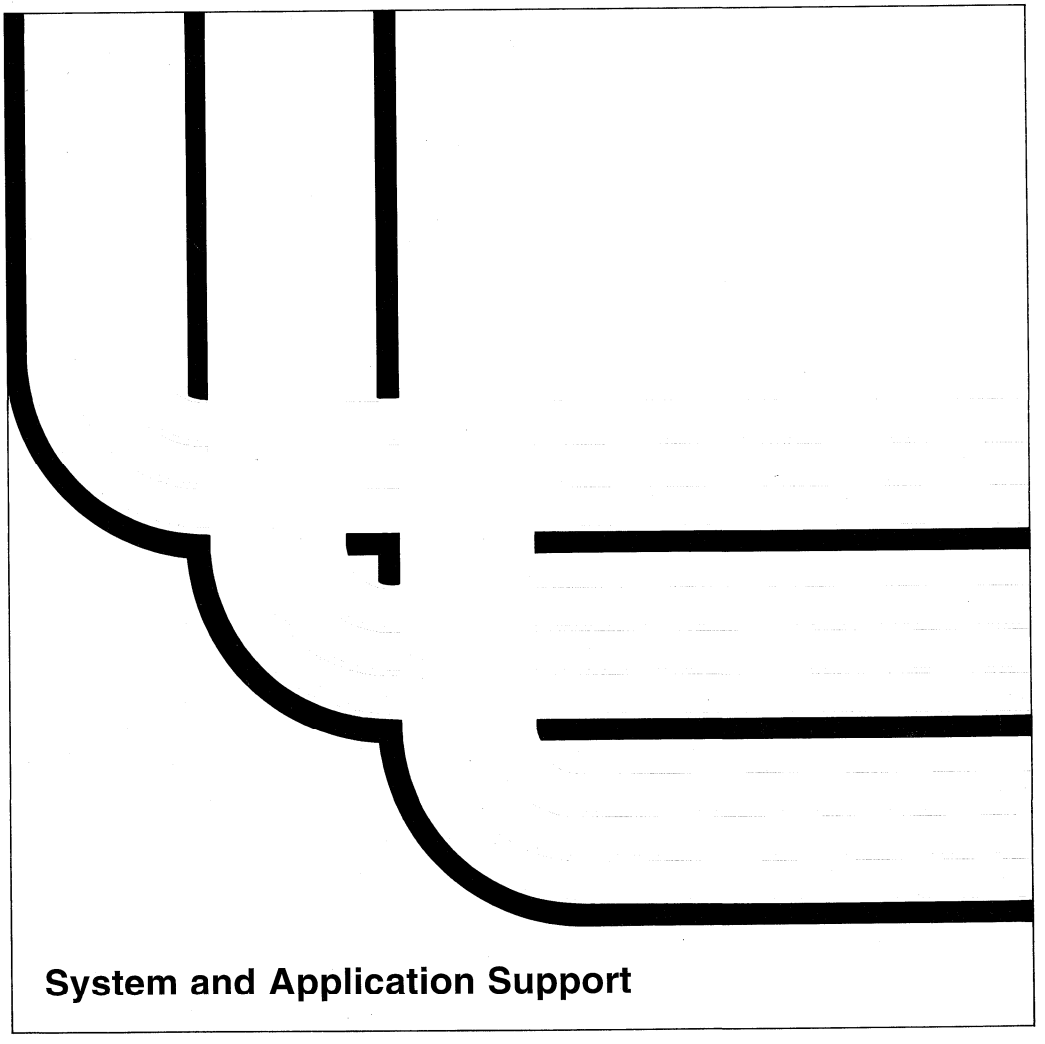
Application System/400

SC41-8077-02

Programming: Control Language Programmer's Guide

Version 2



System and Application Support

Application System/400

SC41-8077-02

Programming: Control Language Programmer's Guide

Version 2

Take Note!

Before using this information and the product it supports, be sure to read the general information under "Notices" on page ix.

Third Edition (November 1993)

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Changes or additions to the text are indicated by a vertical line (|) to the left of the change or addition.

Refer to the “Summary of Changes” on page xiii for a summary of changes made to the CL Programmer's Guide and how they are described in this publication.

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About This Guide

This guide provides a wide-range discussion of AS/400 programming topics, including:

- Control language programming
- AS/400 programming concepts
- Objects and libraries
- Message handling
- User-defined commands
- User-defined menus
- Testing functions

Who Should Use This Guide

This guide is intended for the AS/400 programmer or application programmer, including non-CL programmers. While CL programming is discussed in detail, much of the material in this guide applies to the system in general and may be used by programmers of all high-level languages supported by the AS/400 system.

Before using this guide, you should be familiar with general programming concepts and terminology, and have a general understanding of Operating System/400 (OS/400) and the AS/400 system. You should also be familiar with the work stations you are using.

You may need to refer to other IBM manuals for more specific information about a particular topic. The *Publications Guide*, GC41-9678, provides information on all the manuals in the AS/400 library.

For a list of related publications, see the Bibliography.

Summary of Changes

Retrieving Data Queue Messages

Chapter 3 contains information on a new application programming interface (API), Message Handler Retrieve Data Queue Message (QMHRDQM). The QMHRDQM API retrieves one or more messages from a data queue.

Integrated Language Environment (ILE)

Chapter 7 and Chapter 8 contain information on the Integrated Language Environment (ILE) model. The ILE model is an enhancement to the AS/400 operating system (OS/400) that provides a common run-time environment and run-time bindable application programming interfaces (APIs) for all ILE-conforming high-level programming languages.

Miscellaneous Changes

Other changes have been made to update information on the following topics:

CALL command, Chapter 3.
"Common Errors in Calling Programs" on page 3-9.
"Retrieving Object Descriptions" on page 4-25.
"Automatic Decompression of Objects" on page 4-39.
"Job Message Queues" on page 7-21.
"QSYSMSG Message Queue" on page 8-24.

Chapter 1. Introduction

This introduction describes several major concepts of Operating System/400* (OS/400*). These concepts are discussed in more detail in the following chapters.

System operation is controlled by the following:

- CL commands. CL commands are used singly in batch and interactive jobs, (such as from the Command Entry display) and in CL programs.
- Menu options. System operation can be controlled by selecting menu options. Interactive users can use the AS/400* menus to perform many system tasks.
- System messages. System messages are used to communicate between programs and to communicate between programs and users. Messages can report both status information and error conditions.

Control Language

Control language (CL) is the primary interface to the operating system and can be used at the same time by users at different work stations. A single control language statement is called a **command**. Commands can be entered in the following ways:

- Individually from a work station.
- As part of batch jobs.
- As source statements to create a CL program.

Commands can be entered individually from any command line or the Command Entry display.

To simplify the use of CL, all the commands use a consistent syntax. In addition, the operating system provides prompting support for all commands, default values for most command parameters, and validity checking to ensure that a command is entered correctly before the function is performed. Thus, CL provides a single, flexible interface to many different system functions that can be used by different system users.

Command Syntax

Each command is made up of a command name and parameters. A command name usually consists of a verb, or action, followed by a noun or phrase that identifies the receiver of the action. The words that make up the command name are abbreviated, usually to three letters, to reduce the amount of typing required to enter the command. For example, one of the CL commands is the Send Message command. The command name is SNDMSG, used to send a message from a user to a message queue.

The parameters used in CL commands are keyword parameters. The keyword, usually abbreviated the same way as commands, identifies the purpose of the parameter. However, when commands are entered, some keywords may be omitted by specifying the parameters in a certain order (positional specification).

CL Programs

CL programs are made up of CL commands. The commands are compiled into a program that can be called whenever the functions provided by the program are needed. Advantages of using CL programs include:

- Because the commands are compiled and stored in a form that can be run immediately, using CL programs is faster than entering and running the commands individually.
- Consistent processing of the same set of commands and logic.
- Some functions require CL commands that cannot be entered individually and must be part of a CL program.
- CL programs can be tested and debugged like other high-level language (HLL) programs.
- Parameters can be passed to CL programs to adapt the operations performed by the program to the particular requirements of that use.

CL programs can be used for many kinds of applications. For example, CL programs can be used to:

- Provide an interface to the user of an interactive application through which the user can request application functions without an understanding of the commands used in the program. This makes the work station user's job easier and reduces the chances of errors occurring when commands are entered.
- Control the operation of an application by establishing variables used in the application (such as date, time, and external indicators) and specifying the library list used by the application. This ensures that these operations are performed whenever the application program is run.
- Provide predefined procedures for the system operator, such as procedures to start a subsystem, to provide backup copies of files, or to perform any other procedural operating functions. The use of CL programs to perform these procedures reduces the number of commands the operator uses regularly, and ensures that system operations are performed consistently.

Most of the CL commands provided by the system can be used in CL programs. Some functions are specifically designed for use in CL programs and are not available when commands are entered individually. These functions include:

- Logic control functions that can be used to control which operations are performed by the program according to conditions that exist when the program is run. For example, *if* a certain condition exists, *then do* certain processing, *else* do some other operation. These logic operations provide both conditional and unconditional branching within the CL program.
- Data operations that provide a way for the program to communicate with a work station user. Data operations let the program send formatted data to and receive data from the work station, and allow limited access to the database.
- Functions that allow the program to send messages to the display station user.
- Functions that receive messages sent by other programs. These messages can provide normal communication between programs, or indicate that errors or other exceptional conditions exist.
- The use of variables and parameters for passing information between commands in the program and between programs.

Using CL programs, applications can be designed with a separate program for each function, and with a CL program controlling which programs are run within the application. The application can consist of both CL and other HLL programs. In this type of application, CL programs are used to:

- Determine which programs in the application are to be run.
- Provide system functions that are not available through other HLL languages.
- Provide interaction with the application user.

CL programs provide the flexibility needed to let the application user select what operations to perform and run the necessary programs.

Command Definition

Command definition allows system users to create additional commands to meet specific application needs. These commands are similar to the system commands.

Each command on the system has a command definition object and a command processing program (CPP). The command definition object defines the command, including:

- The command name
- The CPP
- The parameters and values that are valid for the command
- Validity checking information the system can use to validate the command when it is entered
- Prompt text to be displayed if a prompt is requested for the command.
- Online help information

The **CPP** is the program called when the command is entered. Because the system performs validity checking when the command is entered, the CPP does not always have to check the parameters passed to it.

The command definition functions can be used to:

- Create unique commands needed by system users while keeping a consistent interface for CL command users.
- Define alternative versions of CL commands to meet the requirements of system users. This function might include having different defaults for parameter values, or simplifying the commands so that some parameters would not need to be entered. Constant values can be defined for those parameters. The IBM-supplied commands should not be changed.

See Chapter 9, "Defining Commands," for a detailed discussion of command definition.

Menus

The system provides a large number of menus that allow users to perform many functions just by selecting menu options. The advantages of using menus to perform system tasks include:

- Users do not need to understand CL commands and command syntax.
- The amount of typing and the chance of errors are greatly reduced.

The *New User's Guide* provides detailed descriptions of system menus and information about how to use these menus.

Procedures for creating menus that can be used like the system-supplied menus are described in the *Guide to Programming Displays*.

Objects and Libraries

An **object** is a named storage space that consists of a set of characteristics that describe itself and, in some cases, data. An object is anything that exists in and occupies space in storage and on which operations can be performed. The attributes of an object include its name, type, size, the date it was created, and a description provided by the user who created the object. The value of an object is the collection of information stored in the object. The value of a program, for example, is the code that makes up the program. The value of a file is the collection of records that makes up the file. The concept of an object simply provides a term that can be used to refer to a number of different items that can be stored in the system, regardless of what the items are.

Objects

The functions performed by most of the CL commands are applied to objects. Some commands can be used on any type of object and others apply only to a specific type of object.

The system supports various unique types of objects. Some types identify objects common to many data processing systems, such as:

- Files
- Programs
- Commands
- Libraries
- Queues

Other object types are less familiar, such as:

- User profiles
- Job descriptions
- Subsystem descriptions
- Device descriptions

Different object types have different operational characteristics. These differences make each object type unique. For example, because a file is an object that contains data, its operational characteristics differ from those of a program, which contains instructions.

Each object has a name. The object name and the object type are used to identify an object. The object name is assigned by the user creating the object. The object type is determined by the command used to create the object. For example, if a program was created and given the name OEUPDT (for *order entry update*), the program could always be referred to by that name. The system uses the object name (OEUPDT) and object type (program) to locate the object and perform operations on it. Several objects can have the same name, but they must either be different object types or be stored in different libraries.

The system maintains integrity by preventing the misuse of certain functions, depending on the object type. For example, the command CALL causes a program object to be run. If you specified CALL and named a file, the command would fail because the object type must be a program.

Libraries

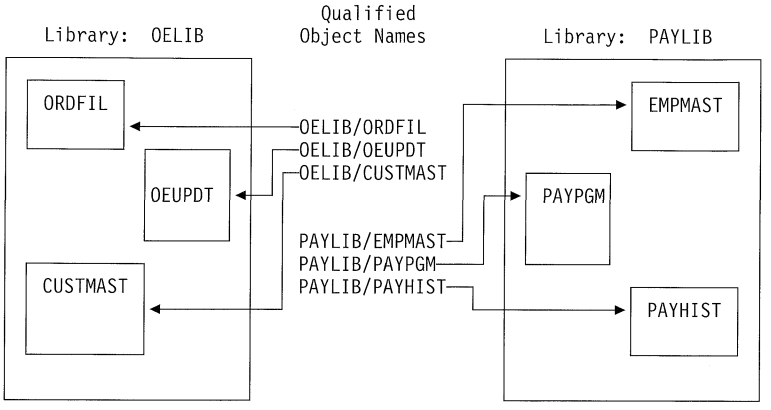
A **library** is an object used to group related objects, and to find objects by name when they are used. Thus, a library is a directory to a group of objects. Libraries can be used to group the objects into any meaningful collection. For example, objects can be grouped according to security requirements, backup requirements, or processing requirements. The number of objects contained in a library and the number of libraries on the system are limited only by the amount of storage available, but should be limited to less than 8000 to ensure that save operations can be performed.

The object grouping performed by libraries is a logical grouping. When a library is created, you can specify into which user auxiliary storage pool (ASP) the library should be created. All objects created into the library are created into the same ASP as the library. Objects in a library are not necessarily physically adjacent to each other. The size of a library, or of any other object, is not restricted by the amount of adjacent space available in storage. The system finds the necessary storage for objects as they are stored in the system.

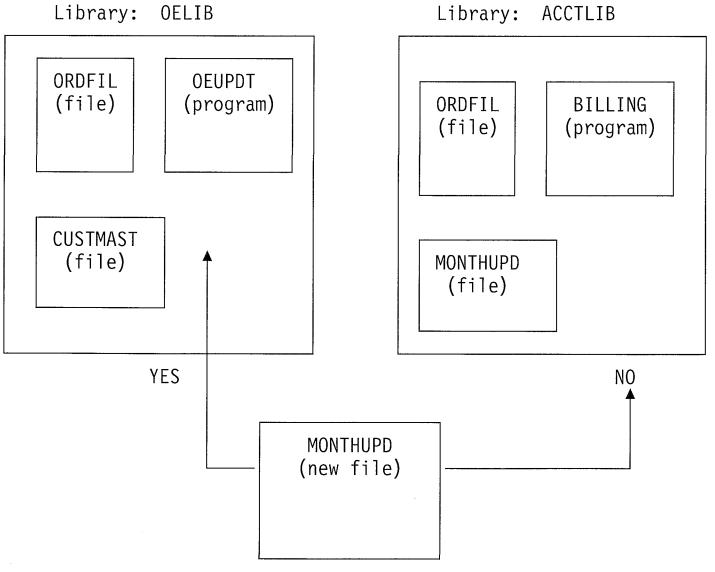
Most types of objects are placed in a library when they are created. An object assumes the public authority of the library it is being placed in. This authority was defined when the library was created using the CRTAUT parameter on the Create Library (CRTLIB) command. Most object types can be moved from one library to another, but a single object cannot be in more than one library at the same time. When an object is moved to a different library, the object is not moved in storage, but it is located through the new library. Most object types can also be renamed and copied from one library into another.

A library name can be used to provide another level of identification to the name of an object. As described earlier, an object is identified by its name and its type. The name of the library further qualifies the object name. The combination of an object name and the library name is called the *qualified name* of the object. The qualified name tells the system the name of the object and the library it is in.

The following diagram shows two libraries and the qualified names of the objects in them:



Two objects with the same name and type can exist in different libraries. Two different objects with the same name cannot exist in the same library unless their object types differ. This design allows a program that refers to objects by name to work with different objects (objects with the same name but stored in different libraries) in successive runs of the program without changing the program itself. Also, a work station user who is creating a new object does not need to be concerned about names used for objects in other libraries. For example, in the following diagram, a new file named MONTHUPD (monthly update) could be added to the library OELIB, but not to the library ACCTLIB. The creation of the file into ACCTLIB would fail because another object named MONTHUPD and of type file already exists in library ACCTLIB.



An object is identified within a library by the object name and type. Many CL commands apply only to a single object type, so the object type does not have to be explicitly identified. For those commands that apply to many object types, the object type must be explicitly identified.

Using Libraries to Find Objects

An object name can be specified as a qualified name (where both the library name and object name are specified) or only the object name may be specified. If a qualified name is specified, the system tries to find the object in the specified library. If only the object name is specified, the system searches a list of libraries, called the *library list*, until it finds the first occurrence of the object of the correct name and type or until it has searched all the libraries on the list without finding the object. The libraries that are searched, and the order in which they are searched, is determined by a search list called the library list. The system creates an initial library list for each job when the job is started.

Note: Initial values for the system and user parts of the library list are found in system values QSYSLIBL and QUSRLIBL. These system values can be overridden in the job description.

A library list has four parts. The first part is the *system part* of the library list. Libraries in the system part of the library list are searched before the remaining libraries in the list. This part specifies the libraries used for all the jobs that run on the system. When the system is installed, the system part of the library list consists of the system library (QSYS), the system user data library (QUSRSYS), the system help information library (QHLPSYS), and the system Communications Programming Interfaces (CPIs) library (QSYS2).

Note: The QSYS2 library contains objects that do not conform to OS/400 naming conventions. These objects *do not* start with the letter Q and therefore can conflict with user object names.

The second part of the library list is the *product library* part. The product library part is changed by the system as users run commands or menus to include the library where the product objects are stored. The product library will vary while a job is running, based on the function being performed.

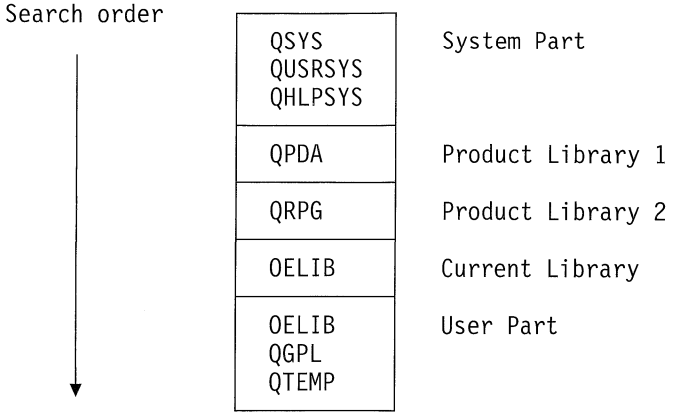
The third part of the library list is the *current library*. The current library is the default library used for creating objects. Users can specify the current library for a job using CL commands.

The fourth part of the library list is the *user part*. The user part contains the libraries used by application programs to perform their functions. When the system is installed, this part contains the general-purpose library (QGPL) and the job's temporary library (QTEMP). Each job has its own QTEMP, which is not visible to other jobs. QTEMP is cleared when a job ends.

When a system has a number of user-defined libraries, the user part of the library list may vary between different jobs. For example, for an order entry job, the user part of the library list might include:

- OELIB (order entry library)
- QGPL (general-purpose library)
- QTEMP (job's temporary library)

The following diagram shows an example of a library list:



Specifying only the object name and using the library list to search for the object can make using the AS/400 system easier and more flexible. A library list can be designed for each job to ensure that the correct objects will be located without using the qualified names. This approach provides advantages such as:

- Easier testing of application programs. Libraries can be created to contain sample data when programs are tested. The object names used in the library are the same as those used in the normal production library. The library with the testing objects is placed before the normal production library in the library list. When the program has been fully tested, that library can be removed from the library list. The program then operates on objects contained in the production libraries, and the object names do not need to be changed in the program.
- Flexible use of the libraries on the system. As processing needs change, existing libraries may need to be divided into more than one library to help simplify the organization of objects on the system. This change does not require the names of objects in the programs to be changed. Only the library lists used by the jobs need to be changed.
- The ability to let different system users operate on different objects using the same application program. Separate libraries can be created for each user or group of users. The library list for each user's job ensures that the correct objects are used by the program for each system user.
- The ability for the same application programs to operate on different data. For example, you may have multiple companies or subsets of a company that are processed independently. Having a library for each company or subset allows the data to be kept separate.

Because of these advantages, qualified names are not usually specified when existing objects are used. However, the qualified name can be specified in situations where it is more efficient than changing the library list, or where specific objects should be specified to ensure that the correct object is used.

Messages

A **message** is a communication sent from one user or program to another. Most data processing systems provide communications between the system and the operator to handle errors and other conditions that occur during processing. OS/400 also provides message handling functions that support two-way communications between programs and system users, between programs, and between system users. Two types of messages are supported:

- Immediate messages, which are created by the program or system user when they are sent and are not permanently stored in the system.
- Predefined messages, which are created before they are used. These messages are placed in a message file when they are created, and retrieved from that file when they are used.

Because messages can be used to provide communications between programs and between programs and users, using the OS/400 message handling functions should be considered when developing applications. The following concepts of message handling are important to application development:

- Messages can be defined in messages files, which are outside the programs that use them, and variable information can be provided in the message text when a message is sent. Because messages are defined outside the programs, the programs do not have to be changed when the messages are changed. This approach also allows the same program to be used with message files containing translations of the messages into different languages.
- Messages are sent to and received from message queues, which are separate objects on the system. A message sent to a queue can remain on the queue until it is explicitly received by a program or work station user.
- A program can send messages to a user who requested the program regardless of what work station that user has signed on to. Messages do not have to be sent to a specific device; one program can be used from different work stations without change.

Message Descriptions

A **message description** defines a message to OS/400. The message description contains the text of the message and information about replacement variables, and can include variable data that is provided by the message sender when the message is sent.

Message descriptions are stored in message files. Each description must have an identifier that is unique within the file. When a message is sent, the message file and the message identifier tell the system which message description is to be used.

Message Queues

When a message is sent to a program or a system user, it is placed on a **message queue** associated with that program or user. The program or user sees the message by receiving it from the queue.

OS/400 provides message queues for:

- Each work station on the system
- Each user enrolled on the system

- The system operator
- The system history log.

Additional message queues can be created to meet any special application requirements. Messages sent to message queues are kept, so the receiver of the message does not need to process the message immediately.

Testing Functions

The system includes functions that let a programmer observe operations performed as a program runs. These functions can be used to locate operations in the program that are not performing as intended. Testing functions can be used in either batch or interactive jobs from a work station. In either case, the program being observed must be in the testing environment, called *debug mode*.

The **testing functions** narrow the search for errors that are difficult to find in the program's source statements. Often, an error is apparent only because the output produced is not what is expected. To find those errors, a programmer needs to be able to stop the program at a given point (called a *breakpoint*) and examine variable information in the program to see if it is correct. The programmer might want to make changes to those variables before letting the program continue running.

The programmer does not need to know machine language instructions, nor is there a need to include special instructions in the program to use the testing functions. The OS/400 testing functions let the programmer:

- Stop a running program at any named point in the program's source statements.
- Display information about program variables at any point where the program can be stopped. The programmer can also change the variable information before continuing program processing.
- Trace the use of variables in the program by recording the steps in the program that change the variables, and what those changes are. This operation produces a list or display tracing the sequence of program statements run and the values of variables at any point in the program.

See Chapter 10, "Testing Functions" on page 10-1, for more information about testing and debugging programs.

Chapter 2. CL Programming

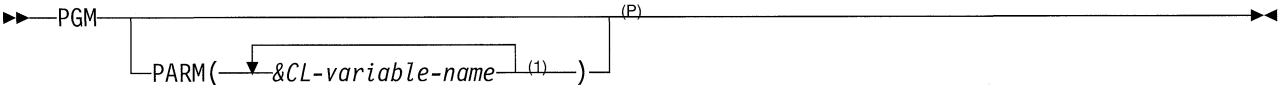
A **CL program** is a group of CL commands that tell the system where to get input, how to process it, and where to place the results. The program is assigned a name by which it can then be called by other programs or directly by you. As with other kinds of programs, you must enter CL program source statements and compile them before you can run the program.

When you enter CL commands individually (from the Command Entry display, for instance, or as individual commands in an input stream), each command is separately processed. When you enter CL commands as source statements for a CL program, the source remains for later modification if you wish, and the commands are compiled together as a program. This program remains as a permanent system object that can be rerun whenever you call it. Thus, CL is actually a high-level programming language for system functions. CL programs ensure consistent processing of groups of commands. You can perform functions with a CL program that you cannot perform by entering commands individually, and the CL program provides better performance at run time than the processing of several separate commands.

CL programs can be used in batch or interactive processing. Certain commands or functions are restricted to either batch or interactive jobs.

CL source statements consist of CL commands. Not all CL can be used as CL source statements, and some of them can be used only in CL programs. You can determine what restrictions are placed on the use of CL commands by checking the box in the upper right-hand corner of the syntax diagram of a command in the *CL Reference*, such as the Program (PGM) command shown:

Pgm: B,I



Notes:

1 A maximum of 40 repetitions

P All parameters preceding this point can be specified positionally.

The syntax diagram for the PGM command shows that this command can be used in either batch or interactive jobs, but can be used only within a CL program.

Commands that can be used only as source statements in CL programs will have only `Pgm:` in the box. If the box does not contain this indicator, the command cannot be used as source for a CL program. More information about how to read a syntax diagram is in Volume 1 of the *CL Reference*.

CL source statements can be entered in a database source member either interactively from a work station or in a batch job input stream from a device. For either method, you must enter the source and then create a permanent object before you can run the CL program.

CL programs can be written for many purposes, including:

- To control the sequence of processing within a program and the calling of other programs.
- To display a menu and run commands based on options selected from that menu. This makes the work station user's job easier and reduces errors.
- To read a database file.
- To handle error conditions issued from commands or programs by monitoring for specific messages.
- To control the operation of an application by establishing variables used in the application, such as date, time, and external indicators.
- To provide predefined procedures for the system operator, such as starting a subsystem or saving files. This reduces the number of commands the operator uses regularly, and it ensures that system operations are performed consistently.

There are many advantages in using CL programs for an application. For example:

- Because the commands are stored in a form that can be processed when the program is created, using CL programs is faster than entering and running the commands individually.
- CL programs are flexible. Parameters can be passed to CL programs to adapt the operations performed by the program to the requirements of a particular use.
- CL programs can be tested and debugged like other high-level language programs.
- CL programs can incorporate conditional logic and special functions not available when commands are entered individually.

You cannot use CL programs to:

- Add or update records in database files.
- Use printer or ICF files.
- Use subfiles within display files.
- Use program-described display files.

Creating a CL Program

All CL programs are created in two steps:

1. Source creation. CL programs consist of CL commands. In most cases, source statements are entered into a database file in the logical sequence determined by your application design.
2. Program creation. Using the Create Control Language Program (CRTCLPGM) command, this source is used to create a system object. The created CL program can be run immediately using the CALL command.

Interactive Entry

The AS/400 system provides many menus and displays to assist the programmer, including the Programmer Menu, the Command Entry display, command prompt displays, and the Programming Development Manager (PDM) Menu. If your AS/400 system uses the security functions described in *Security Reference*, your ability to use these displays is controlled by the authority given to you in your user

profile. User profiles are generally created and maintained by a system security officer.

The most frequently used source entry method is the source entry utility (SEU), which is part of the AS/400 Application Development Tools licensed program.

Batch Entry

You can perform both source creation and program creation in one batch input stream from diskette. The following example shows the basic parts of the input stream from a diskette unit. The input is submitted to a job queue using the Submit Diskette Job (SBMDKTJOB) command. The input stream should follow this format:

```
// BCHJOB
CRTCLPGM PGM(QGPL/EDUPGM) SRCFILE(PERLIST)
// DATA FILE(PERLIST) FILETYPE(*SRC)
   .
   .              (CL Program Source)
   .
//
/*
// ENDINP
```

This stream creates a CL program from inline source. If you want to keep the source online, a Copy File (CPYF) command could be used to copy the source into a database file. The CL program could then be created using the database file.

You can also create a CL program directly from CL source on external media, such as diskette, using an IBM-supplied device file. The IBM-supplied diskette source file is QDKTSRC (use QTAPSRC for tape). Assume, for instance, that the CL source statements are in a source file on diskette named PGMA.

The first step is to identify the location of the source on diskette by using the following override command with LABEL attribute override:

```
OVRDKTF FILE(QDKTSRC) LABEL(PGMA)
```

Now you can consider the QDKTSRC file as the source file on the CRTCLPGM command. To create the CL program based on the source input from the diskette, enter the following command:

```
CRTCLPGM PGM(QGPL/PGMA) SRCFILE(QDKTSRC)
```

When the CRTCLPGM command is processed, it treats the QDKTSRC source file like any database source file. Using the override, the source is located on diskette. PGMA is created in QGPL, and the source for that program remains on diskette. See the *Data Management Guide* for more information on device files.

Command Prompt Displays

When you type a command name on a command line and press F4=Prompt, a command prompt display is shown. To display help information about how to enter parameter values on a command prompt display, press F13=Prompter help.

Parts of a CL Program

While each source statement entered as part of a CL program is actually a CL command, the source can be divided into the following basic parts used in many typical CL programs.

PGM command

```
PGM PARM(&A)
```

Optional PGM command beginning the program and identifying any parameters received. The PGM command is valid only within a CL program.

Declare commands

```
(DCL, DCLF)
```

Mandatory declaration of program variables when variables are used. The declare commands must precede all other commands except the PGM command.

CL processing commands

```
CHGVAR, SNDPGMMSG, OVRDBF, DLTF, ...
```

CL commands used as source statements to manipulate constants or variables (this is a partial list).

Logic control commands

```
IF, THEN, ELSE, DO, ENDDO, GOTO
```

Commands used to control processing within the CL program.

Built-in functions

```
%SUBSTRING (%SST) and %SWITCH
```

Built-in functions and operators used in arithmetic, relational or logical expressions.

Program control commands

```
CALL, RETURN, TFRCTL
```

CL commands used to pass control to other programs.

ENDPGM command

```
ENDPGM
```

Optional End Program command. The ENDPGM command is valid only within a CL program.

The sequence, combination, and extent of these components are determined by the logic and design of your application.

A CL program may refer to other objects, which must exist either when the program is created or when the command is processed, or both. This distinction is discussed in "Accessing Objects in CL Programs" on page 5-1, and in the sections discussing various objects. In some circumstances, for your program to run successfully, you may need:

- A display file. Display files are used to format information on a device display. If your program uses a display, the display file and record format must be entered and created using the Create Display File (CRTDSPF) command before the program is created. It must also be declared to the program in the DCL section using the Declare File (DCLF) command. See "Working with Files in CL Programs" on page 5-4 and the *Data Management Guide* for more information.

- A database file. Records in a database file may be read by a CL program. If your program uses a database file, the file must be created using the Create Physical File (CRTPF) command or the Create Logical File (CRTLF) command before the program is created. You can use data description specifications (DDS), Structured Query Language (SQL), or interactive data definition utility (IDDU) to define the format of the records in the file. The file must also be declared to the program in the DCL section using the Declare File (DCLF) command. See "Working with Files in CL Programs" on page 5-4 and the *Database Guide* for more information.
- Other programs. If you use a CALL command, the called program must exist before the CALL command is processed. It does not have to exist when the calling program is compiled. See "Accessing Objects in CL Programs" on page 5-1 and Chapter 3 for more information.

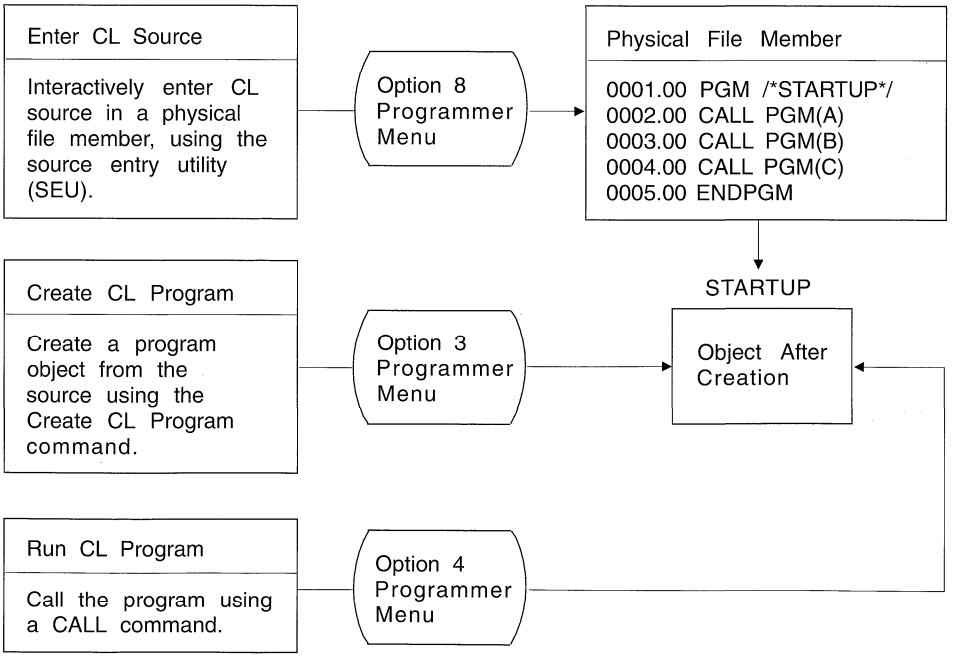
Example of a Simple CL Program

A CL program can be as simple or as complex as you wish. To consolidate several activities normally done by the system operator at the beginning of the day (to call programs A, B, and C, for example), you can create a CL program STARTUP with the following code:

```
PGM  /*  STARTUP  */
CALL PGM(A)
CALL PGM(B)
CALL PGM(C)
ENDPGM
```

In this example, the Programmer Menu is used to create the program. You could also use the programming development manager (PDM), which is part of the Application Development Tools licensed program.

To enter, create, and use this program, follow these steps:



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To enter CL source:

- Select option 8 (Edit source) on the Programmer Menu and specify STARTUP in the Parm field. (This option creates a source member named STARTUP that will also be the name of the program.)
- Specify `CLP` in the Type field and press the Enter key.
- On the SEU display, use the `I` (insert) line command to enter the CL commands (CALL is a CL command).

```
Columns.....:   1  71             Edit                          QGPL/QCLSRC
Find......: _____________________________________                   STARTUP
FMT A* .....A*. 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7
      ********** Beginning of data ************************************
.......
.......
.......
.......
.......
.......
```

When you have finished entering the source statements:

- Press F3 to exit from SEU.
- Accept the default on the exit display (option 2, Exit and update member) and press the Enter key to return to the Programmer Menu.
- Select option 3 (Create object) to create a program from the source statements you entered. You do not have to change any other information on the display.

Note: The referenced programs (A, B, and C) do not have to exist when the program STARTUP is created.

When the program is created, you can call it from the Programmer Menu by selecting option 4 (Call program) and specifying STARTUP in the Parm field. If you attempt to run this sample program, however, the referenced programs must exist by the time the CALL commands are run.

These are the basic steps required to enter, create, and run a simple CL program.

Commands Used in CL Programs

A CL program can contain only CL commands. These can be IBM-supplied or commands defined by you. Some IBM-supplied commands *cannot* be used in CL programs. Refer to the *CL Reference* for the individual command descriptions and their applicability in CL programs.

Commands Entered on the RQSDTA and CMD Parameters

Certain CL commands, such as Transfer Job (TFRJOB) and Submit Job (SBMJOB) have RQSDTA or CMD parameters that can use another CL command as the parameter value. Furthermore, commands that can only be used within CL programs cannot be used as values on the RQSDTA or CMD parameter.

CL Commands

The following is a list of commands frequently used in CL programs. You can use this list to select the appropriate command for the function you want, and to determine which command you might need to refer to in the *CL Reference*. Familiarity with the function of these commands will help you to understand subsequent topics in this chapter. Subscript 1 indicates the commands that can be used *only* in CL programs.

System Function	Command	Command Function
Changing Program Control	CALL (Call)	Calls a program
	RETURN (Return)	Returns to the command following the command that caused a program to be run (called the program)
	TFRCTL (Transfer Control) [1]	Transfers control to a program
CL Program Limits	PGM (Program) [1]	Indicates the start of CL program source
	ENDPGM (End Program) [1]	Indicates the end of CL program source
CL Program Logic	IF (If) [1]	Processes commands based on the value of a logical expression
	ELSE (Else) [1]	Defines the action to be taken for the else (false) condition of an IF command
	DO (Do) [1]	Indicates the start of a Do group
	ENDDO (End Do) [1]	Indicates the end of a Do group
	GOTO (Go To) [1]	Branches to another command
CL Program Variables	CHGVAR (Change Variable) [1]	Changes the value of a CL program variable
	DCL (Declare) [1]	Declares a program variable in a program
Conversion	CHGVAR (Change Variable) [1]	Changes the value of a CL program variable
	CVTDAT (Convert Date) [1]	Changes the format of a date used in a program
Data Areas	CHGDTAARA (Change Data Area)	Changes a data area
	CRTDTAARA (Create Data Area)	Creates a data area
	DLTDTAARA (Delete Data Area)	Deletes a data area
	DSPDTAARA (Display Data Area)	Displays a data area
	RTVDTAARA (Retrieve Data Area)	Copies the content of a data area to a CL variable
Files	ENDRCV (End Receive) [1]	Cancels a request for input previously issued by a RCVF, SNDF, or SNDRCVF command to a display file
	DCLF (Declare File) [1]	Declares a display or database file to a program
	RCVF (Receive File) [1]	Reads a record from a display or database file to a program
	RTVMBRD (Retrieve Member Description) [1]	Retrieves a description of a specific member of a database file
	SNDF (Send File) [1]	Writes a record to a display file
	SNDRCVF (Send/Receive File) [1]	Writes a record to a display file and reads that record after the user has replied

System Function	Command	Command Function
	WAIT (Wait) [1]	Waits for data to be received from an SNDF, RCVF, or SNDRCVF command issued to a display file
Messages	MONMSG (Monitor Message) [1]	Monitors for escape, status, and notify messages sent to a program's message queue
	RCVMSG (Receive Message) [1]	Copies a message from a message queue into CL variables in a CL program
	RMVMSG (Remove Message) [1]	Removes a specified message from a specified message queue
	RTVMSG (Retrieve Message) [1]	Copies a predefined message from a message file into CL program variables
	SNDPGMMSG (Send Program Message) [1]	Sends a program message to a message queue
	SNDRPY (Send Reply) [1]	Sends a reply message to the sender of an inquiry message
	SNDUSRMSG (Send User Message)	Sends an informational or inquiry message to a display station or system operator
Miscellaneous Commands	CHKOBJ (Check Object)	Checks for the existence of an object and, optionally, the necessary authority to use the object
	PRTCMDUSG (Print Command Usage)	Produces a cross-reference list for a specified group of commands used in a specified group of CL programs
	RTVCFGSRC (Retrieve Configuration Source)	Generates CL command source for creating existing configuration objects and places the source in a source file member
	RTVCFGSTS (Retrieve Configuration Status)	Gives applications the capability to retrieve configuration status from three configuration objects: line, controller, and device.
	RTVCLSRC (Retrieve CL Source)	Re-creates source from a CL program (object)
	RTVJOBA (Retrieve Job Attributes) [1]	Retrieves the value of one or more job attributes and places the values in a CL variable
	RTVSYSVAL (Retrieve System Value) [1]	Retrieves a system value and places it into a CL variable
	RTVUSRPRF (Retrieve User Profile) [1]	Retrieves user profile attributes and places them into CL variables
Program Commands	CRTCLPGM (Create CL Program)	Creates a CL program
	DLTPGM (Delete Program)	Deletes a program

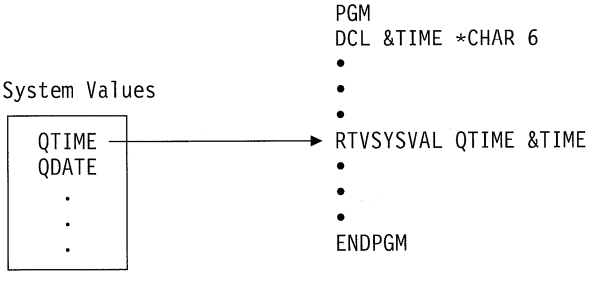
Using CL Programs

CL programming is a flexible tool allowing you to perform a variety of operations. Each of the following uses is described in greater detail in individual sections later in this chapter. In general, you can:

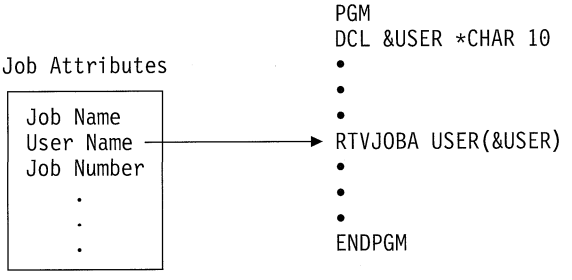
- Use variables, logic control commands, expressions, and built-in functions to manipulate and process data within a CL program:

```
PGM
DCL &C *LGL
DCL &A *DEC VALUE(22)
DCL &B *CHAR VALUE(ABCDE)
•
•
•
CHGVAR &A (&A + 30)
•
•
•
IF (&A < 50) THEN(CHGVAR &C '1')
•
DSPLIB ('Q' || &B)
•
IF (%SST(&B 5 1)=E) THEN(CHGVAR &A 12)
•
•
•
ENDPGM
```

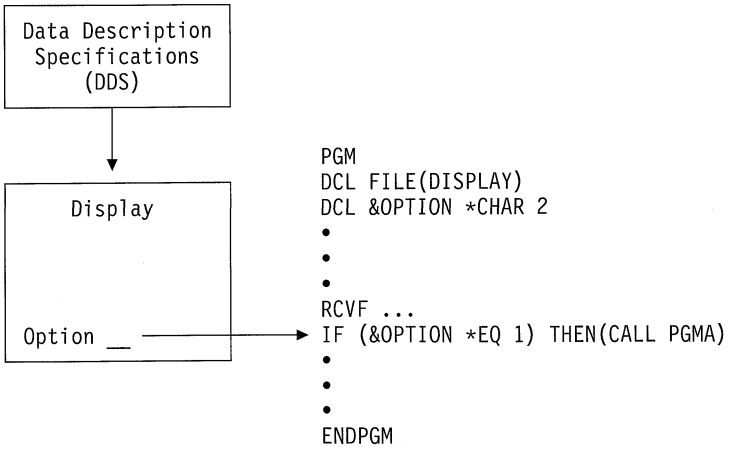
- Use a system value as a variable in a CL program.



- Use a job attribute as a variable in a CL program.



- Send and receive data to and from a display file with a CL program.

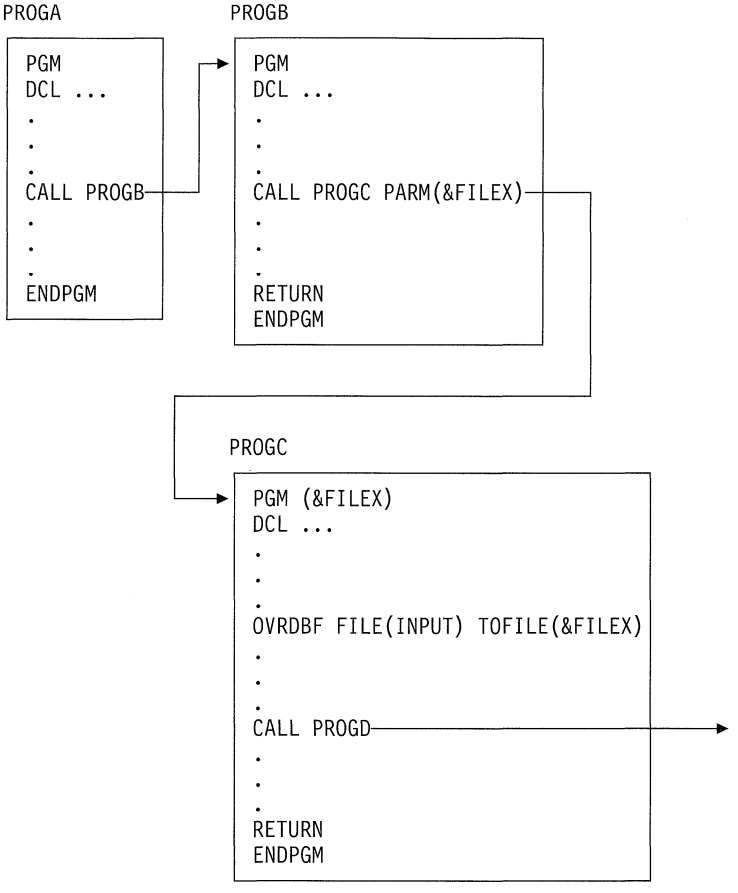


- Create a CL program to monitor error messages for a job, and take corrective action if necessary.

```
            PGM

            MONMSG MSGID(CPF0001) EXEC(GOTO ERROR)
            CALL PROGA
            CALL PROGB
            RETURN
ERROR:      SNDPGMMSG MSG('A CALL command failed') MSGTYPE(*ESCAPE)
            ENDPGM
```

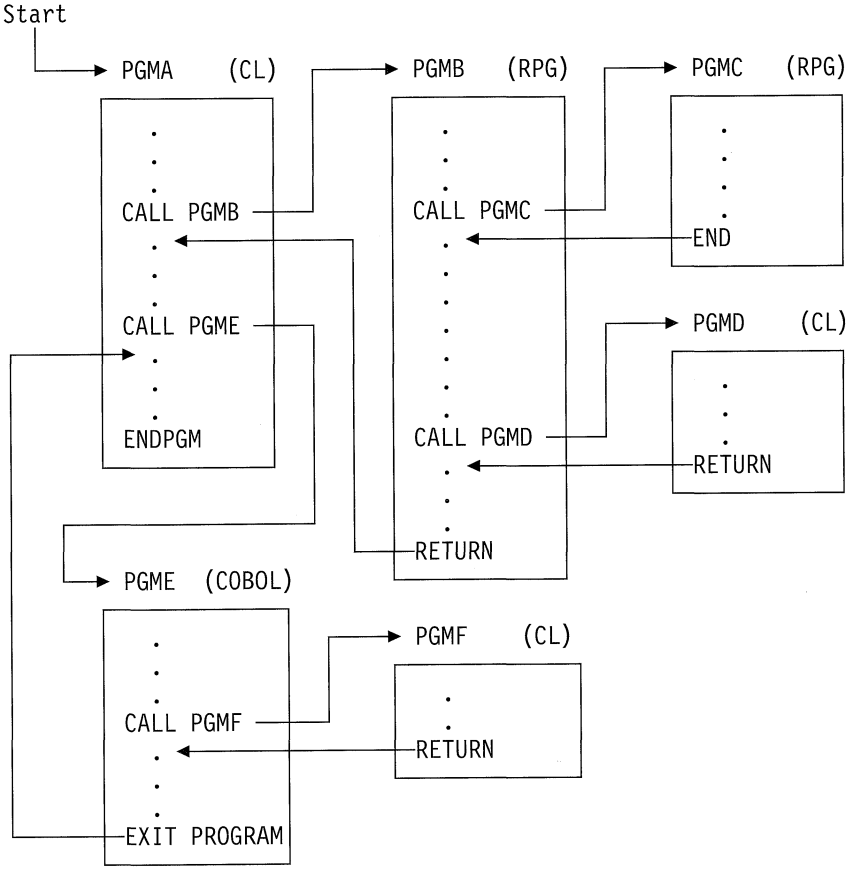
- Control processing among programs and pass parameters from a CL program to other programs to override files.



Using CL Programs to Control Processing

Used as a controlling program, a CL program can call programs written in other languages. The following illustration shows how control can be passed between a CL program and RPG/400* and COBOL programs in an application. To use the application, a work station user would request program A, which controls the entire application. The illustration shows:

- A CL program (PGMA) calling an RPG/400 program (PGMB)
- An RPG/400 program (PGMB) calling another RPG/400 program (PGMC)
- An RPG/400 program (PGMB) calling a CL program (PGMD)
- A CL program (PGMA) calling a COBOL program (PGME)
- A COBOL program (PGME) calling a CL program (PGMF)



Working with Variables

CL programs consist of CL commands, and the commands themselves consist of the command statement, parameters, and parameter values. Syntax rules for writing commands are explained in the *CL Reference*.

Parameter values may be expressed as variables, constants, or expressions. A **variable** is a named changeable value that can be accessed or changed by referring to its name. Variables can be used as substitutes for most parameter values on CL commands. When a CL program variable is specified as a parameter value and the command containing it is run, the value of the variable is used as the parameter value. Every time the command is run, a different value can be substituted for the variable. Variables and expressions can be used as parameter values only in CL programs.

Program variables are not stored in libraries; they are not objects; and their values are destroyed when the program that contains them is no longer called. Variable names in CL programs must begin with an & (ampersand) followed by no more than 10 characters. The first character following the & must be alphabetic and the remaining characters alphanumeric, for example, &FILE or &DSPFL1. The use of variables as values gives CL programming a special flexibility, because this allows high-level manipulation of objects whose content may change by specific applications. You might, for instance, write a CL program to direct the processing of other programs or the operation of several work stations without specifying which programs or work stations are to be controlled. These would be identified as variables in the CL program. The value of the variables can be defined (specified) when the CL program is run.

All variables must be declared (defined) to the CL program before they can be used by the program:

- Declare variable. Defining it is accomplished using the Declare CL Variable (DCL) command and consists of defining the attributes of the variable. The attributes are type, length, and initial value.

  ```
  DCL  VAR(&AREA)  TYPE(*CHAR)  LEN(4)  VALUE(BOOK)
  ```

- Declare file. If your CL program uses a file, you must specify the name of the file in the FILE parameter on the Declare File (DCLF) command. The file contains a description (format) of the records in the file and the fields in the records. During program compilation, the DCLF command implicitly declares CL variables for the fields and indicators defined in the file.

  If the DDS for the file has one record in it with two fields (F1 and F2), then two variables, &F1 and &F2, are automatically declared in the program.

  ```
  DCLF  FILE(MCGANN/GUIDE)
  ```

  If the file is a physical file which was created without DDS, one variable is declared for the entire record. The variable has the same name as the file, and its length is the same as the record length of the file.

The declare commands must precede all other commands in the program (except the PGM command), but they can be intermixed in any order.

In addition to the uses discussed in this section, variables can be used to:

- Pass information between programs and jobs. See Chapter 3, "Controlling Flow and Communicating between Programs" on page 3-1.
- Pass information between programs and device displays. See "Working with Multiple Device Display Files" on page 5-14.
- Conditionally process commands. See "Controlling Processing within a CL Program" on page 2-19.
- Create objects. A variable can be used in place of an object name or library name, or both. The following example shows the Create Physical File (CRTPF) command used with a specified library in the first line, and with a variable replacing the library name in the second line:

  ```
  CRTPF  FILE(DSTPRODLB/&FILE)
  CRTPF  FILE(&LIB/&FILE)
  ```

Variables cannot be used to change a command name or keyword. Command parameters, however, can be changed during the processing of a CL program through the use of the prompting function. See "Allowing User Changes to CL Commands at Run Time" on page 6-12 for more information.

It is also possible to assemble the keywords and parameters for a command and process it using the QCMDEXC function. See "Using the QCMDEXC Program" on page 6-1 for more information about QCMDEXC.

Declaring a Variable

In its simplest form, the Declare CL Variable (DCL) command has the following parameters:

```
DCL     VAR(variable-name)  TYPE {*CHAR} LEN(length)
        VALUE(initial-value)     {*DEC }
                                 {*LGL }
```

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When you use a DCL command, you must use the following rules:

- The CL variable name must begin with an ampersand (&) followed by as many as 10 characters. The first character following the & must be alphabetic and the remaining characters alphanumeric. For example, &PART.
- The CL variable value must be one of the following:
  - A character string as long as 9999 characters.
  - A packed decimal value totaling up to 15 digits with as many as 9 decimal positions.
  - A logical value '0' or '1', where '0' can mean off, false, or no, and '1' can mean on, true, or yes. A logical variable must be either '0' or '1'.
- If you do not specify an initial value, the following is assumed:
  - 0 for decimal variables
  - Blanks for character variables
  - '0' for logical variables.

  For decimal and character types, if you specify an initial value and do not specify the LEN parameter, the default length is the same as the length of the initial value. For type *CHAR, if you do not specify the LEN parameter, the string can be as long as 3000.
- Declare the parameters as variables in the program DCL statements.

Using Variables to Specify a List or Qualified Name

The value on a parameter may be a list. For example, the Change Library List (CHGLIBL) command requires a list of libraries on the LIBL parameter, each separated by blanks. The elements in this list can be variables:

```
CHGLIBL LIBL(&LIB1 &LIB2 &LIB3)
```

When variables are used to specify elements in a list, each element must be declared separately:

```
DCL VAR(&LIB1) TYPE(*CHAR) LEN(10) VALUE(QTEMP)
DCL VAR(&LIB2) TYPE(*CHAR) LEN(10) VALUE(QGPL)
DCL VAR(&LIB3) TYPE(*CHAR) LEN(10) VALUE(DISTLIB)
CHGLIBL LIBL(&LIB1 &LIB2 &LIB3)
```

Variable elements cannot be specified in a list as a character string:

Incorrect:

```
DCL   VAR(&LIBS) TYPE(*CHAR) LEN(20) +
      VALUE('QTEMP QGPL DISTLIB')
CHGLIBL LIBL(&LIBS)
```

When presented as a single character string, the system does not view the list as a list of separate elements, and an error will occur.

You can also use variables to specify a qualified name, if each qualifier is declared as a separate variable:

```
DCL VAR(&PGM) TYPE(*CHAR) LEN(10)
DCL VAR(&LIB) TYPE(*CHAR) LEN(10)
CHGVAR VAR(&PGM) VALUE(MYPGM)
CHGVAR VAR(&LIB) VALUE(MYLIB)
.
.
.
DLTPGM PGM(&LIB/&PGM)
ENDPGM
```

In this example, the program and library name are declared separately. The program and library name cannot be specified in one variable, as in the following example:

Incorrect:

```
DCL VAR(&PGM) TYPE(*CHAR) LEN(10)
CHGVAR VAR(&PGM) VALUE('MYLIB/MYPGM')
DLTPGM PGM(&PGM)
```

Here again the value is viewed by the system as a single character string, not as two objects (a library and an object). If a qualified name must be handled as a single variable with a character string value, you can use the built-in function %SUBSTRING and the *TCAT concatenation function to assign object and library names to separate variables. See "Using the %SUBSTRING Built-In Function" on page 2-33 and Chapter 9 for examples using the %SUBSTRING function.

Lowercase Characters in Variables

Reserved values, such as *LIBL, that can be used as variables must always be expressed in uppercase letters, especially if they are presented as character strings enclosed in apostrophes. For instance, if you wanted to substitute a variable for a library name on a command, the correct code is as follows:

```
DCL VAR(&LIB) TYPE(*CHAR) LEN(10) VALUE('*LIBL')
DLTPGM &LIB/MYPROG
```

However, it would be *incorrect* to specify the VALUE parameter this way:

```
DCL VAR(&LIB) TYPE(*CHAR) LEN(10) VALUE('*libl')
```

Note that if this VALUE parameter had not been enclosed in apostrophes, it would have been correct, because without the apostrophes it would be translated to uppercase automatically. This error frequently occurs when the parameter is passed as input to a program from a display as a character string, and the display entry is made in lowercase.

Variables Replacing Reserved or Numeric Parameter Values

Some CL commands allow both numeric or predefined (reserved) values on certain parameters. Where this is true, you can also use character variables to represent the value on the command parameter.

Each parameter on a command can accept only certain types of values. The parameter may allow an integer, a character string, a reserved value, a variable of a specified type, or some mixture of these, as values. Some types of values are required for parameters. If the parameter allows numeric values (if the value is defined in the command as *INT2, *INT4, or *DEC) and also allows reserved values (a character string preceded by an asterisk), you can use a variable as the value for the parameter. The variable must be declared as TYPE(*CHAR) if you intend to use a reserved value.

For example, the Change Output Queue (CHGOUTQ) command has a job separator (JOBSEP) parameter that can have a value of either a number (0 through 9) or the predefined default, *SAME. Because both the number and the predefined value are acceptable, you can also write a CL program that substitutes a character variable for the JOBSEP value:

```
      PGM
      DCL &NRESP *CHAR LEN(6)
      DCL &SEP *CHAR LEN(4)
      DCL &FILNAM *CHAR LEN(10)
      DCL &FILLIB *CHAR LEN(10)
      DCLF.....
      .
      .
      .
LOOP: SNDRCVF.....
      IF (&SEP *EQ IGNR) GOTO END
      ELSE IF (&SEP *EQ NONE) CHGVAR &NRESP '0'
      ELSE IF (&SEP *EQ NORM) CHGVAR &NRESP '1'
      ELSE IF (&SEP *EQ SAME) CHGVAR &NRESP '*SAME'
      CHGOUTQ OUTQ(&FILLIB/&FILNAM) JOBSEP(&NRESP)
      GOTO LOOP
END:  RETURN
      ENDPGM
```

In the preceding example, the display station user enters information on a display describing the number of job separators desired for a specified output queue. The variable &NRESP is a character variable manipulating numeric and predefined values (note the use of apostrophes). The JOBSEP parameter on the CHGOUTQ command will recognize these values as if they had been entered as numeric or predefined values. The DDS for the display file used in this program should use

the VALUES keyword to restrict the user responses to IGNR, NONE, NORM, or SAME.

If the parameter allows a numeric type of value (*INT2, *INT4, or *DEC) and you do not intend to enter any reserved values (such as *SAME), then you can use a decimal variable in that parameter.

More information about types of values allowed by command parameters can be found in Chapter 9 and in the *CL Reference*.

Another alternative for this function is to use the prompter within CL programs.

Changing the Value of a Variable

You can change the value of a CL program variable using the Change Variable (CHGVAR) command. The value can be changed:

- To a constant:

  ```
  CHGVAR   VAR(&INVCMPLT)   VALUE(0)
  ```

  or

  ```
  CHGVAR   &INVCMPLT  0
  ```

  &INVCMPLT is set to 0.

- To the value of another variable:

  ```
  CHGVAR   VAR(&A)   VALUE(&B)
  ```

  or

  ```
  CHGVAR   &A  &B
  ```

  &A is set to the value of the variable &B.

- To the value of an expression after it is evaluated:

  ```
  CHGVAR   VAR(&A)   VALUE(&A + 1)
  ```

  or

  ```
  CHGVAR   &A  (&A + 1)
  ```

  The value of &A is increased by 1.

- To the value produced by the built-in function %SST (see "Using the %SUBSTRING Built-In Function" on page 2-33 for more information):

  ```
  CHGVAR   VAR(&A)   VALUE(%SST(&B 1 5))
  ```

  &A is set to the first five characters of the value of the variable &B.

- To the value produced by the built-in function %SWITCH (see "Using the %SWITCH Built-In Function" on page 2-35 for more information):

  ```
  CHGVAR  VAR(&A)  VALUE(%SWITCH(0XX111X0))
  ```

  &A is set to 1 if job switches 1 and 8 are 0 and job switches 4, 5 and 6 are 1; otherwise, &A is set to 0.

The CHGVAR command can be used to retrieve and to change the local data area also. For example, the following commands blank out 10 bytes of the local data area and retrieve part of the local data area:

```
CHGVAR %SST(*LDA 1 10) ' '

CHGVAR &A %SST(*LDA 1 10)
```

For a logical variable, the value to which the variable is to be changed must be a logical value. For decimal variables, only a decimal value can be used. For character variables, either character or decimal values are accepted.

When specifying a decimal value for a character variable, remember the following:

- The value of the character variable is right-justified and, if necessary, padded with leading zeros.
- The character variable must be long enough to contain a decimal point and a minus (-) sign, when necessary.
- When used, a minus (-) sign is placed in the leftmost position of the value.

For example, &A is a character variable to be changed to the value of the decimal variable &B. The length of &A is 6. The length and decimal positions of &B are 5 and 2, respectively. The current value of &B is `123`. The resulting value of &A is `123.00`.

When specifying a character value for a decimal variable, remember the following:

- The decimal point is determined by the placement of a decimal point in the character value. If the character value does not contain a decimal point, the decimal point is placed in the rightmost position of the value.
- The character value can contain a minus (-) sign or plus (+) sign immediately to the left of the value; no intervening blanks are allowed. If the character value has no sign, the value is assumed to be positive.
- If the character value contains more characters to the right of the decimal point than can be contained in the decimal variable, the characters are truncated. However, if the excess characters are to the left of the decimal point, they are not truncated and an error occurs.

  For example, &C is a decimal variable to be changed to the value of the character variable &D. The length of &C is 5 with 2 decimal positions. The length of &D is 10 and its current value is +123.1bbbb (where b=blank). The resulting value of &C is `123.10`.

Trailing Blanks on Command Parameters

Some command parameters are defined with the parameter value of VARY(*YES). This parameter value causes the length of the value passed to be the number of characters between the apostrophes. When a CL variable is used to specify the value for a parameter defined in this way, the system removes trailing blanks before determining the length of the variable to be passed to the command processor program. If the trailing blanks are present and are significant for the parameter, you must take special actions to ensure that the length passed includes them. Most command parameters are defined and used in ways which do cause this condition to occur. An example of a parameter defined where this condition is likely to occur is the key value element of the POSITION parameter on the OVRDBF command.

When this condition could occur, the desired result can be attained for these parameters by constructing a command string that delimits the parameter value with apostrophes and passing the string to QCMDEXC for processing.

The following is an example of a program that can be used to run the OVRDBF command so that the trailing blanks will be included as part of the key value. This same technique can be used for other commands that have parameters defined using the parameter VARY(*YES); trailing blanks must be passed with the parameter.

```
            PGM        PARM(&KEYVAL &LEN)
/*   PROGRAM TO SHOW HOW TO SPECIFY A KEY VALUE WITH TRAILING        */
/*      BLANKS AS PART OF THE POSITION PARAMETER ON THE OVRDBF       */
/*      COMMAND IN A CL PROGRAM.                                     */
/*   THE KEY VALUE ELEMENT OF THE POSITION PARAMETER OF THE OVRDBF   */
/*      COMMAND IS DEFINED USING THE VARY(*YES) PARAMETER.           */
/*      THE DESCRIPTION OF THIS PARAMETER ON THE ELEM COMMAND        */
/*      DEFINITION STATEMENT SPECIFIES THAT IF A PARAMETER           */
/*      DEFINED IN THIS WAY IS SPECIFIED AS A CL VARIABLE THE        */
/*      LENGTH IS PASSED AS THE VARIABLE WITH TRAILING BLANKS        */
/*      REMOVED. A CALL TO QCMDEXC USING APOSTROPHES TO DELIMIT      */
/*      THE LENGTH OF THE KEY VALUE CAN BE USED TO CIRCUMVENT        */
/*      THIS ACTION.                                                 */
/*    PARAMETERS--                                                   */
           DCL        VAR(&KEYVAL) TYPE(*CHAR) LEN(32)  /*  THE VALUE +
                        OF THE REQUESTED KEY. NOTE IT IS DEFINED AS +
                        32 CHAR.  */
           DCL        VAR(&LEN) TYPE(*DEC) LEN(15 5)  /*  THE LENGTH +
                        OF THE KEY VALUE TO BE USED. ANY VALUE OF  +
                        1 TO 32 CAN BE USED  */
/*   THE STRING TO BE FINISHED FOR THE OVERRIDE COMMAND TO BE        */
/*        PASSED TO QCMDEXC (NOTE 2 APOSTROPHES TO GET ONE).         */
           DCL        VAR(&STRING) TYPE(*CHAR) LEN(100) +
                        VALUE('OVRDBF FILE(X3) POSITION(*KEY 1 FMT1  '' ')
/*   POSITION MARKER  123456789 123456789 123456789 123456789       */
           DCL        VAR(&END) TYPE(*DEC) LEN(15 5)  /*  A VARIABLE +
                        TO CALCULATE THE END OF THE KEY IN &STRING  */

           CHGVAR     VAR(%SST(&STRING 40 &LEN)) VALUE(&KEYVAL)  /*  +
                        PUT THE KEY VALUE INTO COMMAND STRING FOR +
                        QCMDEXC IMMEDIATELY AFTER THE APOSTROPHE.  */
           CHGVAR     VAR(&END) VALUE(&LEN + 40)  /*  POSITION AFTER +
                        LAST CHARACTER OF KEY VALUE  */
           CHGVAR     VAR(%SST(&STRING &END 2)) VALUE(''')')  /*  PUT +
                        A CLOSING APOSTROPHE & PAREN TO END  +
                        PARAMETER  */
           CALL       PGM(QCMDEXC) PARM(&STRING 100)  /*  CALL TO +
                        PROCESS THE COMMAND   */
           ENDPGM
```

Note: If you use VARY(*YES) and RTNVAL(*YES) and are passing a CL variable, the length of the variable is passed rather than the length of the data in the CL variable.

Writing Comments in CL Programs

When you want to write comments in your CL programs or add comments to commands in your programs, use the character pairs /* and */. The comment is written between these symbols.

The starting comment delimiter, /* , requires three characters unless the /* characters appear in the first two positions of the command string. In the latter situation, /* can be used without a following blank before a command.

You can enter the three-character starting comment delimiters in any of the following ways (b represents a blank):

```
/*b
b/*
/**
```

Therefore, the starting comment delimiter can be entered four ways. The starting comment delimiter, /*, can:

- Begin in the first position of the command string
- Be preceded by a blank
- Be followed by a blank
- Be followed by an asterisk (/**).

For example, in the following program, comments are written to describe possible user responses to a set of menu options:

```
         PGM /* ORD040C Order dept general menu */
         DCLF FILE(ORD040CD)
START:   SNDRCVF RCDFMT(MENU)
         IF (&RESP=1) THEN(CALL CUS210)
         /*Customer inquiry */
         ELSE +
               IF (&RESP=2) THEN(CALL ITM210)
               /**Item inquiry */
               ELSE +
                     IF (&RESP=3) THEN(CALL CUS210)
                      /* Customer name search */
                     ELSE +
                           IF (&RESP=4) THEN(CALL ORD215)
                           /** Orders by cust */
                           ELSE +
                                 IF (&RESP=5) THEN(CALL ORD220)
                                 /* Existing order */
                                 ELSE +
                                       IF (&RESP=6) THEN(CALL ORD410C)
                                       /** Order entry */
                                       ELSE +
                                             IF (&RESP=7) THEN(RETURN)
         GOTO START
         ENDPGM
```

Controlling Processing within a CL Program

Commands in a CL program are processed in consecutive sequence. Each command is processed, one after another, in the sequence in which it is encountered. You can alter this consecutive processing using commands that change the flow of logic in the program. These commands can be conditional (IF) or unconditional (GOTO).

Unconditional branching means that you can instruct processing to branch to commands or sets of commands located anywhere in the program without regard to what conditions exist at the time the branch instruction is processed. You can do this with the GOTO command.

Conditional branching means that under certain specified conditions, processing may branch to sections or commands that are not consecutive within the program. The branching may be to any statement in the program. This is called conditional processing because the branching only occurs when the specified condition is true.

Conditional processing is usually associated with the IF command. With the ELSE command, you can specify alternative processing if the condition is not true.

The DO command allows you to create groups of commands that are always processed together, as a group, under specified conditions.

Using the GOTO Command and Labels

The GOTO command processes an unconditional branch. With the GOTO command, processing is directed to another part (identified by a label) of the program whenever the GOTO command is encountered. This branching does not depend on the evaluation of an expression. After the branch to the labeled statement, processing begins at that statement and continues in consecutive sequence; it does not return to the GOTO command unless specifically directed back by another instruction. You can branch forward or backward. The GOTO command has one parameter, which contains the label of the statement branched to:

```
GOTO CMDLBL(label)
```

A label identifies the statement in the program to which processing is directed by the GOTO command. To use a GOTO command, the command you are branching to must have a label.

```
          PGM
          .
          .
          .
START:    SNDRCVF RCDFMT(MENU)
          IF (&RESP=1) THEN(CALL CUS210)
          .
          .
          .
          GOTO START
          .
          .
          .
          ENDPGM
```

The label in this example is START. A label can have as many as 10 characters and must be immediately followed by a colon, but blanks can occur between the label and the command name.

Using the IF Command

The IF command is used to state a condition that, if true, specifies some other statement or group of statements in the program to be run. The ELSE command can be used with the IF command to specify a statement or group of statements to be run if the condition expressed by the IF command is false.

The command includes an expression, which is tested (true or false), and a THEN parameter that specifies the action to be taken if the expression is true. The IF command is formatted as follows:

```
IF COND(logical-expression) THEN(CL-command)
```

The logical expression on the COND parameter must describe a relationship between two or more operands; the expression is then evaluated as true or false.

See "Using the *AND, *OR, and *NOT Operators" on page 2-27 for more detailed information on the construction of logical expressions.

If the condition described by the logical expression is evaluated as true, the program processes the CL command on the THEN parameter. This may be a single command, or a group of commands (see "Using the DO Command and DO Groups" on page 2-22). If the condition is not true, the program runs the next sequential command.

Both COND and THEN are keywords on the command, and they can be omitted for positional entry. The following are syntactically correct uses of this command:

```
IF COND(&RESP=1) THEN(CALL CUS210)
IF (&A *EQ &B) THEN(GOTO LABEL)
IF (&A=&B) GOTO LABEL
```

Blanks are required between the command name (IF) and the keyword (COND) or value (&A...). No blanks are permitted between the keyword, if specified, and the left parenthesis enclosing the value.

The following is an example of conditional processing with an IF command. Processing branches in different ways depending on the evaluation of the logical expression in the IF commands. Assume, for instance, that at the start of the following code, the value of &A is 2 and the value of &C is 4.

```
       IF (&A=2) THEN(GOTO FINAL)
       IF (&A=3) THEN(CHGVAR &C 5)
       .
       .
       .
FINAL: IF (&C=5) CALL PROGA
       ENDPGM
```

In this case, the program processes the first IF command and then branches to FINAL, skipping the intermediate code. It does not return to the second IF command. At FINAL, because the test for `&C=5` fails, PROGA is not called. The program then processes the next command, ENDPGM, which signals the end of the program, and returns control to the calling program.

Processing logic would be different if, using the same code, the initial values of the variables were different. For instance, if at the beginning of this code the value of &A is 3 and the value of &C is 4, the first IF statement is evaluated as false. Instead of processing the GOTO FINAL command, the program ignores the first IF statement and moves on to the next one. The second IF statement is evaluated as true, and the value of &C is changed to 5. Subsequent statements, not shown here, are also processed consecutively. When processing reaches the last IF statement, the condition `&C=5` is evaluated as true, and PROGA is called.

A series of consecutive IF statements are run independently. For instance:

```
      PGM /*  IFFY  */
      DCL &A...
      DCL &B...
      DCL &C...
      DCL &D...
      DCL &AREA *CHAR LEN(5) VALUE(YESNO)
      DCL &RESP...
      IF (&A=&B) THEN(GOTO END)   /*  IF #1  */
      IF (&C=&D) THEN(CALL PGMA)   /*  IF #2  */
      IF (&RESP=1) THEN(CHGVAR &C 2)  /*  IF #3  */
      IF (%SUBSTRING(&AREA 1 3) *EQ YES) THEN(CALL PGMB)  /*  IF #4  */
      CHGVAR &B &C
      .
      .
      .
END:  ENDPGM
```

If, in this example, &A is not equal to &B, the program runs the next statement. If &C is equal to &D, PGMA is called. When PGMA returns, the third IF statement is considered, and so on. Note the difference in logic and processing between these simple sequential IF statements and the use of IF with ELSE or the use of embedded IF commands described later in the chapter (see "Using the ELSE Command" on page 2-24 and "Using Embedded IF Commands" on page 2-26).

An embedded command is a command that is completely enclosed in the parameter of another command. In the following examples, the CHGVAR command and the DO command are embedded:

```
IF (&A *EQ &B) THEN(CHGVAR &A (&A+1))

IF (&B *EQ &C) THEN(DO)
                    .
                    .
                    .
                    ENDDO
```

Using the DO Command and DO Groups

The DO command lets you process a group of commands together. The group is defined as all those commands between the DO command and the next ENDDO command.

Processing of the group is usually conditioned on the evaluation of an associated command. Do groups are most frequently associated with the IF, ELSE, or MONMSG commands. For instance:

```
IF (&A=&B) THEN(DO)
              :
              :          } Do Group
             ENDDO       }
:
:
:
ENDPGM
```

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If the logical expression (&A=&B) is true, then the Do group is processed. If the expression is not true, then processing starts after the ENDDO command; the Do group is skipped.

In the following program, if &A is not equal to &B, the system calls PGMB. PGMA is not called, nor are any other commands in the Do group processed.

```
IF (&A=&B) THEN(DO)       }
           CALL PGMA      }
           CHGVAR &A &B   } Do Group
           SNDPGMMSG...   }
           ENDDO          }
CALL PGMB
CHGVAR &ACCTS &B
```

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Do groups can be nested within other Do groups, up to a maximum of 10 levels of nesting.

There are three levels of nesting in the following example. Note how each Do group is completed by an ENDDO command.

```
PGM
:
:
IF (&A=&B) DO
           CALL PGMA                          }
           IF (&A=5) DO                       }
                     CHGVAR &A 26             }
                     CALL PGMB                } First Nest
                     IF (&AREA=YES) DO        }
                                CHGVAR &AREA NO   }
                          Third Nest CHGVAR &P (&P+2)  } Second Nest
                                ENDDO               }
                     CALL ACCTSPAY            }
                     ENDDO                    }
           ENDDO                              }
CALL PGMC
ENDPGM
```

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In this example, if &A in the first nest does not equal 5, PGMC is called. If &A does equal 5, the statements in the second Do group are processed. If &AREA in the second Do group does not equal YES, program ACCTSPAY is called, because processing moves to the next command after the Do group.

The CL compiler does not indicate the beginning or ending of Do groups. If any unbalanced conditions are noted as errors by the CL compiler, it is not easy to detect the actual errors. See the DSPCLPDO command in QUSRTOOL for an example of how to indicate Do group nesting.

Using the ELSE Command

The ELSE command is a way of specifying alternative processing if the condition on the associated IF command is false.

The IF command can be used without the ELSE command:

```
IF (&A=&B) THEN(CALL PROGA)
CALL PROGB
```

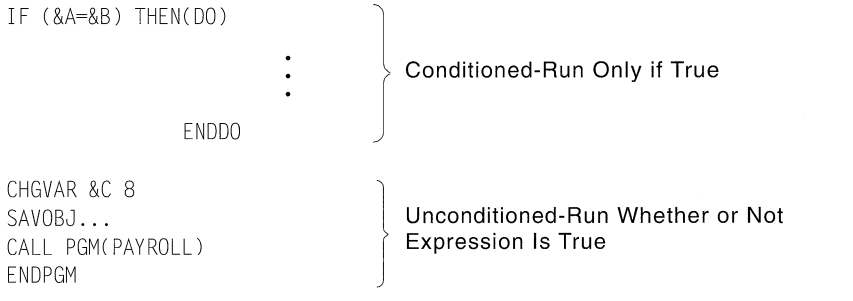
In this case, PROGA is called only if &A=&B, but PROGB is always called.

If you use an ELSE command in this program, however, the processing logic changes. In the following example, if &A=&B, PROGA is called, and PROGB is not called. If the expression &A=&B is not true, PROGB is called.

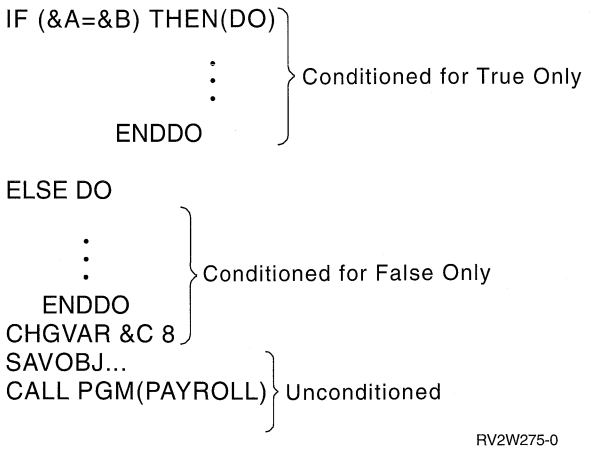
```
IF (&A=&B) THEN(CALL PROGA)
ELSE CMD(CALL PROGB)
CHGVAR &C 8
```

The ELSE command must be used when a false evaluation of an IF expression leads to a distinct branch (that is, an exclusive either/or branch).

The real usefulness of the ELSE command is best demonstrated when combined with Do groups. In the following example, the Do group may not be run, depending on the evaluation of the IF expression, but the remaining commands are always processed.



With the ELSE command you can specify that a command or set of commands be processed only if the expression is not true, thus completing the logical alternatives:



Each ELSE command must have an associated IF command preceding it. If nested levels of IF commands are present, each ELSE command is matched with the innermost IF command that has not already been matched with another ELSE command.

```
IF ... THEN ...
IF ...THEN(DO)
         IF ...THEN(DO)
                    .
                    .
                    .
         ENDDO
         ELSE DO
                    IF ...THEN(DO)
                        .
                        .
                        .
                        ENDDO
                    ELSE DO
                        .
                        .
                        .
                        ENDDO
         ENDDO
ELSE IF ... THEN ...
IF ... THEN ...
IF ... THEN ...
```

In reviewing your program for matched ELSE commands, always start with the innermost set.

The ELSE command can be used to test a series of mutually exclusive options. In the following example, after the first successful IF test, the embedded command is processed and the program processes the RCLRSC command:

```
IF  COND(&OPTION=1) THEN(CALL PGM(ADDREC))
 ELSE    CMD(IF COND(&OPTION=2) THEN(CALL PGM(DSPFILE)))
  ELSE   CMD(IF COND(&OPTION=3) THEN(CALL PGM(PRINTFILE)))
    ELSE CMD(IF COND(&OPTION=4) THEN(CALL PGM(DUMP)))
RCLRSC
RETURN
```

Using Embedded IF Commands

An IF command can be embedded in another IF command. This would occur when the command to be processed under a true evaluation (the CL command placed on the THEN parameter) is itself another IF command:

```
IF (&A=&B) THEN(IF (&C=&D) THEN(GOTO END))
GOTO START
```

This can be useful when several conditions must be satisfied before a certain command or group of commands is run. In the preceding example, if the first expression is true, the system then reads the first THEN parameter; within that, if the &C=&D expression is evaluated as true, the system processes the command in the second THEN parameter, GOTO END. Both expressions must be true to process the GOTO END command. If one or the other is false, the GOTO START command is run. Note the use of parentheses to organize expressions and commands.

Up to 10 levels of such embedding are permitted in CL programming.

As the levels of embedding increase and logic grows more complex, you may wish to enter the code in free-form design to clarify relationships:

```
PGM
DCL &A *DEC 1
DCL &B *CHAR 2
DCL &RESP *DEC 1
IF (&RESP=1) +
    IF (&A=5) +
          IF (&B=NO) THEN(DO)
                         .
                         .
                         .
                         ENDDO
CHGVAR &A VALUE(8)
CALL PGM(DAILY)
ENDPGM
```

The preceding IF series is handled as one embedded command. Whenever any one of the IF conditions fails, processing branches to the remainder of the code (CHGVAR and subsequent commands). If the purpose of this code is to accumulate a series of conditions, all of which must be true for the Do group to process, it could be more easily coded using *AND with several expressions in one command. See "Using the *AND, *OR, and *NOT Operators" on page 2-27.

In some cases, however, the branch must be different depending on which condition fails. You can accomplish this by adding an ELSE command for each embedded IF command:

```
PGM
DCL &A ...
DCL &B ...
DCL &RESP ...
IF (&RESP=1) +
      IF (&A=5) +
            IF (&B=NO) THEN(DO)
                        .
                        .
                        .
                        SNDPGMMSG ...
                        .
                        .
                        .
                        ENDDO
            ELSE CALL PGMA
      ELSE CALL PGMB
CHGVAR &A 8
CALL PGM(DAILY)
ENDPGM
```

Here, if all conditions are true, the SNDPGMMSG command is processed, followed by the CHGVAR command. If the first and second conditions (&RESP=1 and &A=5) are true, but the third (&B=NO) is false, PGMA is called; when PGMA returns, the CHGVAR command is processed. If the second conditions fails, PGMB is called (&B=NO is not tested), followed by the CHGVAR command. Finally, if &RESP does not equal 1, the CHGVAR command is immediately processed. The ELSE command has been used to provide a different branch for each test.

Note: The following three examples are correct syntactical equivalents to the embedded IF command in the preceding example:

```
IF (&RESP=1) THEN(IF (&A=5) THEN(IF (&B=NO) THEN(DO)))

IF (&RESP=1) THEN +
          (IF (&A=5) THEN +
                      (IF (&B=NO) THEN(DO)))

IF (&RESP=1) +
        (IF (&A=5) +
              (IF (&B=NO) THEN(DO)))
```

Using the *AND, *OR, and *NOT Operators

*AND and *OR are the reserved values for logical operators used to specify the relationship between operands in a logical expression. The ampersand symbol (&) can replace the reserved value *AND, and the vertical bar (|) can replace *OR. The reserved values must be preceded and followed by blanks. The operands in a logical expression consist of relational expressions or logical variables or constants separated by logical operators. The *AND operator indicates that both operands (on either side of the operator) have to be true to produce a true result. The *OR operator indicates that one or the other of its operands must be true to produce a true result.

Operators, other than logical operators, are used in expressions to indicate an action to be performed on the operands in the expression or the relationship between the operands. There are three kinds of operators other than logical operators:

- arithmetic (+, -, *, /)
- character (*CAT, ||, *BCAT, |>, *TCAT, |<)
- relational (*EQ, =, *GT, >, *LT, <, *GE, >=, *LE, <=, *NE, ¬=, *NG, ¬>, *NL, ¬<)

Information about these operators is found in the *CL Reference*.

The following are examples of logical expressions:

```
((&C *LT 1) *AND (&TIME *GT 1430))
(&C *LT 1 *AND &TIME *GT 1430)
((&C < 1) & (&TIME>1430))
((&C<1) & (&TIME>1430))
```

In each of these cases, the logical expression consists of three parts: two operands and one operator (*AND or *OR, or their symbols). It is the type of operator (*AND or *OR) that characterizes the expression as logical, not the type of operand. Operands in logical expressions can be logical variables or other expressions, such as relational expressions. (Relational expressions are characterized by >, <, or = symbols or corresponding reserved values.) For instance, in the example:

```
((&C *LT 1) *AND (&TIME *GT 1430))
```

the entire logical expression is enclosed in parentheses, and both operands are relational expressions, also enclosed separately in parentheses. As you can see from the second example of logical expressions, the operands need not be enclosed in separate parentheses, but it is recommended for clarity. Parentheses are not needed because *AND and *OR have different priorities. *AND is always considered before *OR. For operators of the same priority, parentheses can be used to control the order in which operations are performed.

A simple relational expression can be written as the condition in a command:

```
IF (&A=&B) THEN(DO)
             .
             .
             .
           ENDDO
```

The operands in this relational expression could also be constants.

If you wish to specify more than one condition, you can use a logical expression with relational expressions as operands:

```
IF ((&A=&B) *AND (&C=&D)) THEN(DO)
                            .
                            .
                            .
                          ENDDO
```

The series of dependent IF commands cited as an example in "Using Embedded IF Commands" on page 2-26 could be coded:

```
PGM
DCL &RESP *DEC 1
DCL &A *DEC 1
DCL &B *CHAR 2
IF ((&RESP=1) *AND (&A=5) *AND (&B=NO)) THEN(DO)
                                          .
                                          .
                                          .
                                          ENDDO
CHGVAR &A VALUE(8)
CALL PGM(DAILY)
ENDPGM
```

Here the logical operators are again used between relational expressions.

Because a logical expression can also have other logical expressions as operands, quite complex logic is possible:

```
IF (((&A=&B) *OR (&A=&C)) *AND ((&C=1) *OR (&D='0'))) THEN(DO)
```

In this case, &D is defined as a logical variable.

The result of the evaluation of any relational or logical expression is a '1' or '0' (true or false). The dependent command is processed only if the complete expression is evaluated as true ('1'). The following command is interpreted in these terms:

```
IF   ((&A = &B) *AND (&C = &D)) THEN(DO)

     ((true'1') *AND (not true'0'))
          (not true '0')
```

The expression is finally evaluated as not true ('0'), and, therefore, the DO is not processed. For an explanation of how this evaluation was reached, see the matrices later in this section.

This same process is used to evaluate a logical expression using logical variables, as in this example:

```
PGM
DCL &A *LGL
DCL &B *LGL
IF (&A *OR &B) THEN(CALL PGM(PGMA))
.
.
.
ENDPGM
```

Here the conditional expression is evaluated to see if the value of &A or of &B is equal to '1' (true). If either is true, the whole expression is true, and PGMA is called.

The final evaluation arrived at for all these examples of logical expressions is based on standard matrices comparing two values (referred to here as &A and &B) under an *OR or *AND operator.

Use the following matrix when using *OR with logical variables or constants:

If &A is:	'0' '0' '1' '1'
and &B is:	'0' '1' '0' '1'

the OR expression is: '0' '1' '1' '1'

In short, for multiple OR operators with logical variables or constants, the expression is false ('0') if all values are false. The expression is true ('1') if any values are true.

```
PGM
DCL &A *LGL VALUE('0')
DCL &B *LGL VALUE('1')
DCL &C *LGL VALUE('1')
IF (&A *OR &B *OR &C) THEN(CALL PGMA)
.
.
.
ENDPGM
```

Here the values are not all false; therefore, the expression is true, and PGMA is called.

Use the following matrix when evaluating a logical expression with *AND with logical variables or constants:

If &A is: '0' '0' '1' '1'
and &B is: '0' '1' '0' '1'

the ANDed expression is: '0' '0' '0' '1'

For multiple AND operators with logical variables or constants, the expression is false ('0') when any value is false, and true when they are all true.

```
PGM
DCL &A *LGL VALUE('0')
DCL &B *LGL VALUE('1')
DCL &C *LGL VALUE('1')
IF (&A *AND &B *AND &C) THEN(CALL PGMA)
.
.
.
ENDPGM
```

Here the values are not all true; therefore, the expression is false, and PGMA is not called.

These logical operators can only be used *within* an expression when the operands represent a logical value, as in the preceding examples. It is *incorrect* to attempt to use OR or AND for variables that are not logical. For instance:

```
PGM
DCL &A *CHAR 3
DCL &B *CHAR 3
DCL &C *CHAR 3

Incorrect:   IF (&A *OR &B *OR &C = YES) THEN...
```

The correct coding for this would be:

```
IF ((&A=YES) *OR (&B=YES) *OR (&C=YES)) THEN...
```

In this case, the ORing occurs between relational expressions.

The logical operator *NOT (or ¬) is used to negate logical variables or constants. Any *NOT operators must be evaluated before the *AND or *OR operators are evaluated. Any values that follow *NOT operators must be evaluated before the logical relationship between the operands is evaluated.

```
PGM
DCL &A *LGL '1'
DCL &B *LGL '0'
IF (&A *AND *NOT &B) THEN(CALL PGMA)
```

In this example, the values are all true; therefore, the expression is true, and PGMA is called.

For more information about logical and relational expressions, see the *CL Reference*.

Using the %BINARY Built-In Function

The binary built-in function (%BINARY or %BIN) interprets the contents of a specified CL character variable as a signed binary integer. The starting position begins at the position specified and continues for a length of 2 or 4 characters.

The syntax of the binary built-in function is:

```
%BINARY(character-variable-name starting-position length)
```

or

```
%BIN(character-variable-name starting-position length)
```

The starting position and length are optional; however, if the starting position and length are *not specified*, a starting position of 1 and length of the character variable specified are used. The length of the character variable must be declared as 2 or 4.

If the starting position *is specified*, you must also specify a constant length of 2 or 4. The starting position must be a positive number equal to or greater than 1. If the sum of the starting position and the length is greater than the length of the character variable, an error occurs. (A CL decimal variable may also be used for the starting position.)

You can use the binary built-in function with both the IF and CHGVAR commands. It can be used by itself or as part of an arithmetic or logical expression. You can also use the binary built-in function on any command parameter that is defined as numeric (TYPE of *DEC, *INT2, or *INT4) with EXPR(*YES).

When the binary built-in function is used with the condition (COND) parameter on the IF command or with the VALUE parameter on the Change Variable (CHGVAR) command, the contents of the character variable is interpreted as a binary-to-decimal conversion.

When the binary built-in function is used with the VAR parameter on the CHGVAR command, the decimal value in the VALUE parameter is converted to a 2-byte or 4-byte signed binary integer and the result stored in the character variable at the starting position specified. Decimal fractions are truncated.

A 2-byte character variable can hold signed binary integer values from -32 768 through 32 767. A 4-byte character variable can hold signed binary integer values from -2 147 483 648 through 2 147 483 647.

The following are examples of the binary built-in function:

-
```
DCL    VAR(&B2)  TYPE(*CHAR)  LEN(2)    VALUE(X'001C')
DCL    VAR(&N)   TYPE(*DEC)   LEN(3 0)
CHGVAR   &N   %BINARY(&B2)
```
  The contents of variable &B2 is treated as a 2-byte signed binary integer and converted to its decimal equivalent of 28. It is then assigned to the decimal variable &N.

-
```
DCL    VAR(&N)   TYPE(*DEC)   LEN(5 0)  VALUE(107)
DCL    VAR(&B4)  TYPE(*CHAR)  LEN(2)
CHGVAR   %BIN(&B4)    &N
```
  The value of the decimal variable &N is converted to a 4-byte signed binary number and is placed in character variable &B4. Variable &B4 will have the value of X'0000006B'.

-
```
DCL    VAR(&P)  TYPE(*CHAR)  LEN(100)
DCL    VAR(&L)  TYPE(*DEC)   LEN(5 0)
CHGVAR   &L  VALUE(%BIN(&P 1 2) * 5)
```
  The first two characters of variable &P is treated as a signed binary integer, converted to its decimal equivalent, and multiplied by 5. The product is assigned to the decimal variable &L.

-
```
DCL    VAR(&X)   TYPE(*CHAR)  LEN(50)
CHGVAR   %BINARY(&X 15 2)  VALUE(122.56)
```
  The number 122.56 is truncated to the whole number 122 and is then converted to a 2-byte signed binary integer and is placed at positions 15 and 16 of the character variable &X. Positions 15 and 16 of variable &X will contain the hexadecimal equivalent of X'007A'.

-
```
DCL    VAR(&B4)  TYPE(*CHAR)  LEN(4)
CHGVAR   %BIN(&B4)  VALUE(-57)
```
  The value -57 is converted to a 4-byte signed binary integer and assigned to the character variable &B4. The variable &B4 will then contain the value X'FFFFFFC7'.

-
```
DCL    VAR(&B2)  TYPE(*CHAR)  LEN(2)   VALUE(X'FF1B')
DCL    VAR(&C5)  TYPE(*CHAR)  LEN(5)
CHGVAR   &C5  %BINARY(&B2)
```

  The contents of variable &B2 is treated as a 2-byte signed binary integer and converted to its decimal equivalent of -229. The number is converted to character form and stored in the variable character &C5. The character variable &C5 will then contain the value X'-0229'.

-
```
DCL    VAR(&C5)  TYPE(*CHAR)  LEN(5)   VALUE(' 1253')
DCL    VAR(&B2)  TYPE(*CHAR)  LEN(2)
CHGVAR   %BINARY(&B2)  VALUE(&C5)
```

  The character number 1253 in character variable &C5 is converted to a decimal number. The decimal number 1253 is then converted to a 2-byte signed binary integer and stored in the variable &B2. The variable &B2 will then have the value X'04E5'.

-
```
DCL    VAR(&S)  TYPE(*CHAR)  LEN(100)
IF     (%BIN(&S 1 2) > 10)
       THEN( SNDPGMMSG MSG('Too many in list.') )
```

  The first 2 bytes of the character variable &S are treated as a signed binary integer when compared to the number 10. If the binary number has a value larger than 10, then the SNDPGMMSG (Send Program Message) command is run.

Using the %SUBSTRING Built-In Function

The substring built-in function (%SUBSTRING or %SST) produces a character string that is a subset of an existing character string and can only be used within a CL program. In a CHGVAR command, the %SST function can be specified in place of the variable (VAR parameter) to be changed or the value (VALUE parameter) to which the variable is to be changed. In an IF command, the %SST function can be specified in the expression.

The format of the substring built-in function is:

```
%SUBSTRING(character-variable-name starting-position length)
```

or

```
%SST(character-variable-name starting-position length)
```

You can code *LDA in place of the character variable name to indicate that the substring function is performed on the contents of the local data area.

The substring function produces a substring from the contents of the specified CL character variable or the local data area. The substring begins at the specified starting position (which can be a variable name) and continues for the length specified (which can also be a variable name). Neither the starting position nor the length can be 0 or negative. If the sum of the starting position and the length of the substring are greater than the length of the entire variable or the local data area, an error occurs. The length of the local data area is 1024.

The following are examples of the substring built-in function:

- If the first two positions in the character variable &NAME are IN, the program INV210 is called. The entire value of &NAME is passed to INV210 and the value of &ERRCODE is unchanged. Otherwise, the value of &ERRCODE is set to 99.

```
DCL &NAME *CHAR VALUE(INVOICE)
DCL &ERRCODE *DEC (2 0)
IF (%SST(&NAME 1 2) *EQ 'IN') +
THEN(CALL INV210 &NAME)
ELSE CHGVAR &ERRCODE 99
```

- If the first two positions of &A match the first two positions of &B, the program CUS210 is called.

```
DCL &A *CHAR VALUE(ABC)
DCL &B *CHAR VALUE(DEF)
IF (%SST(&A 1 2) *EQ %SUBSTRING(&B 1 2)) +
CALL CUS210
```

- Position and length can also be variables: This example changes the value of &X beginning at position &Y for the length &Z to 123.

```
CHGVAR %SST(&X &Y &Z) '123'
```

- If &A is ABCDEFG before this CHGVAR command is run, &A is

```
CHGVAR %SST(&A 2 3) '123'
```

  A123EFG after the command runs.

- In this example, the length of the substring, 5, exceeds the length of the operand YES to which it is compared. The operand is padded with blanks so that the comparison is between YESNO and YESbb (where b is a blank). The condition is false.

  If the length of the substring is shorter than the operand, the substring is padded with blanks for the comparison. For example:

```
DCL VAR(&NAME) TYPE(*CHAR) LEN(5) VALUE(YESNO)
.
.
.
IF (%SST (&NAME 1 5) *EQ YES) +
  THEN(CALL PROGA)
DCL VAR(&NAME) TYPE(*CHAR) LEN(5) VALUE(YESNO)
.
.
.
IF (%SST(&NAME 1 3 ) *EQ YESNO) THEN(CALL PROG)
```

  This condition is false because YESbb (where bb is two blanks) does not equal YESNO.

- The value of the variable &A is placed into positions 1 through 10 of the local data area.

```
CHGVAR %SST(*LDA 1 10) &A
```

- If the concatenation of positions 1 through 3 of the local data area plus the constant 'XYZ' is equal to variable &A, then PGMA is called. For example, if positions 1 through 3 of the local data area contain 'ABC' and variable &A has a value of ABCXYZ, the test will be true and PGMA will be called.

```
IF (((%SST*LDA 1 3) *CAT 'XYZ') *EQ &A) THEN(CALL PGMA)
```

- This program scans the character variable &NUMBER and changes any leading zeros to blanks. This can be used for simple editing of a field before displaying in a message.

```
      DCL &NUMBER *CHAR LEN(5)
      DCL &X *DEC LEN(3 0) VALUE(1)
      .
      .
LOOP:IF (%SST(&NUMBER &X 1) *EQ '0') DO
      CHGVAR (%SST(&NUMBER &X 1)) ' '  /* Blank out */
      CHGVAR &X (&X + 1)  /* Increment */
      IF (&X *NE 5) GOTO LOOP
      ENDDO
```

The following program uses the substring built-in function to find the first sentence in a 50-character field &INPUT and to place any remaining text in a field &REMAINDER. It assumes that a sentence must have at least 2 characters, and no embedded periods.

```
      PGM (&INPUT &REMAINDER)   /*  SEARCH  */
      DCL &INPUT *CHAR LEN(50)
      DCL &REMAINDER *CHAR LEN(50)
      DCL &X *DEC LEN(2 0) VALUE(03)
      DCL &L *DEC LEN(2 0)   /*  REMAINING LENGTH  */
SCAN: IF (%SST(&INPUT &X 1) *EQ '.') THEN(DO)
          CHGVAR VAR(&L) VALUE(50-&X)
          CHGVAR VAR(&X) VALUE(&X+1)
          CHGVAR VAR(&REMAINDER) VALUE(%SST(&INPUT &X &L))
          RETURN
          ENDDO
      IF (&X *EQ 49) THEN(RETURN)
      CHGVAR &X (&X+1)
      GOTO SCAN
      ENDPGM
```

The program starts by checking the third position for a period. Note that the sub-string function checks &INPUT from position 3 to a length of 1, which is position 3 only (length cannot be zero). If position 3 is a period, the remaining length of &INPUT is calculated. The value of &X is advanced to the beginning of the remainder, and the remaining portion of &INPUT is moved to &REMAINDER.

If position 3 is not a period, the program checks to see if it is at position 49. If so, it assumes that position 50 is a period and returns. If it is not at position 49, the program advances &X to position 4 and repeats the process.

Using the %SWITCH Built-In Function

The switch built-in function (%SWITCH) compares one or more of eight switches with the eight switch settings already established for the job and returns a logical value of '0' or '1'. The initial values of the switches for the job are determined first by the Create Job Description (CRTJOBD) command; the default value is 00000000. You can change this if necessary using the SWS parameter on the SBMJOB, CHGJOB, or JOB command; the default for these is the job description setting. Other high-level languages may also set job switches.

If, in the comparison of your %SWITCH values against the job values, every switch is the same, a logical value of '1' (true) is returned. If any switch tested does not have the value indicated, the result is a '0' (false).

The syntax of the %SWITCH built-in function is:

```
%SWITCH(8-character-mask)
```

The 8-character mask is used to indicate which job switches are to be tested, and what value each switch is to be tested for. Each position in the mask corresponds with one of the eight job switches in a job. Position 1 corresponds with job switch 1, position 2 with switch 2, and so on. Each position in the mask can be specified as one of three values: 0, 1, or X.

0 The corresponding job switch is to be tested for a 0 (off).

1 The corresponding job switch is to be tested for a 1 (on).

X The corresponding job switch is not to be tested. The value in the switch does not affect the result of %SWITCH.

If `%SWITCH(0X111XX0)` is specified, job switches 1 and 8 are tested for 0s; switches 3, 4, and 5 are tested for 1s; and switches 2, 6, and 7 are not tested. If each job switch contains the value (1 or 0 only) shown in the mask, the result of %SWITCH is true '1'.

Switches can be tested in a CL program to control the flow of the program. This function is used in CL programs with the IF and CHGVAR commands. Switches can be changed in a CL program by the Change Job (CHGJOB) command. For CL programs, these changes take effect immediately.

%SWITCH with the IF Command

On the IF command, %SWITCH can be specified on the COND parameter as the logical expression to be tested. In the following example, `0X111XX0` is compared to the predetermined job switch setting:

```
IF  COND(%SWITCH(0X111XX0))  THEN(GOTO C)
```

If job switches 1, 3, 4, 5, and 8 contain 0, 1, 1, 1, and 0, respectively, the result is true and the program branches to the command having the label C. If one or more of the switches tested do not have the values indicated in the mask, the result is false, and the branch does not occur.

In the following example, switches control conditional processing in two programs.

```
SBMJOB  JOB(APP502) JOBD(PAYROLL) CMD(CALL APP502)
    SWS(11000000)

PGM  /* CONTROL */
IF (%SWITCH(11XXXXXX)) CALL PGMA
IF (%SWITCH(10XXXXXX)) CALL PGMB
IF (%SWITCH(01XXXXXX)) CALL PGMC
IF (%SWITCH(00XXXXXX)) CALL PGMD
ENDPGM

PGM  /* PGMA */
CALL TRANS
IF (%SWITCH(1XXXXXXX)) CALL CUS520
ELSE CALL CUS521
ENDPGM
```

%SWITCH with the CHGVAR Command

On the CHGVAR command, you can specify %SWITCH to change the value of a logical variable. The value of the logical variable is determined by the results of comparing your %SWITCH settings with the job switch settings. If the result of the comparison is true, the logical variable is set to '1'. If the result is false, the variable is set to '0'. For instance, if the job switch is set to `10000001` and this program is processed:

```
PGM
DCL &A *LGL
CHGVAR VAR(&A) VALUE(%SWITCH(10000001))
.
.
.
ENDPGM
```

then the variable &A has a value of '1'.

Using the Monitor Message (MONMSG) Command

Escape messages are sent to CL programs by the commands in the CL programs and by the programs they call. These escape messages are sent to tell the programs that errors were detected and requested functions were not performed. CL programs can monitor for the arrival of escape messages, and you can specify through commands how to handle the messages. For example, if a CL program tries to move a data area that has been deleted, an object-not-found escape message is sent to the program by the Move Object (MOVOBJ) command.

Using the Monitor Message (MONMSG) command, you can direct a program to take predetermined action if specific errors occur during the processing of the immediately preceding command. The MONMSG command is used to monitor for escape, notify, or status messages sent to the program message queue of the program in which the MONMSG command is used. The MONMSG command has the following parameters:

```
MONMSG   MSGID(message-identifier) CMPDTA(comparison-data) +
         EXEC(CL-command)
```

Each message sent for a specific error has a unique identifier. You can enter as many as 50 message identifiers on the MSGID parameter. (See the *CL Reference* for messages and identifiers). The CMPDTA parameter allows even greater specification of error messages because you can check for a specific character string in

the MSGDTA portion of the message. On the EXEC parameter, you can specify a CL command (such as a CALL, DO, or a GOTO), which directs the program to perform error recovery.

In the following example, the MONMSG command follows a CHGVAR command and, therefore, is only monitoring for messages sent by the CHGVAR command:

```
CHGVAR VAR(&A) VALUE(&A/&B)
MONMSG MSGID(MCH1211) EXEC(CHGVAR VAR(&A) VALUE(1))
```

The escape message MCH1211 is sent to the program's message queue when a division by 0 is attempted. Because MSGID(MCH1211) is specified, the MONMSG command is monitoring for this condition; when it receives the message, the second CHGVAR command is run.

You can also use the MONMSG command to monitor for messages sent by any command in a CL program. The following example includes two MONMSG commands. The first MONMSG command monitors for the messages CPF0001 and CPF1999; these messages might be sent by any command run later in the program. When either message is received from any of the commands running in the program, control branches to the command identified by the label EXIT2.

The second MONMSG command monitors for the messages CPF2105 and MCH1211. Because no command is coded for the EXEC parameter, any command receiving these messages is ignored.

```
PGM
DCL
MONMSG MSGID(CPF0001 CPF1999) EXEC(GOTO EXIT2)
MONMSG MSGID(CPF2105 MCH1211)
.
.
.
ENDPGM
```

Message CPF0001 states that an error was found in the command that is identified in the message itself. Message CPF1999, which can be sent by many of the debugging commands, such as Change Program Variable (CHGPGMVAR), states that errors occurred on the command, but it does not identify the command in the message.

All error conditions monitored for by the MONMSG command with the EXEC parameter specified (CPF0001 or CPF1999) are handled in the same way at EXIT2, and it is not possible to return to the next sequential statement after the error. You can avoid this by monitoring for specific conditions after each command and branching to specific error correction procedures.

All error conditions monitored for by the MONMSG command without the EXEC parameter specified (CPF2105 or MCH1211) are ignored, and program processing continues with the next command.

If the error occurs on an IF command, the condition is considered false. In the following example, MCH1211 (divide by zero) could occur on the IF command. The condition would be considered false, and PGMA would be called.

```
IF(&A/&B *EQ 5) THEN(DLTF ABC)
ELSE CALL PGMA
```

If you code the MONMSG command at the beginning of your CL program, the messages you specify are monitored throughout the program, regardless of which command produces these messages. If the EXEC parameter is used, only the GOTO command can be specified.

You can specify the same message identifier on a program-level or a command-level MONMSG command. The command-level MONMSG commands take precedence over the program-level MONMSG commands. In the following example, if message CPF0001 is received on CMDB, CMDC is run. If message CPF0001 is received on any other command in the program, the program branches to EXIT2. If message CPF1999 is received on any command, including CMDB, the program branches to EXIT2.

```
PGM
MONMSG MSGID(CPF0001 CPF1999) EXEC(GOTO EXIT2)
CMDA
CMDB
MONMSG MSGID(CPF0001) EXEC(CMDC)
CMDD
EXIT2:  ENDPGM
```

Because many escape messages can be sent to a program, you must decide which ones you want to monitor for and handle. Most of these messages are sent to a program only if there is an error in the program. Others are sent because of conditions outside the program. Generally, a CL program should monitor for those messages that pertain to its basic function and that it can handle appropriately. For all other messages, OS/400 assumes an error has occurred and takes appropriate default action.

For more information about handling messages in CL programs, see Chapter 7 and Chapter 8.

Values That Can Be Used as Variables

Retrieving System Values

A system value contains control information for the operation of certain parts of the system. IBM supplies several types of system values. For example, QDATE and QTIME are date and time system values, which you set when OS/400 is started.

You can bring system values into your program and manipulate them as variables using the Retrieve System Value (RTVSYSVAL) command:

```
RTVSYSVAL  SYSVAL(system-value-name)  RTNVAR(CL-variable-name)
```

The RTNVAR parameter specifies the name of the variable in your CL program that is to receive the value of the system value.

The type of the variable must match the type of the system value. For character and logical system values, the length of the CL variable must equal the length of the value. For decimal values, the length of the variable must be greater than or equal to the length of the system value. System value attributes are defined in the *Work Management Guide*.

RTVSYSVAL Example

In the following example, QTIME is received and moved to a variable, which is then compared with another variable.

```
      PGM
      DCL  VAR(&PWRDNTME)  TYPE(*CHAR)  LEN(6)  VALUE('162500')
      DCL  VAR(&TIME)  TYPE(*CHAR)  LEN(6)
LOOP: RTVSYSVAL  SYSVAL(QTIME)  RTNVAR(&TIME)
      IF  (&TIME *GT &PWRDNTME)  THEN(DO)
      SNDBRKMSG('Powering down in 5 minutes.  Please sign off.')
      PWRDWNSYS  OPTION(*CNTRLD)  DELAY(300)  RESTART(*NO)  +
                 IPLSRC(*PANEL)

      ENDDO
      ENDPGM
```

See the *Work Management Guide* for a list of system values and how you can change and display them.

Converting the Format of a Date

In many applications, you may want to use the current date in your program by retrieving the system value QDATE and placing it in a variable. You may also want to change the format of that date for use in your program. To convert the format of a date in a CL program, use the Convert Date (CVTDAT) command.

The format for the system date is the system value QDATFMT, which is initially MDY (monthdayyear). For example, 062488 is the MDY format for June 24 1988. You can change this format to the YMD, DMY, or the JUL (Julian) format. For Julian, the QDAY value is a 3-character value from 001 to 366. It is used to determine the number of days between two dates. You can also delete the date separators or change the character used as a date separator with the CVTDAT command.

The format for the CVTDAT command is:

```
CVTDAT    DATE(date-to-be-converted) TOVAR(CL-variable) +
          FROMFMT(old-format) TOFMT(new-format) +
          TOSEP(new-separators)
```

The DATE parameter can specify a constant or a variable to be converted. Once the date has been converted, it is placed in the variable named on the TOVAR parameter. In the following example, the date in variable &DATE, which is formatted as MDY, is changed to the DMY format and placed in the variable &CVTDAT.

```
CVTDAT    DATE(&DATE) TOVAR(&CVTDAT) FROMFMT(*MDY) TOFMT(*DMY)
          TOSEP(*SYSVAL)
```

The date separator remains as specified in the system value QDATSEP.

The CVTDAT command can be useful when creating objects or adding a member that uses a date as part of its name. For example, assume that a member must be added to a file using the current system date. Also, assume that the current date is in the MDY format and is to be converted to the Julian format.

```
PGM
DCL &DATE6 *CHAR  LEN(6)
DCL &DATE5  *CHAR  LEN(5)
RTVSYSVAL  QDATE  RTNVAR(&DATE6)
CVTDAT  DATE(&DATE6)  TOVAR(&DATE5)  TOFMT(*JUL)  TOSEP(*NONE)
ADDPFM  LIB1/FILEX  MBR('MBR'  *CAT  &DATE5)
.
.
.
ENDPGM
```

If the current date is 5 January 1988, the added member would be named MBR88005.

Remember the following when converting dates:

- The length of the value in the DATE parameter and the length of the variable on the TOVAR parameter must be compatible with the date format. The length of the variable on the TOVAR parameter must be at least:
  - For non-Julian dates, 6 characters when no separators are used and 8 characters when separators are used.
  - For Julian dates, 5 characters when no separators are used and 6 characters when separators are used.

  Error messages are sent for converted characters that do not fit in the variable. If the converted date is shorter than the variable, it is padded on the right with blanks.
- In every date format except Julian, the year, month, and day are 2-byte fields no matter what value they contain. All converted values are right-justified and, when necessary, padded with leading zeros.
- In the Julian format, day is a 3-byte field and year is a 2-byte field. All converted values are right-justified and, when necessary, padded with leading zeros.

Retrieving Configuration Source

Using the Retrieve Configuration Source (RTVCFGSRC) command, you can generate CL command source for creating existing configuration objects and place the source in a source file member. The CL command source generated can be used for the following:

- Moving configurations from system to system
- Maintaining on-site configurations
- Saving configurations (without using SAVSYS)

Retrieving Configuration Status

Using the Retrieve Configuration Status (RTVCFGSTS) command, you can give applications the capability to retrieve configuration status from three configuration objects: line, controller, and device. The RTVCFGSTS command can be used in a CL program to check the status of a configuration description.

Retrieving Network Attributes

Using the Retrieve Network Attributes (RTVNETA) command, you can retrieve the network attributes of the system into a CL program. These attributes can be changed using the Change Network Attributes (CHGNETA) command and displayed using the Display Network Attributes (DSPNETA) command. See the *Work Management Guide* for more information about network attributes.

RTVNETA Example

In the following example, the default network output queue and the library that contains it are retrieved, changed to QGPL/QPRINT, and later changed back to the previous value.

```
PGM
DCL  VAR(&OUTQNAME) TYPE(*CHAR) LEN(10)
DCL  VAR(&OUTQLIB) TYPE(*CHAR) LEN(10)
RTVNETA  OUTQ(&OUTQNAME) OUTQLIB(&OUTQLIB)
CHGNETA  OUTQ(QGPL/QPRINT)
.
.
.
CHGNETA  OUTQ(&OUTQLIB/&OUTQNAME)
ENDPGM
```

Retrieving Job Attributes

You can retrieve the job attributes and place their values in a CL variable to control your applications.

Job attributes are retrieved using the Retrieve Job Attribute (RTVJOBA) command. You can retrieve all job attributes, or any combination of them, with the RTVJOBA command.

In the following CL program, a RTVJOBA command retrieves the name of the user who called the program.

```
        PGM
         /* ORD410C Order entry program  */
        DCL &CLKNAM TYPE(*CHAR) LEN(10)
        DCL &NXTPGM TYPE(*CHAR) LEN(3)
        .
        .
        .
        RTVJOBA USER(&CLKNAM)
BEGIN:  CALL ORD410S2 PARM(&NXTPGM &CLKNAM)
         /* Customer prompt */
        IF (&NXTPGM *EQ 'END') THEN(RETURN)
        .
        .
        .
```

The variable &CLKNAM, in which the user name is to be passed, is first declared using a DCL command. The RTVJOBA command follows the declare commands. When the program ORD410S2 is called, two variables, &NXTPGM and &CLKNAM, are passed to it. &NXTPGM is passed as blanks but could be changed by ORD410S2.

RTVJOBA Example

Assume in the following CL program, an interactive job submits a CL program to batch. A Retrieve Job Attributes (RTVJOBA) command retrieves the name of the message queue to which the job's completion message is sent, and uses that message queue to communicate with the user who submitted the job.

```
PGM
DCL &MSGQ *CHAR 10
DCL &MSGQLIB *CHAR 10
DCL &MSGKEY *CHAR 4
DCL &REPLY *CHAR 1
DCL &ACCTNO *CHAR 6
.
.
.
RTVJOBA SBMMSGQ(&MSGQ) SBMMSGQLIB(&MSGQLIB)
IF (&MSGQ *EQ '*NONE') THEN(DO)
   CHGVAR &MSGQ 'QSYSOPR'
   CHGVAR &MSGQLIB 'QSYS'
ENDDO
.
.
.
IF (. . . ) THEN(DO)
 SNDMSG:SNDPGMMSG MSG('Account number ' *CAT &ACCTNO *CAT 'is +
                  not valid. Do you want to cancel the update +
                  (Y or N)?') TOMSGQ(&MSGQLIB/&MSGQ) MSGTYPE(*INQ) +
                  KEYVAR(&MSGKEY)
 RCVMSG MSGQ(*PGMQ) MSGTYPE(*RPY) MSGKEY(&MSGKEY) +
          MSG(&REPLY) WAIT(*MAX)
 IF (&REPLY *EQ 'Y') THEN(RETURN)
 ELSE IF (&REPLY *NE 'N') THEN(GOTO SNDMSG)
ENDDO
.
.
.
```

Two variables, &MSGQ and &MSGQLIB, are declared to receive the name and library of the message queue to be used. The RTVJOBA command is used to retrieve the message queue name and library name. Because it is possible that a message queue is not specified for the job, the message queue name is compared to the value *NONE. If the comparison is equal, no message queue is specified, and the variables are changed so that message queue QSYSOPR in library QSYS is used. Later in the program, when an error condition is detected, an inquiry message is sent to the specified message queue and the reply is received and processed. Some of the other possible uses of the RTVJOBA command are:

- Retrieve one or more of the job attributes (such as output queue, library list) so that they can be changed temporarily and later restored to their original values.
- Retrieve one or more of the job attributes for use in the SBMJOB command, so that the submitted job will have the same attributes as the submitting job.

Return Code Summary

The return code (RTNCDE) parameter on the RTVJOBA command is a 5-digit decimal value with no decimal positions (12345. for example). The decimal value indicates the status of called programs.

The following list summarizes the return codes used by languages supported on the AS/400 system:

- RPG/400 programs

  The return codes sent by the RPG/400 compiler are:

  0 When the program is created
  2 When the program is not created

  The return codes sent by running RPG/400 programs are:

  0 When a program is started, or by the CALL operation before a program is called
  1 When a program ends with LR set on
  2 When a program ends with an error (response of C, D, F, or S to an inquiry message)
  3 When a program ends because of a halt indicator (H1-H9)

  RPG/400 return codes are tested only after a CALL:

  - 0 or 1 indicate no error
  - 3 gives an RPG/400 status code of 231
  - Any other value gives an RPG/400 status code 202 (call ended in error)

  The return code cannot be tested directly by the user in the RPG/400 program.

- COBOL programs

  The return codes sent by running COBOL programs are:

  0 By each CALL statement before a program is called
  2 When a program receives a function check (CPF9999) or the generic I/O exception handler gets control and there is no applicable USE procedure

  COBOL programs cannot retrieve these return codes. A return code value of 2 sends message CBE9001 and runs a Reclaim Resources (RCLRSC) command with the *ABNORMAL option.

- BASIC programs

  Compiled or interpreted BASIC programs can set the return code to any value between -32768 and 32767 by coding an expression on the END or STOP statements. If no expression is coded, the return codes are set to:

  0 For normal completion
  1 For programs ending because of an error

  BASIC return code values can be retrieved using the CODE intrinsic function.

- PL/I programs

  The return codes sent by PL/I programs are:

  0 For normal completion, set at the beginning of the run unit
  2 When set by a STOP statement or a call to PLIDUMP with the S option
  3 When an ERROR condition is raised
  4 When PL/I detects an error that did not allow the ERROR condition to be raised

If any other value is found, it is set up by the PLIRETC built-in function or by a called procedure. PLIRETC passes a return code from the PL/I program to the program that called it, changing the current return code value.

PL/I programs can retrieve the return code using the PLIRETV built-in function.

- Pascal programs

  The Pascal compiler sets the following return codes:

  0 For successful compilation
  2 When the program object is not produced

  Pascal does not explicitly set the return code at run time. The user can use the ONERROR exception handling routine to monitor for particular exceptions, then set the return code using the RETCODE procedure.

  Pascal return codes can be retrieved using the RETVALUE parameter of the Pascal SYSTEM procedure. The return code is set to 0 before the SYSTEM call and will contain the updated return code when returned.

- CL programs

  The current value of the return code for compiled CL programs can be retrieved using the RTNCDE parameter on the RTVJOBA command.

Retrieving Object Descriptions

You can use the Retrieve Object Description (RTVOBJD) command to return the descriptions of a specific object to a CL program. Variables are used to return the descriptions. You can use these descriptions to help you detect unused objects. For more information about retrieving object descriptions, see "Retrieving Object Descriptions" on page 4-25.

You can use the Retrieve Object Description (QUSROBJD) application programming interface (API) to return the description of a specific object to a program. A variable is used to return the descriptions. For more information, see the *System Programmer's Interface Reference*.

Retrieving User Profile Attributes

Using the Retrieve User Profile Attributes (RTVUSRPRF) command, you can retrieve the attributes of a user profile (except for the password) and place their values in CL variables to control your applications. On this command, you can specify either the 10-character user profile name or *CURRENT.

You can also monitor for escape messages after running the RTVUSRPRF command. See the *CL Reference* for a list of the messages that could be sent.

RTVUSRPRF Example

In the following CL program, a RTVUSRPRF command retrieves the name of the user who called the program and the name of a message queue to which to send messages for that user:

```
DCL  &USR  *CHAR  10
DCL  &USRMSGQ  *CHAR  10
DCL  &USRMSGQLIB  *CHAR  10
.
.
.
RTVUSRPRF  USRPRF(*CURRENT)  RTNUSRPRF(&USR)  +
           MGSQ(&USRMSGQ)  MSGQLIB(&USRMSGQLIB)
```

The following information is returned to the program:

- &USR contains the user profile name of the user who called the program.
- &USRMSGQ contains the name of the message queue specified in the user profile.
- &USRMSGQLIB contains the name of the library containing the message queue associated with the user profile.

Retrieving Member Description Information

Using the Retrieve Member Description (RTVMBRD) command, you can retrieve information about a member of a database file for use in your applications.

RTVMBRD Example

In the following CL program, a RTVMBRD command retrieves the description of a specific member. Assume a database file called MFILE exists in the current library (MYLIB) and contains 3 members (AMEMBER, BMEMBER, and CMEMBER).

```
DCL  &LIB      TYPE(*CHAR) LEN(10)
DCL  &MBR      TYPE(*CHAR) LEN(10)
DCL  &SYS      TYPE(*CHAR) LEN(4)
DCL  &MTYPE    TYPE(*CHAR) LEN(5)
DCL  &CRTDATE  TYPE(*CHAR) LEN(13)
DCL  &CHGDATE  TYPE(*CHAR) LEN(13)
DCL  &TEXT     TYPE(*CHAR) LEN(50)
DCL  &NBRRCD   TYPE(*DEC)  LEN(10 0)
DCL  &SIZE     TYPE(*DEC)  LEN(10 0)
DCL  &USEDATE  TYPE(*CHAR) LEN(13)
DCL  &USECNT   TYPE(*DEC)  LEN(5 0)
DCL  &RESET    TYPE(*CHAR) LEN(13)
.
.
.
RTVMBRD    FILE(*CURLIB/MYFILE) MBR(AMEMBER *NEXT) +
           RTNLIB(&LIB) RTNSYSTEM(&SYS) RTNMBR(&MBR) +
           FILEATR(&MTYPE) CRTDATE(&CRTDATE) TEXT(&TEXT) +
           NBRCURRCD(&NBRRCD) DTASPCSIZ(&SIZE) USEDATE(&USEDATE) +
           USECOUNT(&USECNT) RESETDATE(&RESET)
```

The following information is returned to the program:

- The current library name (MYLIB) is placed into the CL variable name &LIB.
- The system that MYFILE was found on is placed into the CL variable name &SYS. (*LCL means the file was found on the local system, and *RMT means the file was found on a remote system.)
- The member name (BMEMBER), since BMEMBER is the member immediately after AMEMBER in a name ordered member list (*NEXT), is placed into the CL variable named &MBR.

- The file attribute of MYFILE is placed into the CL variable named &MTYPE. (*DATA means the member is a data member, and *SRC means the file is a source member.)
- The creation date of BMEMBER is placed into the CL variable called &CRTDATE.
- The text used to describe BMEMBER is placed into the CL variable called &TEXT.
- The current number of records in BMEMBER is placed into the CL variable called &NBRRCD.
- The size of BMEMBER's data space (in bytes) is placed into the CL variable called &SIZE.
- The date that BMEMBER was last used is placed into the CL variable called &USEDATE.
- The number of days that BMEMBER has been used is placed into the CL variable called &USECNT. The start date of this count is the value placed into the CL variable called &RESET.

More examples of using Retrieve (RTVxxx) commands can be found in QUSRTOOL.

Working with CL Programs

A CL source program must be created (compiled) before it can be run. To create a CL program, you use the Create Control Language Program (CRTCLPGM) command. The following CRTCLPGM command creates the program ORD040C and places it in library DSTPRODLB:

```
CRTCLPGM     PGM(DSTPRODLB/ORD040C) SRCFILE(QCLSRC)
             TEXT('Order dept general menu program')
```

The source commands for ORD040C are in the source file QCLSRC, and the source member name is ORD040C. By default, a compiler list is created.

On the CRTCLPGM command, you can specify list options and whether the program should operate under the program owner's user profile.

A CL program can run using either the owner's user profile or the user's user profile.

Most CL programs are created using options on the Programming Development Manager (PDM) menu or the Programmer Menu so the CRTCLPGM does not have to be directly entered.

Logging CL Program Commands

You can specify that most CL commands run in a CL program be written (logged) to the job log by specifying one of the following values on the LOG parameter on the CRTCLPGM command when the program is compiled:

*JOB This default value indicates that logging is to occur when the job's logging option is on. The option is initially set for no logging, but it can be changed by the LOGCLPGM parameter on the CHGJOB command. Therefore, if you create the program with this value, you can alter the logging option for each job or several times within a job.

*YES This value indicates that logging is to occur each time the CL program is run. It cannot be changed by the CHGJOB command.

*NO This value indicates that no logging is to occur. It cannot be changed by the CHGJOB command.

Because these values are part of the CRTCLPGM command, you must recompile the program to change them.

When you specify logging, you should use the Remove Message (RMVMSG) command with care in order not to remove any logged commands from the job log. If you specify CLEAR(*ALL) on the RMVMSG command, any commands logged prior to running the RMVMSG command do not appear in the job log. This affects only the CL program containing the RMVMSG command and does not affect any logged commands for the preceding or following recursion levels.

Not all commands are logged to the job log. Following is a list of commands that are not logged:

CHGVAR	DO	GOTO
DCL	ELSE	IF
DCLF	ENDDO	MONMSG
PGM	ENDPGM	

If the logging option is on, logging messages are sent to the CL program's message queue. If the CL program has been called interactively, and the message level on the job's LOG parameter is set to 4, you can press F10 (Display detail messages) to view the logging of all commands. You can print the log if the message level is 4 and you specify *PRINT when you sign off.

The log includes the time, program names, message texts, and command names. Command names are qualified as they are on the original source statement. Command parameters are also logged; if the parameter information is a CL variable, the contents of the variable are printed (except for the RTNVAL parameter). Arguments on the Transfer Control (TFRCTL) command are not printed.

Logging of commands in CL programs affects performance.

Listing Commands Used in CL Programs

You can list which CL programs use specified commands using the PRTCMDUSG command. This provides a cross-reference tool for application analysis.

Using the list of commands used, you can easily determine which programs need to be recompiled when changes are made to the command definitions of the specified commands. You may want to see what is specified for a typical parameter for all uses of a certain command, or you may want to see if you are monitoring for a specific error condition when using a particular command (for example, the CHKJOB command).

The PRTCMDUSG command allows you to specify as many as 50 command names and search all programs or all programs associated with a generic name by the following:

- A specified library for which you are authorized
- All libraries in the user part of the library list for the job
- All user libraries for which you are authorized

CL Program Compiler Lists

When you create a CL program, you can create various types of lists using the OPTION and GENOPT parameters on the CRTCLPGM command.

The OPTION parameter values and their meanings are:

- *SOURCE, *SRC, *NOSOURCE, or *NOSRC

  Whether a list of the source input is to be produced (*SOURCE or *SRC is the default).
- *GEN or *NOGEN

  Whether a program is to be created (*GEN is the default).
- *XREF or *NOXREF

  Whether a list of cross-references to variables and data references in the source input is to be produced (*XREF is the default). This option can only be specified if *SOURCE or *SRC is specified.

The list created by specifying the OPTION parameter is called a *compiler list*. The following shows a sample compiler list. The callout numbers refer to descriptions following the list.

```
      1                                                                                  2                 3
5738SS1 V2R1M0 910524                Control Language                MYLIB/DUMPERR        06/15/88 13:15:57        Page    1
Program . . . . . . . . . . . . . . . . . . . :   DUMPERR
  Library . . . . . . . . . . . . . . . . . . :     MYLIB
Source file . . . . . . . . . . . . . . . . . :   MYFILE
  Library . . . . . . . . . . . . . . . . . . :     QCLSRC
Source member name  . . . . . . . . . . . . . :   DUMPERR          06/15/88 13:15:37    4
Source printing options . . . . . . . . . . . :   *SOURCE   *XREF  *GEN  *NOSECLVL
Program generation options  . . . . . . . . . :   *NOLIST   *NOXREF  *NOPATCH
User profile  . . . . . . . . . . . . . . . . :   *USER
Program logging . . . . . . . . . . . . . . . :   *JOB
Allow RTVCLSRC command  . . . . . . . . . . . :   *YES
Authority . . . . . . . . . . . . . . . . . . :   *CHANGE
Text  . . . . . . . . . . . . . . . . . . . . :   Test program
Compiler  . . . . . . . . . . . . . . . . . . :   IBM AS/400 Control Language Compiler  5
  6                              Control Language Source
SEQNBR  *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+...  5 ...+... 6 ...+... 7 ...+... 8 ...+... 9 ...+.  DATE   8
   100- PGM                                                                                                  06/15/88
   200- DCL &ABC *CHAR 10 VALUE('THIS')                                                                      06/15/88
   300- DCL &XYZ *CHAR 10 VALUE('THAT')     7                                                                06/15/88
   400- DCL &MNO *CHAR 10 VALUE('OTHER')                                                                     06/15/88
   500- CRTLIB LB(LARRY)                                                                                     06/15/88
* CPD0043 30 Keyword LB not valid for this command  9
   600- DLTLIB LIB(MOE                                                                                       06/15/88
* CPD0013 30 Unbalanced parenthesis found
   700- MONMSG CPF0000 EXEC(GOTO ERR)                                                                        06/15/88
   800- ERROR:                                                                                               06/15/88
   900- CHGVAR &ABC 'ONE'                                                                                    06/15/88
  1000- CHGVAR &XYZ 'TWO'                                                                                    06/15/88
  1100- CHGVAR &MNO 'THREE'                                                                                  06/15/88
  1200- DMPCLPGM                                                                                             06/15/88
  1300- ENDPGM                                                                                               11/01/85
                                  * * * * *  E N D  O F  S O U R C E  * * * * *
5738SS1 V2R1M0  910524                Control Language                MYLIB/DUMPERR        06/15/88 13:15:57        Page    2
                                       Cross Reference
Declared Variables
Name            Defined      Type            Length      References
&ABC               200       *CHAR             10          900
&MNO               400       *CHAR             10         1100
&XYZ               300       *CHAR             10         1000   10
Defined Labels
Label           Defined      References     11
ERR             ******         700
* CPD0715 30 Label 'ERR       ' referenced in command but label does not exist
ERROR              800
                              * * * * *  E N D  O F  C R O S S  R E F E R E N C E  * * * * *
5738SS1 V2R1M0 910524                 Control  Language               MYLIB/DUMPERR        06/15/88 13:15:57        Page    3
                                       Message Summary
             Severity
Total        0-9  10-19  20-29  30-39  40-49  50-59   60-69  70-79  80-89  90-99   12
   3           0      0      0      3      0      0       0      0      0      0
Program DUMPERR not created in library MYLIB. Maximum error severity 30.  13
                             * * * * *  E N D  O F  M E S S A G E  S U M M A R Y  * * * * *
                                * * * * *  E N D  O F  C O M P I L A T I O N  * * * * *
```

Title:

1 The program number, release, modification level and date of OS/400.

2 The date and time of the compiler run.

3 The page number in the list.

Prolog:

4 The parameter values specified (or defaults if not specified) on the CRTCLPGM command. If the source is not in a database file, the member name, date, and time are omitted.

5 The name of the compiler.

Source:

6 The sequence numbers of lines (records) in the source. A dash following a sequence number indicates that a source statement begins at that sequence number. The absence of a dash indicates that a statement is the continuation of the previous statement.

Comments between source statements are handled like any other source statement and have sequence numbers.

See the *Database Guide* for information about how sequence numbers are assigned.

7 The source statements.

8 The last date the source statement was changed or added. If the source is not in a database file, or the dates have been reset using RGZPFM, the date is omitted.

9 If an error is found during compilation and can be traced to a specific source statement, the error message is printed immediately following the source statement. An asterisk (*) indicates the line contains an error message. The line contains the message identifier, severity, and the text of the message.

For more information about compilation errors, see "Errors Encountered during Compilation" on page 2-52.

Cross-References:

10 The symbolic variable table is a cross-reference list of the variables validly declared in the program. The table lists the variable, the sequence number of the statement where the variable is declared, the variable's attributes, and the sequence numbers of statements that refer to the variable.

11 The label table is a cross-reference list of the labels validly defined in the program. The table lists the label, the sequence number of the statement where the label is defined, and the sequence numbers of statements that refer to the label.

Messages:

This section is not included in the sample list because no general error messages were issued for the sample program. If there were general error messages for this program, this section would contain, for each message, the message identifier, the severity, and the message.

Message Summary:

12 A summary of the number of messages issued during compilation. The total number is given along with totals by severity.

13 A completion message is printed following the message summary.

The title, prologue, source, and message summary sections are always printed for the *SOURCE option. The cross-reference section is printed if the *XREF option is specified. The message section is printed only if general errors are found.

The CL compiler produces, from the CL commands in a CL program, an intermediate system code needed to cause the requested function to be performed when the program runs. The program resolution monitor (PRM) creates the program from the intermediate system code.

If you specify *GEN on the OPTION parameter (a program is created), you can also specify that the IRP be listed for problem analysis purposes.

Errors Encountered during Compilation

In the compiler list of a program, an error condition that relates directly to a specific command is listed after that command. See "CL Program Compiler Lists" on page 2-49 for an example of these inline messages. Messages that do not relate to a specific command but are more general in nature are listed in a messages section of the list, not inline with source statements.

The types of errors that are detected at compile time include syntax errors, references to variables and labels not defined, and missing statements. The following types of errors stop the program from being created (severity codes are ignored).

- Value errors
- Syntax errors
- Errors related to dependencies between parameters within a command
- Errors detected during validity checking.

Even after an error that stops the program from being created is encountered, the compiler continues to check the source for errors. This lets you see and correct as many errors as possible before you try to create the program again.

Obtaining a Program Dump

You can obtain a CL program dump during program processing. The CL program dump consists of a list of all messages on the program's message queue and the values of all variables declared in the program. This information may be useful in determining the cause of a problem affecting program processing.

To obtain a CL program dump, do one of the following:

- Run the Dump CL Program (DMPCLPGM) command. This command can only be used in a CL program and does not end the CL program.
- Enter D in response to inquiry message CPA0701. This message is sent whenever an unmonitored escape message is received by a CL program. If the program is running in an interactive job, the message is sent to the job's external message queue. If the program is running as a batch job, the message is sent to the system operator message queue, QSYSOPR.
- Specify INQMSGRPG(*SYSRPYL) for the job. See the *Work Management Guide* for a description of this job attribute. The IBM-supplied system reply list specifies a reply of D for message CPA0701, which will cause a dump to be printed when the inquiry message is sent.
- Change the default reply for message CPA0701 from C (cancel program) to D (dump program). A program dump is then printed whenever a function check occurs in a CL program. To change the default, enter the following command:

  ```
  CHGMSGD MSGID(CPA0701) MSGF(QCPFMSG) DFT(D)
  ```

  Note: The CHGMSGD command must be entered by the security officer or another user with update authority to message file QCPFMSG.

Changing the message default causes a dump to be printed under any of the following conditions:

- The system operator message queue is in default mode and the message is sent from a batch job.
- The display station user presses the Enter key without typing a response, causing the message default to be used.
- INQMSGRPY(*DFT) is specified for the job.

```
            [1]                                                                        [2]
5738SS1 R08 M00 861114                          CL Program Dump                  12/18/87 13:13:13        Page    1

Job name  . . . . . . . . :   E_SMITH [3]    User name . . . . . . . . :   SMITH [3]    Job number  . . . . . . . :   006757 [3]
Program name  . . . . . . :   DUMP [4]       Library . . . . . . . . . :   SMITH [4]    Statement . . . . . . . . :   1200   [5]

                                                     Messages

          Message [6]                                                                    From                  To
Time      ID             Sev     Type       Message Text                            Pgm         Inst      Pgm      Inst

103203    CPC2102        00      COMP       Library LARRY created.                  QLICRLIB    0000      DUMP     0000
103203    CPF2110        40      ESC        Library MOE not found.                  QLICRLIB    0151      DUMP     0011

                                                     Variables [7]

Variable        Type            Length     Value                        Value in Hexadecimal
                                           *...+....1....+....2....+    * . . . + . . . . 1 . . . . + . . . . 2 . . . . +

&ABC            *CHAR               10     'ONE       '                 D6D5C540404040404040
&MNO            *CHAR               10     'THREE     '                 E3C8D9C5C54040404040
&XYZ            *CHAR               10     'TWO       '                 E3E6D640404040404040

                                      * * * * *   E N D   O F   D U M P   * * * * *
```

1 The program number, release, modification level and date of OS/400.

2 The date and time the dump was printed.

3 The fully qualified name of the job in which the program was running.

4 The name and library of the program.

5 The number of the statement running when the dump was taken. If the command is a nested command, the statement number is that of the outer command.

6 Each message on the program's message queue, including the time the message was sent, message ID, severity, type, text, sending program and instruction number, and receiving program and instruction number.

7 All variables declared in the program, including variable name, type, length, value, and hexadecimal value.

If a decimal variable contains decimal data that is not valid, the character and hexadecimal values are printed as *CHAR variables.

If the value for the variable cannot be located, *NOT ADDRESSABLE is printed. This can occur if the CL program is used as a command processing program for a command that has a parameter with either TYPE(*NULL) or PASSVAL(*NULL) specified, or if RTNVAL(*YES) was specified for the parameter and a return variable is not coded on the command.

If a variable is declared as TYPE(*LGL), it is shown on the dump as *CHAR with a length of 1.

Displaying Program Attributes

You can use the Display Program (DSPPGM) command to display the attributes of a program. The information displayed or printed can be used to determine the options specified on the command used to create the program. The following information is provided:

- Name of the user profile that owns the program
- Program attribute, which indicates the compiler used to create the program.
- Program creation information:
  - Creation date and time
  - Name of source file and library and member
  - Date and time of last change to source file
  - Observable information associated with the program
  - User profile under which the program runs
  - Handling of adopted authority (if any)
  - Command logging option (for CL programs only)
  - Handling of saved and retrievable source (for CL programs only)
  - Handling of decimal data that is not valid
  - Text
- Program statistics
  - Number of parameters
  - Size of program
  - Size of associated space
  - Size of automatic and static storage
  - Number of machine interface instructions
  - Number of ODT entries (32,767 maximum)
  - State of the program
  - Domain of the program
  - Compiler licensed program ID and release number
- Program performance information:
  - Optimization
  - Paging pool
  - PASA storage information
  - Amount of paging for program.

For more information on this command, see the *CL Reference*.

You can use the Change Program (CHGPGM) command to change some of the attributes.

Retrieving CL Program Source

If you need to recompile a CL program whose source has been deleted, you can re-create the CL source statements using the Retrieve CL Source (RTVCLSRC) command. In this command, you specify the name of the CL program, the name of the database source file to which the CL source statements are written and, optionally, the name of the source file member.

You can only retrieve CL program source for programs created with ALWRTVSRC(*YES) on the CRTCLPGM command. When the source statements are retrieved, a prologue, which includes the following information, is created:

- Owner name
- Last modification date of original source
- Date and time of source reconstruction

- Licensed program level at time of original compilation.

This information may be useful if a new version of the program needs to be created due to changes in the command definition or licensed program, or if the original source is lost. The new source may be used with the Create CL Program (CRTCLPGM) command to create a new version of the program.

Any comments that were present in the original source are not reproduced. The sequence number and source update field also cannot be reproduced; sequence numbers start at 100 and are incremented by 100, and the source update field is set to 0. (However, note that the date of last change to the original source is available in the new prologue.) If the source member already exists, the RTVCLSRC command clears the member before entering the new source.

Compiling Source Programs for a Previous Release

The Create CL Program (CRTCLPGM) command allows you to compile CL source programs to use on a previous release by using the target release (TGTRLS) parameter. The TGTRLS parameter specifies on which release of the OS/400 licensed program the CL program object you are creating is intended to run. You can specify *CURRENT, *PRV, or a specific release level.

A CL program compiled with TGTRLS(*CURRENT) runs only on the current release or later releases of the operating system. A CL program compiled with a specified TGTRLS value other than *CURRENT can run on the specified release value and on later releases.

Previous-Release (*PRV) Libraries

The CL compiler retrieves information about previous-release commands and files from CL previous-release (*PRV) libraries. Two types of libraries are associated with previous-release support: system libraries and user libraries. They are named as Q**SYS**VxRxMx and Q**USR**VxRxMx, where VxRxMx represents the version, release, and modification level of the supported previous release. For example, the QUSRV2R2M0 library supports a system running with Version 2 Release 1 Modification level 0 of the OS/400 licensed program.

Note: ***The QSYSPRV library is no longer used and is deleted from the system*** when the CL compiler support for previous releases is installed.

When compiling for a supported previous release, the CL compiler first checks for commands and files in the previous-release libraries. If the command or file is not found in the previous-release libraries, then the library list (*LIBL) or the qualified library is searched to find the command or file.

QSYSVxRxMx Libraries: The QSYSVxRxMx libraries are installed when the CL compiler support for a previous release is installed. The QSYSVxRxMx libraries include the command definition objects and output files (*OUTFILE) that are found in library QSYS for that particular previous release.

QUSRVxRxMx Libraries: You can create your own QUSRVxRxMx libraries to hold copies of your commands and files as they existed in the supported previous release. This is especially important if the commands or files have changed on the current release.

When the compiler looks for previous-release commands and files, it checks the QUSRVxRxMx library (if it exists) before checking the QSYSVxRxMx library.

Note: The QUSRVxRxMx libraries should be used to hold your previous-release commands and files, instead of the QSYSVxRxMx libraries. As future releases of the CL compiler support for previous releases are installed, the QSYSVxRxMx libraries may be modified or removed.

The previous-release libraries should not be added to the library list (*LIBL). They contain commands and files that support earlier releases and cannot be run on the current system. The commands and files in the previous-release libraries are used only by the CL compiler. The information in the previous-release libraries is used to check the syntax of the commands and to supply file and record information when compiling for a supported previous release. The system commands supplied for a previous release are in English only and are not translated.

For a description of how to save objects that are to be restored on a different release of the operating system, see the appropriate save command (SAVOBJ, SAVCHGOBJ, or SAVLIB) in the *CL Reference*.

Note: CL programs compiled in the System/38 environment cannot be saved for a previous release.

Installing CL Compiler Support for a Previous Release

To install the *PRV CL compiler support and QSYSVxRxMx libraries:

1. Enter:

   `GO LICPGM`

   to view the Licensed Program Menu.

2. Select option 11 (Install licensed programs).

3. Select the option named `5738SS1 OS/400 - *PRV CL Compiler Support`. This causes the QSYSVxRxMx libraries to be installed.

If you are not using the CL compiler support for a previous release, you can remove this support by entering:

```
DLTLICPGM   LICPGM(5738SS1)  OPTION(9)
```

When the CL compiler support is removed, the QSYSVxRxMx libraries are removed from the system, but the QUSRVxRxMx libraries are not. If the QUSRVxRxMx libraries are no longer needed, you must explicitly delete them using the Delete Library (DLTLIB) command.

Chapter 3. Controlling Flow and Communicating between Programs

You can use the CALL, Transfer Control (TFRCTL), and RETURN commands to pass control back and forth between programs. Each command has slightly different characteristics. Information may be passed to called programs as parameters when control is passed.

Special attention should be given to programs created with USRPRF(*OWNER) that run CALL or TFRCTL commands. Security characteristics of these commands differ when they are processed in programs running under an owner's user profile. See *Security Reference* for more information about user profiles.

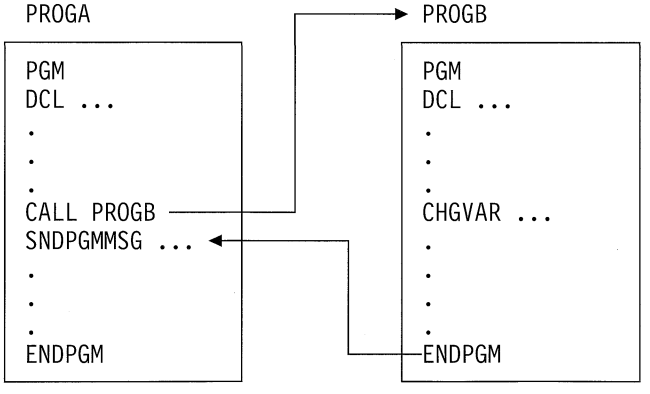
This chapter includes General-Use Programming Interfaces (GUPI), made available by IBM for use in customer-written programs.

CALL Command

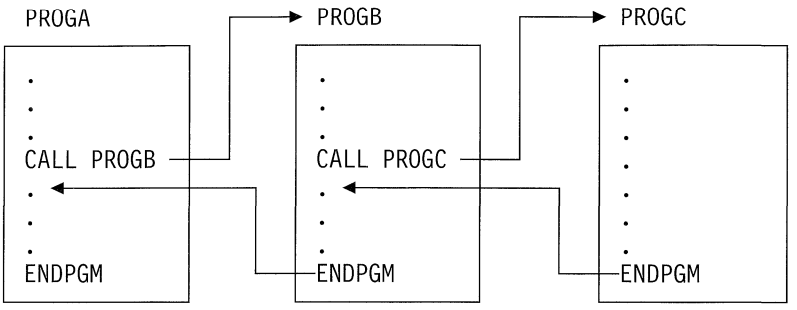
The CALL command calls a program named on the command, and passes control to it. The CALL command has the following format:

```
CALL PGM(library-name/program-name) PARM(parameter-values)
```

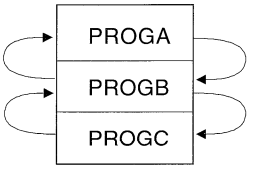
The program name and/or library name may be a variable. If the called program is in a library that is not on the library list, you must specify the qualified name of the program on the PGM parameter. The PARM parameter is discussed under "Passing Parameters between Programs" on page 3-4. When the called program finishes running, control returns to the next command in the calling program.

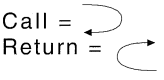


The sequence of CALL commands in a set of programs calling each other is the call stack. For example, in this series:



the call stack is:





RSLF160-0

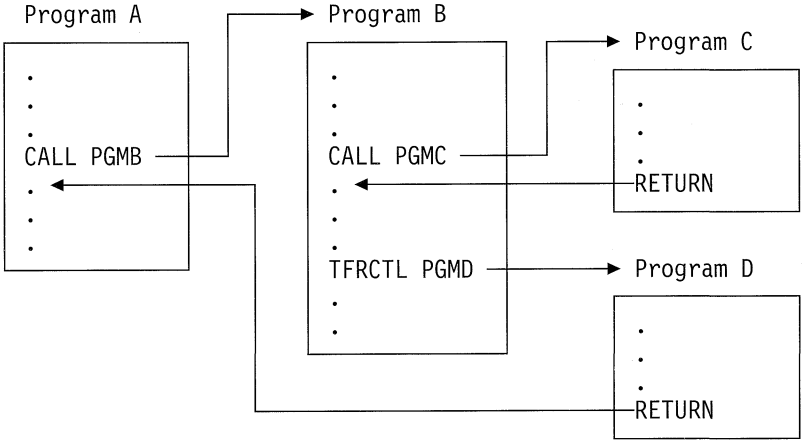
When PROGC finishes processing, control returns to PROGB at the command after the call to PROGC. Control is thus returned up the call stack. This occurs whether or not PROGC ends with a RETURN or an ENDPGM command.

A CL program can call itself.

TFRCTL Command

The Transfer Control (TFRCTL) command calls the program specified on the command, passes control to it, and removes the transferring program from the call stack. Reducing the number of programs on the call stack can have a performance benefit. When a CALL command is used, the program called returns control to the program containing the CALL command. When a TFRCTL command is used, control returns to the first program in the call stack. The first program then initiates the next sequential instruction following the CALL command.

In the following illustration, if Program A is specified with USRPRF(*OWNER), the owner's authorities are in effect for all of the programs shown. If Program B is specified with USRPRF(*OWNER), the owner's authorities are in effect only while Programs B and C are active. When Program B transfers control to Program D, Program B is no longer in the call stack and the owner of Program B is no longer considered for authorization during the running of Program D. When the programs complete processing (by returning or transferring control), the owner's authorities are no longer in effect. Any overrides issued by Program B remain in effect while Program D is running and are lost when Program D does a return.



The TFRCTL command has the following format:

```
TFRCTL PGM(library-name/program-name) PARM(CL-variable)
```

The program (and library qualifier) may be a variable.

It is important to note that only variables may be used as parameter arguments on this command, and that those variables must have been received as a parameter in the argument list from the program that called the transferring program. That is, the TFRCTL command cannot pass a variable that was not passed to the program running the TFRCTL command.

In the following example, the first TRFCTL is valid. The second TFRCTL command is not valid because &B was not passed to this program. The third TFRCTL command is not valid because a constant cannot be specified as an argument.

```
PGM PARM(&A)
DCL &A *DEC 3
DCL &B *CHAR 10
IF (&A *GT 100) THEN (TFRCTL PGM(PGMA) PARM(&A)) /*   valid   */
IF (&A *GT 50) THEN (TFRCTL PGM(PGMB) PARM(&B))  /* not valid */
ELSE (TFRCTL PGM(PGMC) PARM('1'))                /* not valid */
ENDPGM
```

The PARM parameters are discussed under “Passing Parameters between Programs” on page 3-4.

RETURN Command

The RETURN command in a CL program removes that program from the call stack.

If the program containing the RETURN command was called by a CALL command, control is returned to the next sequential statement after that CALL command in the calling program.

Using the illustration describing the TFRCTL command in "TFRCTL Command" on page 3-2, if the program containing the RETURN command (Program D) was called by a TFRCTL command (Program B), control is returned to the next sequential statement after the command that called the transferring program (Program A).

If a MONMSG command specifies an action that ends with a RETURN command, control is returned to the next sequential statement after the statement that called the program containing the MONMSG command.

The RETURN command has no parameters.

Note: If you have a RETURN command in an initial program, the command entry display is shown. You may wish to avoid this for security reasons.

Passing Parameters between Programs

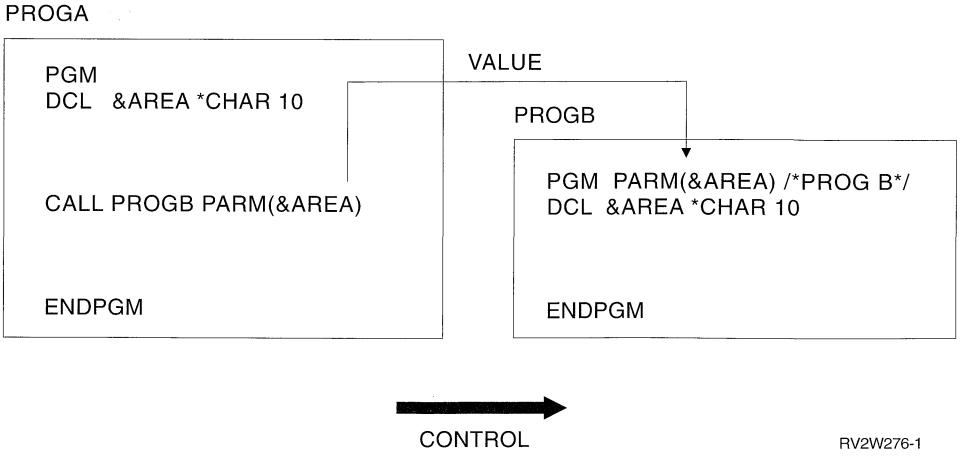
When you pass control to another program, you can also pass information to it for modification or use within the receiving program. See the discussion of this under "Using the CALL Command" on page 3-6. You can specify the information to be passed on the PARM parameter on the CALL or TFRCTL command. The characteristics and requirements for these commands are slightly different.

For instance, if PROGA contains the following command:

```
CALL PROGB PARM(&AREA)
```

then it calls PROGB and passes the value of &AREA to it. PROGB must start with the PGM command, which also must specify the parameter it is to receive:

```
PGM PARM(&AREA) /* PROGB */
```



For either the CALL or TFRCTL command, you must specify the parameters passed on the PARM parameter, and you must specify them on the PARM parameter of the PGM command in the receiving program. Because parameters are passed by position, not name, the position of the value passed in the CALL or TFRCTL command must be the same as its position on the receiving PGM command. For example, if PROGA contains the following command:

```
CALL PROGB PARM(&A &B &C ABC)
```

it passes three variables and a character string, and if PROGB starts with:

```
PGM PARM(&C &B &A &D) /*PROGB*/
```

then the value of &A in PROGA is used for &C in PROGB, and so on; &D in PROGB is ABC. The order of the DCL statements in PROGB is unimportant. Only the order in which the parameters are specified on the PGM statement determines what variables are passed.

In addition to the position of the parameters, you must pay careful attention to their length and type. Parameters listed in the receiving program must be declared as the same length and type as they are in the passing program. Decimal constants are always passed with a length of (15 5). Character string constants of 32 bytes or less are always passed with a length of 32 bytes; if the string is longer than 32, you must specify the exact number of bytes, and pass exactly that number.

For instance, if you wrote a program receiving a value &VAR1, like this:

```
PGM PARM(&VAR1)  /*PGMA*/
DCL VAR1 *CHAR LEN(36)
.
.
.
ENDPGM
```

The CALL command must specify 36 characters:

```
CALL PGMA (ABCDEFCHIJKLMNOPQRSTUVWXYZABCDEFGHIJ)
```

The following example specifies the default lengths:

```
PGM PARM(&P1 &P2)
DCL VAR(&P1) TYPE(*CHAR) LEN(32)
DCL VAR(&P2) TYPE(*DEC) LEN(15 5)
IF (&P1 *EQ DATA) THEN(CALL MYPROG &P2)
ENDPGM
```

To call this program, you could specify:

```
CALL PROG (DATA 136)
```

The character string DATA is passed to &P1; the decimal value 136 is passed to &P2.

Referring to locally defined variables incurs less overhead than referring to passed variables. Therefore, if the called program frequently refers to passed variables, performance can be improved by copying the passed values into the called program and referring to the locally defined value rather than the passed value.

Using the CALL Command

When the CALL command is issued by a CL program, each parameter value passed to the called program can be a character string constant, a numeric constant, a logical constant, or a CL program variable. A maximum of 40 parameters can be passed to the called program. The values of the parameters are passed in the order in which they appear on the CALL command, and this must match the order in which they appear in the parameter list of the called program. The names of the variables passed do not have to be the same as the names on the receiving parameter list. The names of the variables receiving the values in the called program must be declared to the called program, but the order of the declare commands is not important.

No storage in the called program is associated with the variables it receives. Instead, when a variable is passed, the storage for the variable is in the program in which it was originally declared. Variables are passed by address. When a constant is passed, a copy of the constant is made in the calling program and that copy is passed to the called program. Constants are passed by value.

The result is that when a variable is passed, the called program can change the value of the variable, and the change is reflected in the calling program. The new value does not have to be returned to the calling program for later use; it is already there. Thus no special coding is needed for a variable that is to be returned to the calling program. When a constant is passed, and its value is changed by the called program, the changed value is not known to the calling program. Therefore, if the calling program calls the same program again, it reinitializes the values of constants, but not of variables.

An exception to the previous description is when the CALL command is used to call a C/400 program. In this case, the CALL command parameters (both constants and variables) are converted to null terminated strings (ASCI C standards requirement) and are passed by value. For more information, see the *Languages: Systems Application Architecture* C/400* User's Guide*, SC09-1347.

If a CL program might be called using a CALL command that has not been compiled (an interactive CALL command or through the SBMJOB command), the decimal parameters (*DEC) should be declared with `LEN(15 5)`, and the character parameters (*CHAR) should be declared `LEN(32)` or less in the receiving program.

A CALL command run in batch or interactive mode cannot pass variables as arguments. When the CALL command is used with command parameters defined as *CMDSTR, the constants of any variables specified on the PARMS parameter are converted to constants. The command (CMD) parameters on the submit job (SBMJOB) command, add job (ADDJOBSCDE) command, or change job (CHGJOBSCDE) command are examples. For more information on how parameters are passed when using an interactive CALL command, see the description of the CALL command in the *CL Reference*.

Parameters can be passed and received as follows:

- Character string constants of 32 bytes or less are *always* passed with a length of 32 bytes (padded on the right with blanks). If a character constant is longer than 32 bytes, the entire length of the constant is passed. If the parameter is defined to contain more than 32 bytes, the CALL command must pass a con-

stant containing exactly that number of bytes. Constants longer than 32 characters are ***not*** padded to the length expected by the receiving program.

The receiving program can receive less than the number of bytes passed. For example, if a program specifies that 4 characters are to be received and ABCDEF is passed (padded with blanks in 26 positions), only ABCD are accepted and used by the program.

If the receiving program receives more than the number of bytes passed, the results may be unexpected. Numeric values passed as characters must be enclosed in apostrophes.

The system counts the characters on a SBMJOB command. The character following the opening parenthesis is the first character counted. The command name, parameter names, spaces, variable lengths, and apostrophes are counted as characters. If you use character variables in the command string, apostrophes are added and counted when the value is substituted.

- Decimal constants are passed in packed form and with a length of LEN(15 5), where the value is 15 digits long, of which 5 digits are decimal positions. Thus, if a parameter of 12345 is passed, the receiving program must declare the decimal field with a length of LEN(15 5); the parameter is received as 12345.00000.

  If you need to pass a numeric constant to a program and the program is expecting a value with a length and precision other than 15 5, the constant can be coded in hexadecimal format. The following CALL command shows how to pass the value 25.5 to a program variable that is declared as LEN(5 2):

  ```
  CALL PGMA PARM(X'02550F')
  ```

- Logical constants are passed with a length of 32 bytes. The logical value 0 or 1 is in the first byte, and the remaining bytes are blank. If a value other than 0 or 1 is passed to a program that expects a logical value, the results may be unexpected.
- A floating point literal or floating point special value (*NAN, *INF, or *NEGINF) is passed as a double precision value, which occupies 8 bytes. Although a CL program cannot process floating point numbers, it can receive a floating point value into a character variable and pass that variable to an HLL program that can process floating point values.
- A program variable can be passed if the call is made from a CL program, in which case the receiving program must declare the field to match the variable defined in the calling CL program. For example, if a CL program defines a decimal variable named &CHKNUM as LEN(5 0), the receiving program must declare the field as packed with 5 digits total, with no decimal positions. When a CALL command is run in batch mode, via the SBMJOB command in a CL program, variables passed as arguments are treated as constants.
- If either a decimal constant or a program variable can be passed to the called program, the parameter should be defined as LEN(15 5), and any calling program must adhere to that definition. If the type, number, order, and length of the parameters do not match between the calling and receiving programs (other than the length exception noted previously for character constants), results cannot be predicted.
- The value *N cannot be used to specify a null value because a null value cannot be passed to another program.

In the following example, program A passes six parameters: one logical constant, three variables, one character constant, and one numeric constant.

```
PGM /* PROGRAM A */
DCL VAR(&B) TYPE(*CHAR)
DCL VAR(&C) TYPE(*DEC) LEN(15 5) VALUE(13.529)
DCL VAR(&D) TYPE(*CHAR) VALUE('1234.56')
CHGVAR VAR(&B) VALUE(ABCDEF)
CALL PGM(B) PARM('1' &B &C &D XYZ 2)  /* Note blanks between parms */
.
.
.
ENDPGM

PGM PARM(&A &B &C &W &V &U) /* PROGRAM B */
DCL VAR(&A) TYPE(*LGL)
DCL VAR(&B) TYPE(*CHAR) LEN(4)
DCL VAR(&C) TYPE(*DEC)
           /* Default length (15 5) matches DCL LEN in program A */
DCL VAR(&W) TYPE(*CHAR)
DCL VAR(&V) TYPE(*CHAR)
DCL VAR(&U) TYPE(*DEC)
.
.
.
ENDPGM
```

Note: If the fifth parameter passed (XYZ) was 456 and was intended as alphanumeric data, the value would have been specified as '456' in the parameter.

The logical constant '1' does not have to be declared in the passing program. It is declared as type logical and named &A in program B.

Because no length is specified on the DCL command for &B, the default length, which is 32 characters, is passed. Only 6 characters of &B are specified (ABCDEF). Because &B is declared with only 4 characters in program B, only those 4 characters are received. If they are changed in program B, those 4 positions for &B will also be changed in program A for the remainder of this call.

The length (LEN) parameter must be specified for &C in program A. If it were not specified, the length would default to the specified value's length, which would be incompatible with the default length expected in program B. &C has a value of 13.52900.

&W in program B (passed &D in program A) is received as a character because it is declared as a character. Apostrophes are not necessary to indicate a string if TYPE is *CHAR. In program A, the length defaults to the value's length of 7 (the decimal point is considered a position in a character string). Program B expects a length of 32. The first 7 characters are passed, but the contents past the position 7 cannot be predicted.

The variable &V is a character string XYZ, padded with blanks on the right. The variable &U is numeric data, 2.00000.

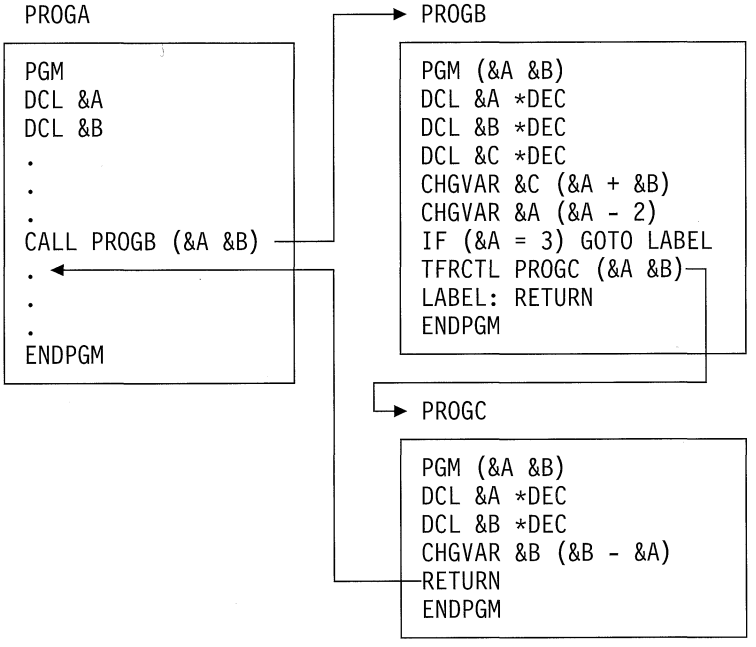
For more information on the default lengths in the DCL commands, see the DCL command in the *CL Reference*.

Using the TFRCTL Command

The TFRCTL command can be used to pass parameters to the program being called in the same way the CALL command passes parameters, but with these restrictions:

- The parameters passed must be CL variables.
- The CL variables passed by the transferring program must have been received as parameters by that program.
- This command is valid only within CL programs.

In the following example, PROGA calls PROGB and passes two variables, &A and &B, to it. PROGB uses these two variables and another internally declared variable, &C. When control is transferred to PROGC, only &A and &B can be passed to PROGC. When PROGC finishes processing, control is returned to PROGA, where these variables originated.



Common Errors in Calling Programs

The following sections describe the errors encountered most frequently in passing values to a program on a CALL or TFRCTL command. Some of these errors can be very difficult to debug, and some have serious consequences for program functions.

Date Type Errors

The total length of the command string includes the command name, spaces, parameter names, parentheses, contents of variables and apostrophes used. For most commands, the command string initiates the command processing program as expected. However, for some commands some variables may not be passed as expected. For more information on the topic of variables, see "Working with Variables" on page 2-11.

When the CALL command is used with the CMD parameter on the SBMJOB command, unexpected results may occur. Syntactically, the CALL command appears the same when used with the CMD parameter as it does when used as

the compiler directive for the CALL command. When used with the CMD parameter, the CALL command is converted to a command string that is run at a later time when the batch subsystem initiates it. When the CALL command is used by itself, the CL compiler generates code to perform the call.

Common problems with decimal constants and character variables often occur. In the following cases, the command string is not constructed as needed:

- When decimal numbers are converted to decimal constants.

  When the command string is run, the decimal constant is passed in a packed form with a length of LEN(15 5). It is not passed in the form specified by the CL variable.
- When a character variable is declared longer than 32 characters.

The contents of the character variable is passed as described previously, usually as a quoted character constant with the trailing blanks removed. As a result, the called program may not be passed enough data.

The following methods can be used to correct errors in constructing command strings:

- Create the CALL command string to be submitted by concatenating the various portions of the command together into one CL variable. Submit the command string using the request data (RQSDTA) parameter of the SBMJOB command.
- For CL character variables larger than 32 characters where trailing blanks are significant, create a variable that is one character larger than needed and substring a non-blank character into the last position. This prevents the significant blanks from being truncated. The called program should ignore the extra character because it is beyond the length expected.
- Create a command that will initiate the program to be called. Submit the new command instead of using the CALL command. The command definition ensures the parameters are passed to the command processing program as expected.

When passing a value, the data type (TYPE parameter) must be the same (*CHAR, *DEC, or *LGL) in the calling program and in the called program. Errors frequently occur in this area when you attempt to pass a numeric constant. If the numeric constant is enclosed in apostrophes, it is passed as a character string. However, if the constant is not enclosed in apostrophes, it is passed as a packed numeric field with LEN(15 5).

In the following example, a quoted numeric value is passed to a program that expects a decimal value. A decimal data error (escape message MCH1202) occurs when variable &A is referred to in the called program (PGMA):

```
CALL   PGMA PARM('123')  /* CALLING PROGRAM */
PGM    PARM(&A)  /* PGMA */
DCL    &A *DEC LEN(15 5)  /* DEFAULT LENGTH */
.
.
.
IF (&A *GT 0) THEN(...) /* MCH1202 OCCURS HERE */
```

In the following example, a decimal value is passed to a program defining a character variable. Generally, this error does not cause run-time failures, but incorrect results are common:

```
CALL PGMB PARM(12345678)  /* CALLING PROG */

PGM PARM(&A)               /* PGMB */
DCL &A *CHAR 8
.
.
.
ENDPGM
```

Variable &A in PGMB has a value of hex 001234567800000F.

Generally, data can be passed from a logical (*LGL) variable to a character (*CHAR) variable, and vice versa, without error, so long as the value is expressed as '0' or '1'.

Decimal Length and Precision Errors

If a decimal value is passed with an incorrect decimal length and precision errors in calling program length, either too long or too short, a decimal data error (MCH1202) occurs when the variable is referred to. In the following examples, the numeric constant is passed as LEN(15 5), but is declared in the receiving program as LEN(5 2). Numeric constants are always passed as packed decimal (15 5).

```
CALL PGMA PARM(123)     /* CALLING PROG */

PGM PARM(&A)                  /* PGMA */
DCL &A *DEC (5 2)
.
.
.
IF (&A *GT 0) THEN(...) /* MCH1202 OCCURS HERE */
```

If a decimal variable had been declared with LEN(5 2) in the calling program and the value had been passed as a variable instead of as a constant, no error would occur.

If you need to pass a numeric constant to a program and the program is expecting a value with a length and precision other than 15 5, the constant can be coded in hexadecimal format. The following CALL command shows how to pass the value 25.5 to a program variable that is declared as LEN(5 2):

```
CALL PGMA PARM(X'02550F')
```

If a decimal value is passed with the correct length but with the wrong precision (number of decimal positions), the receiving program interprets the value incorrectly. In the following example, the numeric constant value (with length (15 5)) passed to the program is handled as 25124.00.

```
CALL PGMA PARM(25.124)  /* CALLING PGM */

PGM PARM(&A)            /* PGMA */
DCL &A *DEC (15 2)      /* LEN SHOULD BE 15 5*/
.
.
.
ENDPGM
```

These errors occur when the variable is first referred to, not when it is passed or declared. In the next example, the called program does not refer to the variable, but instead simply places a value (of the detected wrong length) in the variable returned to the calling program. The error is not detected until the variable is returned to the calling program and first referred to. This kind of error can be especially difficult to detect.

```
PGM           /* PGMA */
DCL &A *DEC (7 2)
CALL PGMB PARM(&A)  /* (7 2) PASSED TO PGMB */
IF (&A *NE 0)  THEN(...)  /* *MCH1202 OCCURS HERE */
.
.
.
ENDPGM

PGM PARM(&A) /* PGMB */
DCL &A *DEC (5 2)        /* WRONG LENGTH */
.
.
.
CHGVAR &A (&B-&C)      /* VALUE PLACED in &A */
RETURN
```

When control returns to program PGMA and &A is referred to, the error occurs.

Character Length Errors

If you pass a character value longer than the declared character length errors in calling program length of the receiving variable, the receiving program cannot access the excess length. In the following example, PGMB changes the variable that is passed to it to blanks. Because the variable is declared with LEN(5), only 5 characters are changed to blanks in PGMB, but the remaining characters are still part of the value when referred to in PGMA.

```
PGM        /* PGMA */
DCL &A *CHAR 10
CHGVAR &A 'ABCDEFGHIJ'
CALL PGMB PARM(&A)           /* PASS to PGMB */
.
.
.
IF (&A *EQ '  ') THEN(...)  /* THIS TEST FAILS */
ENDPGM

PGM PARM(&A)     /* PGMB */
DCL &A *CHAR 5   /* THIS LEN ERROR*/
CHGVAR &A '  '   /* 5 POSITIONS ONLY; OTHERS UNAFFECTED */
RETURN
```

While this kind of error does not cause an escape message, program variables handled this way may function differently than expected.

If the value passed to a program is shorter than its declared length in the receiving program, there may be more serious consequences. In this case, the value of the variable in the receiving program consists of its values as originally passed, and whatever follows that value in storage, up to the length declared in the receiving program. The content of this adopted storage cannot be predicted. If the passed value is a program variable, it could be followed by other program variables or by

internal control structures for the program. If the passed value is a constant, it could be followed in storage by other constants passed on the CALL command.

If the receiving program changes the value, it operates on the original value and on the adopted storage. The immediate effect of this could be to change other variables or constants, or to change internal structures in such a way that the program fails. Changes to the adopted storage take effect immediately.

In the following example, two 3-character constants are passed to the receiving program. Character constants are passed with a minimum of 32 characters; normally, the value is passed as 3 characters left-adjusted with trailing blanks. If the receiving program declares the receiving variable to be longer than 32 positions, the extra positions use adopted storage of unknown value. For this example, assume that the two constants are adjacent in storage.

```
CALL PGMA ('ABC' 'DEF')  /* PASSING PROG */

PGM  PARM(&A &B) /* PGMA */
DCL  &A *CHAR 50  /* VALUE:ABC+29' '+DEF+15' ' */
DCL  &B *CHAR 10  /* VALUE:DEF+7' ' */
CHGVAR VAR(&A) (' ')  /* THIS ALSO BLANKS &B */
.
.
.
ENDPGM
```

Values passed in variables behave in exactly the same way.

Using Data Queues to Communicate between Programs

Data queues are a type of system object that you can create, to which one HLL program can send data, and from which another HLL program can receive data. The receiving program can be already waiting for the data, or can receive the data later.

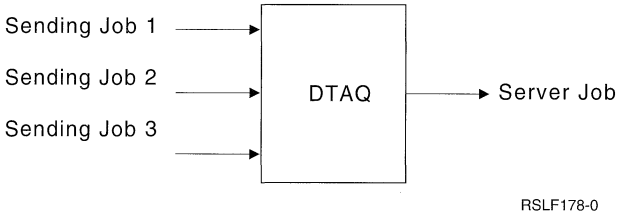
The advantages of using data queues are:

- Using data queues frees a job from performing some work. If the job is an interactive job, this can provide better response time and decrease the size of the interactive program and its process access group (PAG). This, in turn, can help overall system performance. For example, if several work station users enter a transaction that involves updating and adding to several files, the system can perform better if the interactive jobs submit the request for the transaction to a single batch processing job.
- Data queues are the fastest means of asynchronous communication between two jobs. Using a data queue to send and receive data requires less overhead than using database files, message queues, or data areas to send and receive data.
- You can send to, receive from, and retrieve a description of a data queue in any HLL program by calling the QSNDDTAQ, QRCVDTAQ, QMHRDQM, QCLRDTAQ, and QMHQRDQD programs without exiting the HLL program or calling a CL program to send, receive, clear, or retrieve the description.
- When receiving data from a data queue, you can set a time out such that the job waits until an entry arrives on the data queue. This differs from using the

EOFDLY parameter on the OVRDBF command, which causes the job to be activated whenever the delay time ends.

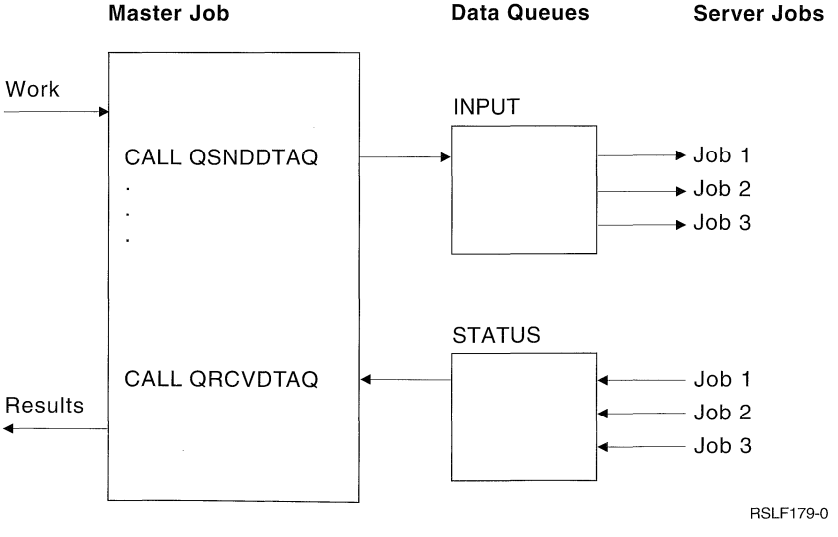
- More than one job can receive data from the same data queue. This has an advantage in certain applications where the number of entries to be processed is greater than one job can handle within the desired performance restraints. For example, if several printers are available to print orders, several interactive jobs could send requests to a single data queue. A separate job for each printer could receive from the data queue, either in first-in-first-out (FIFO), last-in-first-out (LIFO), or in keyed-queue order.
- Data queues have the ability to attach a sender ID to each message being placed on the queue. The sender ID, an attribute of the data queue which is established when the queue is created, contains the qualified job name and current user profile.

The following is an example showing how data queues work. Several jobs place entries on a data queue. The entries are handled by a server job. This might be used to have jobs send processed orders to a single job that would do the printing. Any number of jobs can send to the same queue.



Another example using data queues follows. A primary job gets the work requests and sends the entries to a data queue (by calling the QSNDDTAQ program). The server jobs receive the entries from the data queue (by calling the QRCVDTAQ program) and process the data. The server jobs can report status back to the primary program using another data queue.

Data queues allow the primary job to route the work to the server jobs. This frees the primary job to receive the next work request. Any number of server jobs can receive from the same data queue.



When no entries are on a data queue, server programs have the following options:

- Wait until an entry is placed on the queue
- Wait for a specific period of time; if the entry still has not arrived, then continue processing
- Do not wait, return immediately.

Data queues can also be used when a program needs to wait for input from display files, ICF files, and data queues at the same time. When you specify the DTAQ parameter for the following commands:

- Create Display File (CRTDSPF) command
- Change Display File (CHGDSPF) command
- Override Display File (OVRDSPF) command
- Create ICF File (CRTICFF) command
- Change ICF File (CHGICFF) command
- Override ICF File (OVRICFF) command

you can indicate a data queue that will have entries placed on it when any of the following happens:

- An enabled command key or Enter key is pressed from an invited display device
- Data becomes available from an invited ICF session

Jobs running on the system can also place entries on the same data queue as the one specified in the DTAQ parameter by using the QSNDDTAQ program.

An application program calls the QRCVDTAQ program to receive each entry placed on the data queue and then processes the entry based on whether it was placed there by a display file, an ICF file, or the QSNDDTAQ program. For more information, see "Example 2: Waiting for Input from a Display File and an ICF File" on page 3-28 and "Example 3: Waiting for Input from a Display File and a Data Queue" on page 3-31.

Comparisons with Using Database Files as Queues

The following describes the differences between using data queues and database files:

- Data queues have been improved to communicate between active programs, not to store large volumes of data or large numbers of entries. For these purposes, use database files as queues.
- Data queues should not be used for long-term storage of data. For this purpose, you should use database files.
- When using data queues, you should include abnormal end procedures in your programs to recover any entries not yet completely processed before the system is ended.
- It is good practice to periodically (such as once a day) delete and re-create a data queue at a safe point. Performance can be affected if too many entries exist without being removed. Re-creating the data queue periodically will return the data queue to its optimal size.

Similarities to Message Queues

Data queues are similar to message queues, in that programs can send data to the queue that is received later by another program. However, more than one program can have a receive pending on a data queue at the same time, while only one program can have a receive pending on a message queue at the same time. (Only one program receives an entry from a data queue, even if more than one program is waiting.) Entries on a data queue are handled in either first-in-first-out, last-in-first-out, or keyed-queue order. When an entry is received, it is removed from the data queue.

Prerequisites for Using Data Queues

Before using a data queue, you must first create it using the Create Data Queue (CRTDTAQ) command. The following is an example:

```
CRTDTAQ DTAQ(MYLIB/INPUT)  MAXLEN(128)
        TEXT('Sample data queue')
```

The MAXLEN parameter is required and specifies the maximum length (1 to 64 512 characters) of the entries that can be sent to the data queue.

Managing the Storage Used by a Data Queue

When an entry is received from a data queue, the entry is removed from the data queue but the auxiliary storage is not freed. The same auxiliary storage is used again when a new entry is sent to the data queue. The queue grows larger as entries are sent to the queue and not received. Performance is better if the size of the queue is kept to less than 100 entries. If a data queue has grown too large, delete the data queue using the Delete Data Queue (DLTDTAQ) command, then re-create the queue using the Create Data Queue (CRTDTAQ) command.

Allocating Data Queues

If your application requires that a data queue is not accessed by more than one job at a time, it should be coded to include an Allocate Object (ALCOBJ) command before using a data queue. The data queue should then be deallocated using the Deallocate Object (DLCOBJ) command when the application is finished using it.

The ALCOBJ command does *not*, by itself, restrict another job from sending or receiving data from a data queue or clearing a data queue. However, if all applications are coded to include the ALCOBJ command before any use of a data queue, the allocation of a data queue already allocated to another job will fail, preventing the data queue from use by more than one job at a time.

When an allocation fails because the data queue is already allocated to another job, the system issues an error message, CPF1002. The Monitor Message (MONMSG) command can be used in the application program to monitor for this message and respond to the error message. Possible responses include sending a message to the user and attempting to allocate the data queue again. See "Monitoring for Messages in a CL Program" on page 8-16 for more information.

Sending Data with Data Queues

To send data to a data queue, call the QSNDDTAQ program from your HLL program. For example, in a CL program, you could specify the following:

```
CALL  PGM(QSNDDTAQ)  PARM(&QNAME  &LIB  &FLDLEN  &FIELD  &KEYLEN  &KEY)
```

You must pass four parameters, as follows:

- &QNAME is a 10-byte character field that names the data queue.
- &LIB is a 10-byte character field that names the library containing the data queue. *LIBL or *CURLIB can be used.

  Note: To improve data queue performance, the system uses the name and library of the last data queue used. This has two implications:

  - If *LIBL is specified, the library list for the job that runs the program is used to find the appropriate data queue. If the library list is changed after a call to QSNDDTAQ, but the &LIB parameter value is unchanged, the same queue is used again.
  - A data queue can be renamed (RNMOBJ command), deleted (DLTDTAQ command), or moved (MOVOBJ command). A queue with the same name and library as the data queue that was renamed or moved can be created. If this is done and data is sent to the same named data queue within the same job, the data is sent to the old queue. The data is not sent to the newly created queue.
- &FLDLEN is a 5-digit packed decimal variable with no decimal positions. &FLDLEN specifies the number of characters sent to the data queue.
- &FIELD is a character field of length &FLDLEN. &FIELD is the field that contains the data to be sent to the data queue.

  Notes:

  1. If the length of this field is larger than &FLDLEN, only the number of characters (beginning from the left) as defined by &FLDLEN are sent to the data queue. If the length of this field is smaller than &FLDLEN, unexpected results can occur.
  2. An error occurs if the &FLDLEN value is greater than the length specified by the maximum length (MAXLEN) parameter on the Create Data Queue (CRTDTAQ) command.

You may pass 2 optional parameters; however, if you specify one, you must specify the other:

- &KEYLEN is a 3-digit packed decimal variable with no decimal positions. &KEYLEN specifies the length of the key sent to the data queue.
- &KEY is a character field of length &KEYLEN. &KEY is the field that contains the key data to be sent to the data queue.

The following list contains a description of possible error messages for the QSNDDTAQ program:

```
MSGID   TYPE  MSG
CPF2498  E    Invalid length. MAXLEN for data queue &1 in &2 is &3.
CPF6565  E    User profile storage limit exceeded.
CPF9501  E    Data queue &1 in &2 requires a key value.
CPF9502  E    Key length must be zero for data queue &1 in &2.
CPF9503  E    Cannot lock data queue &1 in &2.
CPF9506  E    Key length must be &3 for data queue &1 in &2.
CPF9507  E    Invalid key length specified.
CPF9509  E    Space access error.
CPF950A  E    Storage limit exceeded for data queue &1 in &2.
CPF9801  E    Object &2 in library &3 not found.
CPF9802  E    Not authorized to object &2 in &3.
CPF9807  E    One or more libraries in library list deleted.
CPF9808  E    Cannot allocate one or more libraries on library list.
CPF9810  E    Library &1 not found.
CPF9820  E    Not authorized to use library &1.
CPF9830  E    Cannot assign library &1.
CPF9872  E    Program &1 in Library &2 ended. Reason code &3.
```

Receiving Data with Data Queues

To receive data from a data queue, call the QRCVDTAQ program from your HLL program. For example, in a CL program, you could specify the following:

```
CALL  PGM(QRCVDTAQ)  PARM(&QNAME  &LIB  &FLDLEN  &FIELD  &WAIT +
          &ORDER  &KEYLEN  &KEY  &SNDRLEN  &SNDR)
```

You must pass five parameters, as follows:

- &QNAME is a 10-byte character field that names the data queue.
- &LIB is a 10-byte character field that names the library containing the data queue. *LIBL or *CURLIB can be used.

  Note: To improve data queue performance, the system remembers the name and library of the last data queue used. This has two implications:

  - If *LIBL is specified, the library list for the job that runs the program is used to find the appropriate data queue. If the library list is changed after a call to QRCVDTAQ, but the &LIB parameter value is unchanged, the same queue is used again.
  - A data queue can be renamed (RNMOBJ command), deleted (DLTDTAQ command), or moved (MOVOBJ command). A queue with the same name and library as the data queue that was renamed, deleted, or moved can be created. If this is done and data is sent to the same named data queue, the data is received from the old queue and is *not* received from the newly created queue.
- &FLDLEN is a 5-digit packed decimal variable with no decimal positions. &FLDLEN specifies the number of characters received from the data queue. If a time out occurs, this field is zero.
- &FIELD is a character field of length &FLDLEN. &FIELD is the field that receives the data coming from the data queue.

  Note: If the length of this field is larger than that specified by &FLDLEN, only the number of characters (beginning from the left) as defined by the message removed from the queue are changed. If the length of this field is smaller than the value specified for the MAXLEN parameter on

the Create Data Queue (CRTDTAQ) command, unexpected results can occur.

- &WAIT is a 5-digit packed decimal field with no decimal positions. When no entries are on the data queue, the WAIT parameter specifies the following:
  - A negative value indicates an unlimited wait request.
  - Zero indicates to continue processing immediately (no waiting). If no entry exists, the call completes immediately with &FLDLEN set to zero.
  - A positive value specifies the number of seconds to wait.
  - The maximum value, 99999, allows a wait time of approximately 28 hours.

  Note: If seconds are less than or equal to "2", the job does not leave the activity level (for 2 seconds). This is described as a short wait. For more details on activity levels and implementation applications, see the Work Management Guide.

You can pass five optional parameters; however, if you specify one parameter, you must specify all parameters:

- &ORDER is a 2-byte character field that retrieves a message using the specified character key. The following character values are used:
  - GT: Greater than
  - LT: Less than
  - NE: Not equal
  - EQ: Equal
  - GE: Greater than or equal
  - LE: Less than or equal
- &KEYLEN is a 3-digit packed decimal field with no decimal positions. &KEYLEN specifies the length of the key parameter.
- &KEY is a character field that identifies the variable containing the key to be used for receiving a message from the data queue. The key of the received message is returned in this field. It may be different than the key specified to search for (for example, if key AA is chosen with the search order of greater than or equal to (GE), the key of the record that is actually retrieved could be AB or anything else greater than AA).
- &SNDRLEN is a 3-digit packed decimal field with no decimal positions. &SNDRLEN specifies the length of the sender identification (ID) parameter. The sender ID length value must be zero, or have a value equal to or greater than 8.
- &SNDR is a character field that identifies the variable to contain the sender ID information associated with the received message.
- The length and content of the data returned is:

  4 bytes — Packed 7,0 field containing the number of bytes returned; for example, the length of data actually retrieved.

  4 bytes — Packed 7,0 field containing the number of bytes available; for example, the total length of all data available.

  26 bytes — Character field containing the job name, user, and job number.

  10 bytes — Character field containing the name of the sender's current user profile.

Note: On the CRTDTAQ command, the SENDERID parameter defaults to *NO. To include the sender ID for each data queue entry, the SENDERID parameter must be *YES when the data queue is created.

When more than one program has a receive pending on a data queue at one time, a data entry sent to the data queue is received by only one of the programs. The program with the highest priority receives the entry. The next entry sent to the queue is given to the job with the next highest priority.

The following list contains a description of possible error messages for the QRCVDTAQ program:

```
MSGID   TYPE  MSG
CPF2472  E    Invalid wait time specified.
CPF9501  E    Data queue &1 in &2 requires a key value.
CPF9502  E    Key length must be zero for data queue &1 in &2.
CPF9503  E    Cannot lock data queue &1 in &2.
CPF9504  E    An invalid search order was specified.
CPF9505  E    Sender ID length value is not valid.
CPF9506  E    Key length must be &3 for data queue &1 in &2.
CPF9507  E    Invalid key length specified.
CPF9508  E    Invalid sender ID length specified.
CPF9509  E    Space access error.
CPF9801  E    Object &2 in library &3 not found.
CPF9802  E    Not authorized to object &2 in &3.
CPF9807  E    One or more libraries in library list deleted.
CPF9808  E    Cannot allocate one or more libraries on library list.
CPF9810  E    Library &1 not found.
CPF9820  E    Not authorized to use library &1.
CPF9830  E    Cannot assign library &1.
CPF9872  E    Program &1 in Library &2 ended. Reason code &3.
```

Clearing Data from Data Queues

To clear data from a data queue, call the QCLRDTAQ program from your HLL program. For example, in a CL program, specify the following:

```
CALL PGM(QCLRDTAQ)  PARM(&QNAME &LIB)
```

You must pass the two parameters as follows:

- &QNAME is a 10-byte character field that names the data queue.
- &LIB is a 10-byte character field that names the library containing the data queue.

The following list contains a description of possible error messages for the QCLRDTAQ program:

```
MSGID   TYPE  MSG
CPF9503  E    Cannot lock data queue &1 in &2.
CPF9801  E    Object &2 in library &3 not found.
CPF9802  E    Not authorized to object &2 in &3.
CPF9807  E    One or more libraries in library list deleted.
CPF9808  E    Cannot allocate one or more libraries on library list.
CPF9810  E    Library &1 not found.
CPF9820  E    Not authorized to use library &1.
CPF9830  E    Cannot assign library &1.
CPF9872  E    Program &1 in Library &2 ended. Reason code &3.
```

Retrieving Descriptions from Data Queues

To retrieve a description of a data queue, call the QMHQRDQD program from your HLL program. For example, in a CL program, specify the following:

```
CALL PGM(QMHQRDQD)  PARM(&RCVR &RCVRLEN &FORMAT &DQNAME)
```

You must pass the four parameters as follows:

- &RCVR is a character field that identifies the variable to contain the attributes of the data queue. The information returned for the &RCVR parameter is dependant on the &FORMAT value. See the &FORMAT parameter for the layout of this field.
- &RCVRLEN is a 4-byte binary variable that specifies the length of the receiver parameter. The length should be 80 to hold all of the data.
- &FORMAT is an 8-byte character field that specifies the format of the receiver template. Information shown in Table 3-1 is returned from the RDQD0100 format.
- &DQNAME is a 20-byte character field that identifies the name and library (the name being the first 10 characters and the library being the second 10 characters) of the data queue. *LIBL or *CURLIB can be used.

Table 3-1 (Page 1 of 2). Layout of RDQD0100

Offset		Type	Information
Decimal	**Hexadecimal**		
0	0	Binary(4)	Bytes returned: indicates the length of the data actually retrieved.
4	4	Binary(4)	Bytes available: indicates the total length of all data available.
8	8	Binary(4)	Message length: specifies the maximum allowed length of messages.
12	C	Binary(4)	Key length: specifies the length in bytes of the message reference key from 1 to 256 if you specify the queue type as keyed. If you specify that the queue is not a keyed queue, the value must be 0.
16	10	Character(1)	Sequence: specifies the sequence in which messages can be removed from the queue. Valid values are: F=First-in first-out, K=Keyed, and L=Last-in first-out.
17	11	Character(1)	Include sender ID: specify Y or N if you want a sender ID included.
18	12	Character(1)	Force indicators: specify Y or N if you want force indicators.

Table 3-1 (Page 2 of 2). Layout of RDQD0100			
Offset		Type	Information
Decimal	Hexadecimal		
19	13	Character(50)	Text: indicates the text description of the data queue. The field is blank if no text description is specified.
69	45	Character(3)	Reserved
72	48	Binary(4)	Number of messages: indicates how many messages are on the queue.
76	46	Binary(4)	Maximum number of messages: indicates the maximum number of messages that can be placed on the queue without overflowing the queue.

The following list contains a description of possible error messages for the QMHQRDQD program:

```
MSGID   TYPE  MSG
CPF2150  E    Object information function failed.
CPF2151  E    Operation failed for &2 in &1 type *&3.
CPF3C21  E    Format name &1 is not valid.
CPF3C24  E    Length of the receiver variable is not valid.
CPF9503  E    Cannot lock data queue &1 in &2.
CPF9509  E    Space access error.
CPF9801  E    Object &2 in library &3 not found.
CPF9802  E    Not authorized to object &2 in &3.
CPF9807  E    One or more libraries in library list deleted.
CPF9808  E    Cannot allocate one or more libraries on library list.
CPF9810  E    Library &1 not found.
CPF9820  E    Not authorized to use library &1.
CPF9830  E    Cannot assign library &1.
CPF9872  E    Program &1 in Library &2 ended. Reason code &3.
```

Retrieving Data Queue Messages

To retrieve one or more messages of a data queue, call the QMHRDQM program from your HLL program. For example, in a CL program, specify the following:

```
CALL PGM(QMHRDQM)  PARM(&RCVR &RCVRLEN &FORMAT &DQNAME &MSGSEL &MSGSLEN
&MSGSFMT &ERRCODE)
```

The QMHRDQM program is similar in function to the QRCVDTAQ program. However, the QRCVDTAQ program removes the received message from the data queue; QMHRDQM program does *not* remove received messages.

The QMHRDQM program places messages in a specified variable. It also allows the retrieval of multiple messages per call. The selection template allows you to have some control over which messages are returned. The returned messages replace any existing messages in the variable. The QMHRDQM program can be used to retrieve the following:

- The first or last message of a data queue
- All messages of a data queue

- Selected messages from a keyed data queue

The QMHRDQM program has the following attributes:

- Library Authority *USE
- Data Queue Authority *USE
- Data Queue Lock *EXCLRD

You must pass the eight parameters as follows:

- &RCVR is a character field that contains the retrieved messages. The QMHRDQM program returns only as many complete messages in this parameter as it can hold, based on the length of the receiver variable. If the variable is not long enough to hold the returned messages, the data is truncated. The length of the receiver variable must be at least 8 bytes. If the value of the *length of receiver variable* field is longer than the actual length of the receiver variable, unpredictable results will occur.
- &RCVRLEN is a 4-byte binary variable that specifies the length of the receiver parameter. If the variable is not long enough to hold the returned messages, the data is truncated. If the value of *length of receiver variable* is longer than the actual length of the receiver variable, unpredictable results will occur.
- &FORMAT is an 8-byte character field that specifies the format of the receiver template. Information shown in Table 3-2 is returned for the RDQM0100 format.

  Note: The offsets will vary for the last 5 fields. The last 5 fields repeat, in the order listed, for each message returned.
- &DQNAME is a 20-byte field that identifies the name and library (the name being the first 10 characters and the library being the second 10 characters) of the data queue. *LIBL or *CURLIB can be used.
- &MSGSEL is a character field that identifies the variable to contain information about which message (or messages) you want to retrieve. See the &MSGSFMT parameter for the layout of this field.
- &MSGSLEN is a 4-byte binary variable that specifies the length of the &MSGSEL parameter.
- &MSGSFMT is an 8-byte character field that specifies the format of the &MSGSEL parameter. The following format names can be used.

  RDQS0100: Selection template format for non-keyed message.
  RDQS0200: Selection template for keyed messages selection.
- &ERRCODE is a character field that identifies the variable to contain error information. For more information on the format of the error code parameters, see the *System Programmer's Interface Reference*, SC41-8223.

The asterisks used in the following table represent a value for the specific type.

Table 3-2 (Page 1 of 2). Layout of RDQM0100

Offset		Type	Information
Decimal	**Hexadecimal**		
0	0	Binary(4)	Bytes returned: indicates the length of the data actually retrieved.

Table 3-2 (Page 2 of 2). Layout of RDQM0100

Offset		Type	Information
Decimal	**Hexadecimal**		
4	4	Binary(4)	Bytes available: indicates the total length of all data available.
8	8	Binary(4)	Number of messages returned: indicates the number of messages retrieved.
12	C	Binary(4)	Number of messages available: indicates how many messages are on the data queue that satisfy the search criteria specified in the &MSGSEL parameter.
16	10	Binary (4)	Message key length returned: indicates the number of bytes retrieved.
20	14	Binary(4)	Actual message key length available: indicates the size (in bytes) of the key at the creation time of the data queue.
24	18	Binary(4)	Message text length returned: indicates the number of message data bytes retrieved.
28	1C	Binary(4)	Actual message text length available: indicates the message size (in bytes) used at the creation time of the data queue.
32	20	Binary(4)	Entry length returned: indicates the number of bytes retrieved for each message entry.
36	24	Binary(4)	Entry length available: indicates the total number of bytes available to be retrieved for each message entry.
40	28	Binary(4)	Offset to first message entry: indicates the offset at which the first message entry begins. If this value is 0, there is no message available.
44	2C	Character(10)	Returned library name: indicates the library in which the data queue was found.
48	30	Character(*)	Reserved.
		Binary(4)	Offset to next message entry
		Character(8)	Message enqueue date and time (in TOD format).
		Character(*)	Message key.
		Character(*)	Message text.
		Character(*)	Reserved.

RDQS0100: Selection Template for Nonkeyed Messages

Table 3-3 describes a template format to use with data queues when selection with keys is not necessary. This template can be used with keyed data queues. To retrieve messages using keys and key search order, use template RDQS0200.

Table 3-3. Selection Template Format for Nonkeyed Message

Offset			
Decimal	**Hexadecimal**	**Type**	**Information**
0	0	Character(1)	Type: specifies the selection type. Values are A for all messages, F for first, and L for last.
1	1	Character(3)	Reserved
4	4	Binary(4)	Number of message text bytes to retrieve: maximum value allowed is 65 536. The length of the data retrieved is equal to this value. If the number of bytes requested exceeds the actual message text length, the text is padded with binary zeros. If the number of message text bytes is less than the actual text, the message text is truncated.

RDQS0200: Selection Template for Keyed Messages

Table 3-4 describes a template for use with keyed data queues when you want to use message selection by key. When using this template, all messages satisfying the key search order are returned. The messages are returned in first-in first-out order.

Note: This format is valid only if the queue was created as a keyed data queue.

Table 3-4 (Page 1 of 2). Selection Template for Keyed Messages

Offset			
Decimal	**Hexadecimal**	**Type**	**Information**
0	0	Character(1)	Type: specifies the selection type. K is the value allowed.
1	1	Character(2)	Key search order: a relational operator with the possible values of greater than (GT), less than (LT), not equal (NE), equal (EQ), greater than or equal (GE), or less than or equal (LE).
3	3	Character(1)	Reserved

Table 3-4 (Page 2 of 2). Selection Template for Keyed Messages

Offset		Type	Information
Decimal	**Hexadecimal**		
4	4	Binary(4)	Number of message text bytes to retrieve: maximum value allowed is 65 536. The length of the data retrieved is equal to this value. If the number of bytes requested exceeds the actual message text length, the text is padded with binary zeros. If the number of message text bytes is less than the actual text, the message text is truncated.
8	8	Binary(4)	Number of message key bytes to retrieve: specifies the number of message key bytes to return. The maximum value allowed is 256. If the number of bytes requested exceeds the actual message key length, the key is padded with binary zeros. If the number of message key bytes requested is less than the actual key, the key is truncated.
12	C	Binary(4)	Length of Key: must be a value from 1 to 256.
16	10	Character(*)	Key: used with the relational operator. If the actual length is different than the specified length for the length-of-key field, you may have unpredictable results.

The following list contains a description of possible error messages for the QMHRDQMD program:

```
MSGID   TYPE  MSG
CPF3C21  E    Format name &1 is not valid.
CPF3C24  E    Receiver length must be at least 8.
CPF3CF1  E    Error code parameter not valid.
CPF9503  E    Could not allocate internal resource.
CPF9504  E    Search order not valid.
CPF9509  E    Space access error.
CPF9801  E    Data Queue not found.
CPF9802  E    Not authorized to object Data Queue.
CPF9807  E    Library on *LIBL deleted.
CPF9808  E    Library on *LIBL on use.
CPF9810  E    Library not found.
CPF9820  E    Not authorized to use library.
CPF9830  E    Library in use.
CPF9872  E    Program &1 in library &2 ended. Reason code &3.
CPF950B  E    Specified selection type is not valid.
CPF950C  E    Specified retrieve length is not valid.
CPF950D  E    Specified message selection length template is not valid.
CPF950E  E    Data queue is not a keyed data queue.
CPF950F  E    Specified key length is not valid.
```

Examples Using a Data Queue

The following examples explain three methods to process data queue files.

Example 1: Waiting up to 2 Hours to Receive Data from Data Queue: In the following example, program B specifies to wait up to 2 hours (7200 seconds) to receive an entry from the data queue. Program A sends an entry to data queue DTAQ1 in library QGPL. If program A sends an entry within 2 hours, program B receives the entries from this data queue. Processing begins immediately. If 2 hours elapse without program A sending an entry, program B processes the time-out condition because the field length returned is 0. Program B continues receiving entries until this time-out condition occurs. The programs are written in CL; however, either program could be written in any high-level language.

The data queue is created with the following command:

```
CRTDTAQ DTAQ(QGPL/DTAQ1) MAXLEN(80)
```

In this example, all data queue entries are 80 bytes long.

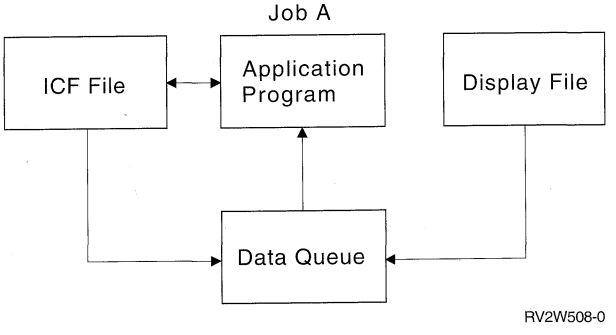
In program A, the following statements relate to the data queue:

```
PGM
DCL  &FLDLEN  *DEC  LEN(5 0)  VALUE(80)
DCL  &FIELD  *CHAR  LEN(80)
.
.(determine data to be sent to the queue)
.
CALL  QSNDDTAQ  PARM(DTAQ1 QGPL &FLDLEN &FIELD)
.
.
.
```

In program B, the following statements relate to the data queue:

```
        PGM
        DCL  &FLDLEN  *DEC  LEN(5 0)  VALUE(80)
        DCL  &FIELD  *CHAR  LEN(80)
        DCL  &WAIT  *DEC  LEN(5 0)  VALUE(7200)   /* 2 hours */
        .
        .
        .
LOOP:   CALL QRCVDTAQ  PARM(DTAQ1 QGPL &FLDLEN &FIELD &WAIT)
        IF    (&FLDLEN *NE 0) DO   /* Entry received */
               .
               . (process data from data queue)
               .
               GOTO LOOP   /* Get next entry from data queue */
        ENDDO
        .
        . (no entries received for 2 hours; process time-out condition)
        .
```

Example 2: Waiting for Input from a Display File and an ICF File: The following example is different from the usual use of data queues because there is only one job. The data queue serves as a communications object within the job rather than between two jobs.



In this example, a program is waiting for input from a display file and an ICF file. Instead of alternately waiting for one and then the other, a data queue is used to allow the program to wait on one object (the data queue). The program calls QRCVDTAQ and waits for an entry to be placed on the data queue that was specified on the display file and the ICF file. Both files specify the same data queue. Two types of entries are put on the queue by display data management and ICF data management support when the data is available from either file. ICF file entries start with *ICFF and display file entries start with *DSPF.

The display file or ICF file entry that is put on the data queue is 80 characters in length and contains the field attributes described in the following list. Therefore, the data queue that is specified using the CRTDSPF, CHGDSPF, OVRDSPF, CRTICFF, CHGICFF, and OVRICFF commands must have a length of at least 80 characters.

Position (and Data Type)	Description
1 through 10 (character)	The type of file that placed the entry on the data queue. This field will have one of two values: *ICFF for ICF file *DSPF for display file If the job receiving the data from the data queue has only one display file or one ICF file open, then this is the only field needed to determine what type of entry has been received from the data queue.
11 through 12 (binary)	The unique identifier for the file. The value of the identifier is the same as the value in the open feedback area for the file. This field should be used by the program receiving the entry from the data queue only if there is more than one file with the same name placing entries on the data queue.
13 through 22 (character)	The name of the display file or ICF file. This is the name of the file actually opened, after all overrides have been processed, and is the same as the file name found in the open feedback area for the file. This field should be used by the program receiving the entry from the data queue only if there is more than one display file or ICF file that is placing entries on the data queue.
23 through 32 (character)	The library where the file is located. This is the name of the library, after all overrides have been processed, and is the same as the library name found in the open feedback area for the file. This field should be used by the program receiving the entry from the data queue only if there is more than one display file or ICF file that is placing entries on the data queue.
33 through 42 (character)	The program device name, after all overrides have been processed. This name is the same as that found in the program device definition list of the open feedback area. For file type *DSPF, this is the name of the display device where the command or Enter key was pressed. For file type *ICFF, this is the name of the program device where data is available. This field should be used by the program receiving the entry from the data queue only if the file that placed the entry on the data queue has more than one device or session invited prior to receiving the data queue entry.
43 through 80 (character)	Reserved.

The following example shows coding logic that the application program previously described might use:

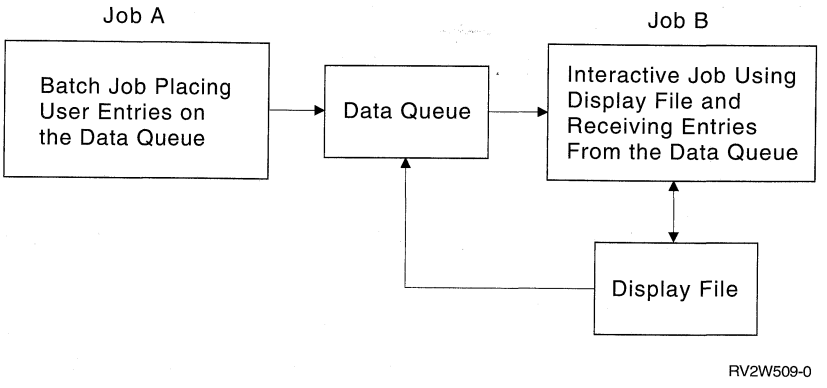
```
.
.
.
.
OPEN DSPFILE ... /* Open the Display file. DTAQ parameter specified on*/
                 /* CRTDSPF, CHGDSPF, or OVRDSPF for the file.       */

OPEN ICFFILE ... /* Open the ICF file. DTAQ parameter specified on   */
                 /* CRTICFF, CHGICFF, or OVRICFF for the file.       */


.
.
DO
  WRITE DSPFILE   /* Write with Invite for the Display file          */
  WRITE ICFFILE   /* Write with Invite for the ICF file              */

  CALL QRCVDTAQ   /* Receive an entry from the data queue specified  */
                  /* on the DTAQ parameters for the files. Entries   */
                  /* are placed on the data queue when the data is   */
                  /* available from any invited device or session    */
                  /* on either file.                                 */
                  /* After the entry is received, determine which file */
                  /* has data available, read the data, process it,  */
                  /* invite the file again and return to process the */
                  /* next entry on the data queue.                   */
  IF 'ENTRY TYPE' FIELD = '*DSPF     ' THEN   /* Entry is from display */
    DO                                        /*  file. Since this entry*/
                                              /* does not contain the  */
                                              /* data received, the data*/
                                              /* must be read from the */
                                              /* file before it can be */
      READ DATA FROM DISPLAY FILE             /* processed.            */
      PROCESS INPUT DATA FROM DISPLAY FILE
      WRITE TO DISPLAY FILE                    /* Write with Invite    */
    END
  ELSE                                        /* Entry is from ICF     */
                                              /*  file. Since this entry*/
                                              /* does not contain the  */
                                              /* data received, the data*/
                                              /* must be read from the */
                                              /* file before it can be */
                                              /* processed.            */
      READ DATA FROM ICF  FILE
      PROCESS INPUT DATA FROM ICF FILE
      WRITE TO ICF FILE                        /* Write with Invite    */
  LOOP BACK TO RECEIVE ENTRY FROM DATA QUEUE
.
.
.
END
```

Example 3: Waiting for Input from a Display File and a Data Queue: In the following example, the program in Job B is waiting for input from a display file that it is using and for input to arrive on the data queue from Job A. Instead of alternately waiting for the display file and then the data queue, the program waits for one object, the data queue.



The program calls QRCVDTAQ and waits for an entry to be placed on the data queue that was specified on the display file. Job A is also placing entries on the same data queue. There are two types of entries put on this queue, the display file entry and the user-defined entry. The display file entry is placed on the data queue by display data management when data is available from the display file. The user-defined entry is placing on the data queue by Job A.

The structure of the display file entry is described in the previous example.

The structure of the entry placed on the queue by Job A is defined by the application programmer.

The following example shows coding logic that the application program in Job B might use:

```
 .
 .
 .
 .
 OPEN DSPFILE ... /* Open the Display file. DTAQ parameter specified on*/
                  /* CRTDSPF, CHGDSPF, or OVRDSPF for the file.       */


.
.
DO
  WRITE DSPFILE   /* Write with Invite for the Display file           */

  CALL QRCVDTAQ   /* Receive an entry from the data queue specified   */
                  /* on the DTAQ parameter for the file. Entries      */
                  /* are placed on the data queue either by Job A or  */
                  /* by display data management when data is          */
                  /* available from any invited device on the display */
                  /* file.                                            */
                  /* After the entry is received, determine what type */
                  /* of entry it is, process it, and return to receive*/
                  /* the next entry on the data queue.                */
  IF 'ENTRY TYPE' FIELD = '*DSPF     ' THEN   /* Entry is from display */
    DO                                       /*  file. Since this entry*/
                                             /* does not contain the   */
                                             /* data received, the data*/
                                             /* must be read from the  */
                                             /* file before it can be  */
      READ DATA FROM DISPLAY FILE            /* processed.             */
      PROCESS INPUT DATA FROM DISPLAY FILE
      WRITE TO DISPLAY FILE                   /* Write with Invite    */
    END
  ELSE                                       /* Entry is from Job A.  */
                                             /* This entry contains   */
                                             /* the data from Job A,  */
                                             /* so no read is required*/
                                             /* before processing the */
                                             /* data.                 */
      PROCESS DATA QUEUE ENTRY FROM JOB A
  LOOP BACK TO RECEIVE ENTRY FROM DATA QUEUE
.
.
.
END
```

Using Data Areas to Communicate between Programs

A data area is an object used to hold data for access by any job running on the system. A data area can be used whenever you need to store information of limited size, independent of the existence of programs or files. Typical uses of data areas are:

- To provide an area (perhaps within each job's QTEMP library) to pass information within a job.

- To provide a field that is easily and frequently changed to control references within a job, such as:
  - Supplying the next order number to be assigned
  - Supplying the next check number
  - Supplying the next save/restore media volume to be used
- To provide a constant field for use in several jobs, such as a tax rate or distribution list.
- To provide limited access to a larger process that requires the data area. A data area can be locked to a single user, thus preventing other users from processing at the same time.

To create a data area other than a local or group data area, use the Create Data Area (CRTDTAARA) command. By doing this, you create a separate object in a specific library, and you can initialize it to a value. To use the value in a CL program, use a Retrieve Data Area (RTVDTAARA) command to bring the current value into a variable in your program. If you change this value in your CL program and want to return the new value to the data area, use the Change Data Area (CHGDTAARA) command.

To display the current value, use the Display Data Area (DSPDTAARA) command. You can delete a data area using the Delete Data Area (DLTDTAARA) command.

Local Data Area

A local data area is created for each job in the system, including autostart jobs, jobs started on the system by a reader, and subsystem monitor jobs.

The system creates a local data area, which is initially filled with blanks, with a length of 1024 and type *CHAR. When you submit a job using the SBMJOB command, the value of the submitting job's local data area is copied into the submitted job's local data area. You can refer to your job's local data area by specifying *LDA for the DTAARA keyword on the CHGDTAARA, RTVDTAARA, and DSPDTAARA commands or *LDA for the substring built-in function (%SST).

The following is true of a local data area:

- The local data area cannot be referred to from any other job.
- You cannot create, delete, or allocate a local data area.
- No library is associated with the local data area.

The local data area contents exist across routing step boundaries. Therefore, using a Transfer Job (TFRJOB), Transfer Batch Job (TFRBCHJOB), Reroute Job (RRTJOB), or Return (RETURN) command does not affect the contents of the local data area.

You can use the local data area to:

- Pass information to a subprogram without the use of a parameter list.
- Pass information to a submitted job by loading your information into the local data area and submitting the job. Then, you can access the data from within your submitted job.
- Improve performance over other types of data area accesses from a CL program.

- Store information without the overhead of creating and deleting a data area yourself.

Most high-level languages can also use the local data area. The SBMxxxJOB and STRxxxRDR commands cause jobs to start with a local data area initialized to blanks. Only the SBMJOB command allows the contents of the submitting job's local data area to be passed to the new job.

Group Data Area

The system creates a group data area when an interactive job becomes a group job (using the Change Group Attributes [CHGGRPA] command). Only one group data area can exist for a group. The group data area is deleted when the last job in the group is ended (with the ENDJOB, SIGNOFF, or ENDGRPJOB command, or with an abnormal end), or when the job is no longer part of the group job (using the CHGGRPA command with GRPJOB(*NONE) specified).

A group data area, which is initially filled with blanks, has a length of 512 and type *CHAR. You can use a group data area from within a group job by specifying *GDA for the DTAARA parameter on the CHGDTAARA, RTVDTAARA, and DSPDTAARA commands. A group data area is accessible to all of the jobs in the group.

The following are true for a group data area:

- You cannot use the group data area as a substitute for a character variable on the substring built-in function (%SUBSTRING or %SST). (You can, however, move a 512-byte character variable used by the substring function into or out of the group data area.)
- A group data area cannot be referred to by jobs outside the group.
- You cannot create, delete, or allocate a group data area.
- No library is associated with a group data area.

The contents of a group data area are unchanged by the Transfer to Group Job (TFRGRPJOB) command.

In addition to using the group data area as you use other data areas, you can use the group data area to communicate information between group jobs in the same group. For example, after issuing the Change Group Job Attributes (CHGGRPA) command, the following command can be used to set the value of the group data area:

```
CHGDTAARA  DTAARA(*GDA)  VALUE('January1988')
```

This command can be run from a CL program or can be issued by the work station user.

Any other CL program in the group can retrieve the value of the group data area with the following CL command:

```
RTVDTAARA  DTAARA(*GDA)  RTNVAR(&GRPARA)
```

This command places the value of the group data area (January1988) into CL variable &GRPARA.

Program Initialization Parameter (PIP) Data Area

A PIP data area (PDA) is created for each prestart job when the job is started. The object sub-type of the PDA is different than a regular data area. The PDA can only be referred to by the special value name *PDA. The size of the PDA is 2000 bytes but the number of parameters contained in it is not restricted.

The RTVDTAARA, CHGDTAARA, and DSPDTAARA CL commands and the RTVDTAARA and CHGDTAARA macro instructions support the special value *PDA for the data area name parameter.

Creating a Data Area

Unlike program variables, data areas are objects and must be created before they can be used in a program or job. A data area can be created as:

- A character string that can be as long as 2000 characters.
- A decimal value with different attributes, depending on whether it will be used only in a CL program or also with other high-level language programs. For CL programs, the data area can have as many as 15 digits to the left of the decimal point and as many as 9 digits to the right, but only 15 digits total. For other languages, the data area can have as many as 15 digits to the left of the decimal point and as many as 9 to the right, for a total of up to 24 digits.
- A logical value '0' or '1', where '0' can mean off, false, or no; and '1' can mean on, true, or yes.

When you create a data area, you can also specify an initial value for the data area. If you do not specify one, the following is assumed:

- 0 for decimal.
- Blanks for character.
- '0' for logical.

To create a data area, use the Create Data Area (CRTDTAARA) command. In the following example, a data area is created to pass a customer number from one program to another:

```
CRTDTAARA  DTAARA(CUST) TYPE(*DEC) +
           LEN(5 0) TEXT('Next customer number')
```

Data Area Locking and Allocation

The CHGDTAARA command uses a *SHRUPD (shared for update) lock on the data area during command processing. The RTVDTAARA and DSPDTAARA commands use a *SHRRD (shared for read) lock on the data area during command processing. If you are performing more than one operation on a data area, you may want to use the Allocate Object (ALCOBJ) command to prevent other users from accessing the data area until your operations are completed. For example, if the data area contains a value that is read and incremented by jobs running at the

same time, the ALCOBJ command can be used to protect the value in both the read and update operations. See Chapter 4 for how to allocate objects.

For information on handling data areas in other (non-CL) languages, refer to the appropriate HLL reference manual.

Displaying a Data Area

You can display the attributes (name, library, type, length, data area text description), and the value of a data area. See the *CL Reference* for a detailed description of the Display Data Area (DSPDTAARA) command.

The display uses the 24-digit format with leading zeros suppressed.

Changing a Data Area

The Change Data Area (CHGDTAARA) command changes all or part of the value of a specified data area. It does not change any other attributes of the data area. The new value can be a constant or a CL variable. If the command is in a CL program, the data area does not need to exist when the program is created.

Retrieving a Data Area

The Retrieve Data Area (RTVDTAARA) command retrieves all or part of a specified data area and copies it into a CL variable in a CL program. The data area does not need to exist when the CL program is created, and the CL variable need not have the same name as the data area. Note that this command retrieves, but does not alter, the contents of the specified data area.

Retrieve Data Area Examples

Example 1: Assume that you are using a data area named ORDINFO to track the status of an order file. This data area is designed so that:

- Position 1 contains an O (open), a P (processing), or a C (complete).
- Position 2 contains an I (in-stock) or an O (out-of-stock).
- Positions 3 through 5 contain the initials of the order clerk.

You would declare these fields in your program as follows:

```
DCL VAR(&ORDSTAT) TYPE(*CHAR) LEN(1)
DCL VAR(&STOCKC) TYPE(*CHAR) LEN(1)
DCL VAR(&CLERK) TYPE(*CHAR) LEN(3)
```

To retrieve the order status into &ORDSTAT, you would enter the following:

```
RTVDTAARA DTAARA(ORDINFO (1  1))  RTNVAR(&ORDSTAT)
```

To retrieve the stock condition into &STOCK, you would enter the following:

```
RTVDTAARA DTAARA(ORDINFO (2  1)) RTNVAR(&STOCKC)
```

To retrieve the clerk's initials into &CLERK, you would enter the following:

```
RTVDTAARA DTAARA(ORDINFO (3  3)) RTNVAR(&CLERK)
```

Each use of the RTVDTAARA command requires the data area to be accessed. If you are retrieving many subfields, it is more efficient to retrieve the entire data area into a variable, then use the substring built-in function to extract the subfields.

Example 2: The following example of the RTVDTAARA command places the specified contents of a 5-character data area into a 3-character variable. This example:

- Creates a 5-character data area named DA1 (in library MYLIB) with the initial value of 'ABCDE'
- Declares a 3-character variable named &CLVAR1
- Copies the contents of the last three positions of DA1 into &CLVAR1

To do this, the following commands would be entered:

```
CRTDTAARA DTAARA(MYLIB/DA1) TYPE(*CHAR) LEN(5) VALUE(ABCDE)
.
.
.
DCL VAR(&CLVAR1) TYPE(*CHAR) LEN(3)
RTVDTAARA DTAARA(MYLIB/DA1 (3 3)) RTNVAR(&CLVAR1)
```

&CLVAR1 now contains 'CDE'.

Example 3: The following example of the RTVDTAARA command places the contents of a 5-digit decimal data area into a 5-digit decimal digit variable. This example:

- Creates a 5-digit data area named DA2 (in library MYLIB) with two decimal positions and the initial value of 12.39
- Declares a 5-digit variable named &CLVAR2 with one decimal position
- Copies the contents of DA2 into &CLVAR2

To do this, the following commands would be entered:

```
CRTDTAARA DTAARA(MYLIB/DA2) TYPE(*DEC) LEN(5 2) VALUE(12.39)
.
.
.
DCL  VAR(&CLVAR2) TYPE(*DEC) LEN(5 1)
RTVDTAARA DTAARA(MYLIB/DA2) RTNVAR(&CLVAR2)
```

&CLVAR2 now contains 0012.3 (fractional truncation occurred).

Changing and Retrieving a Data Area Example

The following is an example of using the CHGDTAARA and RTVDTAARA commands for character substring operations.

This example:

- Creates a 10-character data area named DA1 (in library MYLIB) with initial value ABCD5678IJ
- Declares a 5-character variable named &CLVAR1
- Changes the contents of data area DA1 (starting at position 5 for length 4) to the value EFG padding after the G with 1 blank)
- Retrieves the contents of data area DA1 (starting at position 5 for length 5) into the CL variable &CLVAR1

To do this, the following commands would be entered:

```
DCL VAR(&CLVAR1) TYPE(*CHAR) LEN(5)
.
CRTDTAARA DTAARA(MYLIB/DA1) TYPE(*CHAR) LEN(10) +
     VALUE('ABCD5678IJ')
.
.
.
CHGDTAARA DTAARA((MYLIB/DA1) (5 4)) VALUE('EFG')
RTVDTAARA DTAARA((MYLIB/DA1) (5 5)) RTNVAR(&CLVAR1)
```

The variable &CLVAR1 now contains 'EFG I'.

Chapter 4. Objects and Libraries

Objects are the basic units on which commands perform operations. For example, programs and files are objects. Through objects you can find, maintain, and process your data on the AS/400 system. You need only know what object and what function (command) you want to use; you do not need to know the storage address of your data to use it.

This chapter includes General-Use programming Interface and Associated Guidance Information.

Object Types and Common Attributes

Each type of object on the AS/400 system has a unique purpose within the system and has an associated set of commands which process that type of object. The *CL Reference* contains a complete list of the types of objects, the abbreviations used as parameter values for object type parameters, and the definition of the object belonging to that type.

Each object type has a set of common attributes that describes the object. These common attributes are listed in Table 4-2 on page 4-23. The online help information for the Display Object Descriptions (DSPOBJD) display describes these attributes.

Functions Performed on Objects

Many functions can be performed on objects. Some functions the system performs automatically and others you request through commands.

Functions the System Performs Automatically

The functions performed automatically ensure that objects are processed in a consistent, secure, and proper way. These functions are:

- Object type verification. The system checks the type of object and the type of function being performed on the object to verify that function can be performed on that type of object. For example, if the object specified in a CALL command is not a program, the call function cannot be performed.
- Object authority verification. The system checks the object, the function, and the user to verify that user can perform that function on that object. For example, if USERA is not authorized to use OBJB in any way, he cannot request that any functions be performed on it.
- Object lock enforcement. The system ensures that the integrity of objects is preserved when two or more users try to use an object at the same time. Simultaneous changes to an object are locked out; users cannot use an object while it is being changed.
- Object damage detection and notification. The system monitors for errors during the processing of objects and communicates to you unplanned failures that result from the unrecognizable contents of objects. These failures are communicated to you through standard messages that indicate object damage.

The system is designed so that these failures are rare, and monitoring and communicating these failures provide integrity.

Functions You Can Perform Using Commands

The functions you can request through commands are of two types:

- Specific functions for each object type. For example, create, change, and display are specific functions. The specific functions are described in other sections of this manual that describe the object type.
- Some common functions that apply to objects in general are explained in this guide:

Table 4-1. Common Functions for Objects

Function	Page
Searching for multiple objects or a single object in a library	4-13
Specifying authority for objects in a library	4-15
Placing objects in libraries	4-18
Describing objects	4-22
Displaying object descriptions	4-22
Retrieving object descriptions	4-25
Detecting unused objects on the system	4-27
Moving objects between libraries	4-32
Creating duplicate objects	4-34
Renaming objects	4-36
Deleting objects	4-39
Allocating and deallocating objects	4-40
Displaying the lock states on objects	4-43
Checking for object existence	5-3

Libraries

On the AS/400 system, objects are grouped in special objects called *libraries*. Objects are found using libraries. Usually to access an object, you specify its name and type, and the library in which it exists. Then, the system searches the specified library for the specified object name and type. (To access an object in a library, you must be authorized to the library and to the object. See "Security Considerations" on page 4-13 and "Specifying Authority for Libraries" on page 4-15 for more information.)

The object type and library do not always have to be specified. Sometimes they are implied in the command. For example, the Display Class (DSPCLS) command implies that the object type is a class. Sometimes the command does not imply the object type, and the object type can be specified in the OBJTYPE parameter. For example, the Display Object Description (DSPOBJD) command applies to any type of object.

If you specify a library name in the same parameter as the object name, the object name is called a *qualified name*. If you are entering a command in which you must specify a qualified name, for example, the object name could be:

```
DISTLIB/ORD040C
```

The order entry program ORD040C is in the library DISTLIB.

If you are using prompting during command entry and you are prompted for a qualified name, you receive prompts for both the object name and the library name. On most commands, you can specify a particular library name, specify *CURLIB (the current library for the job), or use a library list. Library lists are described in the following section.

Library Lists

For commands in which a qualified name can be specified, you can omit specifying the library name. If you do so, either of the following happens:

- For a create command, the object is created and placed in the user's current library, *CURLIB, or in a system library, depending on the object type. For example, programs are created and placed in *CURLIB; authorization lists are created and placed in the system library, QSYS.
- For commands other than a create command, the system normally uses a library list to find the object.

Library lists used by the AS/400 system consist of the following four parts.

System part

The system part of the library list (QSYSLIBL) contains objects needed by the system.

Product libraries

Two product libraries may be included in the library list. The system uses product libraries to support languages and utilities that are dependent on libraries other than QSYS to process their commands.

User commands and menus can also specify a product library on the PRDLIB parameter on the Create Command (CRTCMD) and Create Menu (CRTMNU) commands to ensure that dependent objects can be found.

The product libraries are managed by the system, which automatically places product libraries (such as QRPG) into the reserved product library position in the library list when needed. A product library may be a duplicate of the current library or of a library in the user part of the library list. Two product libraries exist, but the second library can only be used by system functions.

Current library

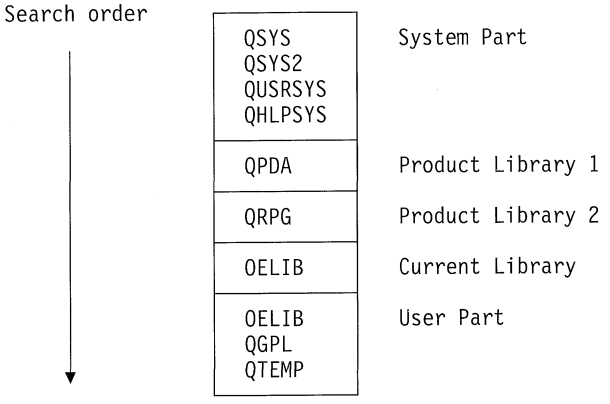
The current library can be, but does not have to be, a duplicate of any library in the library list. The value *CURLIB (current library) may be used on most commands as a library name to represent whatever library has been specified as the current library for the job. If no current library exists in the library list and *CURLIB is specified as the library, QGPL is used. You can change the current library for a job by using the Change Current Library

(CHGCURLIB) or Change Library List (CHGLIBL) command.

User part The user part of the library list contains those libraries referred to by the system's users and applications. The user part, and the product and current libraries, may be different for each job on the system. There is a limit of 25 libraries.

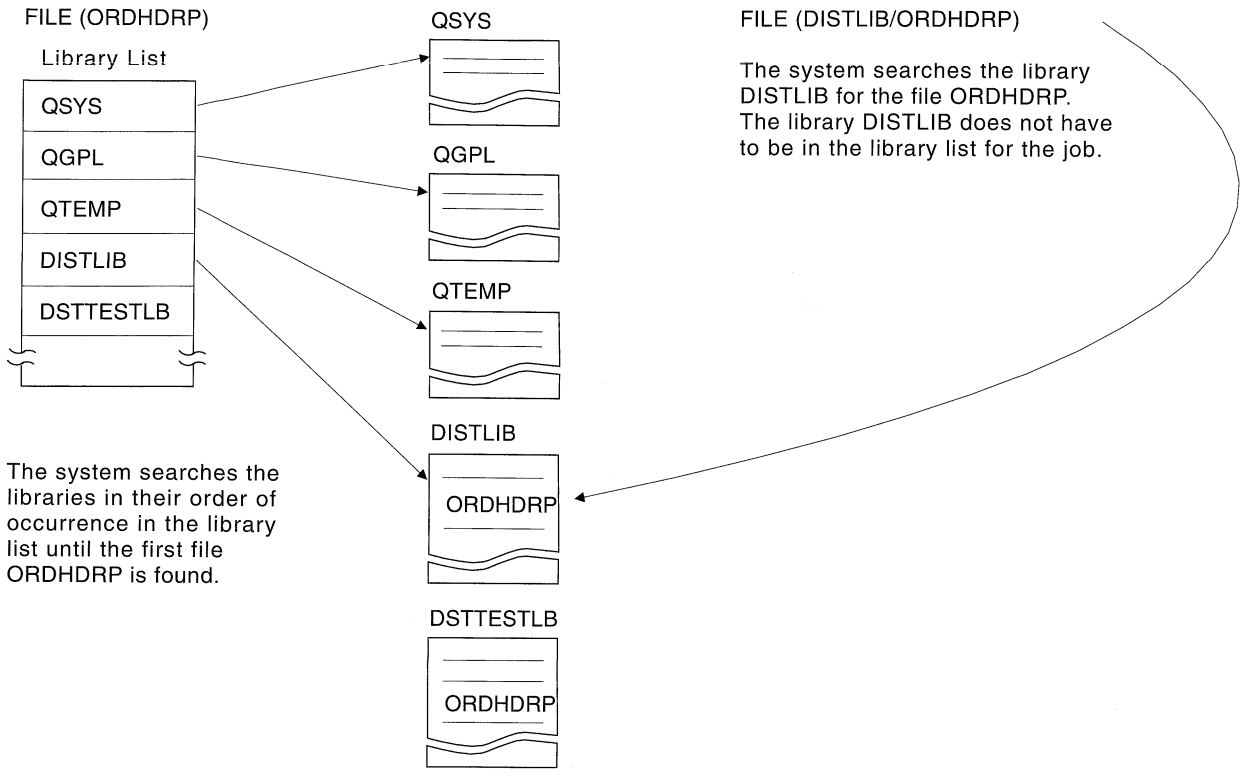
For a list of the libraries shipped with the system or optionally installable on the system, see the *CL Reference*.

The following diagram shows an example of the structure of the library list:



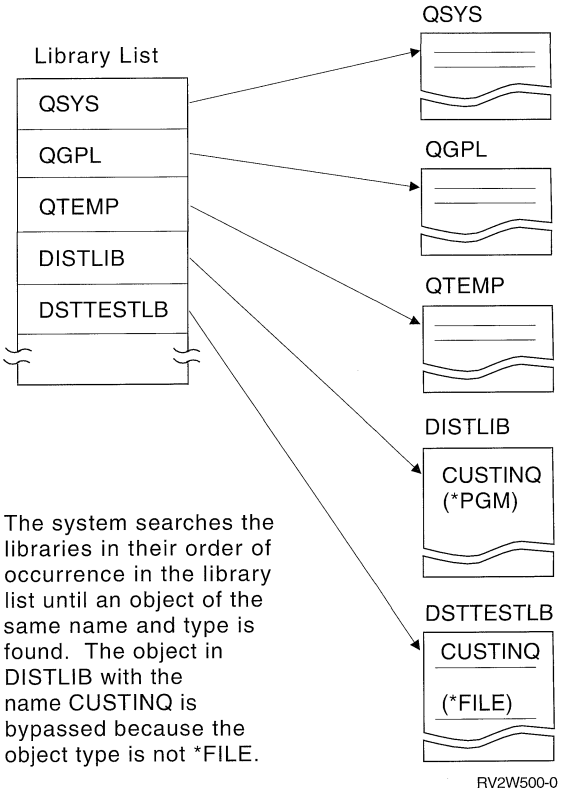
Note: The system places library QPDA in product library 1 when the source entry utility (SEU) is used. When SEU is being used to syntax check source code, a second product library can be added to product library 2. For example, if you are syntax checking RPG source, then QPDA is product library 1 and QRPG is product library 2. In most other system functions, product library 2 is not used.

Using a library list simplifies finding objects on the system. Each job has a library list associated with it. When a library list is used to find an object, each library in the list is searched in the order of its occurrence in the list until an object of the specified name and type is found. If two or more objects of the same type and name exist in the list, you get the object from the library that appears first in the library list. The following diagram shows the searches made for an object both when the library list (*LIBL) is used and when a library name is specified:

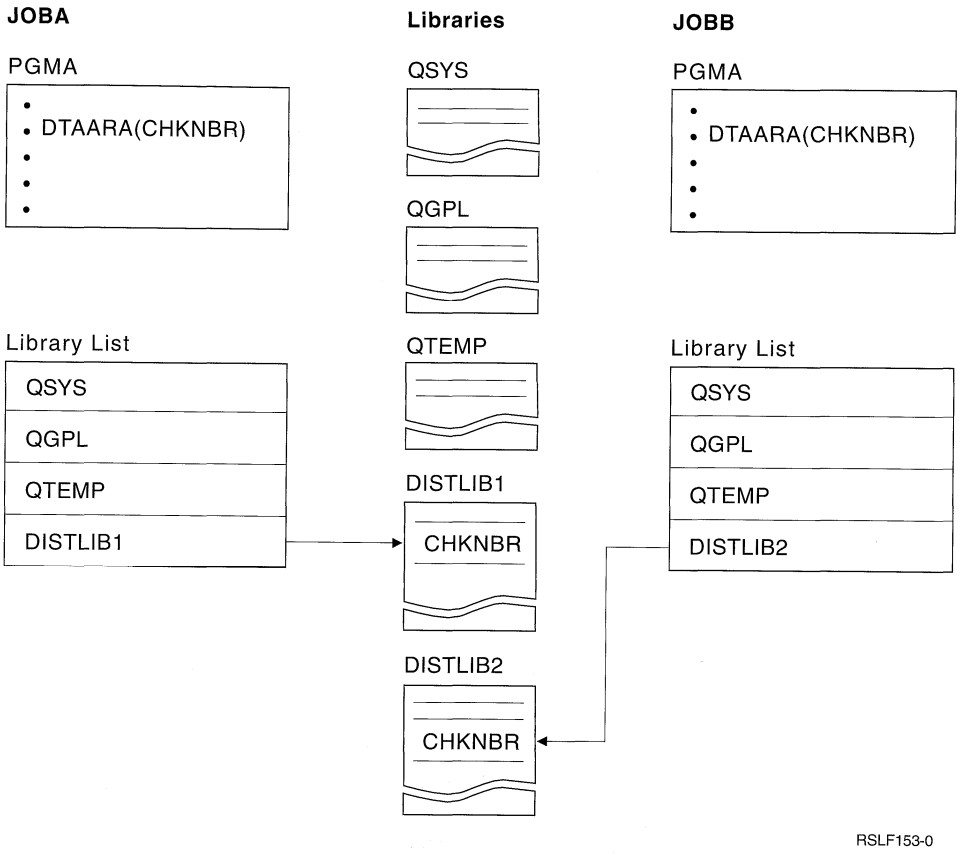

FILE (ORDHDRP)
Library List
QSYS
QGPL
QTEMP
DISTLIB
DSTTESTLB
QSYS
QGPL
QTEMP
DISTLIB
ORDHDRP
DSTTESTLB
ORDHDRP
FILE (DISTLIB/ORDHDRP)
The system searches the library DISTLIB for the file ORDHDRP. The library DISTLIB does not have to be in the library list for the job.
The system searches the libraries in their order of occurrence in the library list until the first file ORDHDRP is found.
RSLF151-0

The following diagram shows what happens when two objects of the same name but different types are in the library list. The system will search for CUSTINQ *FILE in the library list by specifying:

```
DSPOBJD OBJ(*LIBL/CUSTINQ) OBJTYPE(*FILE)
```



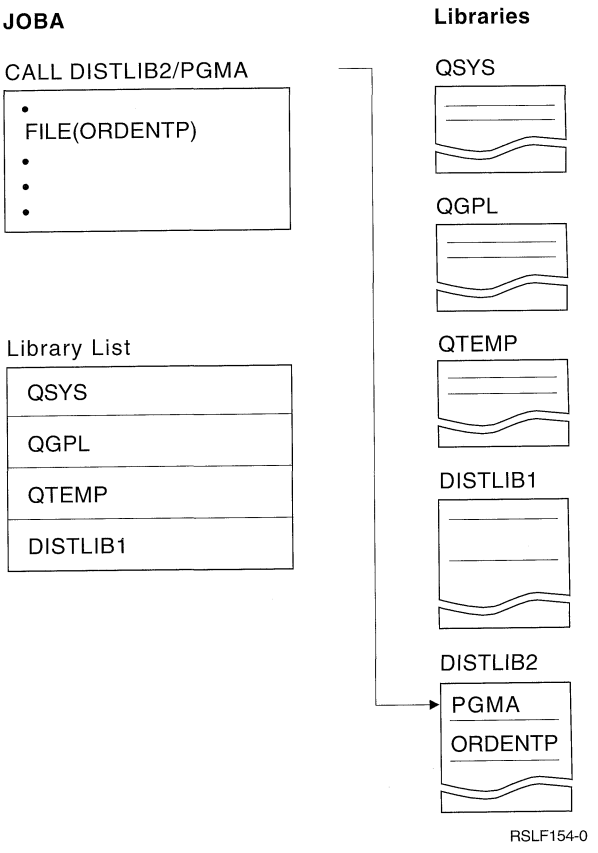
Generally, a library list is more flexible and easier to use than qualified names. More important than the advantage of not entering the library name, is the advantage of performing functions in an application on different data simply by using a different library list without having to change the application. For example, a CL program PGMA updates a data area CHKNBR. If the library name is not specified, the program can update the data area named CHKNBR in different libraries depending on the use of the library list. For example, assume that JOBA and JOBB both call PGMA as shown in the following illustration:



However, the use of a qualified name is advantageous in either of the following situations:

- When the object you are using is not in the library list for the job
- When there is more than one object of the same name in the library list and you want one in a specific library
- When you want to ensure that a specific library is used for security reasons.

If, however, you call a program using a qualified name and the program attempts to open files whose names are not qualified, the files are not opened if they are not in the library list, as shown in the following example:



The call to PGMA is successful because the program name is qualified on the CALL command. However, when the program attempts to open file ORDENTP, the open operation fails because the file is not in one of the libraries in the library list, and its name is not qualified. If library DISTLIB2 was added to the library list or a qualified file name was used, the program could open the file. Some high-level languages do not allow a qualified file name to be specified. By using an Override (OVRxxx) command, a qualified name can be specified.

A Job's Library List

Each job's library list consists of up to four parts: a system part, a user part, and the current and product libraries. Only the system part *must* be included in the library list.

When the system is shipped, the system value QSYSLIBL contains the names of the libraries in the system part of the library list and the library names QSYS, QSYS2, QHLPSYS, and QUSRSYS. The system value QUSRLIBL contains the names of the libraries to become the user part of the library list.

QSYSLIBL can contain 15 library names, and QUSRLIBL can contain 25 library names. To change the system portion of a job's library list, use the Change System Library List (CHGSYSLIBL) command. To change the value of either QSYSLIBL or QUSRLIBL, use the Change System Value (CHGSYSVAL)

command. A change to these system values takes effect on new jobs that are started after the system values are changed.

Changing the Library List

For a running job, you can add entries to or remove entries from the library list by using the Add Library List Entry (ADDLIBLE) command or the Remove Library List Entry (RMVLIBLE) command, or you can change the libraries in the library list by using the CHGLIBL command or the EDTLIBL command. These commands change the user part of the library list, not the system part.

The current library may be added or changed using the Change Current Library (CHGCURLIB) or CHGLIBL command. The current library can also be changed in the user's user profile, at sign-on, or on the Submit Job (SBMJOB) command. The product libraries cannot be added using a CL command; these libraries are added by the system when a command or menu using them is run.

When you use these commands, the change to the library list affects only the job in which the command is run, and the change is effective only as long as the job is running, or until you change the job's library list again. When the library list is changed through the use of these commands, the libraries must exist when the command is run. A library cannot be deleted if it exists on an active user's library list.

When a job is started, the user portion of the library list is determined by the values contained in the job description or by values specified on the SBMJOB command. A value of *SYSVAL can be specified, which causes the libraries specified by the system value QUSRLIBL to become the user portion of the library list. If you have specified library names in both the job description and the Batch Job (BCHJOB) or SBMJOB command, the library names specified in the BCHJOB or SBMJOB command override both the libraries specified in the job description and the system value QUSRLIBL.

The following shows the order in which the user part of the library list specified in QUSRLIBL is overridden by commands for individual jobs:

- A library list can be specified in the job description that, when the job is run, overrides the library list specified in QUSRLIBL. (See the *Work Management Guide* for information on job descriptions.)
- When a job is submitted either through a BCHJOB command or a SBMJOB command, a library list can be specified on the command. This list overrides the library list specified in the job description or in the system value QUSRLIBL.
- When a job is submitted using the SBMJOB command, *CURRENT (the default) can be specified for the library list. *CURRENT indicates that the library list of the job issuing the SBMJOB command is used.
- Within a job, an ADDLIBLE, RMVLIBLE, or CHGLIBL command can be used. These commands override any previous library list specifications.
- The current library for the job can be changed using the CHGCURLIB or CHGLIBL command.

Instead of entering the CHGLIBL command each time you want to change the library list, you can place the command in a CL program:

```
PGM  /* SETLIBL - Set library list */
CHGLIBL LIBL(APPDEVLIB QGPL QTEMP)
ENDPGM
```

If you normally work with this library list, you could set up an initial program to establish the library list instead of calling the program each time:

```
PGM  /* Initial program for QPGMR */
CHGLIBL LIBL(APPDEVLIB QGPL QTEMP)
TFRCTL PGM(QPGMMENU)
ENDPGM
```

This program must be created and the user profile to which it will apply changed to specify the new initial program. Control then transfers from this program to the QPGMMENU program, which displays the Programmer Menu.

If you occasionally need to add a library to the library list specified in your initial program, you can use the ADDLIBLE command to add that library to the library list. For example, the following command adds the library JONES to the end of the library list:

```
ADDLIBLE LIB(JONES) POSITION(*LAST)
```

If part of your job requires a different library list, you can write a CL program that saves the current library list and later restores it, such as the following program.

```
        PGM
        DCL &LIBL *CHAR 275
        DCL &CMD *CHAR 285
(1)     RTVJOBA USRLIBL(&LIBL)
(2)     CHGLIBL (QGPL QTEMP)
        .
        .
        .
(3)     CHGVAR &CMD ('CHGLIBL (' *CAT &LIBL *TCAT ')')
(4)     CALL QCMDEXC (&CMD 285)
        .
        .
        .
        ENDPGM
```

(1) Command to save the library list. The library list is stored into variable &LIBL. Each library name occupies 10 bytes (padded on the right with blanks if necessary), and one blank is between each library name.

(2) This command changes the library list as required by the following function.

(3) The Change Variable (CHGVAR) command builds a CHGLIBL command in variable &CMD.

(4) QCMDEXC is called to process the command string in variable &CMD. The CHGVAR command is required before the call to QCMDEXC because concatenation cannot be done on the CALL command.

This program is an example of a CL program that saves the library list, changes it temporarily, and then restores the library list.

Considerations for Setting Up a Library List

You should consider the following when setting up a library list and using it:

- The libraries in a library list must exist on the system. The system values QSYSLIBL and QUSRLIBL are accessed when OS/400 is started. If a library in either of these values does not exist on the system, a message is sent to the system operator's message queue (QSYSOPR), the library is ignored, and OS/400 is started without the library. Once OS/400 is started, no libraries can be deleted from the library list of any active job. If any library in the library list specified in the job description or in a Job (JOB) or Submit Job (SBMJOB) command does not exist or is not available, the job is not started.
- The libraries in a library list must be authorized to all users who need to use them. To initialize a library list (for example, in a Submit Job [SBMJOB], Job [JOB], or Create Job Description [CRTJOBD] command), a user must have object operational authority for the libraries or the job is not started. A user must also have *USE authority to libraries added to the library list using the Add Library List Entry (ADDLIBLE) or Change Library List (CHGLIBL) command.
- When a program running under an adopted user profile adds a library to the library list that the current user is not authorized to and does not remove the library from the library list before ending the program, the user keeps (*USE authority) access to the library after the program exits. This only occurs when *LIBL is specified to access the objects.
- System performance is better when the library list is kept as short as possible.

Displaying a Library List

You can use the Display Library List (DSPLIBL) command to display the library list for a job currently running. The display contains a list of all the libraries in the library list in the order that they appear in the library list. If you are using batch processing, the library list is printed. If you are using interactive processing, the library list can be displayed or printed.

For a description of the library list display, see the *CL Reference*.

You can also display the library list for an active job using the Display Job (DSPJOB) command and selecting option 13 from the Display Job menu. On the job library list display, the libraries are listed in the order they are searched, and both the system and user parts of the library list are displayed.

Typical Errors in Using Library Lists

The following are some typical errors that can occur when you use library lists:

- When using a qualified name to call a program: If the program tries to open a file using the library list and the file is not in a library in the library list, the file open fails.
- When submitting a create program command in a batch job: If the program uses an externally described file whose name is not qualified and the file is not in a library in the library list, the create program command fails.
- When creating a CL program: If the program being created uses a CHGLIBL command to access an object not in a library in the library list for the job that is doing the create operation, the program creation fails. The CHGLIBL command is not processed by creating the program, therefore the object referred to will

be unavailable, causing the creation to fail. If a program that is being created is dependent on an object that is not in the libraries in the library list, run the CHGLIBL command before attempting to create the program.

- When looking for the message queue for error messages: The message queue for error messages can be found using the system library list, not the library list for the current job.

Using Generic Object Names

Sometimes you may want to search for more than one object (even though only one might be found) when the object names start with the same characters. This type of search is called a *generic search* and can be used on several commands.

To use a generic search, specify a generic name in place of the object name on the command. A generic name consists of a set of characters common to all the object names that identifies a group of objects and ends with an * (asterisk). All objects whose names begin with the specified characters and to which you are authorized have the requested function performed on them. For example, if you entered the Display Object Description (DSPOBJD) command using the generic name ORD*, object descriptions for the objects beginning with ORD are shown.

A generic search can be limited by the following library qualifiers on the generic name (the library name parameter value is given in parentheses, if applicable):

- A specified library. The operation you requested is performed on the generically named objects in the specified library only.
- The library list for the job (*LIBL). The libraries are searched in the order they are listed in the library list. The operation you requested is performed on the generically named objects in the libraries specified in the library list for the job.
- The current library for the job (*CURLIB). The current library for the job is searched. If no current library exists, QGPL is used.
- All libraries in the user part of the library list for the job (*USRLIBL). The libraries are searched in the order they are listed in the library list, including the current library (*CURLIB). The operation you requested is performed on the generically named objects in the libraries specified in the user portion of the library list for the job.
- All user libraries for which you are authorized (*ALLUSR) and the following libraries that begin with the letter Q are searched: QDSNX, QGPL, QGPL38, QPFRDATA, QRCL, QS36F, QUSER38, and QUSRSYS. The libraries are searched in alphanumeric order. The following S/36 environment libraries that begin with # are not searched when *ALLUSR is specified: #CGULIB, #COBLIB, #DFULIB, #RPGLIB, #SDALIB, #SEULIB, and #DSULIB. The operation you requested is performed on the generically named objects in all the user libraries for which you are authorized.
- All libraries on the system for which you are authorized (*ALL). The libraries are searched in alphanumeric order. The operation you requested is performed on the generically named objects in all the libraries on the system for which you are authorized.

For information on operations using generic functions, see the *CL Reference*.

Searching for Multiple Objects or a Single Object

In all commands for which you can specify a generic name, you can specify an object name (no asterisk is specified) and you can search for multiple objects. If you specify an object name and *ALL or *ALLUSR for the library name, the system searches for multiple objects, and the search returns objects of the indicated name and type for which you are authorized. If you specify a generic name, or if you specify *ALL, *ALLUSR, or a library with an object name, you can specify all supported object types (or *ALL object types).

If you specify an object name with *LIBL or *USRLIBL as the library name, you can specify only one object type.

Security Considerations

When the system accesses an object that you refer to, it checks to determine if you are authorized to use the object and to use it in the way you are requesting. Generally, you must be authorized at two levels:

- You must be authorized to use the object on which you have requested a function to be performed.
- You must be authorized to the library containing the object. If a library list is used, you must be authorized to the libraries in the list.

Object authority is controlled by the system's security functions, which include the following:

- An object owner and users with *ALLOBJ special authority have all authority for an object, and can grant and revoke authority to and from other users.
- Users have public authority when private authority has not been granted for the object.

The *Security Reference* explains in detail the types of authority that can be granted for an object and what authority a user needs to perform a function on that object. Authority that can be granted for libraries is discussed under "Specifying Authority for Libraries" on page 4-15.

Special considerations apply when writing a program that must be secure (for example, a program that adopts the security officer's user profile). See *Security Reference* for information about writing these programs.

Using Libraries

A library is an object used to group related objects and to find objects by name. Thus, a library is a directory to a group of objects.

You can use libraries to:

- Group certain objects for individual users. This helps you manage the objects on your system. For example, you might place all the files that a user JOE can use in a library JOELIB.
- Group all objects used for an individual application. For example, you might place all your order entry files and programs into an order entry library DISTLIB. You need only add one library to the library list to ensure that all your order entry files and programs are in the list. This is advantageous if you

do not want to specify a library name every time you use an order entry file or program.

- Ensure security. For example, you can specify which users have authority to use the library and what they are allowed to do with the library.
- Simplify security by having automatic authorization list and public authority assignment for newly created objects based on the CRTAUT parameter value of the library.
- Simplify save/restore operations by grouping objects that are saved and restored at the same time into the same library. You can use a Save Library (SAVLIB) command instead of saving objects individually using the Save Object (SAVOBJ) command.
- Use multiple libraries for testing. Refer to Chapter 10 for more information.
- Use multiple production libraries. For example, you can use one production library for source files and for the creation of objects, one for the application programs and files, one for objects that are infrequently saved, and one for objects that are frequently saved.

Multiple libraries make it easier to use objects. For example, you can have two files with the same name but in different libraries so that one can be used for testing and the other for normal processing. As long as you do not specify the library name in your program, the file name in the program does not have to be changed for testing or normal processing. You control which library is used by using the library list. (Objects of the same type can have the same names only if they are in different libraries.)

The two types of libraries are production and test. A production library is for normal processing. In debug mode, you can protect database files in production libraries from being updated. While in debug mode, any files in test libraries can be updated without any unique specifications. (See Chapter 10 for more information on using test libraries.)

Creating a Library

To create a library, use the Create Library (CRTLIB) command. For example, the following CRTLIB command creates a library to be used to contain order entry files and programs. The library is named DISTLIB and is a production library. The default authority given to the public prevents a user from accessing the library. Any object created into the library will be given the default public authority of *CHANGE based on the CRTAUT value.

```
CRTLIB   LIB(DISTLIB) TYPE(*PROD) CRTAUT(*CHANGE) +
         AUT(*EXCLUDE) TEXT('Distribution library')
```

You should not create a library with a name that begins with the letter Q. During a generic search, the system assumes that any library whose name begins with the letter Q (such as QRPG or QPDA) is a system library.

Specifying Authority for Libraries

The default public authority for a library is *CHANGE, which allows the user access to the objects in the library.

The following describes each of the authorities that can be given to users for libraries. See *Security Reference* for more information.

Object Authority for Libraries

Object operational authority for a library gives the user authority to display the description of a library.

Object management authority for a library includes authority to:

- Grant and revoke authority. You can only grant and revoke authorities that you have. Only the object owner or a user with *ALLOBJ authority can grant object management authority for a library.
- Rename the library.

Object existence authority for a library includes authority to:

- Delete the library
- Transfer ownership of the library

Data Authority for Libraries

Add authority for a library allows a user to create a new object in the library or to move an object into the library.

Update authority and **read authority** for a library allow a user to change the name of an object in the library, provided the user is also authorized to the object.

Delete authority allows the user to remove entries from an object. Delete authority for a library does not allow a user to delete objects in the library. Authority for the object in the library is used to determine if the object can be deleted.

Combined Authority for Libraries

***USE authority** for a library (consisting of object operational authority and read authority) includes authority to:

- Use a library to find an object
- Display library contents
- Place a library in the library list
- Save a library (if sufficient authority to the object)
- Delete objects from the library (if the user is authorized to the object in the library)

***CHANGE authority** provides operational authority to objects and all data authorities. The user can add, change, and delete entries in an object, or read the contents of an entry in the object.

***ALL authority** provides all object authorities and data authorities. The user can control the object's existence, specify the security for the object, change the object, and perform basic operations on the object, such as run a program or display the object's description and contents.

***EXCLUDE authority** prevents users from accessing an object.

The following display shows an example of authority that is in effect for library DISTLIB. See the description of the Display Object Authority (DSPOBJAUT) command in the *CL Reference* for more information.

```
                          Display Object Authority

Object . . . . . :    DISTLIB          Object type . . . . :    *LIB
  Library  . . . . :      QSYS           Owner . . . . . . . :    SECOFR1

Object secured by authorization list   . . . . . . . . . . . :    *NONE

              Object
User          Authority
SECOFR1       *ALL
*PUBLIC       *EXCLUDE

                                                                      Bottom
Press Enter to continue.
                                                   (C) COPYRIGHT IBM CORP.
F3=Exit   F11=Display detail   F12=Cancel   F17=Top    F18=Bottom
```

The following display is shown if the user presses F11 (Display detail) from the first Display Object Authority display:

```
                          Display Object Authority

Object . . . . . :    DISTLIB          Object type  . . . . :    *LIB
  Library  . . . . :      QSYS           Owner  . . . . . . . :    SECOFR1

Object secured by authorization list  . . . . . . . . . . . :    *NONE

            Object      -----Object------     ------------Data------------
User        Authority   Opr   Mgt   Exist     Read   Add   Update   Delete
SECOFR1     *ALL         X     X      X         X     X      X        X
*PUBLIC     *EXCLUDE

                                                                      Bottom
Press Enter to continue.

F3=Exit   F11=Non-display detail   F12=Cancel   F17=Top    F18=Bottom
```

Default Public Authority for Newly Created Objects

When objects are created in a library, the public authority for the object will, by default, be set by using the CRTAUT value of the library. By specifying:

```
CRTLIB LIB(TESTLIB) CRTAUT(*USE) AUT(*LIBCRTAUT)
```

The library TESTLIB is created. All objects created into library TESTLIB will, by default, have public authority of *USE. The public authority for library TESTLIB is determined by the CRTAUT value of library QSYS.

By specifying:

```
CRTDTAARA DTAARA(TESTLIB/DTA1) TYPE(*CHAR) +
          AUT(*LIBCRTAUT)

CRTDTAARA DTAARA(TESTLIB/DTA2) TYPE(*CHAR) +
          AUT(*EXCLUDE)
```

Data area DTA1 is created into library TESTLIB. The public authority of DTA1 is *USE based on the CRTAUT value of library TESTLIB.

Data area DTA2 is created into library TESTLIB. The public authority of DTA2 is *EXCLUDE. *EXCLUDE was specified on the AUT parameter of the Create Data Area (CRTDTAARA) command.

An authorization list can also be used to secure an object when it is created into a library. By specifying:

```
CRTAUTL AUTL(PAYROLL)
CRTLIB  LIB(PAYLIB) CRTAUT(PAYROLL) +
        AUT(*EXCLUDE)
```

An authorization list called PAYROLL is created. Library PAYLIB is created with the public authority of *EXCLUDE. By default, an object created into library PAYLIB is secured by authorization list PAYROLL.

By specifying:

```
CRTPF FILE(PAYLIB/PAYFILE) +
      AUT(*LIBCRTAUT)

CRTPF FILE(PAYLIB/PAYACC) +
      AUT(*CHANGE)
```

File PAYFILE is created into library PAYLIB. File PAYFILE is secured by authorization list PAYROLL. The public authority of file PAYFILE is set to *AUTL as part of the Create Physical File (CRTPF) command. *AUTL indicates that the public authority for file PAYFILE is taken from the authorization list securing file PAYFILE, which is authorization list PAYROLL.

File PAYACC is created into library PAYLIB. The public authority for file PAYACC is *CHANGE since it was specified on the AUT parameter of the CRTPF command.

Note: The *LIBCRTAUT value of the AUT parameter that exists on most CRT commands indicates that the public authority for the object is set to the CRTAUT value of the library that the object is being created into.

The CRTAUT value on the library specifies the default authority for public use of the objects created into the library. These possible values are:

***SYSVAL** The public authority for the object being created will be the value specified in system value QCRTAUT

***ALL**	All public authorities
***CHANGE**	Change authority
***USE**	Use authority
***EXCLUDE**	Exclude authority
authorization list name	The authorization list secures the object

Placing Objects in Libraries

When you create an object, it is placed in a library. If you do not specify a library, the object is placed in the current library for the job (*CURLIB) or, if there is no current library for the job, in QGPL. When a library is created, you can specify the public authority using the CRTAUT parameter on the Create Library (CRTLIB) command. All objects placed in that library will assume the specified public authority of the CRTAUT value of the library. To specify a library, you specify a qualified name; that is, a library name and an object name. For example, the following Create Physical File (CRTPF) command creates an order entry physical file ORDHDRP to be placed in DISTLIB.

```
CRTPF FILE(DISTLIB/ORDHDRP)
```

To place an object in a library, you must have read and add authorities for the library.

More than one object of the same type cannot have the same name and be in the same library. For example, two files with the name ORDHDRP cannot both be in the library DISTLIB. If you try to place into a library an object of the same name and type as an object already in the library, the system rejects the request and sends you a message indicating the reason.

Notes:

1. All objects except libraries, device descriptions, line descriptions, controller descriptions, mode descriptions, class-of-service descriptions, and user profiles are stored in libraries. These object types that are not stored in libraries are stored internally in the system. It is permissible to refer to these objects as being in QSYS even though they are not actually located in this library. Authorization lists are always in QSYS and are therefore not usually qualified by the library name.
2. Use the QSYS library for system objects only. If a new release of OS/400 is installed, other licensed programs should not be restored to the QSYS library because any changes are lost.

Deleting and Clearing Libraries

When you delete a library with the Delete Library (DLTLIB) command, you delete the objects in the library as well as the library itself. When you clear a library with the Clear Library (CLRLIB) command, you delete objects in the library without deleting the library. To delete or clear a library, all you need to specify is the library name. For example:

```
DLTLIB LIB(DISTLIB)
```

or:

```
CLRLIB LIB(DISTLIB)
```

To delete a library, you must have object existence authority for both the library and the objects within the library, and operational authority for the library. If you try to delete a library but do not have object existence authority for all the objects in the library, the library and all objects for which you do not have authority are not deleted. All objects for which you have authority are deleted. If you try to delete a library but do not have object existence authority for the library, not only is the library not deleted, but none of the objects in the library are deleted. If you want to delete a specific object (for which you have object existence authority), you can use a delete command for that type of object, such as the Delete Program (DLTPGM) command.

You cannot delete a library in an active job's library list. You must wait until the end of the job before the deletion of the library is allowed. Because of this, you must delete the library before the next routing step begins. When you delete a library, you must be sure no one else needs the library or the objects within the library.

If a library is part of the initial library list defined by the system values QSYSLIBL and QUSRLIBL, the following steps should be followed to delete the library:

1. Use the Change System Value (CHGSYSVAL) command to remove the library from the system value it is contained in. (The changed system value does not affect the library list of any jobs running.)
2. Use the Change Library List (CHGLIBL) command to change the job's library list.

   The Change System Library List (CHGSYSLIBL), Add Library List Entry (ADDLIBLE), and Remove Library List Entry (RMVLIBLE) commands can also be used to change the library list.
3. Use the DLTLIB command to delete the library and the objects in the library.

Note: You cannot delete the library QSYS and should not delete any objects in it. You may cause the system to end because the system needs objects that are in QSYS to operate properly. You should not delete the library QGPL because it also contains some objects that are necessary for the system to be able to perform effectively. You should not use the library QRECOVERY because it is intended for system use only. The library QRECOVERY contains objects that the system needs to operate properly.

For concerns about deleting objects other than libraries, see "Deleting Objects" on page 4-39.

To clear a library, you must have object existence authority for the objects within the library and read authority for the library. If you try to clear a library but do not have object existence authority for all the objects in the library, the objects you do not have authority for are not deleted from the library. If an object is allocated to someone else, it is not deleted.

Displaying Library Names and Contents

You can use the Display Library (DSPLIB) or Work with Libraries (WRKLIB) command to display or print all the libraries you have authority to and find basic information on each object within the libraries.

The object information includes:

- The name and type of the object
- The attributes of the object
- The size of the object
- The description entered for the object when it was created

On the DSPLIB command, you can also specify a specific library name or names, in which case you bypass the library selection display. In this list, the objects are grouped by library; within each library, they are grouped by object type; within each type, they are listed in alphanumeric order. The order of the libraries is one of the following:

- If libraries are specified on the DSPLIB command, the libraries are displayed in the order they are specified in the display command.
- If *LIBL or *USRLIBL is specified on the DSPLIB command, the order of the libraries matches the order of the libraries in the library list for the job.
- If *ALL or *ALLUSR is specified on the DSPLIB command, the order of the libraries is in alphanumeric order. Only libraries the user is authorized to are displayed.

For example, the following DSPLIB command displays a list of the objects contained in DISTLIB:

```
DSPLIB  LIB(DISTLIB)  OUTPUT(*)
```

The asterisk (*) for the OUTPUT parameter means that the libraries are to be shown at the display station if in interactive processing and printed if in batch processing. To print a list when in interactive processing, specify *PRINT instead of taking the default *.

See the *CL Reference* for more information and sample displays for the DSPLIB command.

Displaying and Retrieving Library Descriptions

You can use the Display Library Description (DSPLIBD) and Retrieve Library Description (RTVLIBD) commands to display and retrieve the description of libraries.

The library description information includes:

- Type of library (either PROD or TEST)
- Auxiliary storage pool of the library
- Create authority of the library
- Text description of the library
- Create object auditing of the library

OS/400 National Language Support

The OS/400 licensed program supports different national languages on the same system. This allows information in one national language to be presented to one user while information in a different national language is presented to another user.

The language used for user-readable information (displays, messages, printed output, and online help information) is controlled by the library list for the job. By adding a national language library to the system portion of the library list, different national language versions of information can be presented. For the primary lan-

guage, a **national language version** is the running code and textual data for each licensed program entered. For the secondary language, it is the textual data for all licensed programs.

The language information for the primary language of the system is stored in the same libraries as the programs for IBM licensed programs. For example, if the primary national language of the system is English, then libraries such as QSYS, QHLPSYS, and QSSP contain information in English. Libraries QSYS and QHLPSYS are on the system portion of the library list. Libraries for other licensed programs (such as QRPG for RPG/400) are added to the library list by the system when they are needed.

National language versions other than the system primary language are installed in secondary national language libraries. Each secondary language library contains a single national language version of the displays, messages, commands prompts, and help for *all* IBM licensed programs. The name of a secondary language library is in the form `QSYSnnnn`, where `nnnn` is a language feature code. For example, the feature code for French is 2928, so the secondary national language library name for French is QSYS2928.

If a user wants information presented in the primary national language of the system, no special action is required. To present information in a national language different from the primary national language of the system, the user must change the library list so that the desired national language library is positioned before all other libraries in the library list that contains national language information.

For example, to present the French version of displays, messages, and so on, the user could enter the following command to place French information at the top of the library list:

```
CHGSYSLIBL  LIB(QSYS2928)
```

The library list for an interactive job can be set up by an initial program specified in the user profile so the user does not have to run the CHGSYSLIBL command at every sign-on. The initial program uses the Change System Library List (CHGSYSLIBL) command to add the desired national language library to the top of the library list.

Note: The authority shipped with the CHGSYSLIBL command does not allow all users to run the command.

To enable a user to run the CHGSYSLIBL command without granting the user rights to the command, you can write a CL program containing the CHGSYSLIBL command. The program is owned by the security officer, and adopts the security officer's authority when created. Any user with authority to run the program can use it to change the system part of the library list in the user's job. The following is an example of a program to set the library list for a French user.

```
PGM
  CHGSYSLIBL  LIB(QSYS2928)  /* Use French information */
ENDPGM
```

Describing Objects

Whenever you use a create command to create an object, you can describe the object in a 50-character field on the TEXT parameter of the create command. Some commands allow a default of *SRCMBRTXT which indicates the text for the object being created is to be taken from the text of the source member from which the object is being created. This is valid only for objects created from source in database source files.

If the source input for the create command is a device or inline file, or if source is not used, the default value is blank. This text becomes part of the object description and can be displayed using the Display Object Description (DSPOBJD) or Display Library (DSPLIB) command. The text can be changed using the Change Object Description (CHGOBJD) command or many of the Change (CHGxxx) commands that are specific to each object type.

Displaying Object Descriptions

You can use the Display Object Description (DSPOBJD) or Work with Objects (WRKOBJ) command to display descriptions of objects. These descriptions are helpful for determining if objects exist on the system but are not being used. If you are using batch processing, the descriptions can be printed or written to a database file. If you are using interactive processing, the descriptions can be displayed, printed, or written to a database file.

You can display basic, full, or service attributes for object descriptions. These object descriptions are found in the following table:

Table 4-2. Attributes Displayed for Object Descriptions

Basic Attributes	Full Attributes	Service Attributes (see Notes)
• Object name • Library name • Object type • Extended attribute • Object size • Text description (partial)	• Object name • Library name • Object type • Owner • Extended attribute • User-defined attribute • Text description • Creation date and time • User who created object • System object created on • Object domain • Change date and time • Whether or not usage data collected • Date last used • Days used count • Date used count reset • Allow change by program • Object auditing value • Object size • Offline size • Freed status • Compression status • Auxiliary storage pool • Object overflowed • Save operation date and time • Restore operation date and time • Save command • File label ID	• Object name • Library name • Object type • Source file and library • Member name • Extended attribute • User-defined attribute • Freed status • Object size • Creation date and time • Date and time member in source file was last updated • System level • Compiler • Object control level • Changed by program • Whether or not changed by user • Licensed program • PTF number • APAR ID • Text description of object or object status conditions

Notes:

1. The service information is used by programming support personnel to determine the level of the system on which an object was created and whether or not the object has been changed since it was shipped. Some of this information may be helpful to you because it indicates the source member used to create an object and the last date of change to that source from which the object was created.
2. Library objects contain only the *names* of the objects included in the library. If DSPOBJD for object type *LIB is used, the object size information refers to the size of the library object only, not the total size of the objects included in the library.

Using the DSPOBJD or WRKOBJ command, you can list the objects in a library for which you are authorized by:

- Name
- Generic name
- Type

- Name or generic name within object type

The objects are listed by library; within a library, they are listed by type. Within object type, the objects are listed in alphanumeric order.

You may want to use the DSPOBJD command in a batch job if you want to display many objects with the *FULL or *SERVICE option. The output can go to a spooled printer file and be printed instead of being shown at the display station, or the output can go to a database file. If you direct the output to a database file, all the attributes of the object are written to the file. Use the Display File Field Description (DSPFFD) command for file QADSPOBJ, in library QSYS, to view the record format for this file.

The following command displays the descriptions of the order entry files (that is, the files in DISTLIB) whose names begin with ORD. ORD* is the generic name.

```
DSPOBJD   OBJ(DISTLIB/ORD*)  OBJTYPE(*FILE) +
          DETAIL(*BASIC)  OUTPUT(*)
```

The resulting basic display is:

```
                    Display Object Description - Basic
                                                              Library 1 of 1
Library:     DISTLIB

Type options, press Enter.
  5=Display full attributes   8=Display service attributes

Opt  Object      Type      Attribute                Size   Text
 _   ORDDTLP     *FILE       PF                     1024   Order detail
 _   ORDHDRP     *FILE       PF                     1024   Order header
                                                                  Bottom
F3=Exit   F12=Cancel   F17=Top   F18=Bottom
```

If you specify *FULL instead of *BASIC or if you enter a 5 in front of ORDDTLP on the basic display, the resulting full display is:

```
                    Display Object Description - Full
                                                                  Library 1 of 1
Object . . . . . :    ORDDTLP        Attribute . . . . . :    PF
  Library  . . . . :      DISTLIB      Owner . . . . . . . :    QSECOFR
Type . . . . . :      *FILE
User-defined information:
   Attribute . . . . . . . . . . . :
   Text  . . . . . . . . . . . . . :
Creation information:
  Creation date and time . . . . . :   06/08/89  10:17:03
  Created by user  . . . . . . . . :   QSECOFR
  System created on  . . . . . . . :   RCHAS790
  Object domain  . . . . . . . . . :   *SYSTEM
Change/Usage information:
  Change date/time . . . . . . . . :   05/11/90  10:03:02
  Usage data collected . . . . . . :   YES
  Date last used . . . . . . . . . :   05/11/90
  Days used count  . . . . . . . . :   20
  Date use count reset . . . . . . :   03/10/90
  Allow change by program  . . . . :   YES
Auditing information:
  Object auditing value  . . . . . :   *NONE
Press Enter to continue.
F3=Exit   F12=Cancel                    (C) COPYRIGHT IBM CORP. 1980, 1993.
```

```
                    Display Object Description - Full
                                                                  Library 1 of 1
Object . . . . . :    ORDDTLP        Attribute . . . . . :    PF
  Library  . . . . :      DISTLIB      Owner . . . . . . . :    QSECOFR
Type . . . . . :      *FILE

Storage information:
  Size . . . . . . . . . . . . . . :   1024
  Offline size . . . . . . . . . . :   0
  Freed  . . . . . . . . . . . . . :   NO
  Compressed . . . . . . . . . . . :   NO
  Auxiliary storage pool . . . . . :   1
    Object overflowed  . . . . . . :   NO
Save/Restore information:
  Save date/time . . . . . . . . . :
  Restore date/time  . . . . . . . :
  Save command . . . . . . . . . . :
  File label ID  . . . . . . . . . :
                                                                      Bottom
Press Enter to continue.


F3=Exit   F12=Cancel
                                        (C) COPYRIGHT IBM CORP. 1980, 1993.
```

Retrieving Object Descriptions

You can use the Retrieve Object Description (RTVOBJD) command to return the descriptions of a specific object to a CL program. Variables are used to return the descriptions. You can use these descriptions to help you detect unused objects on the system.

The descriptions that can be returned as variables for an object are:

- Name of the library that contains the object
- Any extended attribute of an object (such as program or file type)
- User-defined attribute
- Text description of the object
- Name of the object owner's user profile
- Auxiliary storage pool ID

- Object overflowed auxiliary storage pool
- Date and time the object was created
- Date and time the object was last changed
- Date and time the object was last saved
- Date and time the object was last saved during a SAVACT (*LIB, *SYSDFN, or *YES) save operation
- Date and time the object was last restored
- Name of the object creator's user profile
- System the object was created on
- Object domain
- Whether or not usage data was collected
- Date the object was last used
- Count (number) of days the object was used
- Date the use count was last reset
- Storage status of the object data
- Compression status of the object
- Size of the object in bytes
- Size of the object in bytes of storage at the time of the last save
- Command used to save the object
- Tape sequence number generated when the object was saved on tape
- Tape or diskette volumes used for saving the object
- Type of the device the object was last saved to
- Name of the save file if the object was saved to a save file
- Name of the library that contains the save file if the object was saved to a save file
- File label used when the object was saved
- Name of the source file that was used to create the object
- Name of the library that contains the source file that was used to create the object
- Name of the member in the source file
- Date and time the member in the source file was last updated
- Level of the operating system when the object was created
- Licensed program identifier, release level, and modification level of the compiler
- Object control level for the created object
- Information about whether or not the object can be changed by the Change Object Description (CHGOBJD) command
- Indication of whether or not the object has been modified with the Change Object Description (QLICOBJD) API
- Information about whether or not the program was changed by the user
- Name, release level, and modification level of the licensed program if the retrieved object is part of a licensed program
- Program Temporary Fix (PTF) number that resulted in the creation of the retrieved object
- Authorized Program Analysis Report (APAR) identification
- Type of auditing for the object

RTVOBJD Example

In the following CL program, a RTVOBJD command retrieves the description of a specific object. Assume an object called MOBJ exists in the current library (MYLIB).

```
DCL  &LIB      TYPE(*CHAR) LEN(10)
DCL  &CRTDATE  TYPE(*CHAR) LEN(13)
DCL  &USEDATE  TYPE(*CHAR) LEN(13)
DCL  &USECNT   TYPE(*DEC)  LEN(5 0)
DCL  &RESET    TYPE(*CHAR) LEN(13)
.
.
.
RTVOBJD    OBJ(MYLIB/MOBJ) OBJTYPE(*FILE) RTNLIB(&LIB)
           CRTDATE(&CRTDATE) USEDATE(&USEDATE)
           USECOUNT(&USECNT) RESETDATE(&RESET)
```

The following information is returned to the program:

- The current library name (MYLIB) is placed into the CL variable name &LIB.
- The creation date of MOBJ is placed into the CL variable called &CRTDATE.
- The date that MOBJ was last used is placed into the CL variable called &USEDATE.
- The number of days that MOBJ has been used is placed into the CL variable called &USECNT. The start date of this count is the value placed into the CL variable called &RESET.

Detecting Unused Objects on the System

Information provided in the object description can help you detect and manage unused objects on the system.

To detect an unused object, look at both the last-used date and the last-changed date. Change commands do not update the last-used date unless the commands cause the object to be deleted and created again, or the change operation causes the object to be read as a part of the change. The following list contains information about operations that cause the last-used date to be updated for various object types. Table 4-3 on page 4-29 contains additional information about these operations.

- Creator of the object
  - The creator of the object is the user profile that is doing the create operation, even if the user profile has a group profile and the group profile owns the object.
  - The creator of the object does not change when the ownership is changed.
  - When an object is restored, the creator is the creator of the object on the media.
  - When an object is duplicated using CRTDUPOBJ, the creator of the object is the user running the command.
  - For IBM-supplied objects, the creator is *IBM.
  - For user objects that already exist on the system before Version 1, Release 3.0 is installed, the creator of the object is blank.
- System created on (name of the system on which the object was created)
  - When an object is restored, the system created on is the system the object on the media was created on.
  - For IBM-supplied objects, the system created on is 00000000.

- For objects that already exist on the system before Version 1, Release 3.0 is installed, the system created on is blank.

- Date and time of last change
  - When an object is created or changed, the system time stamps the object, indicating the date and time the change occurred.
- Date of last use
  - The date of last use is only updated once per day (the first time an object is used in a day). The system date is used.
  - An unsuccessful attempt to use an object does not update the date last used. For example, if a user tries to use an object for which the user is not authorized, the date of last use does not change.
  - The date of last use is blanks for new objects.
  - When an object that already exists on the system is restored, the date of last use comes from the object on the system. If it does not already exist when restored, the date is blank.
  - Objects that are deleted and re-created during the restore operation lose the date of last use.
  - The last used date for a database file is the last used date of the file member with the most current last used date.
  - For logical files, the last used date is the last time a logical member (or cursor) was used.
  - For physical files, the last used date is the last time the data in the data space was used through a physical or logical access.
- Counter of number of days used
  - The count is increased when the date of last use is updated.
  - When an object that already exists on the system is restored, the number of days used comes from the object on the system. If it does not already exist when restored, the count is zero.
  - Objects that are deleted and re-created during the restore operation lose the days used count.
  - The days used count is zero for new objects.

    Note: The AS/400 system *cannot* determine the difference between old and new device files. If you restore a device file on to the system and a device file of that same name already exists, delete the existing file if you want the days used count to be reset to zero. If the file is not deleted, the system will interpret this as a restore operation of an old object and retain the days used count.
  - The days used count for a database file is the sum of the days used counts for all file members. If there is an overflow on the sum, the maximum size is shown.
- Date days used count was reset
  - When the days used count is reset using the Change Object Description (CHGOBJD) command or the Change Object Description (QLICOBJD) API, the date is recorded. The user then knows how long the days used count has been active.

– If the days used count is reset for a file, all of the members have their days used count reset.

Common situations that can delete the days used count and the date last used are as follows:

- Objects on the system are damaged and are being restored.
- Programs being restored when the system is not in a restricted state.

The Display Object Description (DSPOBJD) command can be used to display a full description of an object. You can use the same command to write the description to an output file. To retrieve the descriptions, use the Retrieve Object Description (RTVOBJD) command.

Note: An application programming interface (API) exists that provides the same information as the Retrieve Object Description command. For more information, see the *System Programmer's Interface Reference*.

The Retrieve Member Description (RTVMBRD) command and Display File Description (DSPFD) command provide similar information for members in a file.

The following table gives information about object types and the commands and operations that update their usage information.

Table 4-3 (Page 1 of 4). Updating Usage Information

Type of Object	Commands and Operations
All object types	Create Duplicate Object (CRTDUPOBJ) command and other commands, such as the Copy Library (CPYLIB) command, that use CRTDUPOBJ to copy objects Grant Object Authority (GRTOBJAUT) command (for referenced objects)
Chart format	Display Chart (DSPCHT) command
C local description	Retrieve C Local Description Source (RTVCLDSRC) command or when referred to in a C program
Class	When used to start a job
System-defined command	When run When compiled in a CL program When prompted during entry of SEU source When calling the system in check mode **Note:** Prompting from the command line and then pressing F3 is not counted as a use of a system-defined command.
Communications side information (CSI)	When the CPI-Communications Initialize Conversation (CMINIT) call is used to initialize values for various conversation characteristics from the side information object.
Connection list	When the connection list goes beyond status of vary on pending
Cross system product map	When referred to in a CSP application
Cross system product table	When referred to in a CSP application

Table 4-3 (Page 2 of 4). Updating Usage Information

Type of Object	Commands and Operations
Controller description	When the controller goes beyond status of vary on pending
Device description	When the device goes beyond status of vary on pending
Data area	Retrieve Data Area (RTVDTAARA) command Display Data Area (DSPDTAARA) command Change Data Area (CHGDTAARA) command
Data queue	Usage information for the following APIs is updated only once per job (the first time one of the APIs is initiated). Send Data Queue (QSNDDTAQ) API Receive Data Queue (QRCVDTAQ) API Retrieve Data Queue (QMHQRDQD) API Read Data Queue (QMHRDQM) API
File (database file only unless specified otherwise)	When closed (other files, such as device and save files, also updated when closed) When cleared When initialized When reorganized Commands: • Apply Journaled Changes (APYJRNCHG) command • Remove Journaled Changes (RMVJRNCHG) command
Font resource	When referred to during a print operation
Form definition	When referred to during a print operation
Graphics symbol set	When referred to by a GDDM or PGR graphics application program When loaded internally or using GSLSS
Job description	When used to establish a job
Job queue	When an entry is placed on or removed from the queue
Line description	When the line goes beyond status of vary on pending
Menu	When a menu is displayed using the GO command
Message files	When a message is retrieved from a message file other than QCPFMSG, ##MSG1, ##MSG2, or QSSPMSG (such as when a job log is built, a message queue is displayed, help is requested on a message in the QHST log, or a program receives a message other than a mark message) Merge Message File (MRGMSGF) command except when the message file is QCPFMSG, ##MSG1, ##MSG2, or QSSPMSG
Message queue	When a message is sent to, received from, or listed message queue other than QSYSOPR and QHST
Network interface description	When the network interface description goes beyond status of vary on pending

Table 4-3 (Page 3 of 4). Updating Usage Information

Type of Object	Commands and Operations
Output queue	When an entry is placed on or removed from the queue
Overlay	When referred to during a print operation
Page definition	When referred to during a print operation
Page segment	When referred to during a print operation
Panel group	When the Help key is used to request help information for a specific prompt or panel, the date of usage is updated When a panel is displayed or printed from a panel group
Print descriptor group	When referred to during a print operation
Program	Retrieve CL Source (RTVCLSRC) command When run and not a system program When bound with another program to create a program object
Query definition	When used to generate a report When extracted or exported
Query manager form	When used to generate a report When extracted or exported
Query manager query	When used to generate a report . When extracted or exported
Search index	When the F11 key is used through the online help information When the Start Search Index (STRSCHIDX) command is used
Subsystem description	When subsystem is started
Spelling aid dictionary	When used to create another dictionary When retrieved When a word is found in the dictionary during a spell check and the dictionary is not an IBM-supplied spelling aid dictionary
Table	When used by a program for translation
User profile	When a job is initiated for the profile When the profile is a group profile and a job is started using a member of the group Grant User Authority (GRTUSRAUT) command (for referenced profile)
Workstation User Customization	Only updated by commands and operations that affect all object types
SQL Package	Only updated by commands and operations that affect all object types
Node List	Only updated by commands and operations that affect all object types
Job schedule	When the system submits a job for a job schedule entry

Table 4-3 (Page 4 of 4). Updating Usage Information

Type of Object	Commands and Operations
When the user takes 'Option 10 = submit immediately' from the WRKJOBSCDE panel	

Object usage information is not updated for the following object types:

- Alert table
- Authorization list
- Configuration list
- Class-of-service description
- Document
- Interactive data definition
- Edit description
- Filter
- Forms control table
- Folder
- Double-byte character set dictionary
- Double-byte character set sort
- Double-byte character set table
- Journal
- Journal receiver
- Library
- Mode description
- Product definition
- Reference code translation table
- Session description
- S/36 machine description
- User index
- User queue

Moving Objects from One Library to Another

You can use the Move Object (MOVOBJ) command to move objects between libraries. Moving objects from one library to another is useful in that you make an object temporarily unavailable and it lets you replace an out-of-date version of an object with a new version. For example, a new primary file can be created to be temporarily placed in a library other than the one containing the old primary file. Because the data in the old primary file is normally copied to the new primary file, the old primary file cannot be deleted until the new primary file has been created. Then, the old primary file can be deleted and the new primary file can be moved to the library that contained the old primary file.

You can only move an object if you have object management authority for the object, delete and read authority for the library the object is being moved from, or add authority to the library the object is being moved to.

You can move an object out of the temporary library, QTEMP, but you cannot move an object into QTEMP. Also, you cannot move an output queue unless it is empty.

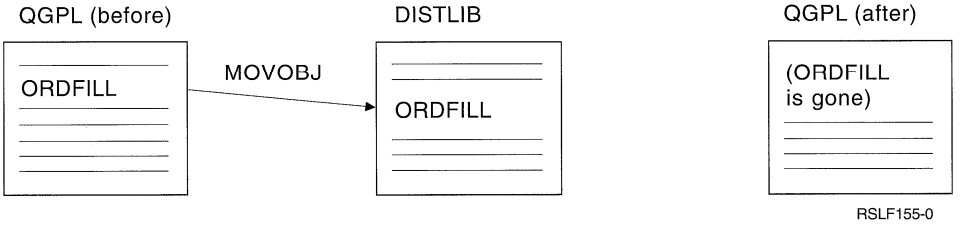
Moving journals and journal receivers is limited to moving these object types back into the library in which they were originally created. If the journal objects have

been placed into QRCL by a Reclaim Storage (RCLSTG) command, they must be moved back into their original library to be made operational.

The following is a list of objects that *cannot* be moved:

- Authorization lists
- Class-of-service descriptions
- Configuration lists
- Connection lists
- Controller descriptions
- Data dictionaries
- Device descriptions
- Display station message queues
- Edit descriptions
- DBCS font tables
- Job schedulers
- Libraries
- Line descriptions
- Mode descriptions
- Network interface descriptions
- SQL packages
- System/36 machine descriptions
- The system history log (QHST)
- The system operator message queue (QSYSOPR)
- User profiles
- Documents
- Document lists
- Folders.

In the following example, a file from QGPL (where it was placed when it was created) is moved to the order entry library DISTLIB so that it is grouped with other order entry files.



To move the object, you must specify the to-library (TOLIB) as well as the object type (OBJTYPE):

```
MOVOBJ  OBJ(QGPL/ORDFILL)  OBJTYPE(*FILE)  TOLIB(DISTLIB)
```

When you move objects, you should be careful not to move objects that other objects depend on. For example, CL programs may depend on the command definitions of the commands used in the program to be in the same library at program run time as they were at program creation time. At program creation time and at program run time, the command definitions are found either in the specified library or in a library in the library list if *LIBL is specified. If a library name is specified, the command definitions must be in the same library at program run time as they were at program creation time. If *LIBL is specified, the command definitions can be moved between program creation time and program run time as long as they

are moved to a library in the library list. Similarly, any application program you write can depend on certain objects being in specific libraries.

An object referring to another object may be dependent on the location of that object (even though *LIBL can be specified for the location of the object). Therefore, if you move an object, you should change any references to it in other objects. The following lists examples of objects that refer to other objects:

- Subsystem descriptions refer to job queues, classes, message queues, and programs.
- Command definitions refer to programs and message files.
- Device files refer to output queues.
- Device descriptions refer to translation tables.
- Job descriptions refer to job queues and output queues.
- Database files refer to other database files.
- Logical files refer to physical files or format selections.
- User profiles refer to programs, menus, job descriptions, message queues, and output queues.
- CL programs refer to display files, data areas, and other programs.
- Display files refer to database files.
- Printer files refer to output queues.

Note: You should be careful when moving objects from the system library QSYS. These objects are necessary for the system to perform effectively and the system must be able to find the objects. This is also true for some of the objects in the general-purpose library QGPL, particularly for job and output queues.

The MOVOBJ command moves only one object at a time. For an example of moving multiple objects in a single command, see the MOVLIBOBJ command in QUSRTOOL.

Creating Duplicate Objects

You can use the Create Duplicate Object (CRTDUPOBJ) command to create a copy of an existing object. The duplicate object has the same object type and authorization as the original object and is created into the same auxiliary storage pool (ASP) as the original object. The user who issues the command owns the duplicate object.

Note: If you create a duplicate object of a journaled file, the duplicate object (file) will not have journaling active. However, you can select this object for journaling later.

You can duplicate an object if you have read, object operational, and object management authority for the object, operational and add authority for the library in which the duplicate object is to be placed, object operational authority for the library in which the original object exists, and add authority for the process user profile.

To duplicate an authorization list, you must have authorization list management authority for the object and both add and object operational authority for library QSYS.

Only the definitions of job queues, message queues, output queues, data queues, and save files are duplicated. Job queues and output queues cannot be duplicated

into the temporary library (QTEMP). For a physical file, you can specify whether the data in the file is also to be duplicated.

The following objects *cannot* be duplicated:

- Class-of-service descriptions
- Configuration lists
- Connection lists
- Controller descriptions
- Data dictionaries
- Device descriptions
- Data queues
- Documents
- Document lists
- Edit descriptions
- Folders
- DBCS font tables
- Job schedulers
- Journals
- Journal receivers
- Libraries
- Line descriptions
- Mode descriptions
- Network interface descriptions
- Reference code translation tables
- Spelling aid dictionaries
- SQL packages
- System/36 machine descriptions
- System operator message queue (QSYSOPR)
- System history log (QHST)
- User profiles
- User queues.

In some cases, you may want to duplicate only some of the data in a file by following the CRTDUPOBJ command with a CPYF command that specifies the selection values.

The following command creates a duplicate copy of the order header physical file, and duplicates the data in the file:

```
CRTDUPOBJ OBJ(ORDHDRP) FROMLIB(DSTPRODLIB) OBJTYPE(*FILE) +
          TOLIB(DISTLIB2) NEWOBJ(*SAME) DATA(*YES)
```

When you create a duplicate object, you should consider the consequences of creating a duplicate of an object that refers to another object. Many objects refer to other objects by name, and many of these references are qualified by a specific library name. Therefore, the duplicate object could contain a reference to an object that exists in a library different from the one in which the duplicate object resides. For all object types other than files, references to other objects are duplicated in the duplicate object. For files, the duplicate objects share the formats of the original file.

Any physical files which exist in the from-library, and on which a logical file is based, must also exist in the to-library. The record format name and record level

ID of the physical files in the to- and from-libraries are compared; if the physical files do not match, the logical file is not duplicated.

If a logical file uses a format selection that exists in the from-library, it is assumed that the format selection also exists in the to-library.

Renaming Objects

You can use the Rename Object (RNMOBJ) command to rename objects. However, you can rename an object only if you have object management authority for the object and update and read authority for the library containing the object.

To rename an authorization list, you must have authorization list management authority, and both update and read authority for library QSYS.

The following objects *cannot* be renamed:

- Class-of-service descriptions
- Data dictionaries
- Display station message queues
- Job schedulers
- Journals
- Journal receivers
- The system library, QSYS, and the temporary library, QTEMP
- Mode descriptions
- SQL packages
- System/36 machine descriptions
- The system history log (QHST)
- The system operator message queue (QSYSOPR)
- User profiles
- Documents
- Document lists
- Folders
- DBCS font tables.

Also, you cannot rename an output queue unless it is empty. You should not rename IBM-supplied commands because the licensed programs also use IBM-supplied commands.

To rename an object, you must specify the current name of the object, the name to which the object is to be renamed, and the object type.

The following RNMOBJ command renames the object ORDERL to ORDFILL:

```
RNMOBJ   OBJ(QGPL/ORDERL)  OBJTYPE(*FILE)   NEWOBJ(ORDFILL)
```

You cannot specify a qualified name for the new object name because the object remains in the same library. If the object being renamed is in use when you issue the RNMOBJ command, the command is not run and the system sends you a message.

When you rename objects, you should be careful not to rename objects that other objects depend on. For example, CL programs depend on the command definitions of the commands used in the program to be named the same at program run time as they were at program creation time. Therefore, if the command definition is

renamed in between these two times, the program cannot be run because the commands will not be found. Similarly, any application program you write depends on certain objects being named the same at both times.

You cannot rename a library that contains a journal, journal receiver, or data dictionary.

An object referring to another object may be dependent on the object and library names (even though *LIBL can be specified for the library name). Therefore, if you rename an object, you should change any references to it in other objects. See "Moving Objects from One Library to Another" on page 4-32 for a list of objects that refer to other objects.

If you rename a physical or logical file, the members in the file are not renamed. However, you can use the Rename Member (RNMM) command to rename a physical or logical file member.

Note: You should be careful when renaming objects in the system library QSYS. These objects are necessary for the system to perform effectively and the system must be able to find the objects. This is also true for some of the objects in the general-purpose library QGPL.

Compressing or Decompressing Objects

You can use the Compress Object (CPROBJ) command to compress selected objects in order to save disk space on the system or you can use the Decompress Object (DCPOBJ) command to decompress objects that have been compressed. The object types that are supported for compression and decompression are *PGM, *SRVPGM, *MODULE, *PNLGRP, *MENU (only UIM menus), and *FILE (only display files or print files). Database files are not allowed to be compressed. Customer objects, as well as AS/400 system-supplied objects, may be compressed or decompressed. To see or retrieve the compression status of an object, use the Display Object Description (DSPOBJD) command (*FULL display), or the Retrieve Object Description (RTVOBJD) command.

Compression of Objects

Object types, *PGM, *SRVPGM, *MODULE, *PNLGRP, *MENU, and *FILE (display and print files only) can be compressed or decompressed using the CPROBJ or DCPOBJ commands. Objects can be compressed only when both of the following are true:

- If the system can obtain an exclusive lock on the object.
- When the compressed size saves disk space.

The following restrictions apply to the compression of objects:

- Programs created before Version 1 Release 3 of the operating system cannot be compressed.
- Programs in IBM-supplied libraries QSYS and QSSP cannot be compressed unless the paging pool value of the program is *BASE. Use the Display Program (DSPPGM) command to see the paging pool value of a program. Programs in libraries other than QSYS and QSSP can be compressed regardless of their paging pool value.
- Only menus with the attribute UIM can be compressed.

- Only files with attributes DSPF and PRTF can be compressed.
- The system must be in restricted state (all subsystems ended) in order to compress program objects in system libraries.
- The program must not be running in the system when it is compressed, or the program will end abnormally.

Compression runs much faster if you use multiple jobs in nonrestricted state as shown in the following table:

Table 4-4. Compressing Objects using Multiple Jobs

Object Type	IBM-supplied	User-supplied
*PGM	Restricted State Only	Job 5: USRLIB1
*PNLGRP	Job 1: QSYS Job 4: QHLPSYS	Job 6: USRLIB1
*MENU	Job 2: QSYS	Job 8: USRLIB1
*FILE	Job 3: QSYS	Job 7: USRLIB1
*SRVPGM	Not applicable	Job 9: USRLIB1
*MODULE	Not applicable	Job 10: USRLIB1

Temporarily Decompressed Objects

Compressed objects are temporarily decompressed automatically by the system when used. A temporarily decompressed object will remain temporarily decompressed until:

- An IPL of the system. This causes the temporarily decompressed object to be deleted (the compressed object remains).
- A Reclaim Temporary Storage (RCLTMPSTG) command is used to reclaim temporarily decompressed objects. This causes temporarily decompressed objects to be deleted (the compressed objects remain) if the objects have not been used for a specified number of days.
- The temporarily decompressed object is used more than 2 days or more than 5 times on the same IPL, in which case it is permanently decompressed.
- A DCPOBJ command is used to decompress the object, in which case it is permanently decompressed.
- The system has an exclusive lock on the object.

Notes:

1. Objects of the type *PGM, *SRVPGM, or *MODULE cannot be temporarily decompressed. If you call a compressed program or debug the program, it is automatically permanently decompressed.
2. Compressed file objects, when opened, are automatically decompressed.
3. If the description of a compressed file is retrieved, the file is temporarily decompressed. Two examples of retrieving a file are:
   - Using the Display File Field Description (DSPFFD) command to display field level information of a file.
   - Using the Declare File (DCLF) command to declare a file to a CL program.

Automatic Decompression of Objects

Compressed objects shipped in the OS/400 or other IBM licensed programs are decompressed by the system *after the licensed programs are installed*. The decompression occurs only when sufficient storage is available on the system.

System jobs called QDCPOBJx are automatically started by the system to decompress objects.

If the operating system was installed over an existing operating system, the following storage requirements apply:

- The system must have greater than 100 megabytes of unused storage for the QDCPOBJx jobs to start.
- On a system with available storage of greater than 500MB, the jobs are submitted to decompress all system objects just installed.
- On a system with available storage of less than 100MB, jobs are not submitted, and the objects are decompressed as they are used.
- On a system with available storage between 100MB and 500MB, only frequently-used objects are automatically decompressed.

Frequently-used objects are objects that have been used at least five times and the last use was within the last 14 days. The remaining low-use objects remain compressed.

The system must have greater than 750MB of unused storage if the operating system is installed on a system that has been initialized using install option 24.

Deleting Objects

To delete an object, you can use a delete (DLTxxx) command for that type of object or you can use the delete option on the Work with Objects display (shown from the Work with Libraries (WRKLIB) display). To delete an object, you must have object existence authority to the object and read authority to the library. Only the owner of an authorization list, or a user with *ALLOBJ special authority, can delete the authorization list.

When you delete an object, you must be sure no one else needs the object or is using the object. Generally, if someone is using an object, it cannot be deleted. However, programs can be deleted unless you use the Allocate Object (ALCOBJ) command to allocate the program before it is called.

The create program commands and create device file commands have a REPLACE parameter to allow users to continue using the old version of a program that has been replaced. The old versions of these re-created programs are stored in library QRPLOBJ.

You should be careful of deleting objects that exist in the system libraries. These objects are necessary for the system to perform properly.

On most delete commands, you can specify a generic name in place of an object name. Before using a generic delete, you may want to use a generic DSPOBJD command to verify that the generic delete will only delete the objects you want to delete. See "Using Generic Object Names" on page 4-12 for more information on specifying objects generically.

For information about deleting libraries, see "Deleting and Clearing Libraries" on page 4-18.

Allocating Resources

Objects are allocated on the system to guarantee integrity and to promote the highest possible degree of concurrency. An object is protected even though several operations may be performed on it at the same time. For example, an object is allocated so that two users can read the object at the same time or one user can only read the object while another can read and update the same object.

OS/400 allocates objects by the function being performed on the object. For example:

- If a user is displaying or dumping an object, another user can read the object.
- If a user is changing, deleting, renaming, or moving an object, no one else can use the object.
- If a user is saving an object, someone else can read the object, but not update or delete it; if a user is restoring the object, no one else can read or update the object.
- If a user is opening a database file for input, another user can read the file. If a user is opening a database file for output, another user can update the file.
- If a user is opening a device file, another user can only read the file.

Generally, objects are allocated on demand; that is, when a job step needs an object, it allocates the object, uses the object, and deallocates the object so another job can use it. The first job that requests the object is allocated the object. In your program, you can handle the exceptions that occur if an object cannot be allocated by your request. (See Chapter 7 and Chapter 8 for more information on monitoring for messages or your high-level language reference manual for information on handling exceptions.)

Sometimes you want to allocate an object for a job before the job needs the object, to ensure its availability so a function that has only partially completed would not have to wait for an object. This is called preallocating an object. You can preallocate objects using the Allocate Object (ALCOBJ) command.

Objects are allocated on the basis of their intended use (read or update) and whether they can be shared (used by more than one job). The file and member are always allocated *SHRRD and the file data is allocated with the level of lock specified with the lock state. A lock state identifies the use of the object and whether it is shared. The five lock states are (parameter values given in parentheses):

- Exclusive (*EXCL). The object is reserved for the exclusive use of the requesting job; no other jobs can use the object. However, if the object is already allocated to another job, your job cannot get exclusive use of the object. This lock state is appropriate when a user does not want any other user to have access to the object until the function being performed is complete.
- Exclusive allow read (*EXCLRD). The object is allocated to the job that requested it, but other jobs can read the object. This lock is appropriate when a user wants to prevent other users from performing any operation other than a read.

- Shared for update (*SHRUPD). The object can be shared either for update or read with another job. That is, another user can request either a shared-for-read lock state or a shared-for-update lock state for the same object. This lock state is appropriate when a user intends to change an object but wants to allow other users to read or change the same object.
- Shared no update (*SHRNUP). The object can be shared with another job if the job requests either a shared-no-update lock state, or a shared-for-read lock state. This lock state is appropriate when a user does not intend to change an object but wants to ensure that no other user changes the object.
- Shared for read (*SHRRD). The object can be shared with another job if the user does not request exclusive use of the object. That is, another user can request an exclusive-allow-read, shared-for-update, shared-for-read, or shared-no-update lock state.

Note: The allocation of a library does not restrict the operations that can be performed on the objects within the library. That is, if one job places an exclusive-allow-read or shared-for-update lock state on a library, other jobs can no longer place objects in or remove objects from the library; however, the other jobs can still update objects within the library.

The following table shows the valid lock state combinations for an object:

If One Job Obtains This Lock State:	Another Job Can Obtain This Lock State:
*EXCL	None
*EXCLRD	*SHRRD
*SHRUPD	*SHRUPD or *SHRRD
*SHRNUP	*SHRNUP or *SHRRD
*SHRRD	*EXCLRD, *SHRUPD, *SHRNUP, or *SHRRD

The following table shows the lock states you can specify by object type:

Object Type	*EXCL	*EXCLRD	*SHRUPD	*SHRNUP	*SHRRD
Authorization list	x	x	x	x	x
Binding directory	x	x	x	x	x
C locale description	x	x	x	x	x
Communications side information	x	x	x	x	x
Cross-system product map	x	x	x	x	x
Cross-system product table	x	x	x	x	x
Data area	x	x	x	x	x
Data dictionary	x	x	x	x	x
Data queue	x	x	x	x	x
Device description		x			
File	x	x	x	x	x
Font resource	x	x	x	x	x

Object Type	*EXCL	*EXCLRD	*SHRUPD	*SHRNUP	*SHRRD
Form definition	x	x	x	x	x
Forms control table	x	x	x	x	x
Library		x	x	x	x
List of SNA noted	x	x	x	x	x
Menu	x	x	x	x	x
Message queue	x				x
Module	x	x	x	x	x
Overlay	x	x	x	x	x
Page definition	x	x	x	x	x
Page segments	x	x	x	x	x
Panel group	x	x			
Print descriptor groups	x	x	x	x	x
Program	x	x			x
Query management form	x	x	x	x	x
Query management query	x	x	x	x	x
Search index	x	x	x	x	x
Session description	x	x	x	x	x
SQL package	x	x	x	x	x
Subsystem description	x				
System/36 machine description	x	x	x	x	x
User index	x	x	x	x	x
User queue	x	x	x	x	x
User space	x	x	x	x	x
Workstation customization	x	x	x	x	x

To allocate an object, you must have object existence authority, object management authority, or operational authority for the object. Allocated objects are automatically deallocated at the end of a routing step. To deallocate an object at any other time, use the Deallocate Object (DLCOBJ) command.

You can allocate a program before it is called to protect it from being deleted. To prevent a program from running in different jobs at the same time, an exclusive lock must be placed on the program in each job before the program is called in any job.

You cannot use the ALCOBJ or DLCOBJ commands to allocate an APPC device description.

The following example is a batch job that needs two files members for updating. Members from either file can be read by another program while being updated, but no other programs can update these members while this job is running. The first member of each file is preallocated with an exclusive-allow-read lock state.

```
//JOB  JOBD(ORDER)
  ALCOBJ  OBJ((FILEA *FILE *EXCLRD) (FILEB *FILE *EXCLRD))
  CALL  PROGX
//ENDJOB
```

Objects that are allocated to you should be deallocated as soon as you are finished using them because other users may need those objects. However, allocated objects are automatically deallocated at the end of the routing step.

If the first members of FILEA and FILEB had not been preallocated, the exclusive-allow-read restriction would not have been in effect. When you are using files, you may want to preallocate them so that you are assured they are not changing while you are using them.

Note: If a single object has been allocated more than once (by more than one allocate command), a single DLCOBJ command will not completely deallocate that object. One deallocate command is required for each allocate command.

It is not an error if the DLCOBJ command is issued against an object where you do not have a lock or do not have the specific lock state requested to be allocated.

You can change the lock state of an object, as the following example shows:

```
PGM
ALCOBJ  OBJ((FILEX *FILE *EXCL)) WAIT(0)
CALL PGMA
ALCOBJ  OBJ((FILEX *FILE *EXCLRD))
DLCOBJ  OBJ((FILEX *FILE *EXCL))
CALL PGMB
DLCOBJ  OBJ((FILEX *FILE *EXCLRD))
ENDPGM
```

File FILEX is allocated exclusively for PGMA, but FILEX is allocated as exclusive-allow-read for PGMB.

You can use record locks to allocate data records within a file. See the *Database Guide* for more information on record locks. You can also use the WAITFILE parameter on a Create File command to specify how long your program is to wait for that file before a time-out occurs.

The WAITRCD parameter on a Create File command specifies how long to wait for a record lock. The DFTWAIT parameter on the Create Class (CRTCLS) command specifies how long to wait for other objects. For a discussion of the WAITRCD parameter, see the *Advanced Backup and Recovery Guide*.

For a description of the record locking functions provided by commitment control, see the *Database Guide*.

Displaying the Lock States for Objects

You can use the Work with Object Locks (WRKOBJLCK) command or the Work with Job (WRKJOB) command to display the lock states for objects.

The WRKOBJLCK command displays all the lock state requests in the system for a specified object. It displays both the held locks and the locks being waited for. For a database file, the WRKOBJLCK command displays the locks at the file level (the

object level) but not at the record level. For example, if a database file is open for update, the lock on the file is displayed, but the lock on any records within the file is not. Locks on database file members can also be displayed using the WRKOBJLCK command.

If you use the WRKJOB command, you can select the locks option on the Display Job menu. This option displays all the lock state requests outstanding for the specified active job, the locks being held by the job, and the locks for which the job is waiting. However, if a job is waiting for a database record lock, this does not appear on the object locks display.

The following command displays all the lock state requests in the system for the logical file ORDFILL:

```
WRKOBJLCK  OBJ(QGPL/ORDFILL)  OBJTYPE(*FILE)
```

The resulting display is:

```
                          Work with Object Locks
                                                              System:   SN020024
Object:   ORDFILL        Library:   QGPL           Type:   *FILE-LGL

Type options, press Enter.
  1=Work with job   2=Work with job locks   4=End job

Opt     Job            User           Lock        Status
 _      WORKST04       QSECOFR        *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                      *SHRRD       HELD
                                                                        More...
F3=Exit   F5=Refresh   F9=Work with member locks   F12=Cancel
```

Chapter 5. Working with Objects in CL Programs

The rules for referring to objects in commands in CL programs are the same as for referring to objects in commands that are processed individually (not within a program). Object names can be either qualified or unqualified. Whenever an object is unqualified, it is found through a search of the library list.

Most objects referred to in CL programs are only accessed at command run time. If you qualify the name (*library/name*) of an object to a specific library in your CL source statement, that object must be in the specified library when the command referring to it is run, but the object does not have to be in that library when the program is created. This means that most objects can be qualified in CL source statements based only on their run-time location. Files declared on a Declare File (DCLF) command and command definitions are exceptions to this, because they are accessed at creation time too. Therefore, when either of these objects are qualified at creation time, they must be in the specified library at creation time and they are bound to that library at run time. These exceptions are discussed under "Accessing Objects in CL Programs."

You can avoid this run time consideration for all objects if you do not qualify object names on CL source statements, but refer to the library list (*LIBL/name) instead. If you refer to the library list at creation time, the object can be in any library on the library list at command run time. This is possible providing you do not have duplicate-name objects in different libraries. If you use the library list, you can move the object to a different library between program creation and command processing.

Accessing Objects in CL Programs

Most objects referred to in CL programs are not accessed until the command referring to them is run. This means that for most objects referred to in a program, the object does not have to exist when the program is compiled, but only when the individual command within the CL program (which refers to the object) is processed. Files and command definitions are exceptions to this rule, because they are also accessed at compile time; they must exist before a program referring to them is compiled. This is why their qualified names, if specified at compile time, must refer to their actual library location. This is not true for all objects, and it is not true for any objects if *LIBL is used.

Because most objects do not have to exist until the command referring to them is run, the following CL program successfully compiles even though program PAYROLL does not exist at compile time:

```
PGM   /* TEST */
DCL ...
MONMSG ...
.
.
.
CALL  PGM(QGPL/PAYROLL)
.
.
.
ENDPGM
```

In fact, PAYROLL does not have to exist when the program TEST is called, but only when the CALL command is processed. Thus the called program can be created within the calling program immediately prior to the CALL command:

```
PGM   /* TEST */
DCL ...
.
.
.
MONMSG
.
.
.
CRTCLPGM  PGM(QGPL/PAYROLL)
CALL  PGM(QGPL/PAYROLL)
.
.
.
ENDPGM
```

Note that for create commands, such as CRTCLPGM or CRTDTAARA, the object accessed at creation time or run time is the create command definition, not the object being created. That is, if you are using a create command, the create command definition must be in the library where it was created if it was qualified at creation time, or it must be in a library on the library list if you used *LIBL. To avoid this type of complication, do not qualify IBM-supplied commands; use the library list instead.

Exceptions: Accessing Command Definitions and Files

When creating a CL program from source statements that refer to command definitions or files, the objects must exist at creation time, and when the command referring to them is processed. This means that when you use the Receive File (RCVF) command, you must create the file before creating a program referring to that file. After the program is created, you can delete the file, as long as it exists when the command referring to it is processed.

Accessing Command Definitions

Command definitions are accessed at creation time and at command run time. The command must exist when a program using it is created (to allow for statement syntax checking). If it is qualified at creation time, it must be in the library referred to during creation, and in the same library when it is processed. If it is not qualified, it must be in some library on the library list during creation and at run time.

If the command's definition might not be accessible through the library list when the program is running, or if there are multiple command definitions with the same name, the command name should be qualified in the program.

The name of the command must be the same when the program is processed as it was when the program was created. If the name of a command is changed after a program referring to that command is created, the program cannot find the command when it runs, and an error occurs. However, if a default is changed for a parameter on a command, the new default will be used when that command is processed. For more detail on attributes that can be changed on a command without re-creating the command, see "Effect of Changing the Command Definition of a Command in a Program" on page 9-46 and the Change Command (CHGCMD) command description in the *CL Reference*.

Accessing Files

Files are also accessed when the command referring to them is compiled. A file must exist before a CL program using it is created.

To create the file, DDS must be entered into a source file first. (DDS is not required, but may be used for a physical file referred to by a CL program.) The DDS describes the record formats and the fields within the records, and this information is compiled to create the file object using the Create Display File (CRTDSPF) command. The fields described in the DDS can be input or output fields (or both), and they are declared to the CL program as variables when the program (specifically, the DCLF command in the program) is compiled. It is through these variables that data from the display is manipulated by the program.

If DDS is not used to create a physical file, a CL variable is declared to the program to contain the entire record. This variable has the same name as the file, and its length is the same as the record length of the file.

CL programs cannot manipulate data in any types of files other than display files and database files, except with specific CL commands.

After the file is created, you may delete the DDS, though it is not recommended. After the CL program referring to the file is compiled, you can delete the file too, so long as it exists when the command referring to it, such as a Declare File (DCLF), Send File (SNDF), or Receive File (RCVF), is processed in the program.

The rules on qualified names described here for data areas and command definitions also apply to files. For more details on files, see "Working with Files in CL Programs" on page 5-4.

Checking for the Existence of an Object

Before you try to use an object in a CL program, you can check to determine if the object exists and if you have the authority needed to use it. This is useful when more than one object is used by a function at one time.

To check for the existence of an object, use the Check Object (CHKOBJ) command. You can use this command at any place in a program. The CHKOBJ command has the following format:

```
CHKOBJ  OBJ(library-name/object-name)  OBJTYPE(object-type)
```

Other optional parameters allow object authorization verification. If you are checking for authorization and intend to open a file, you should check for both operational and data authority.

When this command is processed, messages are sent to your program to report the result of the object check. You can monitor for these messages and handle them as you wish. For example:

```
          CHKOBJ  OBJ(OELIB/PGMA)  OBJTYPE(*PGM)
          MONMSG  MSGID(CPF9801)  EXEC(GOTO NOTFOUND)
          CALL OELIB/PGMA
          .
          .
          .
NOTFOUND: CALL FIX001  /* PGMA Not Found Routine */
          ENDPGM
```

In this example, the MONMSG command checks only for the object-not-found escape message. For a list of all the messages which may be sent by the CHKOBJ command, see the *CL Reference*. Additional information about monitoring for messages can be found under "Using the Monitor Message (MONMSG) Command" on page 2-37 and in Chapter 7 and Chapter 8.

The CHKOBJ command does not allocate an object. In many application uses, the check for existence is not an adequate function, and allocation should be performed. The Allocate Object (ALCOBJ) command provides both an existence check and allocation.

You can use the Check Tape (CHKTAP) or Check Diskette (CHKDKT) command in a CL program to ensure that a specific tape or diskette is placed on the drive and ready. These commands also provide an escape message that you can monitor for in your CL program.

Working with Files in CL Programs

Two types of files are supported in CL programs, display files and database files. You can send a display to a work station and receive input from the work station for use in the program, or you can read data from a database file for use in the program.

Note: Database files are made available for use within the CL program through the DCLF and RCVF commands. See the discussion on opening and closing database files in the *Database Guide*; it contains information about the OPNDBF and CLOF commands, which make database files available for later use in High-Level Language (HLL) programs.

To use a file in a CL program, you must:

- Format the display or database record, identifying fields and conditions which you enter as DDS source. The use of DDS is not required for a database file.
- Create the file using the Create Display File (CRTDSPF) command, Create Physical File (CRTPF) command, or Create Logical File (CRTLF) command. Subfiles (except for message subfiles) are not supported by CL programs.
- For database files, add a member to the file using the Add Physical File Member (ADDPFM) command or Add Logical File Member (ADDLFM)

command. This is not required if a member was added by the CRTPF or CRTLF commands. The file must have a member when the program is processed, but does not need to have a member when the file is referred to create the program.

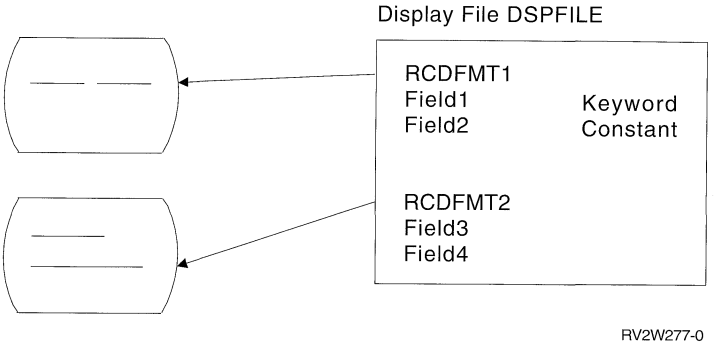
- Refer to the file in the CL program using the DCLF command, and refer to the record format on the appropriate data manipulation CL commands in your CL source.
- Create the CL program.

Only one display or database file can be referred to in a CL program. The support for database files and display files is similar as the same commands are used. However, there are a few differences, which are described here.

- The following statements apply only to database files used with CL programs:
  - Only database files with a single record format may be used by a CL program.
  - The file may be either a physical or logical file, and a logical file may be defined over multiple physical file members.
  - Only input operations, with the RCVF command, are allowed. The SNDF, SNDRCVF, ENDRCV, WAIT and DEV parameters on the RCVF command are not allowed for database files.
  - DDS is not required to create a physical file which is referred to in a CL program. If DDS is not used to create a physical file, the file has a record format with the same name as the file, and there is one field in the record format with the same name as the file, and with the same length as the record length of the file (RCDLEN parameter of the CRTPF command).
  - The file need not have a member when it is referred to create the program. It must have a member when the program is processed.
  - The file is opened for input only when the first RCVF command is processed.
  - The file remains open until the program returns or transfers control, or when the end of file is reached. When end of file is reached, message CPF0864 is sent to the CL program, and additional operations are not allowed for the file. The program should monitor for this message and take appropriate action when end of file is reached.
- The following statements apply only to display files used with CL programs:
  - Display files may have up to 99 record formats.
  - All data manipulation commands (SNDF, SNDRCVF, RCVF, ENDRCV and WAIT) are allowed for display files.
  - The display file must be defined with the DDS.
  - The display file is opened for both input and output when the first SNDF, SNDRCVF, or RCVF command is processed. The file remains open until the program returns or transfers control.

Note: The open does not occur for both types of files until the first send or receive occurs. Because of this, the file to be used can be created during the program and an override can be performed before the first send or receive.

The format for the display is identified as a record format in DDS. Each record format may contain fields (input, output, and input/output), conditions/indicators, and constants. Several record formats can be entered in one display file. The display file name, record format name, and field names should be unique, because other HLLs may require it, even though CL programs do not.



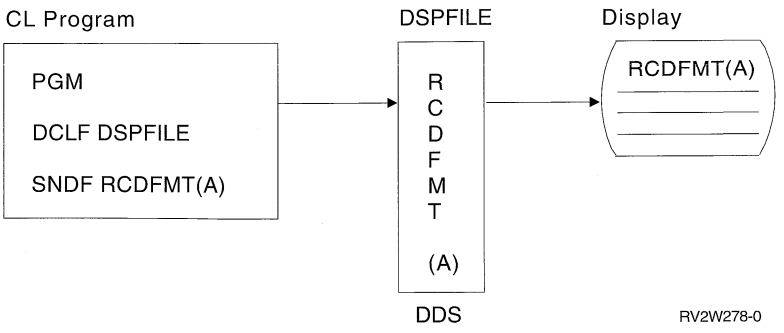
See the *DDS Reference* for more information about specifying DDS.

You can use the methods discussed in the *Guide to Programming Displays* or the Screen Design Aid (SDA) to enter DDS source for records and fields in the display file. See the *SDA User's Guide and Reference* for detailed information about interactive screen design.

A CL program can use several commands, called data manipulation commands. These commands let you refer to a display file to send data to and receive data from device displays. These commands also let you refer to a display file to read records from a database file. These commands are:

- Declare File (DCLF). Defines a display or database file to be used in a program. The fields in the file are automatically declared as variables for use in the program.
- Send File (SNDF). Sends data to the display.
- Receive File (RCVF). Receives data from the display or database.
- Send/Receive File (SNDRCVF). Sends data to the display; then asks for input and, optionally, receives data from the display.
- Override with Display File (OVRDSPF). Allows a run-time override of a file used by a program with a display file.
- Override with Database File (OVRDBF). Allows a run-time override of a file used by a program with a database file.

These commands let a running CL program communicate with a device display using the display functions provided by DDS, and to read records from a database file. DDS provides functions for writing menus and performing basic application-oriented data requests that are characteristic of many CL applications.



The fields on the display or in the record are identified in the DDS for the file. In order for the CL program to use the fields, the file must be referred to in the CL program by the DCLF command. This reference causes the fields and indicators in the file to be declared automatically in your program as variables. You can use these variables in any way in CL commands; however, their primary purpose is to send information to and receive information from a display. The DCLF command is not used at run time.

The format of the display and the options for the fields are specified in the device file and controlled through the use of indicators. Up to 99 indicator values can be used with DDS and CL support. Indicator variables are declared in your CL program in the form of logical variables with names &IN01 through &IN99 for each indicator that appears in the device file record formats referred to on the DCLF command. Indicators let you display fields and control data management display functions, and provide response information to your program from the device display. Indicators are not used with database files.

Referring to Files in a CL Program

Files are accessed during compiling of DCLF commands when CL programs are created so that variables can be declared for each field in the file.

If you have qualified the name of the file at compile time, the file must be in that library at run time. If you have used the library list at compile time, the file must be in a library on the library list at run time.

Opening and Closing Files in a CL Program

When you use CL support, you can refer to only one file in a program. The file referred to is implicitly opened when you do your first send, receive, or send/receive operation. An opened display file remains open until the program in which it was opened returns or transfers control. An opened database file is closed when end of file is reached, or when the program in which it was opened returns or transfers control. Once a database file has been closed, it cannot be opened again during the same call of the program.

When a database file is opened, the first member in the file is opened, unless an OVRDBF command was previously used to specify a different member (MBR parameter). If a program ends because of an error, files are closed. Because a file remains open until the program in which that file was opened completes processing, you have an easy way to share open data paths between running programs. A file can be opened in one program and then its open data path can be shared with another program under either of the following conditions:

- The file was created with or has been changed to have the SHARE(*YES) attribute.
- An override for that file specifying SHARE(*YES) is in effect.

Files can be shared in this way between any two programs. For a detailed description of the function available when open data paths are shared, see the description of the SHARE parameter on the CRTDSPF, CRTPF, and CRTLF commands in the *CL Reference*. When a display file is opened in a CL program, it is always opened for both input and output. When a database file is opened in a CL program, it is opened for input only.

Do not specify LVL(*CALLER) on the Reclaim Resources (RCLRSC) command in CL programs using files. If you specified LVL(*CALLER), all files opened by the program would be immediately closed, and any attempt to access the file would end abnormally.

Declaring a File

The Declare File (DCLF) command is used to declare a display or database file to your CL program. The DCLF command cannot be used to declare files, such as tape, diskette, printer, and mixed files. Only one DCLF command is allowed in a CL program. The DCLF command has the following parameters:

```
DCLF    FILE(library-name/file-name)
        RCDFMT(record-format-names)
```

Note that the file must exist before the program is compiled.

If you are using a file in your program, you may have to specify input/output fields in your DDS. These fields are handled as variables in the program. When a DCLF command is used, the CL compiler declares CL variables for each field and option indicators in each record format in the file. For a field, the CL variable name is the field name preceded by an ampersand (&). For an option indicator, the CL variable name is the indicator preceded by &IN.

For example, if a field named INPUT and indicator 10 are defined in DDS, the DCLF command automatically declares them as &INPUT and &IN10. This declaration is performed when the CL program is compiled. Up to 50 record format names can be specified on one command, but none can be variables. Only one record format may be specified for a database file.

If the following DDS were used to create display file CNTRLDSP in library MCGANN:

```
|...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....8
     A          R MASTER
     A                                        CA01(01 'F1 RESPONSE')
     A            TEXT                  2  4
     A            RESPONSE     300      8  4 BLINK
     A                          15   1
     A
```

Three variables, &IN01, &TEXT, and &RESPONSE, would be available from the display file. In a CL program referring to this display file, you would enter only the DCLF source statement:

```
DCLF MCGANN/CNTRLDSP
```

The compiler will expand this statement to individually declare all display file variables. The expanded declaration in the compiler list looks like this:

```
  .
  .
  .
500-              DCLF        MCGANN/CNTRLDSP
      QUALIFIED FILE NAME    'MCGANN    '  'CNTRLDSP   '

        RECORD FORMAT NAME   'MASTER    '

          CL VARIABLE     TYPE     LENGTH     PRECISION (IF *DEC)
           &IN01          *LGL        1
           &TEXT          *CHAR     300
           &RESPONSE      *CHAR      15
  .
  .
  .
```

Sending and Receiving Data with a Display File

The only commands you can use with a display file to send or receive data in CL programs are the SNDF, RCVF, and SNDRCVF commands.

When you run an SNDF command, the content of the variables associated with the output or output/input fields in the record format you specify is formatted by system and sent to the display device. Similarly, when you run an RCVF command, the values of the fields associated with input or output/input fields in the record format on the display are placed in the corresponding CL variables.

The SNDRCVF command sends the contents of the CL variables to the display and then performs the equivalent of an RCVF command to obtain the updated fields from the display. Note that CL does not support zoned decimal numbers. Consequently, fields in the display file defined as zoned decimal cause *DEC fields to be defined in the CL program. *DEC fields are internally supported as packed decimal, and the CL commands convert the packed and zoned data types as required. Fields that overlap in the display file because of coincident display positions result in separately defined CL variables that do not overlap. Record formats that contain floating point data cannot be used in a CL program.

Note: If a SNDRCVF or RCVF command for a work station indicates WAIT(*NO), or if a SNDF command is issued using a record format containing the INVITE DDS keyword, then the WAIT command is used to receive data.

Except for message subfiles, any attempt to send or receive subfile records causes run-time errors. Most other functions specified for display files in DDS are available; some functions (such as using variable starting line numbers) are not. For more information on messages and subfiles in CL programs, see Chapter 8.

The following example shows the steps required to create a typical operator menu and to send and receive data using the SNDRCVF command. The menu looks like this:

```
Operator Menu

  1. Accounts Payable
  2. Accounts Receivable
  90. Signoff

Option:
```

First, enter the following DDS source. The record format is MENU, and OPTION is an input-capable field. The OPTION field uses DSPATR(MDT). This causes the system to check this field for valid values even if the operator does not enter anything.

```
|...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....8
     A          R MENU
     A                                  1  2'Operator Menu'
     A                                  3  4'1. Accounts Payable'
     A                                  5  4'2. Accounts Receivable'
     A                                  5  4'90. Signoff'
     A                                  7  2'Option'
     A            OPTION         2Y 01   + 2VALUES(1 2 90) DSPATR(MDT)
     A
     A
```

Enter the CRTDSPF command to create the display file. In CL programming, the display file name (INTMENU) can be the same as the record format name (MENU), though this is not true for some other languages, like RPG/400.

The display file could also be created using the Screen Design Aid (SDA) utility.

Next, enter the CL source to run the menu.

The CL source for this menu is:

```
         PGM /* OPERATOR MENU */
         DCLF INTMENU
BEGIN:   SNDRCVF RCDFMT(MENU)
         IF COND(&OPTION *EQ 1) THEN(CALL ACTSPAYMNU)
         IF COND(&OPTION *EQ 2) THEN(CALL ACTSRCVMNU)
         IF COND(&OPTION *EQ 90) THEN(SIGNOFF)
         GOTO BEGIN
         ENDPGM
```

When this source is compiled, the DCLF command automatically declares the input field OPTION in the program as a CL variable.

The SNDRCVF command defaults to WAIT(*YES); that is, the program waits until input is received by the program.

Writing a CL Program to Control a Menu

The following example shows how a CL program can be written to display and control a menu. See the *Guide to Programming Displays* for another method of creating and controlling menus.

This example shows a CL program, ORD040C, that controls the displaying of the order department general menu and determines which HLL program to call based on the option selected from the menu. The program shows the menu at the display station.

The order department general menu looks like this:

```
 Order Dept General Menu

  1 Inquire into customer file
  2 Inquire into item file
  3 Customer name search
  4 Inquire into orders for a customer
  5 Inquire into an existing order
  6 Order entry
 98 End of menu

Option:
```

The DDS for the display file ORD040C looks like this:

```
|...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....8
     A* MENU ORD040CD ORDER DEPT GENERAL MENU
     A
     A          R MENU                        TEXT('General Menu')
     A                                   1  2'Order Dept General Menu'
     A                                   3  3'1 Inquire into customer file'
     A                                   4  3'2 Inquire into item file'
     A                                   5  3'3 Customer name search'
     A                                   6  3'4 Inquire into orders for a custom+
     A                                      er'
     A                                   7  3'5 Inquire into existing order'
     A                                   8  3'6 Order Entry'
     A                                   9  2'98 End of menu'
     A                                  11  2'Option'
     A            RESP           2Y001 11 10VALUES(1 2 3 4 5 6 98)
     A                                       DSPATR(MDT)
     A
     A
```

The source program for ORD040C looks like this:

```
       PGM /* ORD040C Order Dept General Menu */
       DCLF FILE(ORD040CD)
START: SNDRCVF RCDFMT(MENU)
       IF (&RESP=1) THEN(CALL CUS210)
       /* Customer inquiry */
       ELSE +
         IF (&RESP=2) THEN(CALL ITM210)
         /*Item inquiry*/
         ELSE +
           IF (&RESP=3) THEN(CALL CUS220)
           /* Cust name search */
           ELSE +
             IF (&RESP=4) THEN(CALL ORD215)
             /* Orders by cust */
             ELSE +
               IF (&RESP=5) THEN(CALL ORD220)
               /* Existing order */
               ELSE +
                 IF (&RESP=6) THEN(CALL ORD410C)
                 /* Order entry */
                 ELSE +
                   IF (&RESP=98) THEN(RETURN)
                   /* End of Menu */
       GOTO START
       ENDPGM
```

The DCLF command indicates which file contains the field attributes the system needs to format the order department general menu when the SNDRCVF command is processed. The system automatically declares a variable for each field in the record format in the specified file if that record format is used in an SNDF, RCVF, or SNDRCVF command. The variable name for each field automatically declared is an ampersand (&) followed by the field name. For example, the variable name of the response field RESP in ORD040C is &RESP.

Other notes on the operation of this menu:

The SNDRCVF command is used to send the menu to the display and to receive the option selected from the display.

If the option selected from the menu is 98, ORD040C returns to the program that called it.

The ELSE statements are necessary to process the responses as mutually exclusive alternatives.

Note: This menu is run using the CALL command. See the *Guide to Programming Displays* for a discussion of those menus run using the GO command.

Overriding Display Files in a CL Program

You can use the Override with Display File (OVRDSPF) command to replace the display file named in a CL program or to change certain parameters of the existing display file. This may be especially useful for files that have been renamed or moved since the program was compiled.

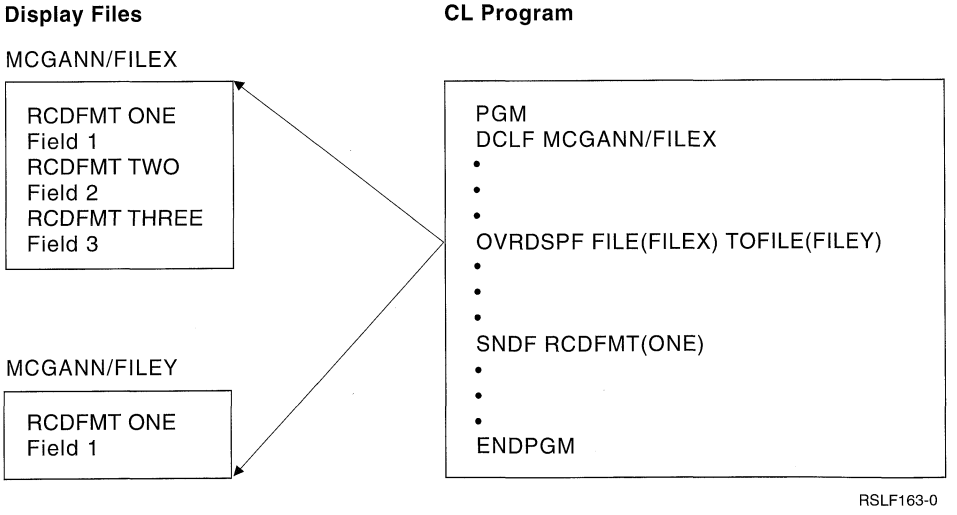
The initial parameters of the OVRDSPF command are:

```
OVRDSPF   FILE(overridden-file-name) TOFILE(new-file-name)
          DEV(device-name)
```

The OVRDSPF command is valid for a file referred to by a CL program only if the file specified on the DCLF command was a display file when the program was created. The file used when the program is run must be of the same type as the file referred to when the program was created.

The OVRDSPF command must be run before the file to be overridden is opened for use. An open is caused by the first use of a send or receive command. The file is overridden if it is opened in the program containing the OVRDSPF command, or if it is opened in another program to which control is transferred by the TFRCTL or CALL command. See the *Data Management Guide* for more information about overriding files.

When you override to a different file, only those record format names referred to in the CL program on the SNDF, RCVF, or SNDRCVF command need to be in the overriding file. In the following illustration, display file FILEY does not need record format TWO or THREE.



You should make sure that the record format referred to names of the original file and the overriding files have the same field definitions and indicator names in the same order. You may get unexpected results if you specify LVLCHK(*NO).

Another consideration has to do with the DEV parameter on the SNDF, RCVF, and SNDRCVF commands when an OVRDSPF command is applied. If *FILE is specified on the DEV parameter of the RCVF, SNDF, or SNDRCVF command, the system automatically directs the operation to the correct device for the overridden file. If a specific device is specified on the DEV keyword of the RCVF, SNDF, or SNDRCVF command, one of the following may occur:

- If a single device display file is being used, an error will occur if the display file is overridden to a device other than the one specified on the RCVF, SNDF, or SNDRCVF command.
- If a multiple device display file is being used, an error will occur if the device specified on the RCVF, SNDF, or SNDRCVF command is not among those specified on the OVRDSPF command.

Working with Multiple Device Display Files

The normal mode of operation on a system is for the work station user to sign on and become the requester for an interactive job. Many users can do this at the same time, because each will use a logical copy of the program, including the display file in the program. Each requester calls a separate job in this kind of use. This is not considered to be multiple device display use.

A multiple device display configuration occurs when a single job called by one requester communicates with multiple display stations through one display file. While only one display file can be handled by a CL program, the display file, or different record formats within it, can be sent to several device displays. Commands used primarily with multiple device display files are:

- End Receive (ENDRCV). This command cancels requests for input that have not been satisfied.
- Wait (WAIT). Accepts input from any device display from which user data was requested by one or more previous RCVF or SNDRCVF commands when WAIT(*NO) was specified on the command, or by one or more previous SNDF commands to a record format containing the INVITE DDS keyword.

If you use a multiple device display file, the device names must be specified on the DEV parameter on the CRTDSPF command when the display file is created, on the CHGDSPF command when the display file is changed, or on an override command, and the number of devices must be less than or equal to the number specified on the MAXDEV parameter on the CRTDSPF command.

Multiple device display configurations affect the SNDRCVF and the RCVF commands and you may need to use the WAIT or ENDRCV commands. When an RCVF or SNDRCVF command is used with multiple display devices, the default value WAIT(*YES) prevents further processing until an input-capable field is returned to the program from the device named on the DEV parameter. Because the response may be delayed, it is sometimes useful to specify WAIT(*NO), thus letting your program continue running other commands before the receive operation is satisfied.

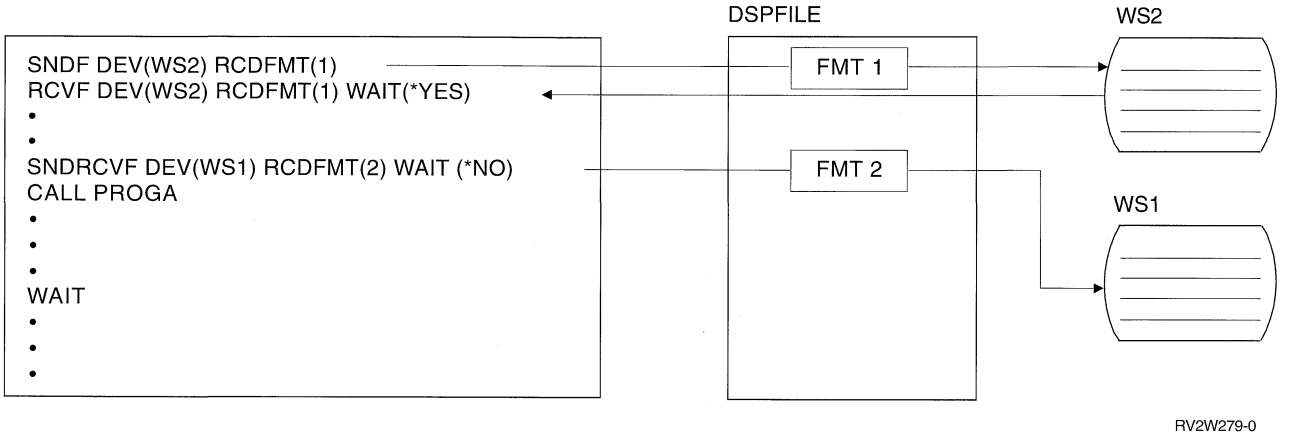
If you use an RCVF or SNDRCVF command and specify WAIT(*NO), the CL program continues running until a WAIT command is processed.

Using a SNDF command with a record format which has the DDS INVITE keyword is equivalent to using a SNDRCVF command with WAIT(*NO) specified. The DDS INVITE keyword is ignored for SNDRCVF and RCVF commands.

The WAIT command must be issued to access a data record. If no data is available, program processing is suspended until data is received from a device display or until the time limit specified in the WAITRCD parameter for the display file on the CRTDSPF, CHGDSPF, or OVRDSPF commands has passed. If the time limit passes, message CPF0889 is issued.

The WAIT will also be satisfied by the job being canceled with the controlled option on the ENDJOB, ENDSYS, PWRDWNSYS, and ENDSBS commands. In this case, message CPF0888 is issued and no data is returned. If a WAIT command is issued without a preceding receive request (such as RCVF . . . WAIT(*NO)), a processing error occurs.

A typical multiple device display configuration (with code) might look like this:



In the above example, the first two commands show a typical sequence in which the default is taken; processing waits for the receive operation from WS2 to complete. Because WS2 is specified on the DEV parameter, the RCVF command does not run until WS2 responds, even if prior outstanding requests (not shown) from other stations are satisfied.

The SNDRCVF command, however, has WAIT(*NO) specified and so does not wait for a response from WS1. Instead, processing continues and PROGA is called. Processing then stops at the WAIT command until an outstanding request is satisfied by a work station, or until the function reaches time-out.

The WAIT command has the following format:

```
WAIT DEV(CL-variable-name)
```

If the DEV parameter is specified, the CL variable name is the name of the device that responded. (The default is *NONE.) If there are several receive requests (such as RCVF. . . WAIT(*NO)), this variable takes the name of the first device to respond after the WAIT command is encountered in the program, and processing continues. The data received is placed in the program variable associated with the field in the device display.

A RCVF command with WAIT(*YES) specified can be used to wait for data from a specific device. The same record format name must be specified for both the operation that started the receive request and the RCVF command.

In some cases, several receive requests are outstanding, but processing cannot proceed further without a reply from a specific device display. In the following example, three commands specify WAIT(*NO), but processing cannot continue at label LOOP until WS3 replies:

```
         PGM
         .
         .
         .
         SNDF DEV(WS1) RCDFMT(ONE)
         SNDF DEV(WS2) RCDFMT(TWO)
         SNDRCVF DEV(WS3) RCDFMT(THREE) WAIT(*NO)
         RCVF DEV(WS2) RCDFMT(TWO) WAIT(*NO)
         RCVF DEV(WS1) RCDFMT(ONE) WAIT(*NO)
         CALL...
         CALL...
         .
         .
         RCVF DEV(WS3) RCDFMT(THREE) WAIT(*YES)
LOOP:    WAIT DEV(&WSNAME)
         MONMSG CPF0882 EXEC(GOTO REPLY)
         .
         .
         .
         GOTO LOOP
REPLY:   CALL...
         .
         .
         .
         ENDPGM
```

CL programs also support the ENDRCV command, which lets you cancel a request for input that has not yet been satisfied. A SNDF or SNDRCVF command will also cancel a request for input that has not yet been satisfied. However, if the data was available at the time the SNDF or SNDRCVF command was processed, message CPF0887 will be sent. In this case the data must be received with the WAIT command or RCVF command, or the request must be explicitly canceled with a ENDRCV command before the SNDF or SNDRCVF command can be processed.

Receiving Data from a Database File

The only command you can use to receive data from a database file is the RCVF command.

When you run a RCVF command, the next record on the file's access path is read, and the values of the fields defined in the database record format are placed in the corresponding CL variables. Note that CL does not support zoned decimal or binary numbers. Consequently, fields in the database file defined as zoned decimal or binary cause *DEC fields to be defined in the CL program. *DEC fields are internally supported as packed decimal, and the RCVF command performs the conversion from zoned decimal and binary to packed decimal as required. Database files which contain floating point data cannot be used in a CL program.

When the end of file is reached, message CPF0864 is sent to the program. The CL variables declared for the record format are not changed by the processing of the RCVF command when this message is sent. You should monitor for this message and perform the appropriate action for end of file. If you attempt to run

additional RCVF commands after end of file has been reached, message CPF0864 will be sent again.

Overriding Database Files in a CL Program

You can use the Override with Database File (OVRDBF) command to replace the database file named in a CL program or to change certain parameters of the existing database file. This may be especially useful for files that have been renamed or moved since the program was created. It can also be used to access a file member other than the first member.

The initial parameters of the OVRDBF command are:

```
OVRDBF FILE(overridden-file-name) TOFILE(new-file-name)
       MBR(member-name)
```

The OVRDBF command is valid for a file referred to by a CL program only if the file specified in the DCLF command was a database file when the program was created. The file used when the program was processed must be of the same type as the file referred to when the program was created.

The OVRDBF command must be processed before the file to be overridden is opened for use (an open occurs by the first use of the RCVF command). The file is overridden if it is opened in the program containing the OVRDBF command, or if it is opened in another program to which control is transferred by the TFRCTL or CALL command. See the *Data Management Guide* for more information about the OVRDBF command.

When you override to a different file, the overriding file must have only one record format. A logical file which has multiple record formats defined in DDS may be used if it is defined over only one physical file member. A logical file which has only one record format defined in the DDS may be defined over more than one physical file member. The name of the format does not have to be the same as the format name referred to when the program was created. You should ensure that the format of the data in the overriding file is the same as in the original file. You may get unexpected results if you specify LVLCHK(*NO). See the *Database Guide* for more information about LVLCHK considerations.

Referring to Output Files from Display Commands

A number of the IBM display commands allow you to place the output from the command into a database file (OUTFILE parameter). The data in this file can be received directly into a CL program and processed. See the *Database Guide* for a discussion of some of these commands and the format descriptions.

The following CL program accepts two parameters, a user name and a library name. The program determines the names of all programs, files, and data areas in the library and grants normal authority to the specified users.

```
            PGM PARM(&USER &LIB)
            DCL &USER *CHAR 10
            DCL &LIB *CHAR 10
(1)  DCLF QSYS/QADSPOBJ
(2)  DSPOBJD OBJ(&LIB/*ALL) OBJTYPE(*FILE *PGM *DTAARA) +
     OUTPUT(*OUTFILE) OUTFILE(QTEMP/DSPOBJD)
(3)  OVRDBF QADSPOBJ TOFILE(QTEMP/DSPOBJD)
(4)  READ:  RCVF
(5)  MONMSG CPF0864 EXEC(RETURN)  /* EXIT WHEN END OF FILE REACHED  */
(6)  GRTOBJAUT OBJ(&ODLBNM/&ODOBNM) OBJTYPE(&ODOBTP) +
            USER(&USER) AUT(*CHANGE)
            GOTO READ         /*GO BACK FOR NEXT RECORD*/
            ENDPGM
```

(1) The declared file, QADSPOBJ in QSYS, is the IBM-supplied file that will be used by the DSPOBJD command. This file is the primary file which is referred to by the command when creating the output file. It is referred to by the CL compiler to determine the format of the records and to declare variables for the fields in the record format.

(2) The DSPOBJD command creates a file named DSPOBJD in library QTEMP. This file has the same format as file QADSPOBJ.

(3) The OVRDBF command overrides the declare file (QADSPOBJ) to the file created by the DSPOBJD command.

(4) The RCVF command reads a record from the DSPOBJD file. The values of the fields in the record are copied into the corresponding CL variables, which were implicitly declared by the DCLF command. Because the OVRDBF command was used, the file QTEMP/DSPOBJD is read instead of QSYS/QADSPOBJ (the file QSYS/QADSPOBJ is not read).

(5) Message CPF0864 is monitored. This indicates that the end of file has been reached, so the program returns control to the calling program.

(6) The GRTOBJAUT command is processed, using the variables for object name, library name and object type, which were read by the RCVF command.

Note: QUSRTOOL also provides several commands (CVTxxx) that create output files.

Chapter 6. Advanced Programming Topics

This chapter introduces more advanced programming topics, including:

- Special functions that can be called from high-level language programs (including CL programs)
- Using prompting and the Programmer Menu to enter program source

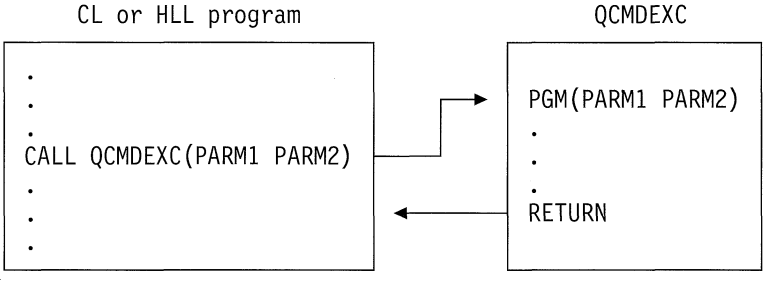
See the *System Programmer's Interface Reference* for information on advanced function command processing.

This chapter includes General-Use Programming Interfaces (GUPI), which IBM makes available for use in customer-written programs.

Several sample programs are included at the end of the chapter.

Using the QCMDEXC Program

QCMDEXC is an IBM-supplied program that runs a single command. It is used to run a command from within a high-level language (HLL) program or from within a CL program where it is not known at compile time what command is to be run or what parameters are to be used. The QCMDEXC program is called from within your HLL or CL program and the command it runs is passed to it as a parameter on the CALL command.



After the command runs, control returns to your HLL or CL program.

The command is run as if it were not in a program. Therefore, program variables cannot be used on the command; values cannot be returned by the command to CL variables; and commands that can only be used in CL programs cannot be run by the QCMDEXC program. The format of the call to the QCMDEXC program is the following:

```
CALL PGM(QCMDEXC) PARM(command command-length)
```

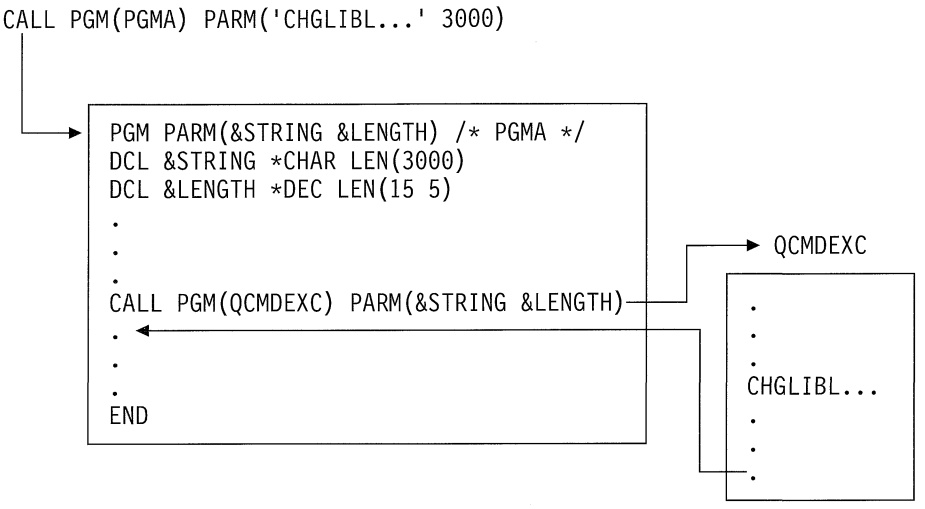
The command you wish to run is entered as a character string on the first parameter. If the command contains blanks, it must be enclosed in apostrophes. The maximum length of the character string is 6000 characters; delimiters (the apostrophes enclosing the string) are never counted as part of the string. The length specified as the second value on the PARM parameter is the length of the character string passed as the command. Length must be a packed decimal value of length 15 with 5 decimal positions.

Thus, if you wish to replace a library list, the call to the QCMDEXC program would look like this:

```
CALL PGM(QCMDEXC) PARM('CHGLIBL LIBL(QGPL NEWLIB QTEMP)' 31)
```

This statement could be coded into the HLL or CL program, and when the program runs, the library list would be replaced. Used this way, however, the QCMDEXC program does not provide run-time flexibility. That is accomplished by substituting variables for the constants in the parameter list, and specifying the values for the variables in the call to the HLL or CL program.

For instance:



The command length, which is passed to the QCMDEXC program on the second parameter, is the maximum length of the command string being passed. If the command string is passed as a quoted string, the command length is exactly the length of the quoted string. If the command string is passed in a variable, the command length is the length of the CL variable. It is not necessary to reduce the command length to the actual length of the command string in the variable, although it is permissible to do so.

The same command could be run using the following CALL command from the CL program because numeric literals are passed as packed decimal values of length 15 with 5 decimal positions:

```
CALL QCMDEXC (&STRING 3000)
```

Not all commands can be run using the QCMDEXC program. The command passed on a call to the QCMDEXC program must be valid within the current environment (interactive or batch) in which the call is being made. The command cannot be one of the following:

- An input stream control command (BCHJOB, ENDBCHJOB, and DATA)
- A command that can be used only in a CL program

To determine whether a CL command can be passed on a call to the QCMDEXC program, look up the command in the *CL Reference*. To find the environment in which the command can be run, look at the syntax diagram for the command. The small box in the upper right corner of the diagram indicates the environment in which the command can be run. For example, `JOB: I` indicates that the command can be run interactively; `JOB: B` indicates that the command can be run in a batch job; Exec indicates that the command can be run with QCMDEXC.

You can precede the CL command with a question mark (?) to request prompting, or use selective prompting, when you call QCMDEXC in an interactive job.

If an error is detected while a command is being processed through the QCMDEXC program, an escape message is sent. You can monitor for this escape message in your CL program using the Monitor Message (MONMSG) command. For more information about monitoring for messages, see Chapter 7 and Chapter 8.

If a syntax error is detected, message CPF0006 is sent. If an error is detected during the processing of a command, any escape message sent by the command is returned by the QCMDEXC program. You monitor for messages from commands run through the QCMDEXC program in the same way you monitor for messages from commands contained in CL programs.

See the appropriate HLL reference for information on how HLL programs handle errors on calls.

Using the QCMDEXC Program with DBCS Data

You can use QCMDEXC to request double-byte character set (DBCS) input data to be entered with a command. The command format used for QCMDEXC to prompt double-byte data is:

```
CALL QCMDEXC ('command' command-length IGC)
```

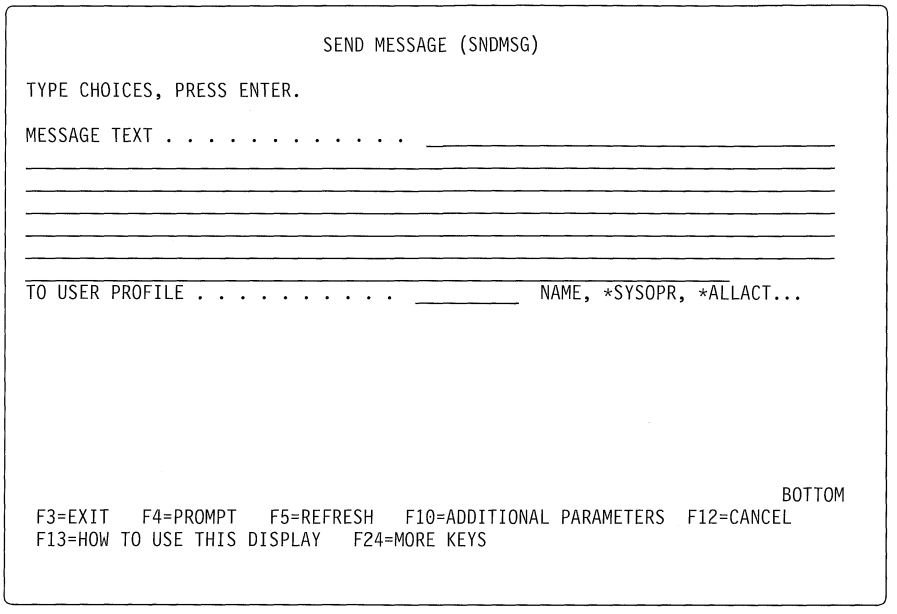
The third parameter of the QCMDEXC program, IGC, instructs the system to accept double-byte data. For example, the following CL program asks a user to provide double-byte text for a message. Then the system sends the following message:

```
PGM
   CALL QCMDEXC ('?SNDMSG' 7 IGC)
ENDPGM
```

An explanation of the system message follows:

- The ? character instructs the system to present the command prompt for the Send Message (SNDMSG) command.
- The value 7 is the length of the SNDMSG command plus the question mark.
- The value IGC lets you request double-byte data.

The following display is shown after running the QCMDEXC program. You can use double-byte conversion on this display:



Using the QCMDCHK Program

QCMDCHK is an IBM-supplied program that performs syntax checking for a single command, and optionally prompts for the command. The command is not run. If prompting is requested, the command string is returned to the calling program with the updated values as entered through prompting. The QCMDCHK program can be called from a CL program or an HLL program.

Typical uses of QCMDCHK are:

- Prompt the user for a command and then store the command for later processing.
- Determine the options the user specified.
- Log the processed command. First, prompt with QCMDCHK, run with QCMDEXC, and then log the processed command.

The format of the call to QCMDCHK is:

```
CALL PGM(QCMDCHK) PARM(command  command-length)
```

The first parameter passed to QCMDCHK is a character string containing the command to be checked or prompted. If the first parameter is a variable and prompting is requested, the command entered by the work station user is placed in the variable.

The second parameter is the maximum length of the command string being passed. If the command string is passed as a quoted string, the command length is exactly the length of the quoted string. If the command string is passed in a variable, the command length is the length of the CL variable. The second parameter must be a packed decimal value of length 15 with 5 decimal positions.

The QCMDCHK program performs syntax checking on the command string which is passed to it. It verifies that all required parameters are coded, and that all parameters have allowable values. It does not check for the processing environment. That is, a command can be checked whether it is allowed in batch only, interactive only, or only in a batch or interactive CL program. QCMDCHK does not allow checking of command definition statements.

If a syntax error is detected on the command, message CPF0006 is sent. You can monitor for this message to determine if an error occurred on the command. Message CPF0006 is preceded by one or more diagnostic messages that identify the error. In the following example, control is passed to the label ERROR within the program, because the value 123 is not valid for the PGM parameter of the CRTCLPGM command.

```
CALL QCMDCHK ('CRTCLPGM PGM(QGPL/123)' 22)
MONMSG CPF0006 EXEC(GOTO ERROR)
```

You can request prompting for the command by either placing a question mark before the command name or by placing selective prompt characters before one or more keyword names in the command string.

If no errors are detected during checking and prompting for the command, the updated command string is placed in the variable specified for the first parameter. The prompt request characters are removed from the command string. This is shown in the following example:

```
DCL &CMD *CHAR 2000
 .
 .
CHGVAR &CMD '?CRTCLPGM'
CALL QCMDCHK (&CMD 2000)
```

After the call to the QCMDCHK program is run, variable &CMD contains the command string with all values entered through the prompter. This might be something like:

```
CRTCLPGM PGM(PGMA) SRCFILE(TESTLIB/SOURCE) USRPRF(*OWNER)
```

Note that the question mark preceding the command name is removed.

When prompting is requested through the QCMDCHK program, the command string should be passed in a CL variable. Otherwise, the updated command string is not returned to your program. You must also be sure that the variable for the command string is long enough to contain the updated command string which is returned from the prompter. If it is not long enough, message CPF0005 is sent, and the variable containing the command string is not changed. Without selective prompting, the prompter only returns entries that were typed by the user.

The length of the variable is determined by the value of the second parameter, and not the actual length of the variable. In the following example, escape message CPF0005 is sent because the specified length is too short to contain the updated command, even though the variable was declared with an adequate length.

```
DCL &CMD *CHAR 2000
 .
 .
CHGVAR &CMD '?CRTCLPGM'
CALL QCMDCHK (&CMD 9)
```

If you press F3 or F12 to exit from the prompter while running QCMDCHK, message CPF6801 is sent to the program that called QCMDCHK, and the variable containing the command string is not changed.

If PASSATR(*YES) is specified on the PARM, ELEM, or QUAL command definition statement, and the default value is changed using the CHGCMDDFT command, the default value will be highlighted as though this was a user-specified value and not a default value. If a default value of a changed PARM, ELEM, or QUAL command definition statement is changed back to its original default value, the default value will no longer be highlighted.

Using the QCLSCAN Program

You can use the QCLSCAN program to scan a string of characters to see if the string contains a pattern. This function is similar to the scan function supported within SEU and on the display presented by the DSPSPLF command. In addition, the QCLSCAN program also allows you to specify a 1-byte character in the pattern that matches with any character in the string to be searched, and a start position, which allows you to search the same string more than once.

A typical use of the QCLSCAN program is to allow the work station user to retrieve all records that contain a pattern that he specifies. For example, if the database has records with book titles, the work station user may want to retrieve all those books with the pattern CHICAGO in the title. The work station user enters CHICAGO on the device display. The application program reads the database, calling the QCLSCAN program at least once for each record to test for the pattern. The application program only processes the records that pass the test for the pattern CHICAGO.

Another alternative for this function is using the Open Query File (OPNQRYF) command. If you are searching an entire database member, OPNQRYF normally produces faster results. If you are searching a small subset of a member or the file is already open, QCLSCAN normally produces faster results.

Scanning a field can require many lines of code in a high level language such as RPG/400 and can cause a significant amount of overhead. Calling the QCLSCAN program and passing it a parameter list is simpler, and provides you with a fast-performing IBM-supplied program to do the scan. In a CL program, use the following CALL command:

```
CALL  PGM(QCLSCAN)    PARM(&STRING  &STRLEN  &STRPOS  &PATTERN  +
                      &PATLEN  &TRANSLATE  &TRIM  &WILD  &RESULT)
```

where:

- &STRING is a character field from 1 through 999 characters long. &STRING contains the string to be scanned for the pattern.
- &STRLEN is a 3-digit packed decimal variable with no decimal positions. &STRLEN contains the length of the string to be scanned. If this length is greater than the actual length of the string, unexpected results can occur.
- &STRPOS is a 3-digit packed decimal variable with no decimal positions. &STRPOS specifies the position in the string where the scan is to start. This must be greater than zero and not greater than the string length. Normally this value is 1. If the same string has multiple sets of patterns, this allows the string

to remain the same while only the start position is varied to find the additional patterns.

- &PATTERN is a character variable from 1 through 999 bytes long. &PATTERN contains the pattern being scanned for.
- &PATLEN is a 3-digit packed decimal variable with no decimal positions. &PATLEN is the length of the pattern. If this length is greater than the actual length of the pattern, unexpected results can occur. See also the TRIM parameter.
- &TRANSLATE is a 1-byte character variable. If this field contains '1', the program translates lowercase characters of the string to uppercase before the scan. Only the lowercase EBCDIC characters 'a' through 'z' are translated. This does not change the user's data. Note that if '1' is specified and the pattern contains lowercase characters, a match will never occur. If '1' is specified and the data to be searched contains other than EBCDIC characters 'a' through 'z', unexpected results can occur.
- &TRIM is a 1-byte character variable. If this variable contains '1', trailing blanks are trimmed off the end of the pattern before the scan is started. This allows a fixed length pattern field to be filled (left-adjusted) by a variable number of characters. See Example 2 later in this section.
- &WILD is a 1-byte character variable. The value of this variable is a character that you can specify in the pattern in positions that should not be tested when scanning for a match. When this character appears in the pattern, any character in the data will be considered a match. A value of blank indicates that all characters of the pattern take part in the scan. If the wild character is the first character in the pattern, an error will occur. See Example 3 later in this section.
- &RESULT is a 3-digit packed decimal variable with no decimal positions. This parameter is returned to the user program when the call completes.

  If the value returned is positive, the result is the position of the first character of the pattern in the string.

  If the value returned is zero, the pattern was not found.

  If the value returned is negative, one of the following errors occurred:

  -1 The pattern is longer than the string.

  -2 The pattern length is less than 1.

  -3 The first character of the pattern is a wild character.

  -4 The pattern is blank and TRIM was requested.

  -5 The starting position within the string is not valid.

QCLSCAN is a program in the QSYS library. The command interface to QCLSCAN is the SCNCMD tool, which is in QUSRTOOL. The command interface is easier to use in CL programs, but requires more processing overhead.

Example 1

Assume a 20-character database field containing only uppercase characters and the pattern 'ABC' will be scanned for. The user program calls the QCLSCAN program for each database record read. The parameters would be as follows:

&STRING	= The 20-byte field to be scanned
&STRLEN	= 20
&STRPOS	= 1
&PATTERN	= 'ABC'
&PATLEN	= 3
&TRANSLATE	= '0'
&TRIM	= '0'
&WILD	= ' '
&RESULT	= A value returned to your program

The following describes some fields and the results of the scan:

	String	Result	Comments
Scan 1:	ABCDEFGHIJKLMNOPQRST	001	
Scan 2:	XXXXABCXXXXXXXXXXXXX	005	
Scan 3:	abcXXXXXXXXXXXXXXXXX	000	Translation not requested
Scan 4:	XXXABCXXXXXABCXXXXXX	004	First occurrence found; see note
Scan 5:	ABABABABBCACCBACBABA	000	Not found
Scan 6:	ABABABCABCABCABCABCA	005	

Note: In scan 4, the string has two places where the pattern could have been found. Since the STRPOS value is 1, the first value (position 004) was found. If the value of STRPOS had been 4, the result would still have been 004. If the STRPOS value had been in a range of 5 through 12, the result would have been 012.

Example 2

Assume a 25-character database field containing only uppercase characters and a user program that will prompt for the pattern to be scanned, which will not exceed 10 characters. The work station user is allowed to enter 1 through 10 characters to search with and trailing blanks will be trimmed from the pattern. The program would call the QCLSCAN program for each database record read. The program parameters would be as follows:

&STRING	= The 25-byte field to be scanned
&STRLEN	= 25
&STRPOS	= 1
&PATTERN	= Varies
&PATLEN	= 10
&TRANSLATE	= '0'
&TRIM	= '1'
&WILD	= ' '
&RESULT	= A value returned to your program

The following describes some fields and the results of the scan:

	String	Pattern	Result	Comments
Scan 1:	ABCDEFGHIJKLMNOPQRSTUVWXY	'CDE '	003	
Scan 2:	ABCDEFGHIJKLMNOPQRSTUVWXY	'CDEFGH '	003	

	String	Pattern	Result	Comments
Scan 3:	ABCDEFGHIJKLMNOPQRSTUVWXY	'CDEFGHIJKL'	003	
Scan 4:	XXXXABCXXXXXXXXXXXXXXXXX	'ABCD '	000	Not found
Scan 5:	abcXXXXXXXXXXXXXXXXXXXXX	'ABC '	000	Not translated
Scan 6:	ABCXXXXXABC EXXXXXXXXXXXX	'ABC E '	009	
Scan 7:	XXXABCXXXXXABCXXXXXXXXXXX	'ABC '	004	See note

Note: In scan 7, the string has two places where the pattern could be found. Since the STRPOS value is 1, only the first value (position 004) is found. If the value of STRPOS were 4, the result would still be 004. If the STRPOS value were in the range of 5 through 12, the result would be 012.

Example 3

Assume a 25-character database field containing either uppercase or lowercase characters. The user program prompts for the pattern to be scanned, which does not exceed 5 characters. The work station user can enter 1 through 5 characters to be found. The system trims trailing blanks from the pattern. If the user enters an asterisk (*) in the pattern, the asterisk is handled as a wild character. The program calls the QCLSCAN program for each database record read. The parameters are as follows:

&STRING	= The 25-byte field to be scanned
&STRLEN	= 25
&STRPOS	= 1
&PATTERN	Varies
&PATLEN	= 5
&TRANSLATE	='1' (See note 1)
&TRIM	='1'
&WILD	= '*'
&RESULT	= A value returned to your program

The following describes some fields and the results of the scan:

	String	Pattern	Result	Comments
Scan 1:	ABCDEFGHIJKLMNOPQRSTUVWXY	'CDE '	003	
Scan 2:	ABCDEFGHIJKLMNOPQRSTUVWXY	'C*E '	003	
Scan 3:	abcdefghijklmnopqrstuvwxy	'C***G'	003	See Note 1
Scan 4:	abcdefghijklmnopqrstuvwxy	'ABCD '	001	
Scan 5:	abcXXXXXXXXXXXXXXXXXXXXX	'C*E '	000	Not found
Scan 6:	XXXAbcXXXXXabcXXXXXXXXXXX	'ABC '	004	See Note 2
Scan 7:	ABCDEFGHIJKLMNOPQRSTUVWXY	'*BC '	-003	See Note 3
Scan 8:	ABCDEFGHIJKLMNOPQRSTUVWXY	' '	-004	See Note 4

Notes:

1. When field translation is specified (the TRANSLATE parameter is specified as '1'), the string is translated to uppercase characters before scanning occurs; the data in the string is not changed.
2. In scan 6, the string has two places where the pattern could have been found. Since the STRPOS value is 1, the first value (position 004) was found.
3. In scan 7, the wild character (*) is the first character in the trimmed pattern. Wild characters cannot be the first character in a pattern.
4. In scan 8, the trimmed pattern is blank.

Using the QDCXLATE Program to Translate Fields

You can call the QDCXLATE program to translate individual fields. You can specify the translation table used by QDCXLATE to translate, for example, ASCII characters to EBCDIC.

IBM supplies four translation tables:

- QASCII and QEBCDIC for translation between ASCII and EBCDIC characters
- QSYSTRNTBL and QCASE256 for translation of lowercase to uppercase characters

You can also create your own translation tables.

QDCXLATE can distinguish double-byte from single-byte characters when converting from EBCDIC to ASCII and from ASCII to EBCDIC. QDCXLATE translates fields byte-for-byte and returns the translated fields to your program. For example, in a CL program, you could specify the following:

```
CALL PGM(QDCXLATE) PARM(&BUFLEN &BUFFER &SBCSTBLN &SBCSTBLL)
```

where:

- &BUFLEN is a 5-digit packed decimal field with no decimal positions. &BUFLEN contains the length of the field to be translated. The &FLDLEN variable cannot exceed 32767 and cannot be coded as a numeric constant in a CL program because a 15-digit packed decimal field will result.
- &BUFFER is a character field containing the data to be translated. This buffer also contains the output data after conversion when the program is called with only three or four parameters.
- &SBCSTBLN is a 10-character field containing the name of the SBCS translation table to be used. (The table name must be left-adjusted.)
- &SBCSTBLL is a 10-character field containing the name of the library that contains the SBCS translation table. (The library name must be left-adjusted.) If this field is not specified, the library list is used to find the translation table.

Note: Parameter lists cannot be used when a high-level language program calls QDCXLATE. Parameters must be passed parameter for parameter.

When the field is translated, the input (untranslated) data is replaced with the translated data.

When QDCXLATE is called with three or four parameters, it converts using single-byte characters. If more than four parameters are specified, then all 10 parameters must be specified and the conversion is done using the DBCS convert routines. All 10 parameters should only be specified when doing DBCS conversions.

The remaining parameters for QDCXLATE are:

- &OUTBUFF is a character field containing the output buffer. Because of the insertion of shift-out and shift-in characters, it is possible that the translated data is longer than the source data, and it is not possible to do the translation in place, as is done on a 3- or 4-parameter call. The translated data is placed in the area pointed to by this parameter.

- &MAXOUTLN is a 5-digit packed decimal field containing the maximum length of converted output. The maximum length should match the actual size of OUTBUFF. If the translated output is longer than MAXOUTLN characters, an exception is signaled.
- &OUTLEN is a 5-digit packed decimal field containing the actual length of the translated output in OUTBUFF.
- &DBCSTBLN is a 10-character field containing the DBCS language which is being translated. It must be one of the following:

  ***JPN** Japanese

  ***KOR** Korean

  CHS Simplified Chinese

  CHT Traditional Chinese

  The value of this parameter determines which module is called to do the DBCS translation.
- &DBCSSISO is a one-character field that indicates whether shift-out and shift-in characters should be inserted during the conversion. It must be one of the following:

  Y Insert shift-out and shift-in characters

  N Do not insert shift-out and shift-in characters
- &TRNTYPE is a 10-character field containing the type of conversion being done. It must be one of the following:

  ***AE** Convert ASCII to EBCDIC

  ***EA** Convert EBCDIC to ASCII

  A 10-character call can only be used to translate ASCII data to EBCDIC, or EBCDIC to ASCII. The &TRNTYPE parameter determines which translation is performed. This applies only to the DBCS conversion. The user is responsible to specify the correct SBCS table name for the type of conversion being done.

Character Equivalent Translation between ASCII and EBCDIC

When data is read from a tape or diskette file recorded in ASCII character code, the system converts each record to EBCDIC before returning it to the program using the data.

EBCDIC to ASCII Translation

IBM supplies a translation table, QASCII in library QSYS, with OS/400. If you need to determine the ASCII character equivalent of any fields recorded in EBCDIC, you should use the program QDCXLATE and specify QASCII as the value for the TBL parameter and QSYS for the LIB parameter.

ASCII to EBCDIC Translation

IBM supplies a translation table, QEBCDIC in library QSYS, with OS/400. If you need to determine the EBCDIC character equivalent of any fields recorded in ASCII, you should use the program QDCXLATE and specify QEBCDIC as the value for the TBL parameter.

Usually, translation between ASCII and EBCDIC for tape and diskette is handled automatically by the system. The QASCII table can be used when a tape or diskette is written with ASCII labels but contains some packed decimal fields. These translation tables cannot be used for ICF files. Translation between ASCII and EBCDIC for ICF is handled by the system using the special tables required for ICF.

Lowercase to Uppercase Translation

IBM supplies two translation tables for lowercase to uppercase translation:

- QSYSTRNTBL in library QSYS translates only unaccented alphabetics (a through z) from lowercase to uppercase.
- QCASE256 in library QUSRSYS translates extended alphabetics (such as ä, ç, and ñ) as well as unaccented alphabetics (a through z) from lowercase to uppercase in code page 256.

Using one of these tables would allow your program to sort uppercase and lowercase letters together, such as a with A, b with B, and so forth.

Using Message Subfiles in a CL Program

In CL programs, message subfiles are the only type of subfiles supported. To use subfile message support, run a SNDF or SNDRCVF command using the subfile message control record. In the DDS, supply SFLPGMQ data and always have SFLINZ active.

When you use message subfiles in CL programs, you must name a program. You cannot specify an * for the SFLPGMQ keyword in DDS. When you specify a program name, all messages sent to that program's message queue are taken from the program message queue and placed in the message subfile. All messages associated with the current request are taken from the program message queue and placed in the message subfile.

Message subfiles let a controlling program display one or more error messages.

Allowing User Changes to CL Commands at Run Time

With most CL programs, the work station user provides input to the program by specifying parameter values passed to the program or by typing into input-capable fields on a display prompt.

You can also prompt the work station user for input to a CL program in the following ways:

- If you enter a ? before the CL command in the CL program source, the system displays a prompt for the CL command. Parameter values you have already specified in your program are filled in and cannot be changed by the work station user. See "Using the Prompter within a CL Program" on page 6-13 later in this section.
- If you call the QCMDEXC program and request selective prompting, the system displays a prompt for a CL command, but you need not specify in the CL program source which CL command is to be used at processing time. For more information on the QCMDEXC program, see "Using the QCMDEXC Program" on page 6-1.

Using the Prompter within a CL Program

You can request prompting within the interactive processing of a CL program. For example, the following program can be compiled and run:

```
PGM
.
.
.
?DSPLIB
.
.
.
ENDPGM
```

In this case, the prompt for the Display Library (DSPLIB) command appears on the display during processing of the program. Processing of the DSPLIB command waits until you have entered values for required parameters and pressed the Enter key.

Any values specified in the source program cannot be changed directly by the operator (or user). For example:

```
PGM
.
.
.
?SNDMSG TOMSGQ(WS01 WS02)
.
.
.
ENDPGM
```

When the program is called and the prompt for the Send Message (SNDMSG) command appears, the operator (or user) can enter values on the MSG, MSGTYPE, and RPYMSGQ parameters, but cannot alter the values on the TOMSGQ parameter. For example, the operator (or user) cannot add WS03 or delete WS02. See "QCMDEXC with Prompting in CL Programs" on page 6-17 for an exception to this restriction. The following restrictions apply to the use of the prompter within a CL program at processing time:

- When the prompter is called from a CL program, you cannot enter a variable name or an expression for a parameter value on the prompt.
- Prompting cannot be requested on a command embedded on an IF, ELSE, or MONMSG command:

  Correct

  ```
  IF (&A=5) THEN(DO)
              ?SNDMSG
              ENDDO
  ```

  Incorrect

  ```
  IF (&A=5) THEN(?SNDMSG)
  ```

- Prompting *cannot* be used for the following commands:

CALL	ENDDO	PGM
CHGVAR	ENDPGM	RCVF
DCL	ENDRCV	RETURN
DCLF	IF	SNDF
DO	GOTO	SNDRCVF
ELSE	MONMSG	TFRCTL
		WAIT

- Prompting cannot be used in batch jobs.

When you enter a prompting request (?) on a command in a CL source program, you may receive a diagnostic message on the command and still have a successful compilation. In this case, you must examine the messages carefully to see that the errors can be corrected by values entered through the prompt display when the program runs.

You can prompt for all commands you are authorized to in any mode while in an interactive environment except for the previously listed commands, which cannot be prompted for during processing of a CL program. This allows you to prompt for any command while at a work station and reduces the need to refer to the manuals that describe the various commands and their parameters.

If you press F3 or F12 to cancel the prompted command while running that command, an escape message (CPF6801) is sent to the CL program. You can monitor for this message using the MONMSG command in the CL program.

When you prompt for a command, your program does not receive the command string you entered. To achieve this, prompt using QCMDCHK and then run the command using QCMDEXC.

Selective Prompting for CL Commands

You can request to prompt for selected parameters within a command. This is especially helpful when you are using some of the longer commands and do not want to be prompted for certain parameters.

Selective prompting can be used during interactive prompting or entered as source (in SEU) for use within a CL program. You can enter the source for selective prompting with SEU but you cannot use selective prompting while entering commands in SEU.

You can use selective prompting to:

- Select the parameters for which prompting is needed.
- Determine which parameters are protected.
- Omit parameters from the prompt.

The following restrictions apply to selective prompting:

- The command name or label must be preceded by a ? (question mark):
  - When one or more of the selective prompt options is ?- (question mark, minus).
  - To avoid getting a CPF6805 message (a message that indicates a diagnostic problem on the command although compilation is successful)

- Parameters can be specified by position but they cannot be preceded by selective prompt characters.
- A parameter must be in keyword form to be selectively prompted for.
- Blanks cannot be entered between the selective prompt characters and the keyword.
- Selective prompting is only applicable at a parameter level; that is, you cannot specify particular keyword values within a list of values.
- ?- is not allowed in prompt override programs.
- If a parameter is required, the ?? selective prompt must be used.

  You can tell that a parameter is required because the input slot is highlighted when the command is prompted.

User-specified values are marked with a special symbol (>) in front of the values in both selective and regular prompting. If a user-specified value on the parameter prompt is not preceded by this symbol, the command default is passed to the command processing program.

If PASSATR(*YES) is specified on the PARM, ELEM, or QUAL command definition statement, and the default value is changed using the CHGCMDDFT command, the default value is shown as a user-specified value (using the > symbol) and not a default value. If a default value of a changed PARM, ELEM, or QUAL command definition statement is changed back to its original default value, the > symbol is removed.

You can press F5 while you are using selective prompting to again display those values initially shown on the display.

If a CL variable is used to specify a value for a parameter which is to be displayed through selective prompting, you can change the value on the prompt, and the changed value is used when the command is run. The value of the variable in the program is not changed. If a CL program contains the following:

```
OVRDBF ?*FILE(FILEA) ??TOFILE(&FILENAME) ??MBR(MBR1)
```

the three parameters, FILE, TOFILE, and MBR will be shown on the prompt display. The value specified for the FILE parameter cannot be changed by you, but the values for the TOFILE and MBR parameters can be changed. Assume that the CL variable &FILENAME has a value of FILE1, and you change it to FILE2. When the command is run, the value of FILE2 is used, but the value of &FILENAME is not changed in the program. The following tables list the various selective prompting characters and the resulting action.

You Enter	Value Displayed	Protected	Value Passed to CPP if Nothing Specified	Marked with > Symbol
??KEYWORD()	Default	No	Default	No
??KEYWORD(VALUE)	Value	No	Value	Yes
?*KEYWORD()	Default	Yes	Default	No
?*KEYWORD(VALUE)	Value	Yes	Value	Yes
?<KEYWORD()	Default	No	Default	No

You Enter	Value Displayed	Protected	Value Passed to CPP if Nothing Specified	Marked with > Symbol
?<KEYWORD(VALUE)	Value	No	Default	No
?/KEYWORD()	Default	Yes	Default	No
?/KEYWORD(VALUE)	Value	Yes	Default	No
?-KEYWORD()	None	N/A	Default	N/A
?-KEYWORD(VALUE)	None	N/A	Value	N/A
?&KEYWORD()	Default	No	Default	No
?&KEYWORD(VALUE)	Value	No	Default	No
?%KEYWORD()	Default	Yes	Default	No
?%KEYWORD(VALUE)	Value	Yes	Default	No

You Enter	Display Value When F5 Pressed or Blanked Out	Description
??KEYWORD()	Default	Normal keyword prompt with command default.
??KEYWORD(VALUE)	Value	Normal keyword prompt with program specified default.
?*KEYWORD()	Default	Show protected prompt (as information) where command default is the only value used.
?*KEYWORD(VALUE)	Value	Show protected prompt (as information) where program specified value is the only value used. For example, when a value should be shown as information but not changed.
?<KEYWORD()	Default	Normal keyword prompt with command default.
?<KEYWORD(VALUE)	Value	Normal keyword prompt with program specified default.
?/KEYWORD()	Default	Reserved for IBM use.
?/KEYWORD(VALUE)	Value	Reserved for IBM use.
?&KEYWORD()	Default	Normal keyword prompt with command default.
?&KEYWORD(VALUE)	Value	Normal keyword prompt with program specified default.
?%KEYWORD()	Default	Show protected prompt (as information) where command default is the only value used.
?%KEYWORD(VALUE)	Value	Show protected prompt (as information) where program specified value is the only value used. For example, when a value should be shown as information but not changed.

Selective prompting can be used with the QCMDEXC or QCMDCHK program. The format of the call is:

```
CALL PGM(QCMDEXC or QCMDCHK) PARM(command command-length)
```

Following is a brief description of the selective prompting characters:

Selective Prompting Character	Description
??	The parameter is displayed and input-capable.
?*	The parameter is displayed but is not input-capable. Any user-specified value will be passed to the command processing program.
?<	The parameter is displayed and is input-capable, but the command default is sent to the CPP unless the value displayed on the parameter is changed.
?/	Reserved for IBM use.
?–	The parameter is not displayed. The specified value (or default) is passed to the CPP. Not allowed in prompt override programs.
?&	The parameter is not displayed until F9=All parameters is pressed. Once displayed, it is input-capable. The command default is sent to the CPP unless the value displayed on the parameter is changed.
?%	The parameter is not displayed until F9=All parameters is pressed. Once displayed, it is not input-capable. The command default is sent to the CPP.

For a further discussion of QCMDEXC or QCMDCHK refer to "Using the QCMDEXC Program" on page 6-1 and "Using the QCMDCHK Program" on page 6-4.

QCMDEXC with Prompting in CL Programs

The QCMDEXC program may be used to call the prompter. This QCMDEXC with Prompting in CL Programs allows you to alter all values on the command except the command name itself. This is more flexible than direct use of the prompter, where you can only enter values not specified in the source program (see previous section). If the prompter is called directly with a command such as:

```
?OVRDBF FILE(FILEX)
```

you can specify a value for any parameter except FILE. However, if the command is called during processing of a CL program using the QCMDEXC program, such as:

```
CALL QCMDEXC PARM('?OVRDBF FILE(FILEX)' 19)
```

you can specify a value for any parameter, including FILE. In this example, FILEX is the default.

Prompting with modifiable specified values may also be accomplished using selective prompting as described earlier in this chapter. However, each keyword which is desired must be explicitly selected. The prompter will be called directly with a command such as:

```
OVRDBF ??FILE(FILEX) ??TOFILE(*N) ??MBR(*N)
```

Using the Programmer Menu

The programmer menu can be called directly by calling the QPGMMENU program, or by using the Start Programmer Menu (STRPGMMNU) command. You can use the command to specify in advance the defaults that you will be using with the programmer menu. In addition, the STRPGMMNU command also supports other options that can be used to tailor the use of the programmer menu.

For a description of the STRPGMMNU command and its parameters, see the *CL Reference*.

Uses of the Start Programmer Menu (STRPGMMNU) Command

The Start Programmer Menu command can be used for the following:

- Performing the same function as a call to QPGMMENU
- Filling in the standard input fields

  Four of the command parameters allow you to fill in the standard input fields at the bottom of the menu. These parameters are the following:
  - Source file
  - Source library
  - Object library
  - Job description

The command may be used with one or more of the parameters that control the initial values of the menu. You could design this as part of an initial program for sign-on or for situations in which a user calls a specific user-written function. The following example shows such a program, with a separate function for each application area requiring different initial values.

```
      PGM
      CHGLIBL   LIBL(PGMR1 QGPL QTEMP)
LOOP:
      STRPGMMNU SRCLIB(PGMR1) OBJLIB(PGMR1) JOBD(PGMR1)
      MONMSG    MSGID(CPF2320) EXEC(GOTO END) /* F3 or F12 to leave menu */
      GOTO LOOP
END:  ENDPGM
```

- Controlling programmer menu options

  The other parameters assist you in controlling the menu and its functions. For example, you can specify ALWUSRCHG(*NO) to prevent a user from changing the values that appear on the menu. This parameter should not be considered to be a security feature because a user who is using the menu can call the STRPGMMNU command and change the values in a separate call. (The user can also start functions by using F10 to call the command entry display.) If the menu is displayed by the STRPGMMNU command, you can prevent the user (by authorization) from calling the QPGMMENU program directly, but you cannot prevent the user from requesting another call of the STRPGMMNU command.

- Adapting the menu create option

  The EXITPGM and DLTOPT parameters allow you to provide your own support for the menu create option (option 3). A user program may be called when option 3 is requested. For a full discussion of the parameters and the parameter list passed to the user program, see the *CL Reference*. The following describes some typical uses of the EXITPGM parameter.

The EXITPGM Parameter

The EXITPGM parameter can be used for the following purposes:

- To change the defaults used on the create commands submitted by option 3.

  For example, if F4 (Prompt) is not used, the EXITPGM parameter could change one or more of the create commands to specify your own default requirements. If F4 is used, the EXITPGM parameter could submit the command as entered by the programmer (with no parameters changed).

- To change parameters regardless of the programmer's use of F4.

  This requires scanning the value of the &RQSDTA512 parameter (which is passed to the exit program) to see if it had already been used and substituting the required value.

- To change other parameters on the SBMJOB command.

  For example, the user parameter of the SBMJOB command could be changed to specify the value of the job description instead of the value of *CURRENT. It is also possible to retrieve the values of one or more job attributes by using the RTVJOBA command, entering the attributes as specific values.

- To enforce local programming conventions.

  For example, if you have a naming standard that requires all physical files to be named with 7 characters and end with a P, the exit program could reject any attempt to use the CRTPF command with a name that did not follow this standard.

- To assist in replacing existing objects, see the member SBMPARMS in file QATTINFO in library QUSRTOOL for documentation and example source for this function and the STRPGMMNU exit program.

Application Programming for DBCS Data

Special considerations must be made when designing application programs to process double-byte data or converting alphanumeric application programs to double-byte programs.

Designing DBCS Application Programs

Design your application programs for processing double-byte data in the same way you design application programs for processing alphanumeric data, with the following additional considerations:

- Identify double-byte data used in the database files, if any.
- Design display and printer formats that can be used with double-byte data.
- If needed, provide double-byte conversion as a means of entering data for interactive applications. Use the DDS keyword for double-byte conversion (IGCCNV) to specify DBCS conversion in display files.
- Write double-byte error messages to be displayed by the program.
- Specify extension character processing so that the system prints and displays all double-byte data.
- Determine which double-byte characters, if any, must be defined. The *CGU User's Guide* describes how to define double-byte characters for DBCS-supported countries.

Converting Alphanumeric Programs to Process DBCS Data

If an alphanumeric application program uses externally-described display files, you can change that application program to a double-byte application program by changing only the files. To convert an application program, do the following:

1. Create a duplicate copy of the source statements for the alphanumeric file you want to change.
2. Change alphanumeric constants and literals to double-byte constants and literals.
3. Change fields in the file to the open (o) keyboard shift so that you can enter both double-byte and alphanumeric data in these fields. You do not have to change the length of the fields.
4. Store the converted display file in a separate library. Give the file the same name as its alphanumeric version.
5. To use the converted file in a job, change the library list, using the Change Library List (CHGLIBL) command, for the job in which the file will be used. The library in which the double-byte display file is stored is then checked before the library in which the alphanumeric version of the file is stored.

Using DBCS Data in a CL Program

The following program shows the use of different keyboard shifts within a CL program. Note how the double-byte data is used only as text values in this program; the commands themselves are in alphanumeric characters.

When run, this program shows you how the different keyboard shifts for DDS display files are used. See the *DDS Reference* for information about double-byte keyboard shifts.

```
PGM

      DCLF     IGCTEST

START: CHGVAR &OUTPUTA   'ABCDEFGHIJ'

       CGVAR   &OUTPUTJ   'ABCD'
       CGVAR   &BOTHJ     'ABCD'
       CGVAR   &OUTPUTE   'EFGH'
       CGVAR   &OUTBUTO   'A B C D F'

LOOP:  SBDRCVF

       IF & INO1 RETURN
       CHGVAR &OUTPUTA   &INPUTA
       CHGVAR &OUTPUTJ   &INPUTJ
       CHGVAR &OUTPUTE   &INPUTE
       CHGVAR &BOTHE     &INPUTE
       CHGVAR &OUTPUTO   INPUTO

     GOTO LOOP

ENDPGM
```

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Sample CL Programs

The following sample programs demonstrate the flexibility, simplicity, and versatility of CL programs. The following programs are described by their function and probable user.

Initial Program for Setup (Programmer)

```
PGM
CHGLIBL LIBL(TESTLIB QGPL QTEMP)
CHGJOB OUTQ(WSPRTR)
TFRCTL QPGMMENU
ENDPGM
```

The test library is placed first on the library list, an output queue is selected for a convenient printer, and the programmer menu is displayed.

Moving an Object from a Test Library to a Production Library (Programmer)

```
PGM PARM(&OBJ &OBJTYPE &OPER)
DCL &OBJ *CHAR LEN(10)
DCL &OBJTYPE *CHAR LEN(7)
DCL &OPER *CHAR LEN(1)  /* R=Replace M=Move */
IF ((&OPER *NE 'M') *AND (&OPER *NE 'R')) THEN(DO)
        SNDPGMMSG MSG('Operation code must be "R" or "M" ')
        RETURN
        ENDDO
IF ((&OBJTYPE *NE *PGM) *AND (&OBJTYPE *NE *FILE) *AND (&OBJTYPE +
    *NE *DTAARA)) THEN(DO)
        SNDPGMMSG MSG('Object' *BCAT &OBJ *BCAT ' must be *PGM, +
                  *FILE, or *DTAARA')
        RETURN
        ENDDO
CHKOBJ BLDLIB/&OBJ OBJTYPE(&OBJTYPE)
MONMSG MSGID(CPF9801) EXEC(DO)
        SNDPGMMSG MSG('Object or object type does not exist +
                  in BLDLIB')
        RETURN
        ENDDO
IF (&OPER *EQ 'M') THEN(DO)
        MOVOBJ BLDLIB/&OBJ OBJTYPE(&OBJTYPE) TOLIB(PRODLIB)
        MONMSG MSGID(CPF3208) EXEC(DO)
                        SNDPGMMSG MSG('Object' *BCAT &OBJ *BCAT ' +
                                  already exists in PRODLIB')
                        RETURN
                        ENDDO
        CHKOBJ PRODLIB/&OBJ OBJTYPE(&OBJTYPE)
        MONMSG MSGID(CPF9801) EXEC(DO)
        SNDPGMMSG MSG('Object or object type does not +
                  exist in PRODLIB')
                  RETURN
                  ENDDO
        ENDDO
RETURN
ENDPGM
```

The object name, object type, and operation code are passed from another program. Checks are performed to see that the operation code and object type are correct, and that the object exists in the test library. The object is moved unless it already exists in the production library. The move is then confirmed. More commands can be added to grant additional authority to the object or to handle additional exceptions and additional object types.

Saving Specific Objects in an Application (System Operator)

Example

```
PGM
SAVOBJ OBJ(FILE1 FILE2) LIB(LIBA) OBJTYPE(*FILE) LOC(*S12) +
  CLEAR(*YES)
SAVOBJ OBJ(DTAARA1) LIB(LIBA) OBJTYPE(*DTAARA) LOC(*S12)
SNDPGMMSG MSG('Save of daily backup of LIBA completed') +
  MSGTYPE(*COMP)
ENDPGM
```

This program ensures consistent command entry for regularly repeated procedures.

Additional Save Object (SAVOBJ) commands can, of course, be added. However, this program relies on the operator selecting the correct diskette or tape for each periodic backup of each application. This can be controlled by assigning unique names to each diskette or tape set for each save operation. If you want to save your payroll files separately each week for four weeks, for instance, you might name each diskette or tape differently and write the program to compare the name of the diskette or tape against the correct name for that week.

Recovery from Abnormal End (System Operator)

```
PGM
DCL &SWITCH *CHAR LEN(1)
RTVSYSVAL SYSVAL(QABNORMSW) RTNVAR(&SWITCH)
IF (&SWITCH *EQ '1') THEN(DO)  /*CALL RECOVERY PROGRAMS*/
        SNDPGMMSG MSG('Recovery programs in process. +
          Do not start subsystems until notified') +
          MSGTYPE(*INFO) TOMSGQ(QSYSOPR)
        CALL PGMA
        CALL PGMB
        SNDPGMMSG MSG('Recovery programs complete. +
          Startup subsystems') +
          MSGTYPE(*INFO) TOMSGQ(QSYSOPR)
        RETURN
        ENDDO
ENDPGM
```

Submitting a Job (System Operator)

```
PGM  /*DAILYAC*/
SBMJOB JOB(DAILYACCRC) JOBD(ACCRC2) +
             CMD(CALL ACCRC305 PARM(DAILY))
SNDPGMMSG    MSG('Daily Accounts Receivable job DAILYACCRC +
             submitted to batch') MSGTYPE(*COMP)
ENDPGM
```

Instead of typing in all the parameters for submitting a job, the system operator simply calls DAILYAC.

Timing Out While Waiting for Input from a Device Display

```
            PGM
            DCLF FILE(QGPL/MENU)
START:      SNDRCVF DEV(*FILE) RCDFMT(MENUFMT) WAIT(*NO)
            WAIT
            MONMSG MSGID(CPF0889) EXEC(SIGNOFF)
            CHGVAR VAR(&IN99) VALUE('0')
            IF COND(&IN01) THEN(GOTO CMDLBL(START))
OPTION1:    /* OPTION 1-ORDER ENTRY */
            IF COND(&OPTION *EQ '1') THEN(DO)
            CALL PGM(ORDENT)
            GOTO CMDLBL(START)
            ENDDO
OPTION2:    /* OPTION 2-ORDER DISPLAY */
            IF COND(&OPTION *EQ '2') THEN(DO)
            CALL PGM(ORDDSP)
            GOTO CMDLBL(START)
            ENDDO
OPTION3:    /* OPTION 3-ORDER CHANGE */
            IF COND(&OPTION *EQ '3') THEN(DO)
            CALL PGM(ORDCHG)
            GOTO CMDLBL(START)
            ENDDO
OPTION4:    /* OPTION 4-ORDER PRINT */
            IF COND(&OPTION *EQ '4') THEN(DO)
            CALL PGM(ORDPRT)
            GOTO CMDLBL(START)
            ENDDO
OPTION9:    /* OPTION 9-SIGNOFF */
            IF COND(&OPTION *EQ '9') THEN(SIGNOFF)
OPTIONERR:  /* OPTION SELECTED NOT VALID */
            CHGVAR VAR(&IN99) VALUE('1')
            GOTO CMDLBL(START)
            ENDPGM
```

This program illustrates how to write a CL program using a display file that will wait for a specified amount of time for the user to enter an option. If he does not, the user is signed off.

The display file was created with the following command:

```
CRTDSPF FILE(MENU) SRCFILE(QGPL/QDDSSRC) SRCMBR(MENU)  +
    DEV(*REQUESTER) WAITRCD(60)
```

The display file will use the *REQUESTER device. When a WAIT command is issued, it waits for the number of seconds (60) specified on the WAITRCD keyword. The following is the DDS for the display file:

```
SEQNBR *... ... 1 ... ... 2 ... ... 3 ... ... 4 ... ... 5 ... ... 6 ... ... 7 ... ... 8

0100       A                                      PRINT CA01(01)
0200       A          R MENUFMT                   BLINK
0300       A                                      TEXT('Order Entry Menu')
0400       A                                    1 31'Order Entry Menu'
0500       A                                    2  2'Select one of the following:    '
0600       A                                    3  4'1.  Enter Order'
0700       A                                    4  4'2.  Display Order'
0800       A                                    5  4'3.  Change Order'
0900       A                                    6  4'4.  Print Order'
1000       A                                    7  4'9.  Sign Off'
1100       A                                   23  2'Option:'
1200       A            OPTION         1   I 23 10
1300       A  99                                  ERRMSG('Invalid option selected.')

                          ****** END OF SOURCE *****
```

The program performs a SNDRCVF WAIT(*NO) to display the menu and request an option from the user. Then it issues a WAIT command to accept an option from the user. If the user enters a 1 through 4, the appropriate program is called. If the user enters a 9, the SIGNOFF command is issued. If the user enters an option that is not valid, the menu is displayed with an 'OPTION SELECTED NOT VALID' message. The user can then enter another valid option. If the user does not respond within 60 seconds, the CPF0889 message is issued to the program and the MONMSG command issues the SIGNOFF command.

A SNDF command using a record format containing the INVITE DDS keyword could be used instead of the SNDRCVF WAIT(*NO). The function would be the same.

Retrieving Program Attributes

The Display Program (DSPPGM) command can be used to display the attributes of a program. To retrieve some of the attributes (such as program type, source member, text, creation date) into CL variables, the Display Object Description (DSPOBJD) command can be used to build an output file. The output file can then be read within a CL program using the Declare File (DCLF) and Receive File (RCVF) commands. To access some of the other attributes of the DSPPGM command (such as USRPRF), the QUSRTOOL tool RTVPGMATR can be used.

Loading and Running an Application from Tapes or Diskettes

The Load and Run Media Program (LODRUN) command allows the user to load and run an application written by another user or a software vendor from tapes or diskettes supplied by the other user.

When the LODRUN command is run:

- The media is searched for the user-written program, which must be named QINSTAPP. If tape is used, the tape is rewound first.
- If a QINSTAPP program already exists in the QTEMP library on the user's system, it is deleted.
- The QINSTAPP program is restored to the QTEMP library using the RSTOBJ command.
- Control of the system is passed to the QINSTAPP program. The QINSTAPP program may be used, for example, to restore other applications to the user's system and run those applications.

Responsibilities of the Application Writer

The user supplying the QINSTAPP program is responsible for writing and supporting it. The QINSTAPP program is not supplied by IBM*. The program can be designed to accomplish many different tasks. For example, the program could:

- Restore and run other programs or applications
- Restore a library
- Delete another program or application
- Create specific environments
- Correct problems in existing applications

Figure 6-1 on page 6-26 shows an example of a QINSTAPP program. The program is saved to a tape or diskette by the program writer and loaded on the system using the LODRUN command. The LODRUN command passes control of the system to the program, which then performs the tasks written into the program.

```
PGM         PARM(&DEV)  /* "Device" is only Parm allowed          */
DCL         VAR(&DEV)   TYPE(*CHAR) LEN(10)
DCL         VAR(&MODEL) TYPE(*CHAR) LEN(4)

/* Can check for appropriate model number, release level, and so on */
RTVSYSVAL   SYSVAL(QMODEL) RTNVAR(&MODEL)
IF          (&MODEL *EQ 'xxxxx') THEN...

/* Install a library for new application (programs, data):         */
RSTLIB      SAVLIB(NEWAPP) DEV(&DEV) ENDOPT(*LEAVE) +
              MBROPT(*ALL)
/* Install a command to start new application:                     */
            RSTOBJ OBJ(NEWAPP) SAVLIB(QGPL) DEV(&DEV) +
              MBROPT(*ALL)

END:        ENDPGM
```

Figure 6-1. Example of an Application Using the LODRUN Command

Chapter 7. Defining Messages

On the AS/400 system, communication between programs, between jobs, between users, and between users and programs occurs through messages. A message can be predefined or immediate:

- A predefined message is created and exists outside the program that uses it. Predefined messages are stored in message files and have a message number. An example of a system predefined message is:

  ```
  CPF0006  Errors occurred in command.
  ```

- An immediate message is created by the sender at the time it is sent. An immediate message is not stored in a message file. An example of an immediate message received at a display station is:

  ```
  From . . . :   QSYSOPR      06/12/88   10:50:54
  System going down at 11:00; please sign off
  ```

Your system comes with an extensive set of predefined messages that allow communication between programs within the system and between the system and its users. Each licensed program you order has a message file that is stored in the same library as the licensed program it applies to. For example, system messages are stored in the file QCPFMSG in the library QSYS.

Each predefined message in a message file is uniquely identified by a 7-character code and is defined by a message description. The message description contains information, such as message text and message help text, severity level, valid and default reply values, and various other attributes. See the Add Message Description (ADDMSGD) command description in the *CL Reference*.

All messages that are sent or received in the system are transmitted through a message queue. Messages that are issued in response to a direct request, such as a command, are automatically displayed on the display from which the request was made. For all other messages, the user or program must receive the message from the queue or display it. There are several IBM-supplied message queues in the system; these message queues are described later in this chapter (see "Types of Message Queues" on page 7-18).

The system also writes some of the messages that are issued to logs. A job log contains information related to requests entered for a job, the history log contains job, subsystem, and device status information. See "Message Logging" on page 8-36 for more information on logging.

You can create your own message files and message descriptions. By creating predefined messages, you can use the same message in several programs but define it only once. You can also change and translate predefined messages into languages other than English (based on the user viewing the messages) without affecting the program that uses them. If the messages were included in the program, the program would have to be recompiled when you change the messages.

In addition to creating your own messages and message files, the system message handling function allows you to:

- Create and change message queues (Create Message Queue [CRTMSGQ], Change Message Queue [CHGMSGQ], and Work with Message Queues [WRKMSGQ] commands)
- Change message descriptions (Change Message Description [CHGMSGD] command)
- Remove message descriptions (Remove Message Description [RMVMSGD] command)
- Send immediate messages (Send Message [SNDMSG], Send Break Message [SNDBRKMSG], Send Program Message [SNDPGMMSG], and Send User Message [SNDUSRMSG] commands)
- Display messages and message descriptions (Display Messages [DSPMSG], Display Message Description [DSPMSGD], Work with Messages [WRKMSG], and Work with Message Descriptions [WRKMSGD] commands)
- Use a CL program to:
  - Send a message to a work station user or the system operator (Send User Message [SNDUSRMSG] command)
  - Send a message to a message queue (Send Program Message [SNDPGMMSG] command)
  - Receive a message from a message queue (Receive Message [RCVMSG] command)
  - Send a reply for a message to a message queue (Send Reply [SNDRPY] command)
  - Retrieve a message from a message file (Retrieve Message [RTVMSG] command)
  - Remove a message from a message queue (Remove Message [RMVMSG] command)
  - Monitor for escape, notify, and status messages that are sent to a program's program message queue (Monitor Message [MONMSG] command)
- Use the system reply list to specify the replies for predefined inquiry messages sent by a job (Add Reply List Entry [ADDRPYLE], Change Reply List Entry [CHGRPYLE], Remove Reply List Entry [RMVRPYLE], and Work with Reply List Entry [WRKRPYLE] commands)

When a message is sent, it is defined as one of the following types:

- Informational (*INFO). A message that conveys information about the condition of a function.
- Inquiry (*INQ). A message that conveys information but also asks for a reply.
- Notify (*NOTIFY). A message that describes a condition for which a program requires corrective action or a reply from its calling program. A program can monitor for the arrival of notify messages from the programs it calls.
- Reply (*RPY). A message that is a response to a received inquiry or notify message.
- Sender's copy (*COPY). A copy of an inquiry or notify message that is kept by the sender.

- Request (*RQS). A message that requests a function from the receiving program. (For example, a CL command can be a request message.)
- Completion (*COMP). A message that conveys completion status of work.
- Diagnostic (*DIAG). A message about errors in the processing of a system function, in an application program, or in input data.
- Status (*STATUS). A message that describes the status of the work done by a program. A program can monitor for the arrival of status messages from the program it calls. Status messages sent to the external message queue (*EXT) are shown at the display station and can be used to inform the display station user of an operation in progress.
- Escape (*ESCAPE). A message that describes a condition for which a program must end abnormally. A program can monitor for the arrival of escape messages from the program it calls or from the machine.

This chapter describes:

- How to create your own message files
- How to add message descriptions to a message file
- Types of message queues
- How to create message queues

Creating a Message File

To create your own predefined messages, you must first create the message file into which the messages are to be placed. Use the Create Message File (CRTMSGF) command to create the message file. You then use the Add Message Description (ADDMSGD) command to describe your messages and place them in the message file.

On the CRTMSGF command, you can specify the maximum size in K bytes on the SIZE parameter. The following formula can be used to determine the maximum:

```
S + (I x N)
```

where:

S Is the initial amount of storage

I Is the amount of storage to add each time

N Is the number of times to add storage

The defaults for S, I, and N are 10, 2, and *NOMAX, respectively.

For example, you specify S as 5, I as 1, and N as 2. When the file reaches the initial storage amount of 5K, the system automatically adds another 1K to the initial storage. The amount added (1K) can be added to the storage two times to make the total maximum of 7K. If you specify *NOMAX as N, the maximum size of the message file is 16M.

When you specify a maximum size for a message file and the message file becomes full, you cannot change the size of the message file. You then need to create another message file and re-create the messages in the new file. The Merge Message File (MRGMSGF) command can be used to copy message descriptions from one message file to another. Since you will want to avoid this

step, it is important to calculate the size needed for your message file when you create it, or specify *NOMAX.

Determining the Size of a Message File

You can determine the size of a message by using the following formula. (The ADDMSGD command parameters are given in parentheses.)

- Message index equals 42 bytes base plus the length of the message.
- Message text (MSG) equals 16 bytes base plus the length of the message.
- Message online help information (SECLVL), if any, equals 16 bytes base plus the length of the message help.
- Formats (FMT), if any, equal 14 bytes plus (3 x number of FMTS).
- Type and length (TYPE and LEN) equal 48 bytes.
- Special value (SPCVAL) equals 2 plus (64 x number of SPCVALs).
- Values (VALUES) equal 32 x (number of VALUES).
- Range (RANGE) equals 64 bytes.
- Relation (REL) equals the length of the relation.
- Default (DFT) equals the length of the default reply.
- Default program, log problem, and dump list (DFTPBM, LOGPRB, DMPLST) equal 35 plus (2 x number in DMPLST).
- ALROPT equals 12 bytes.

The smallest possible entry in a message file is 59 bytes and the largest possible entry is 5764 bytes. The following table describes the largest possible entry:

Message index	42 bytes
Message text	148 bytes
Message help text	3016 bytes
99 formats	311 bytes
Type and length	48 bytes
20 special values	1282 bytes
20 values	640 bytes
Default reply value	32 bytes
Default program and dump list	233 bytes
Alert option	12 bytes

In the following example, the CRTMSGF command creates the message file USRMSG:

```
CRTMSGF   MSGF(QGPL/USRMSG) +
          TEXT('Message file for user-created messages')
```

If you are creating a message file to be used with the DSPLY operation code in RPG/400, the message file must be named QUSERMSG.

Adding Messages to a File

You use the Add Message Description (ADDMSGD) command to describe your predefined messages and to add them to the message file you created. On the ADDMSGD command, you specify the message identifier, the name of the message file into which the message is to be placed, and the message description. In the message description, you can specify:

- Message text (required) with optional substitution variables
- Message help text with optional substitution variables
- Severity code
- Description of the format of the message data to be used for the substitution variables
- Validity checking values for a reply
- Default value for a reply
- Default message handling action for escape messages
- Creation level
- Alert options
- Entry in the error log

Each of the items that can be contained in the message description is described in more detail on the following pages.

The following commands are also available for use with message descriptions:

Change Message Description (CHGMSGD)
Changes a message description.

Display Message Description (DSPMSGD)
Displays a message description. (A range of message identifiers can be specified in this command.)

Remove Message Description (RMVMSGD)
Removes a message description from a message file.

Retrieve Message (RTVMSG)
Retrieves a message from a message file.

Merge Message File (MRGMSGF)
Merges messages from one message file into another message file.

Work with Message Descriptions (WRKMSGD)
Displays a list of messages in a file and allows you to add, change, or delete message descriptions.

Assigning a Message Identifier

The message identifier you specify on the ADDMSGD command is used to refer to the message and is the name of the message description. The message identifier must be 7 characters:

```
pppmmnn
```

where `ppp` is the product or application code, `mm` is the numeric group code, and `nn` is the numeric subtype code. The number specified as `mmnn` can be used to further divide a set of product or application messages. Numeric group and subtype codes consist of decimal numbers 0 through 9 and the characters A through F.

For example:

```
CPF1234
```

is message 1234 of CPF.

When you create your own messages, using the letter U as the first character in the product code is a good way to distinguish your messages from system messages. For example:

```
USR3567
```

The first character of the code must be alphabetic, the second and third characters can be alphanumeric; the group code and the subtype code must consist of decimal numbers 0 through 9 and the characters A through F. Note that although this range can be called a set of hexadecimal numbers, any sorting of the message numerics treats A through F as characters.

For example, when displaying a range of message descriptions, CPFA000 precedes CPF1000.

You should use care in using a numeric subtype code of 00 in the message identifier. If you use a numeric subtype code of 00 for a message that can be sent as an escape, notify, or status message and that can, therefore, be monitored, a subtype code of 00 in the Monitor Message (MONMSG) command causes all messages in the numeric group to be monitored. See "Monitoring for Messages in a CL Program" on page 8-16 for more information.

Defining Messages and Message Help

You can define two levels of messages on the ADDMSGD command. The text of the message is required and should identify the condition that caused the message to be issued. Message help is optional and should explain the condition further or explain the corrective action to be taken. To get message help, the display station user must move the cursor to the message line and press the Help key when the message is displayed. Message help can be formatted for the display station using three format control characters. These characters may be used to make the message help (usually online help information) more readable for the user.

Each of the three format control characters must be followed by a blank to separate them from the message.

&Nb (where b is a blank)
Forces the text to a new line (column 2). If the text is longer than one line, the next lines are indented to column 4 until the end of the text or until another format control character is found.

&Pb (where b is a blank)
Forces the text to a new line, indented to column 6. If the text is longer than one line, the next lines start in column 4 until the end of the text or until another format control character is found.

&Bb (where b is a blank)
Forces the text to a new line, starting in column 4. If the text is longer than one line, the next lines are indented to column 6 until the end of the text or until another format control character is found.

Assigning a Severity Code

The severity code you assign to a message on the ADDMSGD command indicates how important the message is. The higher the severity code the more serious the condition is. The following lists the severity codes you can use and their meanings. (These severity codes and their meanings are consistent with the severity codes assigned to IBM-predefined messages.)

00: Information. For information purposes only; no error was detected and no reply is needed. The message could indicate that a function is in progress or that a function has completed successfully.

10: Warning. A potential error condition exists. The program may have taken a default, such as supplying missing input. The results of the operation are assumed to be successful.

20: Error. An error has been detected, but it is one for which automatic recovery procedures probably were applied; processing has continued. A default may have been taken to replace erroneous input. The results of the operation may not be valid. The function may have been only partially completed; for example, some items in a list processed correctly while others failed.

30: Severe error. The error detected is too severe for automatic recovery, and no defaults are possible. If the error was in source data, the entire input record was skipped. If the error occurred during program processing, it leads to an abnormal end of the program (severity 40). The results of the operation are not valid.

40: Abnormal end of program or function. The operation has ended, possibly because the program was unable to handle data that was not valid, or possibly because the user has canceled it.

50: Abnormal end of job. The job was ended or was not started. A routing step may have ended abnormally or failed to start, a job-level function may not have been performed as required, or the job may have been canceled.

60: System status. Issued only to the system operator. It gives either the status of or a warning about a device, a subsystem, or the system.

70: Device integrity. Issued only to the system operator. It indicates that a device is malfunctioning or in some way is no longer operational. The user may be able to recover from the failure, or the assistance of a service representative may be required.

80: System alert. A message with a severity code of 80 is issued for immediate messages. It also warns of a condition that, although not severe enough to stop the system now, could become more severe unless preventive measures are taken.

90: System integrity. Issued only to the system operator. It describes a condition that renders either a subsystem or the system inoperative.

99: Action. Some manual action is required, such as entering a reply, changing printer forms, or replacing diskettes.

For a detailed discussion of the SEV parameter, see the *CL Reference*.

Defining Substitution Variables

On the FMT parameter on the ADDMSGD command, you can specify substitution variables for either first- or second-level messages. For example:

```
File &1 not found
```

contains the substitution variable &1. When the message is displayed or retrieved, the variable &1 is replaced with the name of the file that could not be found. This name is supplied by the sender of the message. For example:

```
File ORDHDRP not found
```

Compare this to:

```
File not found
```

Substitution variables can make your message more specific and more meaningful.

The substitution variable must begin with & (ampersand) and be followed by n, where n is any number from 1 through 99. For example, for the message:

```
File &1 not found
```

the substitution variable is defined as:

```
FMT((*CHAR 10))
```

When you assign numbers to substitution variables, you must begin with the number 1 and use the numbers consecutively. For example, &1, &2, &3, and so on. However, you do not have to use all the substitution variables defined for a message description in the message that is sent.

For example, the message:

```
File &3 not available
```

is valid even though &1 and &2 are not used in the messages. However, to do this, you must define &1, &2, and &3 on the FMT parameter of the ADDMSGD command. For the preceding message, the FMT parameter could be:

```
FMT((*CHAR 10) (*CHAR 2) (*CHAR 10))
```

where the first value describes &1, the second &2, and the third &3. The description for &1 and &2 must be present if &3 is used. In addition, when this message is sent, the MSGDTA parameter on the Send Program Message (SNDPGMMSG) command should include all the data described on the FMT parameter. To send the preceding message, the MSGDTA parameter should be at least 22 characters long.

For the preceding message, you could also specify the FMT parameter as:

```
FMT((*CHAR 0) (*CHAR 0) (*CHAR 10))
```

Because &1 and &2 are not used in the message, they can be described with a length of 0. Then no message data needs to be sent. (The MSGDTA parameter on the SNDPGMMSG command needs to be only 10 characters long in this case.)

An example of using &3 in the message and including &1 and &2 in the FMT parameter is when &1 and &2 are specified on the DMPLST parameter. (The DMPLST parameter specifies that the data is to be dumped when this message is sent as an escape message to a program that is not monitoring for it.)

The substitution variables do not have to be specified in the message in the same order in which they are defined in the FMT parameter. For example, three values can be defined in the FMT parameter as:

```
FMT((*CHAR 10) (*CHAR 10) (*CHAR 7))
```

The substitution variables can be used in the message as follows:

```
Object &1 of type &3 in library &2 is not available
```

If this message is sent in a CL program, you can concatenate the values used for the message data such as:

```
SNDPGMMSG .....MSGDTA(&OBJ *CAT &LIB *CAT &OBJTYPE)
```

You must specify the format of the message data field for the substitution variable by specifying data type and, optionally, length on the ADDMSGD command. The valid data types for message data fields are:

- Quoted character string (*QTDCHAR). A string of character data to be enclosed in apostrophes. Preceding and trailing blanks are not deleted. If length is not specified in the message description, the sender determines the length of the field.
- Character string without quotation marks (*CHAR). A string of character data not to be enclosed in apostrophes. Trailing blanks are deleted. If length is not specified in the message description, the sender determines the length of the field.
- Hexadecimal (*HEX). A string to be preceded by the character X and enclosed in apostrophes; each byte of the string is to be converted into two hexadecimal characters (0 through 9 and A through F). If length is not specified in the message description, the sender determines the length of the field.
- Binary (*BIN). A binary integer (either 2 or 4 bytes long) formatted as a signed decimal integer. If length is not specified, 2 is assumed.
- Decimal (*DEC). A packed decimal number to be formatted as a signed decimal number with a decimal point. Length must be specified; decimal positions default to 0.

The following data types are valid only in IBM-supplied message descriptions and should not be used for other messages:

- Time interval (*ITV). An 8-byte time interval that contains the time to the nearest whole second for various wait time out conditions.
- Date and time stamp (*DTS). An 8-byte system date and time stamp for which the date is to be formatted as specified in the QDATFMT and QDATSEP system values and the time is to be formatted as hh:mm:ss.
- System pointer (*SYP). A 16-byte pointer to a system object. In a message or message help, the name of the object is formatted the same as the *CHAR type data.
- Space pointer (*SPP). A 16-byte pointer to a program object. In a dump, the data in the object is formatted the same as the *HEX type data. *SPP cannot be used as substitution text in a message; it can only be used as part of the DMPLST parameter on the ADDMSGD command.

Specifying Validity Checking for Replies

On the ADDMSGD command, you can specify the type of reply that is valid for an inquiry or notify message. You can specify (parameters are given in parentheses):

- Type of reply (TYPE)
  - Decimal (*DEC)
  - Character (*CHAR)
  - Alphabetic (*ALPHA)
  - Name (*NAME)
- Maximum length of reply (LEN)
  - For decimal, 15 digits (9 decimal positions)
  - For character and alphabetic, 32 characters
  - For name, 10 characters

  Note: If you do not specify any validity checking (VALUES, RANGE, REL, SPCVAL, DFT), the maximum length of a reply is 132 characters for types *CHAR and *ALPHA.
- Values that can be used for the reply (VALUES SPCVAL RANGE REL)
  - A list of values
  - A list of special values
  - A range of values
  - A simple relationship that the reply value must meet

  Note: The special values are values that can be accepted but that do not satisfy any other validity checking values.

When a display station user enters a reply to a message, the keyboard is in lower shift which causes lowercase characters to be entered. If your program needs the reply to be in uppercase characters, you can do one of the following:

- Use the SNDUSRMSG command which supports a translation table option which defaults to converting lowercase to uppercase.
- Require the display station user to enter uppercase characters by specifying only uppercase characters for the VALUES parameter.
- Specify the VALUES parameter as uppercase and use the SPCVAL parameter to convert the corresponding lowercase characters to uppercase.
- Use TYPE(*NAME) if the characters to be entered are all letters (A-Z). The characters are converted to uppercase before being checked.

Sending an Immediate Message and Handling a Reply

In this example, the program does the following:

- Sends an immediate inquiry message to QSYSOPR
- Requests a reply of yes or no (Y or N)
- Ensures that a valid reply has been entered
- Does a time-out if the operator does not reply within 120 seconds

```
            PGM
            DCL         &MSGKEY *CHAR LEN(4)
            DCL         &MSGRPY *CHAR LEN(1)
SNDMSG:     SNDPGMMSG   MSG('.... Reply Y or N') TOMSGQ(QSYSOPR) +
                          MSGTYPE(*INQ) KEYVAR(&MSGKEY)
            RCVMSG      MSGTYPE(*RPY) MSGKEY(&MSGKEY) WAIT(120) +
                          MSG(&MSGRPY)
            IF          ((&MSGRPY *EQ 'Y') *OR (&MSGRPY *EQ 'y')) DO
            .
            .
            GOTO        END
            ENDDO       /* Reply of Y */
            IF          ((&MSGRPY *EQ 'N') *OR (&MSGRPY *EQ 'n')) DO
            .
            .
            GOTO        END
            ENDDO       /* Reply of N */
            IF          (&MSGRPY *NE ' ') DO
            SNDPGMMSG   MSG('Reply was not Y or N, try again') +
                          TOMSGQ(QSYSOPR)
            GOTO        SNDMSG
            ENDDO       /* Reply not valid */
    /* Timeout occurred */
            SNDPGMMSG   MSG('No reply from the previous message +
                          was received in 120 seconds and a ''Y'' +
                          value was assumed') TOMSGQ(QSYSOPR)
            .
            .
END:        ENDPGM
```

The SNDUSRMSG command cannot be used instead of this program because it does not support a time-out option (SNDUSRMSG waits until it receives a reply or until the job is canceled).

The SNDPGMMSG command sends the message and specifies the KEYVAR parameter. This returns a message reference key, which uniquely identifies this message so that the reply can be properly matched with the RCVMSG command. The KEYVAR value must be defined as a character field length of 4.

The RCVMSG command specifies the message reference key value from the SNDPGMMSG command for the MSGKEY parameter to receive the specific message. The reply is passed back into the MSG parameter. The WAIT parameter specifies how long to wait for a reply before timing out.

When the reply is received, the program logic checks for an upper or lower case value of the Y or N. Normally the value is entered by the operator as a lower case value. If the operator enters a non-blank value other than Y or N, the program sends a different message and then repeats the inquiry message.

If the operator had entered a blank, no reply is sent to the program. If a blank is returned to the program, the time out occurred (the operator did not reply). The program sends a message to the system operator stating that a reply was not received and the default was assumed (the "Y" value is shown as 'Y' in the message queue). Because the assumed value of 'Y' is not displayed as the reply, you cannot determine when looking at a message queue whether the message should be answered or has already timed out. The program cannot remove a message from the message queue once it has been sent. The second message should minimize this concern and provides an audit trail for what has occurred.

If the time out has already occurred and the operator replies to the message, the reply is ignored. The operator receives no indication that the reply has been ignored.

Sending Immediate Messages with Double-Byte Characters

To send an immediate message with double-byte text, limit the text to 37 double-byte characters plus the shift control characters. The limited size of the message ensures it is properly displayed.

Defining Default Values for Replies

The ADDMSGD command allows you to specify a default value for a reply to your message. A default reply must meet the same validity checking values as the other replies for the message or be specified as a special value in the message description. A default value is used when a user has indicated (using the CHGMSGQ command) that default replies should be issued for all inquiry messages sent to the user's message queue. Default replies are also sent when the unanswered inquiry messages are deleted. For example, the work station user uses the DSPMSG command to display messages, and removes unanswered inquiry messages by pressing either F13 to delete all the messages or F11 to delete a particular message.

Default replies are also used when the job attribute of INQMSGRPY is set to *DFT and may be used if set to *SYSRPYL option. You can use the system reply list to change the default reply.

Specifying Default Message Handling for Escape Messages

For each message you create that can be sent as an escape message, you can set up a default message handling action to be used if the program to which the message is sent does not monitor for or handle it.

Default message handling actions can consist of:

- Default program name. A program to be called that takes default action to handle a message. The following parameters are passed to the default program:
  - Program message queue name (10 characters). The name of the program message queue to which the message was sent (this is the same name as that of the program that did not monitor for the escape message).
  - Message reference key (4 characters). The message reference key of the escape message on the program message queue.
- Dump list. A list of message data field numbers (the same numbers as the substitution variables) that indicate which objects are to be dumped.

  In addition, you can dump any of the following:

- The data areas for the job
- An internal machine data structure of a job
- A job

  Specifying a dump list for a job is equivalent to specifying the Display Job (DSPJOB) command with the parameters JOB(*) OUTPUT(*PRINT).

If you do not specify default actions in message descriptions, you will get a dump of the job (as if DSPJOB JOB(*) OUTPUT(*PRINT) was specified).

Example of a Default Program

The following program is a sample default program that could be used when a diagnostic message is sent followed by an escape message.

```
            PGM PARM(&PGMNAME &MRK)
            DCL VAR(&PGMNAME) TYPE(*CHAR) LEN(10)
            DCL VAR(&MRK) TYPE(*CHAR) LEN(4)
            DCL VAR(&BLANKMRK) TYPE(*CHAR) LEN(4) VALUE('  ')
            DCL VAR(&DIAGMRK) TYPE(*CHAR) LEN(4) VALUE('  ')
            DCL VAR(&SAVEMRK) TYPE(*CHAR) LEN(4)
            DCL VAR(&MSGID) TYPE(*CHAR) LEN(7)
            DCL VAR(&MSGDTA) TYPE(*CHAR) LEN(100)
            DCL VAR(&MSGF) TYPE(*CHAR) LEN(10)
            DCL VAR(&MSGLIB) TYPE(*CHAR) LEN(10)
GETNEXTMSG: CHGVAR VAR(&SAVEMRK) VALUE(&DIAGMRK)
            RCVMSG PGMQ(*SAME &PGMNAME) MSGTYPE(*DIAG) +
                   RMV(*NO) KEYVAR(&DIAGMRK)
            IF  (&DIAGMRK *NE &BLANKMRK) THEN(GOTO GETNEXTMSG)
            ELSE
             DO
              RCVMSG      PGMQ(*SAME &PGMNAME) MSGTYPE(*DIAG) +
                            MSGKEY(&SAVEMRK) RMV(*NO) +
                            MSGDTA(&MSGDTA) MSGID(&MSGID) MSGF(&MSGF) +
                            MSGFLIB(&MSGFLIB)
              SNDPGMMSG   MSGID(&MSGID) MSGF(&MSGLIB/&MSGF) +
                            MSGDTA(&MSGDTA) TOPGMQ(*PRV &PGMNAME) +
                            MSGTYPE(*ESCAPE)
             ENDDO
            ENDPGM
```

The program receives all the diagnostic messages in FIFO order. Then it sends the last diagnostic message as an escape message to allow the previous program to monitor for it.

Specifying the Alert Option

On the ADDMSGD command, you can specify an alert option to allow an alert to be created for a message. A message, for which an alert can be created, can cause an SNA alert to be created and sent to a problem management focal point. The alert created for a message can be defined using the Add Alert Description (ADDALRD) command. For more information about the OS/400 alerts support, you can refer to the *Alerts and DSNX Guide*.

Example of Describing a Message

In the following example, the ADDMSGD command creates a message to be used in applications such as order entry. The message is issued when a customer number entered on the display is not found. The message is:

```
Customer number &1 not found
```

The ADDMSGD command for this message is:

```
ADDMSGD   MSGID(USR4310) +
          MSGF(QGPL/USRMSG)  +
          MSG('Customer number &1 not found') +
          SECLVL('Change customer number') +
          SEV(40) +
          FMT((*CHAR 8))
```

The message is added to the USRMSG file in the library QGPL.

You can use the DSPMSGD or WRKMSGD command to print or display message descriptions.

The SECLVL parameter provides very simple text. To make this appear on the Additional Message Information display, you specify `SECLVL('message text')`. The text you specify on this parameter appears on the Additional Message Information display when you press the Help key after placing the cursor on this message.

Defining Double-Byte Messages

To define a message with double-byte text, write a CL program using the ADDMSGD command. The defined message is put into a message file and then sent normally. When writing the program, do the following:

1. Make sure the source file containing the program is a double-byte file. Specify IGCDTA(*YES) on the Create Source Physical File (CRTSRCPF) command.
2. Use the source entry utility (SEU) to enter the program. CL commands using double-byte characters can only be entered through SEU. For this reason, double-byte messages must be created in a CL program.
3. Limit the length of the message to 37 double-byte characters, so the complete message can be displayed or printed.

   When using the MONMSG command, also limit the Comparison Data (CMPDATA) parameter to 6 double-byte characters.
4. If the double-byte message file replaces an alphanumeric message file (such as files of translated messages to be sent only to double-byte display stations), enter a command similar to the following to override the alphanumeric message file:

   ```
   OVRMSGF MSGF(QCPFMSG) TOMSGF(DBCSLIB/QCPFMSG)
   ```

   Double-byte messages can be displayed only at double-byte display stations.

Overriding Message Files

You can override message files used in a program. The creation (Override Message File command), deletion (Delete Override command), and display (Display Override command) of message file overrides is similar to other types of overrides (see the *Data Management Guide*). Here, however, only the name of the message file, not the attributes, is overridden, and the rules for applying the overrides are slightly different.

To override a message file, use the Override Message File (OVRMSGF) command. The file overridden is specified in the MSGF parameter; the file overriding it is specified in the TOMSGF parameter.

For example, to override QCPFMSG with a user message file named USRMSGF, the following command would be used:

```
OVRMSGF MSGF(QCPFMSG) TOMSGF(USRMSGF)
```

When a predefined message is retrieved or displayed, the overriding file is searched for a message description. If the message description is not found in that file, the overridden file is searched.

If an error occurs during the RTVMSG command, the operating system issues escape message CPF2469 if any of the following occurs while sending (SNDPGMMSG command, SNDMSG command, SNDBRKMSG command, SNDUSRMSG command, or SNDRPY command) a message:

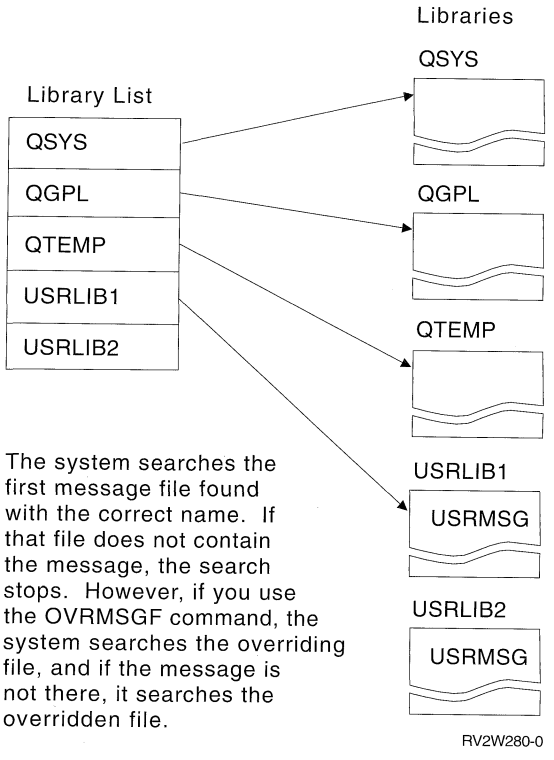
- The receiver is not authorized to the library in which the message file is located.
- The message file is not found.
- The receiver is not authorized to the message file.
- The message file is damaged.
- OS/400 is unable to allocate the library containing the message file.

OS/400 attempts to retrieve the message from the message file found at the time the message was sent to that message queue.

There are several basic reasons to override message files:

- To provide changed default replies or dump lists. A message file can be created with message descriptions for messages with changed default replies or dump lists because those in the original message descriptions are not satisfactory. You can establish several operating environments, each with different default replies.
- To change severity levels of the messages.
- To provide a default program.
- To change the text of a message. If the text is blank, it appears to the user as if no message was sent. For example, you may not want the status message sent by the Copy File (CPYF) command to appear to the user.
- To provide translation of messages into national languages. Message files written in English can be overridden by message files written in other languages. (If all messages are changed, use the library list for the job to change the order of the message files instead of overriding the message files.)

Another way you can select the message file from which messages are to be retrieved is by changing the order of the files in the library list for the job. However, if you use this approach, the search for the message stops on the first message file found that has the specified name. If the message is not in that file, the search stops. For example, assume that a message file named USRMSG is in library USRLIB1, and another message file named USRMSG is in library USRLIB2. To use the message file in USRLIB1, USRLIB1 should precede USRLIB2 in the library list:



Example of Overriding a Message File

Assume that you want to change an IBM-supplied message for use in a job. For example, suppose you want to change message CPC2191, which says:

```
Object XXX in YYY type *ZZZ deleted
```

to say:

```
Object XXX in YYY deleted
```

Specifics on how to describe the FMT parameter are provided by displaying the detailed description of CPC2191.

First, you create a message file:

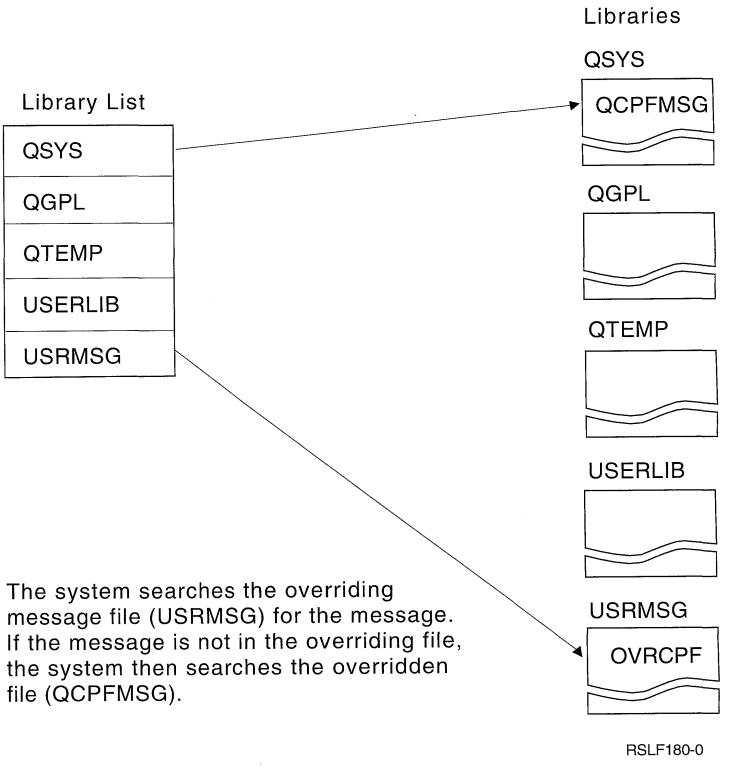
```
CRTMSGF MSGF(USRMSG/OVRCPF)
```

Then you use the message CPC2191 as a basis for your message and add it to the message file:

```
ADDMSGD  MSGID(CPC2191) MSGF(USRMSG/OVRCPF) +
         MSG('Object &1 in &2 deleted') +
         SEV(00) FMT((*CHAR 10) (*CHAR 10))
```

You then use the OVRMSGF command to override the message file when you run the job:

```
OVRMSGF MSGF(QCPFMSG) TOMSGF(USRMSG/OVRCPF)
```



If you want to change this message for use in all your jobs, you can use the Change Message Description (CHGMSGD) command to change the message. Then you do not have to override the system message file.

If you use the CHGMSGD command to change an IBM-supplied message, the message will need to be changed again when a new release of the system is installed. To change the message again, you can place any changes in an input stream or a CL program that can be run at any time.

You can also override overriding files. For example, you can specify the following OVRMSGF commands during a job.

```
OVRMSGF  MSGF(MSGFILE1)  TOMSGF(MSGFILE2)
OVRMSGF  MSGF(MSGFILE2)  TOMSGF(MSGFILE3)
```

First, file MSGFILE1 was overridden with MSGFILE2. Second, MSGFILE2 was overridden with MSGFILE3. When a message is sent, the files are searched in this order:

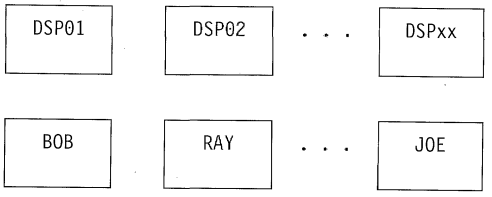
1. MSGFILE3
2. MSGFILE2
3. MSGFILE1

You can prevent message files from being overridden. To do so, you must specify the SECURE parameter on the OVRMSGF command.

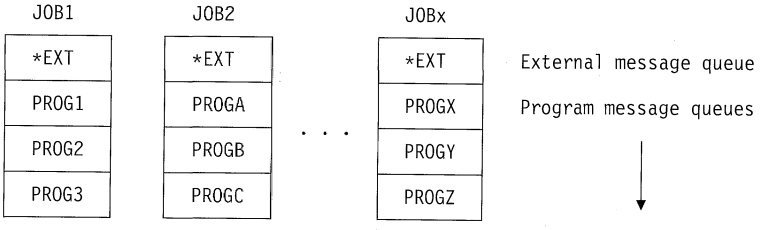
Types of Message Queues

All messages on the system are sent to a message queue. The system user or program associated with the message queue receives the message from the queue. Similarly, a reply to a message is sent back to the message queue of the user or program requesting the reply.

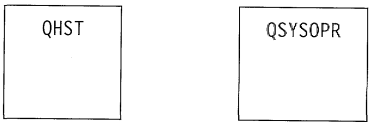
The following diagrams show the message queues supplied by IBM. A message queue is supplied for each display station (where DSP01 and DSP02 are display station names) and each user profile (where BOB and RAY are user profile names):



Job message queues are supplied for each job running on the system. Each job is given an external message queue (*EXT) and each call of a program within the job has its own message queue, with the same name as the program:



Message queues are also supplied for the system history log (QHST) and the system operator (QSYSOPR):



These message queues are used as follows:

- Work station message queues are used for sending and receiving messages between work station users and between work station users and the system operator. The name of the queue is the same as the name of the work station. The queue is created by the system when the work station is described to the system.
- User profile message queues can be used for communication between users. User profile message queues are automatically created in library QUSRSYS when the user profile is created.
- Job message queues are used for receiving requests to be processed (such as commands) and for sending messages that result from processing the requests; the messages are sent to the requester of the job. Job message queues exist for each job and only exist for the life of the job. Job message queues consist of an external message queue (*EXT) and a set of call stack entry message queues. See "Job Message Queues" on page 7-21 for more information.

- System operator message queue (QSYSOPR) is used for receiving and replying to messages from the system, display station users, and application programs.
- The history log message queue is used for sending information to the history log (QHST) from any job in the system.

In addition to these message queues, you can create your own user message queues for sending messages to system users and between application programs.

Creating or Changing a Message Queue

To create your own user message queues, you use the Create Message Queue (CRTMSGQ) command. In addition, you also use the Change Message Queue (CHGMSGQ) command to change the following attributes of your message queue.

The attributes of a message queue are:

- Whether changes to the message queue must be written immediately to the disk. Writing the changes immediately to the disk ensures that no messages are lost in cases like a system failure. Note that this will cause a decrease in system performance.
- The method of delivery for messages arriving at a message queue. When a message queue is created, the method of delivery is defined as hold delivery. When a display station is signed on, the user's message queue is set to the mode specified in the user profile. The types of delivery you can specify on the CHGMSGQ command are:
  - Break delivery. A job is interrupted and a program is called to deliver the message. If a user program is not specified on the CHGMSGQ command that requests break delivery, or if *SAME is specified, the Display Message (DSPMSG) command automatically displays the message. Break messages for a job can be controlled with the BRKMSG parameter on the CHGJOB command.
  - Notify delivery. A display station user is notified by means of the Attention light or audible alarm (or by both) that a message is on the queue. The display station user can view the message by using the DSPMSG command.
  - Hold delivery. The message queue holds the messages until the display station user requests them with the DSPMSG command.
  - Default delivery. All messages are ignored, and any messages requiring a reply are sent the default reply for the message.
- How to handle messages for break delivery.
  - Automatically run the DSPMSG command. For an interactive job, the messages are displayed at the display station if the severity code is high enough. For a batch job, the messages are listed to a spooled printer file if the severity code is high enough.
  - Call a break-handling program to handle the messages. You must use the CHGMSGQ command to specify the program to be called and to set the method of delivery to break mode.
- The severity code for filtering messages for break and notify delivery. Messages with severity equal to or greater than the minimum severity code speci-

fied are displayed. When the queue is created, the minimum severity code is set to 00. To change the minimum severity code, you must use the CHGMSGQ command.

When the DSPMSG command is used to display messages on the message queue, the severity code filter (SEV) parameter can be used to filter the messages shown. This filter is used rather than the severity filter specified for the message queue at creation time. To use this filter, specify DSPMSG SEV(*MSGQ).

You can use the DSPMSG command to determine the current severity code used for filtering break and notify messages. The code is displayed on the heading line of the message display.

Note: When a work station device description is created, the system establishes a message queue for the device to receive all action messages for the device. For work station printers, tape drives, and APPC devices, the MSGQ parameter can be used to specify a message queue when creating a device description. If no message queue is specified for these devices, the default, QSYSOPR, is used as the message queue. All other devices are assigned to the QSYSOPR message queue when they are created.

The message queue defined in your user profile is known as a user message queue. When you sign on the system using your profile, the user message queue is put into the delivery mode specified in your user profile.

If your user message queue is in break or notify delivery mode while you are signed on a display station and then you sign on another display station, the user message queue will not change the delivery mode for the new sign on. User message queues (along with work station message queues and the QSYSOPR message queue) cannot have their delivery mode changed by a job when the message queue is in break or notify delivery mode for a different job.

When you sign off the display station, or the job ends unexpectedly, the user message queue delivery mode is changed to hold mode, if the delivery mode of the user message queue is break or notify for this job. The user message queue delivery mode is also changed from break or notify mode to hold mode when you transfer to an alternative job. You can do this using the Transfer Secondary Job (TFRSECJOB) command or by pressing the System Request key and specifying option 1 on the System Request menu.

After transferring to an alternative job, you sign on using your user profile. Your user message queue is put into the delivery mode specified in your user profile. This allows the user message queue to transfer to the alternative job. You are then able to transfer back and forth between these two jobs and have your user message queue follow you.

However, if after transferring to an alternative job, you sign on using a user profile other than your own, the user message queue for the job from which you transferred is left in hold delivery mode. The user message queue for the user profile you signed on with is put in the delivery mode specified in that user profile. Because of this, your user message queue could be put into break or notify delivery mode by another user. If another user still has your user message queue in that delivery mode when you transfer back to the first job, your user message queue delivery mode cannot be changed back to the original delivery mode.

The QSYSOPR message queue is the message queue for the system operator, unless it has been changed. The above situation can occur for a system operator as well.

Break-Handling Program

A break-handling program is called whenever a message of higher severity than the severity code filter arrives on the message queue. To request a break-handling program, you must specify the name of the program and break delivery on the same CHGMSGQ command. The message handling program must receive the message with the Receive Message (RCVMSG) command so the message is marked as handled and the program is not called again. For more information on receiving messages and break handling programs, see Chapter 8, "Working with Messages."

Note: This program cannot open a display file if the interrupted program is waiting for input data from the device display.

You can use the system reply list to specify that the system issue the reply to specified predefined inquiry messages so that the display station user does not need to reply. See "Using the System Reply List" on page 8-34 for more information.

Example of Changing the Delivery Mode

When the system is started, it puts the QSYSOPR message queue in break delivery when the controlling subsystem is started. However, if the system operator signs off, the message queue is put in hold delivery. When the system operator signs on again, QSYSOPR is placed in the mode specified in the QSYSOPR user profile.

The following program can be used to place the QSYSOPR message queue in break mode. Similar programs can be used as initial programs to monitor message queues other than the one specified in a user's own user profile.

```
PGM /* Initial program to place a msg queue in break mode */
CHGMSGQ  QSYSOPR DLVRY(*BREAK) SEV(50)
MONMSG   MSGID(CPF0000) EXEC(SNDPGMMSG MSG('Unable to put QSYSOPR +
         message queue in *BREAK mode') TOPGMQ(*EXT))
ENDPGM
```

The program attempts to set the QSYSOPR message queue to break delivery with a severity level of 50. If this is unsuccessful, a message is sent to the external job message queue (*EXT). When the program ends, the initial menu is displayed. A severity level of 50 is used to decrease the number of break messages that interrupts the work station user. A common reason for failure is when another user has QSYSOPR in break mode already.

Job Message Queues

Job message queues are created for each job on the system to handle all the message requirements of the job. Job message queues for a single job consist of an external message queue (*EXT) and a set of program message queues.

The external message queue (*EXT) is used to communicate with the external requester (such as a display station user) of the job. Messages (except status messages) sent to the external message queue of a job are also written to the job log for printing at end of job (see "Job Log" on page 8-37 for more information).

If an informational, inquiry, or notify message is sent to the external message queue for an interactive job, the message is displayed on the Display Program Messages display, and the program waits for a reply to inquiry or notify messages from the display station user. If the user does not enter a reply and presses the Enter key or F3 (Exit), the default message reply is returned to the sender of the message. If there is no default message reply, *N is sent. If an inquiry or notify message is sent to the external message queue for a batch job, the default reply is sent to the sender of the message. If there is no default message, *N is the reply. The system reply list may override the displaying of inquiries or the sending of default replies to inquiries to *EXT.

If a status message is sent to the external message queue of an interactive job, the message is displayed on the message line of the display station. You can use status messages like this to inform the display station user of the progress of a long-running operation. For example, the system sends status messages when running the CPYF command if you copy a file with several members.

Note: When your application completes the long-running operation, you must send another message to clear the message line at the display. You can use message CPI9801, which is a blank message, for this purpose. For example:

```
PGM
.
.
.
SNDPGMMSG  MSGID(CPF9898)  MSGF(QCPFMSG)  MSGDTA('Status 1')  +
           TOPGMQ(*EXT)  MSGTYPE(*STATUS)
.
.
.
SNDPGMMSG  MSGID(CPF9898)  MSGF(QCPFMSG)  MSGDTA('Status 2')  +
           TOPGMQ(*EXT)  MSGTYPE(*STATUS)
.
.
.
SNDPGMMSG  MSGID(CPI9801)  MSGF(QCPFMSG)  TOPGMQ(*EXT)  +
           MSGTYPE(*STATUS)
.
.
.
ENDPGM
```

Message queues of a call stack entry are used to send messages between program and procedure calls of a job. These messages can be informational, request, completion, diagnostic, status, escape, or notify messages.

A message queue of a call stack entry is created for each original program model (OPM) program or each Integrated Language Environment (ILE) procedure that is called. A message queue of a call stack entry for an OPM program is given the same name as the program.

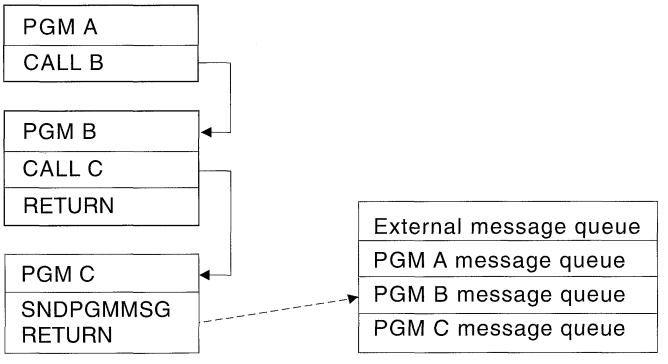
A message queue of a call stack entry in an ILE procedure is given a three-part name consisting of the procedure name, the module name, and the ILE program name. The module name is the name of the module into which the procedure was compiled. The ILE program name is the name of the ILE program into which the procedure was bound.

When addressing a call stack entry message for an ILE procedure, it is sufficient to specify only the procedure name. If the procedure name does not uniquely identify the procedure, the module name or the ILE program name can also be specified. If a program is called more than once, only the program message queue of the most current call can be used for message handling. That is, when program A sends a message to program B, the message goes to the program message queue for the last call of program B.

You can send a message to the caller of your program or procedure without specifying the name of the caller. The caller is always the previous program or procedure in the call stack. In addition, you can send a message to the caller of a specified program or procedure. In this case, you must specify the name of the program or procedure that was called.

A message queue for a call stack entry of a program or procedure is no longer available when the program or procedure ends. A program or procedure higher in the call stack cannot work with a lower level message queue of a call stack entry by using the call stack entry name. A program or procedure can continue to be able to receive information about the messages by using the message reference key.

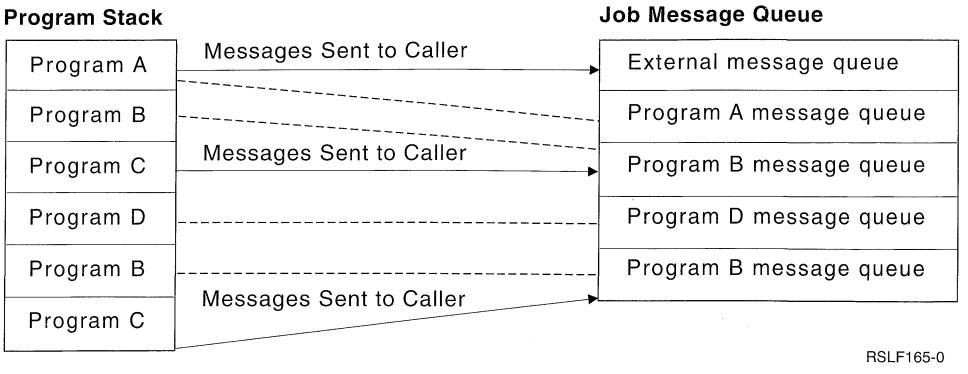
For example, as shown in the following figure, assume program A calls program B which calls program C. Program C sends a message to program B and ends. The message is available to program B. However, when program B ends, its program message queue is no longer available and cannot be accessed by program A, even though the message is shown in the job log. When CL programs end as in program B, the program is deleted and cannot be accessed for further processing of any kind.



If program A needs to delete the specific messages, you could do the following:

- Have program C send specific messages to program A
- Have program B resend the messages to program A

The following figure shows the relationship of program calls, the job message queue, and the program message queues. A dashed line (-----) indicates which message queue is associated with which call of a program.



In the preceding figure, program B has two program message queues, one for each call of the program. There are no message queues for program C because no messages were sent to program C. When program C sends a message to program B, the message goes to the program message queue for the last call of program B.

Note: When you are using the command entry display, you can display all the messages sent to the job message queue by pressing F10 (Include detailed messages). Once the messages are displayed, you can roll through them using one of the roll keys.

You can also display the messages for a job by using the Display Job Log (DSPJOBLOG) command.

Chapter 8. Working with Messages

This chapter discusses some of the ways that messages can be used to communicate between users and programs. Messages can be sent:

- From one system user to another system user, even if the receiver of the messages is not currently using the system
- From one program or procedure to another program or procedure
- From a program or procedure to a system user, even if the receiver of the messages is not currently using the system

Interactive system users can send only immediate messages and replies.

Programs or procedures can send immediate messages or predefined messages with user-defined data. In addition, programs or procedures can:

- Receive messages
- Retrieve a message from a message file and place it into a program variable
- Remove messages from a message queue
- Monitor for messages

Sending Messages to a System User

Several commands can be used to send messages to system users:

- Send Message (SNDMSG)
- Send Break Message (SNDBRKMSG)
- Send Program Message (SNDPGMMSG)
- Send User Message (SNDUSRMSG)

SNDPGMMSG and SNDUSRMSG can only be used in batch or interactive programs. These commands cannot be entered on a command line. The SNDMSG command sends an informational or inquiry message to the system operator message queue (QSYSOPR), a display station message queue, or a user message queue. You can send an informational message to more than one message queue at a time. But you can send an inquiry message to only one message queue at a time. The message is delivered by the delivery type specified for the message queue. The message does not interrupt the user unless the message queue is in break mode.

The following SNDMSG command is sent by a display station user to the system operator:

```
SNDMSG   MSG('Mount tape on device TAP1') TOUSR(*SYSOPR)
```

The SNDBRKMSG command sends an immediate message from a work station, a program, or a job to one or more display stations to be delivered in the break mode regardless of what delivery mode the receiver's message queue is set to. This command can be used to send a message only to display station message queues. You should use the SNDBRKMSG command when sending any message that requires the immediate attention of a display station user. You cannot ensure the message will cause a break, because each job has control by using the BRKMSG parameter on the Change Job (CHGJOB) command.

If you send an inquiry message, you can specify that the reply be sent to a message queue other than that of your display station.

The following SNDBRKMSG command is sent by the system operator to all the display station message queues:

```
SNDBRKMSG MSG('System going down in 15 minutes')
          TOMSGQ(*ALLWS)
```

The disadvantage of sending this message is that it is sent to *all* users, not just those users who are active at the time the message is sent.

Sending Messages from a CL Program

Use the Send Program Message (SNDPGMMSG) command or the Send User Message (SNDUSRMSG) command to send a message from a CL program.

Using the SNDPGMMSG command, you can send the following types of messages:

- Informational
- Inquiry
- Completion
- Diagnostic
- Request
- Escape
- Status
- Notify

You can send messages from a program to the following types of queues:

- External message queue of the requester of the job (see "Job Message Queues" on page 7-21)
- Call message queue of a program or procedure called by the job (see "Job Message Queues" on page 7-21)
- System operator message queue
- Work station message queue
- User message queue

To send a message from a program, you can specify the following on the SNDPGMMSG command:

- Message identifier or an immediate message. The message identifier is the name of the message description for a predefined message.
- Message file. The name of the message file containing the message description when a predefined message is sent.
- Message data fields. If a predefined message is sent, these fields contain the values for the substitution variables in the message. The format of each field must be described in the message description. If an immediate message is sent, there are no message data fields.
- Message queue or user to receive the message.
- Message type. The following indicates which types of messages can be sent to which types of queues (V = valid).

Table 8-1. Valid Message Types for Message Queue Types

Message Type	Message Queue Type				
	External	Call	QSYSOPR	Work Station	User
Informational	V	V	V	V	V
Inquiry	V		V	V	V
Completion	V	V	V	V	V
Diagnostic	V	V	V	V	V
Request	V	V			
Escape		V			
Status	V	V			
Notify	V	V			

- Reply message queue. The name of the message queue that receives the reply to an inquiry message. By default, the reply is sent to the call message queue of the program or procedure that sent the inquiry message.
- Key variable name. The name of the CL variable to contain the message reference key for a message.

To send the message created in "Example of Describing a Message" on page 7-14, you would use the following command:

```
SNDPGMMSG   MSGID(USR4310) MSGF(QGPL/USRMSG) +
            MSGDTA(&CUSNO) TOPGMQ(*EXT) +
            MSGTYPE(*INFO)
```

The substitution variable for the message is the customer number. Because the customer number varies, you cannot specify the exact customer number in the message. Instead, in your program you declare a program variable for the customer number &CUSNO and then specify this variable as the message data field. When the message is sent, the current value of the variable is passed in the message:

```
Customer number 35500 not found
```

In addition, you do not always know which display station is using the program, so you cannot specify the exact display station message queue that the message is to be sent to (TOPGMQ parameter); therefore, you specify the external message queue *EXT.

Inquiry and Informational Messages

Using the SNDUSRMSG command, you can send an inquiry message or an informational message to a display station user, the system operator, or a user-defined message queue. If you use the SNDUSRMSG command to send an inquiry message to the user, the program waits for a response from the user. The message can be either an immediate message or a predefined message. For an interactive job, the message is sent to the display station operator by default. For a batch job, the message is sent to the system operator by default. To send a message from a program using the SNDUSRMSG command, you can specify the following on the SNDUSRMSG command:

- Message identifier or an immediate message. The message identifier is the name of the message description for a predefined message.
- Message file. The name of the message file containing the message description when a predefined message is sent.
- Message data fields. If a predefined message is sent, these fields contain the value for the substitution variables in the message. The format of each field must be described in the message description. If an immediate message is sent, there are no message data fields.
- Valid replies to an inquiry message.
- Default reply value to an inquiry message.
- Message type.
- Message queue to which the message is to be sent.
- Message reply. A CL variable, if any, that is to contain the reply received in response to an inquiry message.
- Translation table. The translation table to be used, if any, to translate the reply value. This is normally used for translating lowercase to uppercase.

Completion and Diagnostic Messages

Using the SNDPGMMSG command, you can send diagnostic and completion messages. From your CL program, you can send these message types to any message queue. Diagnostic messages tell the calling program or procedure about errors detected by the program. Completion messages tell the results of work done by the program.

Normally, an escape message is sent to the message queue of the calling program or procedure to tell the caller what the problem was or that diagnostic messages were also sent. For a completion message, an escape message is usually not sent because the requested function was performed.

For an example of sending a completion message, assume that the system operator uses the system operator menu to call a CL program SAVPAY to save certain objects. The CL program saves the objects and issues a completion message:

```
PGM
SAVOBJ OBJ(PAY1 PAY2) LIB(PAYROLL) CLEAR(*YES)
SNDPGMMSG MSG('Payroll objects have been saved') MSGTYPE(*COMP)
ENDPGM
```

If the SAVOBJ command fails, the CL program function checks and the system operator has to display the detailed messages to locate the specific escape message explaining the reason for the failure as described later in this chapter. If

the SAVOBJ command completes successfully, the completion message is sent to the message queue associated with the program that displays the system operator menu.

One of the advantages of completion messages is their consistency with IBM-supplied commands. Many IBM commands send completion messages indicating successful completion. Seeing the type of message sent to the job log can assist in problem analysis.

Status Messages

You can send status messages from your CL program, using the SNDPGMMSG command, to the program message queue or to the external message queue (*EXT) for the job. When a status message is sent to a call message queue, the receiving program or procedure can monitor for the arrival of the status message and can handle the condition it describes. If the receiving program or procedure does not monitor for the message, control returns to the sender to resume processing. See "Monitoring for Messages in a CL Program" on page 8-16.

Escape and Notify Messages

Using the SNDPGMMSG command, you can send escape messages from your CL program to the message queue of the calling program. An escape message tells the caller that the program ended abnormally and why. The caller can monitor for the arrival of the escape message and handle the condition it describes. Control does not return to the sender of an escape message, and the sending program immediately ends. If the caller does not monitor for an escape message, default system action is taken.

You can send notify messages from your CL program to the message queue of the calling program or to the external message queue. A notify message tells the calling program about a condition under which processing can continue. The calling program can monitor for the arrival of the notify message and handle the condition it describes. If the caller is an Integrated Language Environment (ILE) procedure, the procedure can handle the condition, send a reply back, and then allow the sending program to continue processing. If the calling program is not monitoring for the message, a default reply is returned to the sender, who resumes processing. See "Monitoring for Messages in a CL Program" on page 8-16.

Immediate messages are not allowed as escape and notify messages. The system has defined the message CPF9898, which can be used for immediate escape and notify messages in application programs. For example:

```
SNDUSRMSG MSGID(CPF9898) MSGF(QCPFMSG) MSGDTA('Error condition') +
          MSGTYPE(*ESCAPE)
```

Examples of Sending Messages

Example 1: The following CL program allows the display station user to submit a job by calling this program instead of entering the Submit Job (SBMJOB) command. The program sends a completion message when the job has been submitted.

```
PGM
SBMJOB JOB(WKLYPAY) JOBD(USERA) RQSDTA('CALL WKLY PARM(PAY1)')
SNDPGMMSG MSG('WKLPAY job submitted') MSGTYPE(*COMP)
ENDPGM
```

Example 2: The following CL program changes a message based on a parameter received from a program and sends the message as a completion message. (The RCDCNT field is defined as characters in PGMA.)

```
PGM
DCL &RCDCNT TYPE(*CHAR) LEN(3)
CALL PGMA PARM(&RCDCNT)
SNDPGMMSG MSG('PGMA completed' *BCAT &RCDCNT *BCAT +
          'records processed') MSGTYPE(*COMP)
ENDPGM
```

Example 3: The following program sends a message requesting the system operator to load a special form. The Receive Message (RCVMSG) command waits for the reply. The system operator must enter at least 1 character as a reply to the inquiry message, but the program does not use the reply value.

```
PGM
DCL &MSGKEY TYPE(*CHAR) LEN(4)
SNDPGMMSG   MSG('Load special form') TOUSR(*SYSOPR) +
            KEYVAR(&MSGKEY) MSGTYPE(*INQ)
RCVMSG MSGTYPE(*RPY) MSGKEY(&MSGKEY) WAIT(120)
.
.
.
ENDPGM
```

The WAIT parameter must be specified on the RCVMSG command so that the program waits for the reply. If the WAIT parameter is not specified, the program continues with the instruction following the RCVMSG command, without receiving the reply. The MSGKEY parameter is used in the RCVMSG command to allow the program to receive the reply to a specific message. The variable &MSGKEY in the SNDPGMMSG command is returned to the program for use in the RCVMSG command.

Example 4: The following program sends a message to the system operator when it is run in batch mode or to the display station operator when it is run from a display station. The program accepts either an uppercase or lowercase Y or N. (The lowercase values are translated to uppercase by the translation table (TRNTBL parameter) to make program logic easier.) If the value entered is not one of these four, the operator is issued a message indicating the reply is not valid.

```
PGM
DCL &REPLY *CHAR LEN(1)
.
.
SNDUSRMSG MSG('Update YTD Information Y or N') VALUES(Y N) +
     MSGRPY(&REPLY)
IF (&REPLY *EQ Y)
 DO
 .
 .
 .
 ENDDO
ELSE
 DO
 .
 .
 ENDDO
 .
 .
 .
ENDPGM
```

Example 5: The following program uses the message CPF9898 to send an escape message. The text of the message is `'Program detected failure'`. Immediate messages are not allowed as escape messages so message CPF9898 can be used with the message as message data.

```
   PGM
   .
   .
   .
SNDPGMMSG MSGID(CPF9898) MSGF(QCPFMSG) MSGTYPE(*ESCAPE)
     MSGDTA('Program detected failure')
   .
   .
   ENDPGM
```

Example 6: The following program allows the system operator to send a message to several display stations. When the system operator calls the program, the program displays a prompt on which the system operator can enter the type of message to be sent and the text for the message. The program concatenates the date, time, and name of the message.

```
           PGM
           DCLF WSMSGD
           DCL &MSG TYPE(*CHAR) LEN(150)
           DCL &HOUR TYPE(*CHAR) LEN(2)
           DCL &MINUTE TYPE(*CHAR) LEN(2)
           DCL &MONTH TYPE(*CHAR) LEN(2)
           DCL &DAY TYPE(*CHAR) LEN(2)
           DCL &WORKHR TYPE(*DEC) LEN(2 0)
           SNDRCVF RCDFMT(PROMPT)
           IF &IN91 RETURN /* Request was ended  */
           RTVSYSVAL QMONTH RTNVAR(&MONTH)
           RTVSYSVAL QDAY RTNVAR(&DAY)
           RTVSYSVAL QHOUR RTNVAR(&HOUR)
           IF (&HOUR *GT '12') DO
           CHGVAR &WORKHR &HOUR
           CHGVAR &WORKHR (&WORKHR - 12)
           CHGVAR &HOUR &WORKHR /* Change from military time */
           ENDDO
           RTVSYSVAL QMINUTE RTNVAR(&MINUTE)
           CHGVAR    &MSG ('From Sys Opr ' *CAT &MONTH *CAT '/' +
                     *CAT &DAY +
                     *BCAT &HOUR *CAT ':' *CAT &MINUTE +
                     *BCAT &TEXT)
           IF (&TYPE *EQ 'B') GOTO BREAK
NORMAL:    SNDPGMMSG MSG(&MSG) TOMSGQ(WS1 WS2 WS3)
           GOTO ENDMSG
BREAK:     SNDBRKMSG MSG(&MSG) TOMSGQ(WS1 WS2 WS3)
ENDMSG:    SNDPGMMSG MSG('Message sent to display stations') +
                     MSGTYPE(*COMP)
           ENDPGM
```

The DDS for the display file, WSMSGD, used in this program follows:

```
|...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....8
     A                                      DSPSIZ(24 80)
     A          R PROMPT                    TEXT('Prompt')
     A                                      BLINK
     A                                      CA03(91 'Return')
     A                                    1  2'Send Messages To Work Stations'
     A                                       DSPATR(HI)
     A                                    3  2'TYPE'
     A            TYPE           1   1    +2VALUES('N' 'B')
     A                                      CHECK(ME)
     A                                      DSPATR(MDT)
     A                                    +3'(N = No breaks  B = Break)'
     A                                    5  2'Text'
     A            TEXT         100   1    +2LOWER
     A
     A
```

If the system operator enters the following on the prompt:

```
B

Please sign off by 3:30 today
```

the following break message is sent:

```
From Sys Opr 10/30 02:00  Please sign off by 3:30 today
```

Receiving Messages in a CL Program

For your program to receive messages from a message queue, you use the Receive Message (RCVMSG) command. Messages can be received in the following ways:

- By message type. You can specify that any type or specific types can be received (MSGTYPE parameter). For new messages (messages that have not been received in the program), the messages are received in a first-in-first-out (FIFO) order. However, ESCAPE type messages are received in last-in-first-out (LIFO) order.
- By message reference key. You can do one of the following:
  - Receive a message using its message reference key. The system assigns a message reference key to each message on a message queue and passes the key as variable data because it is unprintable. You must declare this variable in your CL program (DCL command). You must specify on the RCVMSG command the CL variable through which the key is to be passed (MSGKEY parameter).
  - Receive the next message on a message queue following the message with a specified message reference key. In addition to specifying the MSGKEY parameter, you must specify MSGTYPE(*NEXT).
  - Receive the message on a message queue that is before a message with a specified message reference key. In addition to specifying the MSGKEY parameter, you must specify MSGTYPE(*PRV).
- By its location on the message queue. You must specify MSGTYPE(*FIRST) for the first message on the message queue; specify MSGTYPE(*LAST) for the last.
- By both message type and message reference key (MSGTYPE and MSGKEY parameters).

To receive a message, you can specify:

- Message queue. Where the message is to be received from.
- Message type. Either a specific message type can be specified or all types can be specified.
- Whether to wait for the arrival of a message. After the wait is over and no message is received, the CL variables requested to be returned are filled with blanks (or zeros if numeric) and control returns to the program running the RCVMSG command.
- Whether to remove the message from the message queue after it is received. If it is not removed, it becomes an old message on the message queue and can only be received again (by a program) through its message reference key.

However, if messages on the message queue are reset to new messages through the CHGMSGQ command, you do not have to use the message reference key to receive the message. Note that inquiry messages that have already been replied to are not reset to a new status. (See "Removing Messages from a Message Queue" on page 8-15 for more information.)

- A group of CL variables into which the following information is placed (each corresponds to one variable):
  - Message reference key of the message in the message queue (character variable, 4 characters)
  - Message (character variable, length varies)
  - Length of message, including length of substitution variable data (decimal variable, 5 decimal positions)
  - Message help text (character variable, length varies)
  - Length of message help, including length of substitution variable data (decimal variable, 5 decimal positions)
  - Message data for the substitution variables provided by the sender of the message (character variable, length varies)
  - Length of the message data (decimal variable, 5 decimal positions)
  - Message identifier (character variable, 7 characters)
  - Severity code (decimal variable, length of 2)
  - Sender of the message (character variable must be 80 characters)
  - Type of message received (character variable, 2 characters long)
  - Alert option of the message received (character variable, 9 characters)
  - Message file that contains the predefined message (character variable, 10 characters)
  - Message file library name that contains the message file used to receive the message (character variable, 10 characters)
  - Message file library name that contains the message file used to send the message (character variable, 10 characters)

The following RCVMSG command specifies that any new message on the inventory application message queue INVN is to be received:

```
RCVMSG MSGQ(QGPL/INVN) MSGTYPE(*ANY) MSG(&MSG)
```

The message received is placed in the variable &MSG. *ANY is the default value on the MSGTYPE parameter.

When working with the message queue of an ILE procedure, it is possible to receive an exception message (Escape, Notify, or Status) when the exception is not yet handled. Unlike AS/400 original program model programs, an ILE procedure must take explicit action to tell the system that the exception is handled. The RCVMSG command can be used to tell the system the exception is handled.

This can be controlled by using the RMV keyword. If *YES is specified for this keyword, the exception is handled and and the message is left on the message queue as an old message. If *KEEPEXCP is specified, the exception is not handled and the message is left on the message queue as a new message. If *NO is specified, the exception message is handled and the message is removed from the message queue.

The RTNTYPE keyword can be used to determine if the message received is an exception message, and if so, whether the exception has been handled.

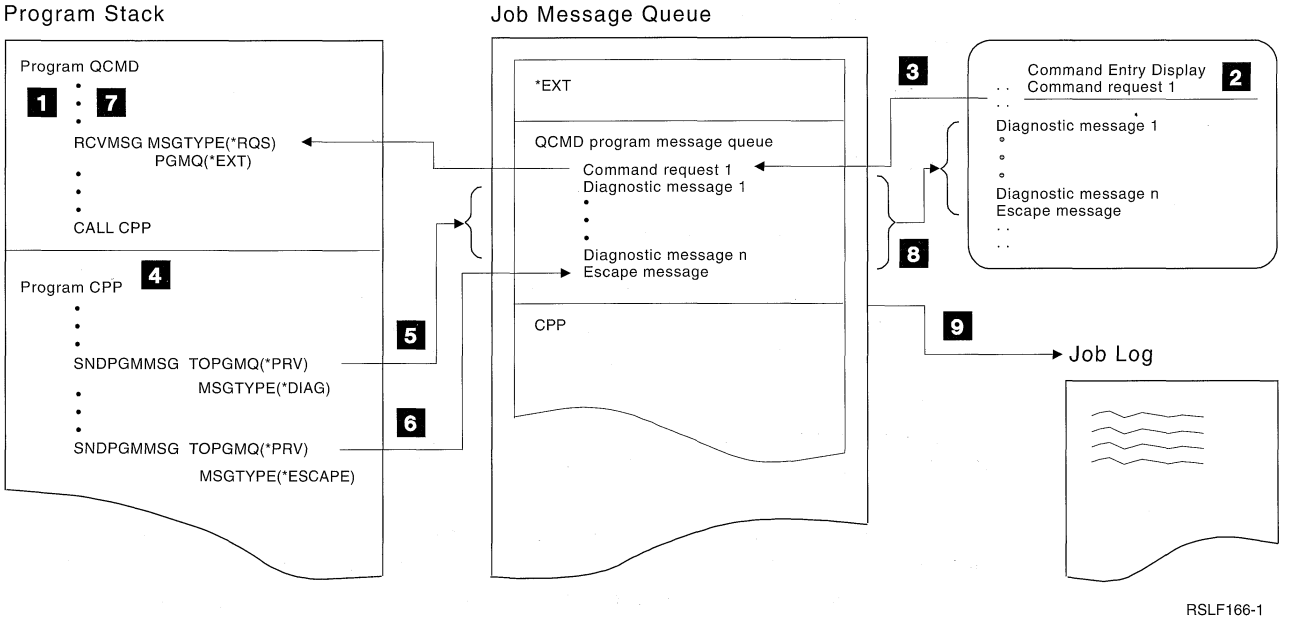
Request Messages

Receiving request messages is a method for your CL program to process CL commands. For example, your program can obtain input from a display station and handle the messages that result from the analysis and processing of the program. Usually, request messages are received from the external message queue (*EXT) of the job. For batch jobs, the requests received are those read from the input stream. For interactive jobs, the requests received are those the display station user enters one at a time on the Command Entry display. For example, CL commands are requests that are received by the IBM-supplied CL processor.

Your program must define the syntax of the data in the request message, interpret the request, and diagnose any errors. While the request is being analyzed or the request function is being run, any number of errors can be detected. As a result of these errors, messages are sent to the program message queue for the program. The program handles these messages and then receives the next request message. Thus, a request processing cycle is defined; a request message is received, the request is analyzed and run by your program with resulting messages displayed, and the next request received. If there are no more request messages to be received in a batch job, an escape message is sent to your program to indicate this.

More than one program of a job can receive request messages for processing. The requests received by more recent program calls are considered to be nested within those received by higher level program calls. The request processing cycles at each nesting level are independent of each other.

The following diagram shows how request messages are processed by QCMD:



1. The CL processor QCMD receives a request message from *EXT.
2. If there is no request message on *EXT, the Command Entry display is displayed. The display station user enters a command on the display. When the command is entered, it is placed on *EXT as a request message.

3. The command is then moved to the end of the QCMD program message queue and is passed from there to QCMD.

4. The command is analyzed and its command processing program (CPP) is called.

5. The command processing program sends diagnostic messages to the program message queue for QCMD.

6. Then the command processing program sends an escape message to the program message queue for QCMD. The escape message notifies QCMD that diagnostic messages are on the queue and that QCMD should end processing of the CPP.

7. QCMD is monitoring for the arrival of a request-check (CPF9901) or function-check (CPF9999) escape message. QCMD then tries to receive the next request message. If a request processor receives message CPF9901 or CPF9999, it should run a Reclaim Resources (RCLRSC) command. The request processor should also monitor for messages CPF1907 (end request) and CPF2415 (which indicates that the user pressed F3 or F12 on the Command Entry display).

8. Because a request message was being processed, all the messages on the program message queue for QCMD are written to the Command Entry display, which then prompts the display station user for another command.

9. The previous request message (command) and its associated messages are written to the job log by the message logging level specified for the job. For more information, see "Message Logging" on page 8-36.

Writing Request-Processing Programs

Having your job specified as a request-processing program has several advantages:

- Processes request messages as described in "Request Messages" on page 8-11.
- Allows the use of the End Request (ENDRQS) command, which can be used from the System Request menu or as part of the disconnect job function.
- Allows filtering of messages to occur.

To become a request-processing program, your program must include the Send Program Message (SNDPGMMSG) and Receive Message (RCVMSG) commands. For example, the following commands would allow a program to become a request processor (request-processing program):

```
SNDPGMMSG  MSG('Request Message') TOPGMQ(*EXT) MSGTYPE(*RQS)
RCVMSG     PGMQ(*EXT) MSGTYPE(*RQS) RMV(*NO)
```

The request message was received from PGMQ *EXT. When any request message is received, it is moved to the program message queue of the program that specified the RCVMSG command. Therefore, the correct program message queue must be used when the message is removed. RMV(*NO) must be specified on the RCVMSG command because the program is not a request processor if the request message is removed from the program's message queue.

The program becomes a request processor when it receives a request message. While the program is a request processor, other programs that are called can be ended using option 2 (End request) on the System Request menu. The request-

processing program should include a monitor for message CPF1907 (MONMSG command) because the end request function (from either option 2 on the System Request menu or the End Request command) sends this message to the request-processing program.

The program remains a request processor until the program ends (either normally or abnormally) or until an RMVMSG command is run to remove all the request messages from the request processor's program message queue. For example, the following command removes all request messages from the message queue and, therefore, ends request processing:

```
RMVMSG  CLEAR(*ALL)
```

Determining if a Request-Processing Program Exists

To determine if a job has a request-processing program, display the job's call stack. Use either option 11 on the Display Job (DSPJOB) or Work with Job (WRKJOB) command, or select option 10 for the job listed on the WRKACTJOB display. If a number is shown in the request level column on the display of the job's call stack, the program or ILE procedure associated with the number is a request-processing program. In the following example, both QCMD and QTEVIREF are request-processing programs:

```
                          Display Call Stack
                                                          System:   S0000000
Job:   WS31          User:   QSECOFR       Number:   000173

Job status:   ACTIVE

     Request   Program or
Opt   Level    Procedure      Library       Statement      Instruction
               QCMD           QSYS                            01DC
       1       QCMD           QSYS                            016B
               QTECADTR       QSYS                            0001
       2       QTEVIREF       QSYS                            02BA









                                                                      Bottom
Press Enter to continue.

F3=Exit   F5=Refresh   F12=Cancel
```

The following is an example of a request-processing program:

```
PGM
    SNDPGMMSG  MSG('Request Message') TOPGMQ(*EXT) MSGTYPE(*RQS)
    RCVMSG     PGMQ(*EXT) MSGTYPE(*RQS) RMV(*NO)
      .
      .
      .
    CALL   PGM(PGMONE)
    MONMSG MSGID(CPF1907)
      .
      .
      .
    RMVMSG CLEAR(*ALL)
    CALL   PGM(PGMTWO)
      .
      .
      .
ENDPGM
```

The first two commands in the program make it a request processor. The program remains a request processor until the RMVMSG command is run. A Monitor Message command is placed after the call to program PGMONE because an end request may be sent from PGMONE to the request-processing program. If monitoring were not used, a function check would occur for an end request. No message monitor is specified after the call to PGMTWO because the RMVMSG command ends request processing.

Note that if an end request is attempted when no request-processing program is called, an error message is issued and the end operation is not performed.

Note: In the sample programs, the RCVMSG command uses the minimal number of parameters needed to become a request processor. You need to say you want to receive a request message but do not want to remove it. You also need to identify the specific program queue from which the message request originated. Other parameters can be added as necessary.

Retrieving Messages in a CL Program

You can use the Retrieve Message (RTVMSG) command to retrieve the text of a message from a message file into a program variable. This differs from RCVMSG in that RTVMSG operates on predefined message descriptions that have not been sent. By doing this, you can write the message to an output list or handle it in other ways. Besides specifying the message identifier and message file name, you can specify:

- Message data fields. The message data for the substitution variables.
- A group of CL variables into which the following information is placed (each corresponds to one variable):
  - Message (character variable, length varies)
  - Length of message, including length of substitution variable data (decimal variable, 5 decimal positions)
  - Message help text (character variable, length varies)
  - Length of message help, including length of substitution variable data (decimal variable, 5 decimal positions)

- Severity code (decimal variable, 2 decimal positions)
- Alert option (character variable, 9 characters)
- Log problem in the service activity log (character variable, 1 character)

For example, the following command adds the message description for the message USR1001 to the message file USRMSG:

```
ADDMSGD   MSGID(USR1001) MSGF(QGPL/USRMSG) +
          MSG('File &1 not found in library &2') +
          SECLVL('Change file name or library name') +
          SEV(40) FMT((*CHAR 10) (*CHAR 10))
```

The following commands result in the substitution of the file name INVENT in the 10-character variable &FILE and the library name QGPL in the 10-character variable &LIB in the retrieved message USR1001.

```
DCL &FILE TYPE(*CHAR) LEN(10) VALUE(INVENT)
DCL &LIB TYPE(*CHAR) LEN(10) VALUE(QGPL)
DCL &A TYPE(*CHAR) LEN(20)
DCL &MSG TYPE(*CHAR) LEN(50)
CHGVAR VAR(&A) VALUE(&FILE||&LIB)
RTVMSG   MSGID(USR1001) MSGF(QGPL/USRMSG) +
         MSGDTA(&A) MSG(&MSG)
```

The data for &1 and &2 is contained in the program variable &A, in which the values of the program variables &FILE and &LIB have been concatenated. The following message is placed in the CL variable &MSG:

```
File INVENT not found in library QGPL
```

If the MSGDTA parameter is not used in the RTVMSG command, the following message is placed in the CL variable &MSG:

```
File not found in library
```

After the message is placed in the variable &MSG, you could do the following:

- Send the message using the SNDPGMMSG command
- Use the variable as the text for a message line in DDS (M in position 38)
- Use a message subfile
- Print or display the message

Note: You cannot retrieve the message text with the variable names included in the text. RTVMSGD is intended to return a message that can be sent. To access the message as entered on ADDMSGD, see the CVTMSGF tool in QUSRTOOL.

Removing Messages from a Message Queue

Messages are held on a message queue until they are removed by a Remove Message (RMVMSG) command, Clear Message Queue (CLRMSGQ) command, the RMV parameter on the Receive Message (RCVMSG) and Send Reply (SNDRPY) commands, the remove function keys of the Display Messages display, or the clear message queue option on the Work with Message Queue display. You can remove:

- A single message
- All messages
- All except unanswered messages
- All old messages

- All new messages
- All messages from all inactive programs

To remove a single message using the RMVMSG command or a single old message using the RCVMSG command, you specify the message reference key of the message to be removed.

Note: The message reference key can also be used to receive a message and to reply to a message.

If you remove an inquiry message that you have not answered, a default reply is sent to the sender of the message and the inquiry message and the default reply are removed. If you remove an inquiry message that you have already answered, both the message and your reply are removed.

To remove all messages for all inactive programs from a user's job message queue, specify *ALLINACT for the PGMQ parameter and *ALL for the CLEAR parameter on the RMVMSG command. If you wish to print your job log before you remove all the inactive messages, use the Display Job Log (DSPJOBLOG) command and specify *PRINT for the OUTPUT parameter.

When working with a call message queue of an ILE procedure, it is possible that an exception message for unhandled exceptions is on the queue at the time the RMVMSG command is run. The RMVEXCP keyword of this command can be used to control actions for messages of this type. If *YES is specified for this keyword, the RMVMSG command causes the exception to be handled and the message to be removed. If *NO is specified, the message is not removed. As a result, the exception is not handled.

The following RMVMSG command removes a message from the user message queue JONES. The message reference key is in the CL variable &MRKEY.

```
DCL &MRKEY TYPE(*CHAR) LEN(4)
RCVMSG MSGQ(JONES) RMV(*NO) KEYVAR(&MRKEY)
RMVMSG MSGQ(JONES) MSGKEY(&MRKEY)
```

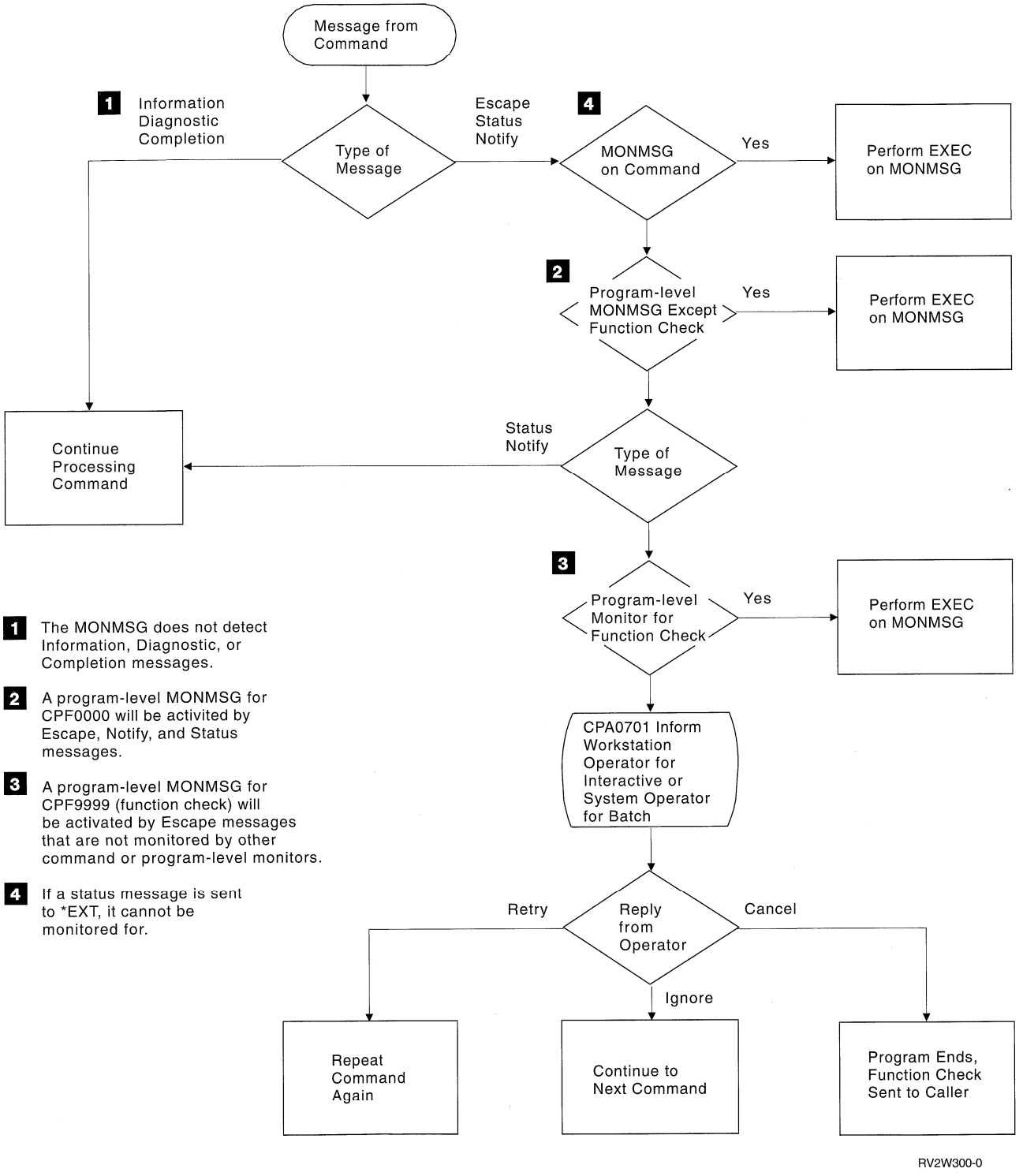
The following RMVMSG command removes all messages from a message queue.

```
RMVMSG CLEAR(*ALL)
```

Note: The maximum number of messages on a user message queue or a work station message queue is 65 535 for each type of message sent. For example, 65 535 diagnostic messages can be on the queue; 65 535 completion messages can be on the queue, and so on. For a call message queue or the *EXT queue, there is no restriction on the maximum number of messages per type.

Monitoring for Messages in a CL Program

You can monitor for escape, notify, and status messages that are sent to your CL program's program message queue by the commands in your program. The Monitor Message (MONMSG) command monitors the messages sent to the program message queue for the conditions specified in the command. If the condition exists, the CL command specified on the MONMSG command is run. The logic involved with the MONMSG command is as follows:



The *Programming Reference Summary* contains a list of the escape, notify, and status messages that are issued for CL commands. You should also keep a list of all messages that you have defined.

Escape Messages: Escape messages are sent to tell your program of an error condition that forced the sender to end. By monitoring for escape messages, you can take corrective actions or clean up and end your program.

Status or Notify Messages: Status and notify messages are sent to tell your program of an abnormal condition that is not serious enough for the sender to end. By monitoring for status or notify messages, your program can detect this condition and not allow the function to continue.

You can monitor for messages using two levels of MONMSG commands:

- Program level: You can monitor for an escape, notify, or status message sent by any command in your program by specifying the MONMSG command immediately following the last declare command in your CL program. This is called a program-level MONMSG command. You can use as many as 100 program-level MONMSG commands in a program. (A CL program can contain a total of 1000 MONMSG commands.) This lets you handle the same escape message in the same way for all commands. The EXEC parameter is optional, and only the GOTO command can be specified on this EXEC parameter.
- Specific command level: You can monitor for an escape, notify, or status message sent by a specific command in your program by specifying the MONMSG command immediately following the command. This is called a command level MONMSG command. You can use as many as 100 command-level MONMSG commands for a single command. This lets you handle different escape messages in different ways.

To monitor for escape, status, or notify messages, you must specify, on the MONMSG command, generic message identifiers for the messages in one of the following ways:

- `pppmmnn`

  Monitors for a specific message. For example, MCH1211 is the message identifier of the zero divide escape message.

- `pppmm00`

  Monitors for any message with a generic message identifier that begins with a specific licensed program (`ppp`) and the digits specified by mm. For example, CPF5100 indicates that all notify, status, and escape messages beginning with CPF51 are monitored.

- `ppp0000`

  Monitors for every message with a generic message identifier that begins with a specific licensed program (`ppp`). For example, `CPF0000` indicates that all notify, status, and escape messages beginning with `CPF` are monitored.

  Note: Do not use `MONMSG CPF0000` when doing system function, such as install or saving or restoring your entire system, since you may lose important information.

- CPF9999

  Monitors for function check messages for all generic message identifiers. If an error message is not monitored, it becomes a CPF9999 (function check).

Note: Generally, when monitoring, your monitor also gets control when notify and status messages are sent.

In addition to monitoring for escape messages by message identifier, you can compare a character string, which you specify on the MONMSG command, to data sent in the message. For example, the following command monitors for an escape

message (CPF5101) for the file MYFILE. The name of the file is sent as message data.

```
MONMSG MSGID(CPF5101) CMPDTA(MYFILE) EXEC(GOTO EOJ)
```

The compare data can be as long as 28 characters, and the comparison starts with the first character of the first field of the message data. If the compare data matches the message data, the action specified on the EXEC parameter is run.

The EXEC parameter on the MONMSG command specifies how an escape message is to be handled. Any command except PGM, ENDPGM, IF, ELSE, DCL, DCLF, ENDDO, and MONMSG can be specified on the EXEC parameter. You can specify a DO command on the EXEC parameter, in which case, the commands in the do group are run. When the command or do group (on the EXEC parameter) has been run, control returns to the command in your program that is after the command that sent the escape message. However, if you specify a GOTO or RETURN command, control does not return. If you do not specify the EXEC parameter, the escape message is ignored and your program continues.

The following shows an example of a Change Variable (CHGVAR) command being monitored for a zero divide escape message, message identifier MCH1211:

```
CHGVAR VAR(&A) VALUE(&A/&B)
MONMSG MSGID(MCH1211) EXEC(CHGVAR VAR(&A) VALUE(1))
```

The value of the variable &A is changed to the value of &A divided by &B. If &B equals 0, the divide operation cannot be done and the zero divide escape message is sent to the program. When this happens, the value of &A is changed to 1 (as specified on the EXEC parameter). You may also test &B for zero and only perform the division if it is not zero.

In the following example, the program monitors for the escape message CPF9801 (object not found message) on the Check Object (CHKOBJ) command:

```
          PGM
          CHKOBJ LIB1/PGMA *PGM
          MONMSG MSGID(CPF9801) EXEC(GOTO NOTFOUND)
          CALL LIB1/PGMA
          RETURN
NOTFOUND: CALL FIX001 /* PGMA Not Found Routine */
          ENDPGM
```

The following CL program contains two CALL commands and a program-level MONMSG command for CPF0001. (This escape message occurs if a CALL command cannot be completed successfully.) If either CALL command fails, the program sends the completion message and ends.

```
        PGM
        MONMSG MSGID(CPF0001) EXEC(GOTO ERROR)
        CALL PROGA
        CALL PROGB
        RETURN
ERROR:  SNDPGMMSG MSG('A CALL command failed') MSGTYPE(*COMP)
        ENDPGM
```

If the EXEC parameter is not coded on a program-level MONMSG command, any escape message that is handled by the MONMSG command is ignored. If the escape message occurs on any command except an IF command, the program continues processing with the command that would have been run next if the

escape message had not occurred. If the escape message occurs on an IF command, the program continues processing as if the condition on the IF command were false. The following example illustrates what happens if an escape message occurs at different points in the program:

```
PGM
DCL &A TYPE(*DEC) LEN(5 0)
DCL &B TYPE(*DEC) LEN(5 0)
MONMSG MSGID(CPF0001 MCH1211)
CALL PGMA PARM(&A &B)
IF (&A/&B *EQ 5) THEN(CALL PGMB)
ELSE CALL PGMC
CALL PGMD
ENDPGM
```

Depending on where an escape message occurs, the following happens:

- If CPF0001 occurs on the call to PGMA, the program resumes processing on the IF command.
- If MCH1211 (divide by 0) occurs on the IF command, the IF condition is considered false, and the program resumes processing with the call to PGMC.
- If CPF0001 occurs on the call to PGMB or PGMC, the program resumes processing with the call to PGMD.
- If CPF0001 occurs on the call to PGMD, the program resumes processing with the ENDPGM command, which causes a return to the calling program.

You can also monitor simultaneously for the same escape message to be sent by a specific command in your program *and* by any command. This requires two MONMSG commands. One MONMSG command follows the command that needs special handling for the escape message; for that command, this MONMSG command is used when the escape message is sent. The other MONMSG command follows the last declare command so that for all other commands, this MONMSG command is used.

Default Handling

Many escape messages can be sent to your program by commands and programs it calls. Probably, you will not want to monitor for and handle all of these. Normally, only a few escape messages pertain to the function of your program; the remaining escape messages should never actually be sent. The system provides default monitoring and handling of any messages you do not monitor.

Default handling assumes that an error has been detected in your program. If you are debugging the program, the message is sent to your display station. Then you can enter commands to analyze and correct the error. If you are not debugging the program, a dump is taken and the function-check escape message (CPF9999) is sent to your program. You can monitor for function-check escape messages so that you can either:

- Clean up and end the program
- Continue with some other aspect of your program

If you do not monitor for a function-check escape message, your program is ended and the function-check message is sent to the calling program of the program.

Notify Messages

Besides monitoring for escape messages, you can monitor for notify messages that are sent to your CL program's program message queue by the commands in your program or by the programs it calls. Notify messages are sent by these programs to tell your program of a condition that is not typically an error. By monitoring for notify messages, you can specify an action different from what you would specify if the condition had not been detected. Very few IBM-supplied commands send notify messages.

Monitoring for and handling notify messages are similar to monitoring for and handling escape messages. The difference is in what happens if you do not monitor for and handle notify messages. Unlike escape messages, unmonitored notify messages are not considered an indication of an error in your program. Instead, for notify messages, the default reply stored in the message description is used to tell the sender of the message what to do.

Status Messages

You can monitor for status messages that are sent by the commands in your CL program or by the programs your program calls. Status messages tell your program the status of the work performed by the sending program. By monitoring for status messages, you can prevent the sending program from proceeding with any more processing.

No message information is stored in a message queue for status messages. Therefore, if the status message is monitored for, the status message cannot be received. If the status message is not monitored, no information is placed on the message queue and control is returned to the sending program for more processing. Status messages are often sent to communicate normal conditions that have been detected where processing can continue.

Status messages sent to the external message queue are shown on the interactive display, informing the user of a function in progress. For example, the Copy File (CPYF) command sends a message informing the user that a copy operation is in progress.

Only messages contained in message files can be sent as status messages; immediate messages cannot be sent. You can use the system-supplied message ID, CPF9898, and supply message data to send a status message if you do not have an existing message description.

When the function is completed, your program should remove the status message from the interactive display. The message cannot be removed using a command, but sending another status message to *EXT with a blank message gives the appearance of removing the message. The system-supplied message ID CPI9801 can be used for this purpose. When control returns to the OS/400 program, the *STATUS message may be cleared from line 24, without sending the CPI9801 message. The following example shows a typical application of message IDs CPF9898 and CPI9801:

```
SNDPGMMSG MSGID(CPF9898) MSGF(QCPFMSG) +
          MSGDTA('Function xxx being performed') +
          TOPGMQ(*EXT) MSGTYPE(*STATUS)
    •
    •   /*  Your processing function  */
    •
SNDPGMMSG MSGID(CPI9801) MSGF(QCPFMSG) +
          TOPGMQ(*EXT) MSGTYPE(*STATUS)
```

Preventing the Display of Status Messages

You cannot prevent commands from sending status messages, but you can prevent the status messages from being displayed at the bottom of the screen.

There are two preferred ways to prevent the status messages from being shown:

- Change User Profile (CHGUSRPRF) command

  You can change your user profile so that whenever you sign on using that profile, status messages are not shown. To do this, use the CHGUSRPRF command and specify *NOSTSMSG on the User Option (USROPT) parameter.

- Change Job (CHGJOB) command

  You can change the job you are currently running so that status messages are not shown. To do this, use the CHGJOB command and specify *NONE on the Status Message (STSMSG) parameter. You can also use the CHGJOB command to see status messages by specifying *NORMAL on the STSMSG parameter.

A third alternative, however less preferred, is to use the Override Message File (OVRMSGF) command and change the status message identifiers to a blank message.

Break-Handling Programs

A break-handling program is one that is automatically called when a message arrives at a message queue that is in *BREAK mode. The name of the program and break delivery must both be specified on the same Change Message Queue (CHGMSGQ) command. The program must run a Receive Message (RCVMSG) command to receive the message. To receive and handle the message, the user-defined program called to handle messages for break delivery is passed parameters. The parameters are:

- The name of the message queue that received the message. The message queue name is a 10-character field and is left-justified and padded with blanks to the right, if necessary.
- The name of the library that contains the message queue. The library name is a 10-character field and is left-justified and padded with blanks to the right, if necessary.
- The message reference key of the received message. The key is a 4-character field.

If the break-handling program is called, it interrupts the job in which the message occurred and runs. When the break-handling program ends, the original program resumes processing.

The following program (PGMA) is an example of a break-handling program.

```
PGM PARM(&MSGQ &MSGLIB &MRK)
DCL VAR(&MSGQ) TYPE(*CHAR) LEN(10)
DCL VAR(&MSGLIB) TYPE(*CHAR) LEN(10)
DCL VAR(&MRK) TYPE(*CHAR) LEN(4)
DCL VAR(&MSG) TYPE(*CHAR) LEN(75)
RCVMSG  MSGQ(&MSGLIB/&MSGQ) MSGKEY(&MRK) +
        MSG(&MSG)
.
.
.
ENDPGM
```

After the break-handling program is created, running the following command connects it to the QSYSMSG message queue.

```
CHGMSGQ   MSGQ(QSYS/QSYSMSG) DLVRY(*BREAK) PGM(PGMA)
```

Notes:

1. When messages are handled, they should be removed from the message queue. When a message queue is put in break mode, any message on the queue will cause the break-handling program to get called.
2. Break-handling programs should not be coded to receive a message. Specify a value other than zero for the wait parameter with the receive message command. The message arrival event cannot be handled by the system while the job is running a break-handling event.

An example of a break-handling program is to have the program send a message, which is normally sent to the QSYSOPR queue, to another queue in place of or in addition to QSYSOPR.

The following is an example of a user-defined program to handle break messages. The display station user does not need to respond to the messages CPA5243 (Press Ready, Start, or Start-Stop on device &1) and CPA5316 (Verify alignment on device &3) when this program is used.

```
BRKPGM:      PGM (&MSGQ &MSGQLIB &MSGMRK)
             DCL &MSGQ TYPE(*CHAR) LEN(10)
             DCL &MSGQLIB TYPE(*CHAR) LEN(10)
             DCL &MSGMRK TYPE(*CHAR) LEN(4)
             DCL &MSGID TYPE(*CHAR) LEN(7)
             RCVMSG MSGQ(&MSGQLIB/&MSGQ) MSGKEY(&MSGMRK) +
                    MSGID(&MSGID) RMV(*NO)
             /* Ignore message CPA5243 */
             IF (&MSGID *EQ 'CPA5243') GOTO ENDBRKPGM
             /* Reply to forms alignment message */
             IF (&MSGID *EQ 'CPA5316') +
                    DO
                    SNDRPY MSGKEY(&MSGMRK) MSGQ(&MSGQLIB/&MSGQ) RPY(I)
                    ENDDO
             /* Other messages require user intervention */
             ELSE CMD(DSPMSG MSGQ(&MSGQLIB/&MSGQ))
ENDBRKPGM:   ENDPGM
```

Warning: In the above example of a break-handling program, if a CPA5316 message should arrive at the queue while the DSPMSG command is running, the DSPMSG display shows the original message that caused the break and the CPA5316 message. The DSPMSG display waits for the operator to reply to the CPA5316 message before proceeding.

Note: This program cannot open a display file if the interrupted program is waiting for input data from the display.

You can use the system reply list to indicate the system will issue a reply to predefined inquiry messages. The display station user, therefore, does not need to reply. For more information, see "Using the System Reply List" on page 8-34.

Another example of a break-handling program is shown in QUSRTOOL with the STSMSG tool. It allows you to change some or all of the messages received at your work station into status messages.

QSYSMSG Message Queue

The QSYSMSG message queue is an optional queue that you can create in the QSYS library. If it exists and is not damaged, certain messages are directed to it instead of, or in addition to, the QSYSOPR message queue. This allows a user-written program to gain control when certain messages are sent. You should not create the QSYSMSG queue unless you want it to receive specific messages.

Enter the following command to create the QSYSMSG queue:

```
CRTMSGQ  QSYS/QSYSMSG +
         TEXT('Optional MSGQ to receive specific system messages')
```

Once the QSYSMSG message queue is created, all of the specific messages (shown below in "Messages Sent to QSYSMSG Message Queue") are directed to it. You can write a program to receive messages for which you can perform special action and send other messages to the QSYSOPR message queue or another message queue. This program should be written as a break-handling program.

Messages Sent to QSYSMSG Message Queue

The following describes the specific messages sent to the QSYSMSG queue:

CPF0907 Serious storage condition may exist. Press HELP.

This message is sent if the amount of available auxiliary storage in the system auxiliary storage pool has reached the threshold value.

The system service tools function can be used to display and change the threshold value. For more information, see the *Advanced Backup and Recovery Guide*.

CPF1269 Program start request received on communications device was rejected with reason codes.

This message is sent when a start request is rejected and contains a reason code identifying why the rejection occurred. For a detailed explanation of each reason code, see the message description for CPF1269 in the *ICF Programmer's Guide*.

If a password is not valid or an unauthorized condition occurs using APPC, it may mean that a normal job is in error or that someone is attempting to break security. You may choose to prevent further use of the APPC device description until the condition is understood by doing the following:

- Sending the message to the QSYSOPR message queue.
- Recording the attempt for the security officer to review.
- Issuing the End Mode (ENDMOD) command to set the allowed jobs to zero. This allows jobs that are currently using the peer device description to remain active, but prevents other jobs from starting until the condition is understood.
- Counting the number of attempts in a given time period. You could establish a threshold in your program for the number of attempts that were not valid before you take serious action (such as changing the maximum number of sessions to zero). You may want to assign this threshold value by unit of work identifier (which may be blank), by APPC device description, or for your entire APPC environment.

CPF1393 `User profile has been disabled because maximum number of sign-on attempts has been reached.`

This message is sent when a user has attempted to sign-on multiple times, causing the User Profile to be disabled.

CPF1397 `Subsystem varied off work station.`

This message is sent if the threshold value assigned by the system value QMAXSIGN is reached and the device is varied off. The message indicates that a user is not entering a valid password. The message data for CPF1397 contains the name of the device from which the message was sent. You can use this information and design a program to take appropriate action. You could consider performing one or several of the following:

- Send the same message to the QSYSOPR message queue
- Record the attempt for the security officer to review
- Automatically vary on the device after a significant time delay

CPI0920 `Error occurred on disk unit &1.`

This message is sent if a disk unit has detected errors and is requesting service. No data has been lost but a loss may occur if this condition is not corrected.

CPI0945 `Mirrored protection is suspended on disk unit &1.`

This message is sent if an error occurred when the system was copying data from one storage unit to another. Data has not been lost.

CPI0946 `Mirrored protection is suspended on disk unit &1.`

This message is sent if a disk unit has detected errors and is requesting service. A disk unit did not complete an operation in the time allowed. Data has not been lost.

CPI0947 `Mirrored protection is suspended on disk unit &1.`

The I/O processor was not able to complete an operation in the time allowed. Data has not been lost.

CPI0948 Mirrored protection is suspended on disk unit &1.

The system is not able to locate a storage unit. Data has not been lost.

CPI0949 Mirrored protection is suspended on disk unit &1.

The mirrored protection for the disk is suspended.

CPI0950 Storage unit now available.

A storage unit, which was missing from the configuration, is now available. Data has not been lost.

CPI0953 ASP storage threshold reached.

This message is sent if the amount of available storage in the specified auxiliary storage pool (ASP) has reached the threshold value. The message data for CPI0953 contains the auxiliary storage capacity, the auxiliary storage used, the percentage of threshold, and the percentage of auxiliary storage available. You can use this information to take appropriate action.

CPI0954 ASP storage limit exceeded.

This message is sent if all available storage in the specified ASP has been used.

CPI0955 System ASP unprotected storage limit exceeded.

This message is sent if all available storage in the system ASP has been used.

CPI0956 Mirrored protection is suspended on disk unit &1.

This message is sent if a disk unit has detected errors and is requesting service. Errors were found on a disk unit. Data has not been lost.

CPI0957 Mirrored protection is suspended on disk unit &1.

An error is found on an I/O processor. Data has not been lost. Every disk unit attached to the I/O processor is suspended from disk mirroring protection. For more information, see the previous messages.

CPI0958 Mirrored protection is suspended on disk unit &1.

An error was found on a bus. Data has not been lost. Every disk unit attached to the bus is suspended from disk mirroring protection. For more information, see the previous messages.

CPI0959 Mirrored protection is suspended on disk unit &1.

This message is sent if a disk unit has detected errors and is requesting service. A disk unit is not operating.

CPI0964 Weak battery condition exists.

This message is sent if the external uninterruptible power supply or internal battery indicates a weak battery condition.

CPI0965 Failure of battery power unit feature in system unit.

This message is sent if there is a failure of the battery or the battery charger for the battery power unit feature in the system unit.

CPI0966 Failure of battery power unit feature in expansion unit.

This message is sent if there is a failure of the battery or the battery charger for the battery power unit feature in the expansion unit.

CPI0970 Disk unit &1 not operating.

This message is sent if a disk unit has stopped operating.

CPI0988 Mirrored protection is resuming on disk unit &1.

This message is sent if the mirroring synchronization of a disk unit has started and disk mirroring protection is being resumed. One of the steps the system performs before disk mirroring protection is resumed is to copy data from one disk unit to another so that the data on both disk units is the same. You may observe slow system performance during the time that the data is being copied. After the copy of the disk data is complete, message CPI0989 is sent to this message queue, and disk mirroring protection resumes.

CPI0989 Mirrored protection resumed on disk unit &1.

This message is sent if the mirroring synchronization of a disk unit completed successfully. The system completed the copy of data from one disk unit to the other. Disk mirroring protection is resumed.

CPI0992 Error occurred on disk unit &1.

This message is sent if a disk unit has determined that it has too many errors and is starting to fail. The system has recovered from the error. However, machine checks and possible data loss may occur if this condition is not corrected.

CPI0996 Error occurred on disk unit &1.

This message is sent if a disk unit has found an error. Machine checks and data loss can occur. You can press F14 to run problem analysis.

CPI0997 Nearly all available machine addresses used.

CPI1117 Damaged job schedule &1 in library &2 deleted.

This message is sent when the job schedule in the library was deleted because of damage.

CPI0998 Error occurred on disk unit &1.

This message is sent if errors were found on disk unit &1. The message does not include information about the failure to run problem analysis.

CPI1136 Mirrored protection still suspended.

This message is sent each hour after the most recent occurrence of one of the messages (CPI0945, CPI0946, CPI0947, CPI0948, CPI0949, CPI0956, CPI0957, CPI0958, or CPI0959) indicating mirrored protection is suspended and mirrored protection is still suspended on one or more disk units.

CPI1138 Storage overflow recovered.

This message is sent when ASP &1 no longer has any objects that have overflowed into the system ASP for reason &2.

CPI1139 Storage overflow recovery failed.

This message is sent when an attempt to recover from storage overflow failed.

CPI1153 System password bypass period ended.

This message is sent when the system has been operating with the system password bypass period in effect. The bypass period has ended. Unless the correct system password is provided, the next IPL will not be allowed to complete successfully.

CPI1154 System password bypass period will end in &5 days.

This message is sent when the system password (during a previous IPL) was either not entered or not entered correctly, and the system bypass period was selected.

CPI1393 Subsystem &1 disabled user profile &2 on device &3.

This message is sent when the user reaches the maximum number of sign-on attempts as determined by the QMAXSIGN system value. The action taken when this value is reached is determined by the QMAXSGNACN system value.

CPI2209 User profile &1 deleted because it was damaged.

This message is sent when a user profile is deleted because it was damaged. This user profile may have owned objects prior to being deleted. These objects now have no owner. A Reclaim Storage (RCLSTG) command can be used to transfer the ownership of these objects to the QDFTOWN user profile.

CPI2283 QAUDCTL system value changed to *NONE.

This message is sent each hour after auditing has been turned off by the system because auditing failed. To turn auditing back on or to determine why auditing failed, you can change system value QAUDCTL to a value other than *NONE.

CPI2284 QAUDCTL system value changed to *NONE.

This message is sent during IPL if auditing was turned off by the system because auditing failed. To turn auditing back on or to determine why auditing failed, you can change system value QAUDCTL to a value other than *NONE.

CPI8A13 QDOC library nearing save history limit.

This message is sent when the number of objects in library QDOC is approaching the limit for the number of objects that the system supports storing in one library.

CPI8A14 QDOC library has exceeded save history limit.

This message is sent when the number of objects in Library QDOC has exceeded the limit for the number of objects that the system supports in one library.

CPI8898 Optical signal loss is detected on optical bus.

This message is sent when an optical bus failure is detected. The bus is running at reduced mode. This message will be logged in the service activity log and have the PAR option available.

CPI9014 Password received from device not valid.

This message is sent when a password has been received on a document interchange session that is not correct. It may indicate unauthorized attempts to access the system.

CPI9490 Disk error on device &25.

This message is sent when a disk error has been detected.

CPI94A0 Disk error on device &25.

This message is sent when a disk error has been detected.

CPI94CE Error detected in bus expansion adapter, bus extension adapter, System Processor, or cables.

This message is sent when the system has detected a failure in the main storage. System performance may be degraded. Run problem analysis to determine the failing card.

CPI94CF Main storage card failure is detected.

This message is sent when the system has detected a failure in the main storage. System performance may be degraded. Run problem analysis to determine the failing card.

CPI94FC Disk error on device &25.

This message is sent when the 9336 Disk Unit has determined that one of its parts is exceeding the error threshold and is starting to fail.

CPP0DD9 A system processor failure is detected.

This message is sent when a system processor or system processor cache has failed. System performance may be degraded.

CPP0DDA A system processor failure is detected in slot 9.

This message is sent when a system processor or system processor cache has failed. System performance may be degraded.

CPP0DDB A system processor failure is detected in slot 10.

This message is sent when a system processor or system processor cache has failed. System performance may be degraded.

CPP0DDC A system processor failure is detected.

This message is sent when the system has detected an error on the system processor. System performance may be degraded.

CPP0DDD System processor diagnostic code detected an error.

This message is sent when a failure has been detected by the system-processor diagnostics during IPL, but the system is still able to function.

CPP0DDE A system processor error is detected.

This message is sent when a control failure is detected on a system processor. Hardware ECC is correcting the failure. However, if you performed an initial program load (IPL), control could not be initialized and the system would reconfigure itself without that processor.

CPP0DDF A system processor is missing.

This message is sent when a processor is missing on a multi-processor system.

CPP29B0 Recovery threshold exceeded on device &25.

This message is sent when one of the parts in the 9337 disk unit is starting to fail.

CPP29B8 Device parity protection suspended on device &25.

This message is sent when one of the parts in the 9337 disk array is failing. Protection for implementation of RAID 5 technique has been suspended on the disk array.

CPP29B9 Power protection suspended on device &25.

This message is sent when one of the power modules in the 9337 disk array is failing. Power protection has been suspended on the disk array.

CPP29BA Hardware error on device &25.

This message is sent when one of the parts in the 9337 disk array has failed. Service action is required.

CPP95IB Battery power unit fault.

This message is sent when the battery power unit has failed.

CPP9522 Battery power unit fault.

This message is sent when the battery power unit in the 5042 Expansion Unit or 5040 Extension Unit has failed.

CPP955E Battery power unit not installed.

This message is sent when the battery power unit in the 9406 System Unit power supply is not installed.

CPP9575 Battery power unit in 9406 needs to be replaced.

This message is sent when the battery power unit in the 9406 System Unit has failed and needs to be replaced. It may still work, but more than the recommended number of charge-discharge cycles have occurred.

CPP9576 Battery power unit in 9406 needs to be replaced.

This message is sent when the battery power unit in the 9406 System Unit has failed and needs to be replaced. It may still work, but it has been installed longer than recommended.

CPP9589 Test of battery power unit complete.

This message is sent when testing has been completed for the battery power unit, and the results have been logged.

CPP9616 Battery power unit not installed.

This message is sent when the battery power unit has not been installed in the 5042 Expansion Unit or 5040 Extension Unit power supply.

CPP9617 Battery power unit needs to be replaced.

This message is sent when the battery power unit in the 5042 Expansion Unit or 5040 Extension Unit needs to be replaced. It may still work,

but more than the recommended number of charge-discharge cycles have occurred.

CPP9618 `Battery power unit needs to be replaced.`

This message is sent when the battery power unit in the 5042 Expansion Unit or 5040 Extension Unit needs to be replaced. It may still work, but it has been installed longer than recommended.

CPP961F `DC Bulk Module 3 fault.`

This message is sent when the dc bulk module 3 of the 9406 System Unit has failed.

CPP9620 `DC Bulk Module 2 fault.`

This message is sent when the dc bulk module 2 of the 9406 System Unit has failed.

CPP9621 `DC Bulk Module 1 fault.`

This message is sent when the dc bulk module 1 of the 9406 System Unit has failed.

CPP9622 `DC Bulk Module 1 fault.`

This message is sent when the dc bulk module 1 of the 5042 Expansion Unit or 5040 Extension Unit has failed. Other dc bulk modules can also cause this fault.

CPP9623 `DC Bulk Module 2 fault.`

This message is sent when the dc bulk module 2 of the 5042 Expansion Unit or 5040 Extension Unit has failed. Other DC bulk modules can also cause this fault.

CPP962B `DC Bulk Module 3 fault.`

This message is sent when the dc bulk module 3 of the 5042 Expansion Unit or 5040 Extension Unit has failed. Other dc bulk modules can also cause this fault.

Sample Program to Receive Messages from QSYSMSG

The following is a sample program which receives messages from the QSYSMSG message queue. The program is receiving messages and handling message CPF1269. The reason code in the CPF1269 message is in binary format. This must be converted to a decimal value for the comparisons to the 704 and 705 reason codes. The program issues the ENDMOD command to prevent new jobs from being started until the situation is understood. It then sends the same message to a user-defined message queue to be reviewed by the security officer. It also sends a message to the system operator informing him of what occurred. If a different message is received, it is sent to the system operator.

A separate job would be started to call this sample program. The job would remain active, waiting for a message to arrive. The job could be ended using the ENDJOB command.

```
/*****************************************************************/
/*                                                               */
/*  Sample program to receive messages from QSYSMSG              */
/*                                                               */
/*****************************************************************/
/*                                                               */
/*  Program looks for message CPF1269 with a reason code of 704  */
/*  or 705.  If found then notify QSECOFR of the security failure.*/
/*  Otherwise resend the message to QSYSOPR.                     */
/*                                                               */
/*  The following describes message CPF1269                      */
/*                                                               */
/*      CPF1269:  Program start request received on communications*/
/*                device &1 was rejected with reason codes &6, &7.*/
/*                                                               */
/*      Message data from DSPMSGD CPF1269                        */
/*                                                               */
/*        Data  type   offset length Description                 */
/*                                                               */
/*         &1   *CHAR      1     10  Device                      */
/*         &2   *CHAR     11      8  Mode                        */
/*         &3   *CHAR     19     10  Job - number                */
/*         &4   *CHAR     29     10  Job - user                  */
/*         &5   *CHAR     39      6  Job - name                  */
/*         &6   *BIN      45      2  Reason code - major         */
/*         &7   *BIN      47      2  Reason code - minor         */
/*         &8   *CHAR     49      8  Remote location name        */
/*         &9   *CHAR     57  *VARY  Unit of work identifier     */
/*                                                               */
/*****************************************************************/

         PGM

         DCL        &MSGID   *CHAR LEN(  7)
         DCL        &MSGDTA  *CHAR LEN(100)
         DCL        &MSG     *CHAR LEN(132)

         DCL        &DEVICE  *CHAR LEN( 10)
         DCL        &MODE    *CHAR LEN(  8)
         DCL        &RMTLOC  *CHAR LEN(  8)

         MONMSG     CPF0000  EXEC(GOTO PROBLEM)

       /*********************************************************/
       /* Fetch messages from QSYSMSG message queue             */
       /*********************************************************/
```

```
LOOP:     RCVMSG     MSGQ(QSYS/QSYSMSG) WAIT(*MAX) MSGID(&MSGID) +
                       MSG(&MSG) MSGDTA(&MSGDTA)

          IF         ((&MSGID *EQ 'CPF1269') /* Start failed msg */ +
            *AND      ((%BIN(&MSGDTA 45 2) *EQ 704)                +
              *OR      (%BIN(&MSGDTA 45 2) *EQ 705)) )             +
          THEN(DO)
            /*********************************************************/
            /* Report security failure to QSECOFR                    */
            /*********************************************************/

            CHGVAR     &DEVICE %SST(&MSGDTA 1 10) /* Extract device */
            CHGVAR     &MODE   %SST(&MSGDTA 11 8) /* Extract mode   */
            CHGVAR     &RMTLOC %SST(&MSGDTA 49 8) /* Get loc name   */

            ENDMOD     RMTLOCNAME(&RMTLOC) MODE(&MODE)

            SNDPGMMSG  MSGID(&MSGID) MSGF(QCPFMSG) MSGDTA(&MSGDTA) +
                         TOMSGQ(QSECOFR)

            SNDPGMMSG  MSG('Device ' *CAT &DEVICE *TCAT ' Mode '  +
                         *CAT &MODE *TCAT ' had security failure, +
                         session max changed to zero')           +
                         TOMSGQ(QSYSOPR)
          ENDDO
          ELSE DO
            /*********************************************************/
            /* Other message - Resend to QSYSOPR                     */
            /*********************************************************/

            SNDPGMMSG  MSGID(&MSGID) MSGF(QCPFMSG) MSGDTA(&MSGDTA) +
                         TOMSGQ(QSYSOPR)

            /* SNDPGMMSG would fail if the message does             */
            /*   not have a MSGID or is not in QCPFMSG              */

            MONMSG     MSGID(CPF0000)  +
                       EXEC(SNDPGMMSG MSG(&MSG) TOMSGQ(QSYSOPR))
          ENDDO

          GOTO       LOOP    /* Go fetch next message             */


          /*************************************************************/
          /* Notify QSYSOPR of abnormal end                            */
          /*************************************************************/

PROBLEM:  SNDPGMMSG  MSG('QSYSMSG job has abnormally ended') +
                       TOMSGQ(QSYSOPR)
          MONMSG     CPF0000

          SNDPGMMSG  MSGID(CPF9898) MSGF(QCPFMSG) MSGTYPE(*ESCAPE) +
                       MSGDTA('Unexpected error occurred')
          MONMSG     CPF0000

          ENDPGM
```

Using the System Reply List

The system reply list allows you to specify that the system issue the reply to specified predefined inquiry messages so the display station user does not need to reply. Only inquiry messages can be automatically responded to.

The system reply list contains message identifiers, optional compare data, a reply value for each message, and a dump attribute. The system reply list applies only to predefined inquiry messages that are sent by a job that uses the system reply list. You specify that a job is to use the system reply list for inquiry messages on the INQMSGRPY(*SYSRPYL) parameter on the following commands:

- Batch Job (BCHJOB)
- Submit Job (SBMJOB)
- Change Job (CHGJOB)
- Create Job Description (CRTJOBD)
- Change Job Description (CHGJOBD)

When a predefined inquiry message is sent by a job that uses the system reply list, the system searches the reply list in ascending sequence number order for an entry that matches the message identifier and, optionally, the compare data of the reply message. If an entry is found, the reply specified is issued and the user is not required to enter a reply. If an entry is not found, the message is sent to the display station user for interactive jobs or system operator for batch jobs.

The system reply list is shipped with the system with the following initial entries defined:

Sequence Number	Message Identifier	Compare Value	Reply	Dump
10	CPA0700	*NONE	D	*YES
20	RPG0000	*NONE	D	*YES
30	CBE0000	*NONE	D	*YES
40	PLI0000	*NONE	D	*YES

These entries indicate that a reply of D is to be sent and a job dump is to be taken if the message CPA0700-CPA0799, RPG0000-RPG9999, CBE0000-CBE9999, or PLI0000-PLI9999 (which indicate a program failure) is sent by a job using the system reply list. For the system to use these entries, you must specify that the jobs are to use the system reply list.

To add other inquiry messages to the system reply list, use the Add Reply List Entry (ADDRPYLE) command. On this command you can specify the sequence number, the message identifier, optional compare data, reply action, and the dump attribute. The ADDRPYLE command function can be easily accessed by using the Work with System Reply List Entries (WRKRPYLE) command.

The following reply actions can be specified for the inquiry messages that are placed on the system reply list (the parameter value is given in parentheses):

- Send the default reply for the inquiry messages (*DFT). In this case, the default reply for the message is sent. The message is not displayed, and no default handling program is called.

- Require the work station user or system operator to respond to the message (*RQD). If the message queue to which the message is sent (work station message queue for interactive jobs and QSYSOPR for batch jobs) is in break mode, the message is displayed, and the work station user must respond to the message. This option operates as if the system reply list were not being used.
- Send the reply specified in the system reply list entry (message reply, 32 characters maximum). In this case, the specified reply is sent as the response to the message. The message is not displayed, and no default handling program is called.

The following commands add entries to the system reply list for messages RPG1241, RPG1200, CPA4002, CPA5316, and any other inquiry messages:

```
• ADDRPYLE SEQNBR(15) MSGID(RPG1241) RPY(C)
• ADDRPYLE SEQNBR(18) MSGID(RPG1200) RPY(*DFT) DUMP(*YES)
• ADDRPYLE SEQNBR(22) MSGID(CPA4002) RPY(*RQD) +
           CMPDTA('QSYSPRT')
• ADDRPYLE SEQNBR(25) MSGID(CPA4002) RPY(G)
• ADDRPYLE SEQNBR(27) MSGID(CPA5316) RPY(I) DUMP(*NO) +
            CMPDTA('QSYSPRT' 21)
• ADDRPYLE SEQNBR(9999) MSGID(*ANY) RPY(*DFT)
```

The system reply list now appears as follows:

Sequence Number	Message Identifier	Compare Value (b is a blank)	Compare Start Position	Reply	Dump
10	CPA0700		1	D	*YES
15	RPG1241		1	C	*NO
18	RPG1200		1	*DFT	*YES
20	RPG0000		1	D	*YES
22	CPA4002	'QSYSPRT'	1	*RQD	*NO
25	CPA4002		1	G	*NO
27	CPA5316	'QSYSPRT'	21	I	*NO
30	CBE0000		1	D	*YES
40	PLI0000		1	D	*YES
9999	*ANY		1	*DFT	*NO

For a job that uses this system reply list, the following occurs when the messages that were added to the reply list are sent by the job:

- For sequence number 15, whenever an RPG1241 message is sent by a job that uses the system reply list, a reply of C is sent and the job is not dumped.
- For sequence number 18, a generic message identifier is used so whenever an RPG1200 inquiry message is sent by the job, the default reply is sent. The default reply can be the default reply specified in the message description or the system default reply. Before the default reply is sent, the job is dumped. The previous entry that was added overrides this entry for message RPG1241.

- For sequence number 22, if the inquiry message CPA4002 is sent with the compare data of QSYSPRT, the message is sent to the display station user, and the user must issue the reply.

When a compare value is specified without a start position, the compare value is compared to the message data beginning in position 1 of the substitution data in the message. Sequence number 22 tests for a printer device name of QSYSPRT. For an example of testing one substitution variable with a different start position, see sequence number 27.

- For sequence number 25, if the inquiry message CPA4002 (verify alignment on printer &1.) is sent with the compare not equal to QSYSPRT, a reply of G is sent. The job is not dumped. Sequence number 22 requires an operator response to the forms alignment message if the printer device is QSYSPRT. Sequence number 25 defines that if the forms alignment inquiry message occurs for any other device, to assume a default response of G=Go.
- For sequence number 27, if the inquiry message CPA5316 is sent with the compare data of `TESTEDFILETSTLIBRARYQSYSPRT`, a reply of `I` is sent.

  When a compare value and a start position are specified, the compare value is compared with the message data beginning with the start position. In this case, position 21 is the beginning of the third substitution variable. For message CPA5316, the first four substitution variables are as follows:

&1	ODP file name	*CHAR	10
&2	ODP library name	*CHAR	10
&3	ODP device name	*CHAR	10
&4	Line number for first line	*BIN	2

Therefore, sequence number 27 tests for an ODP device name of QSYSPRT before sending a reply.

- For sequence number `9999`, the message identifier of *ANY applies to any pre-defined inquiry message that is not matched by an entry with a lower sequence number, and the default reply for these inquiry messages is sent. If this entry were not included in the system reply list, the display station user would have to respond to all other inquiry messages that were not included in the system reply list.

An entry remains on the system reply list until you use the Remove Reply List Entry (RMVRPYLE) command to remove it. You can use the Change Reply List Entry (CHGRPYLE) command to change the attributes of a reply list entry, and you can use the Work with System Reply List Entry (WRKRPYLE) command to display the reply entries currently in the reply list.

Message Logging

The two types of logs for messages are:

- Job log
- History log

A job log contains information related to requests entered for a job. The QHST log contains system data, such as a history of job start and end activity on your system.

Job Log

Each job has an associated job log that can contain the following for the job:

- The commands in the job.
- The commands in a CL program if the CL program was created with the LOG(*YES) option or with the LOG(*JOB) option and a Change Job (CHGJOB) command was run with the LOGCLPGM(*YES) option (for more information on logging CL program commands, see "Logging CL Program Commands" on page 2-47).
- All messages and message help sent to the requester and not removed from the program message queues.

At the end of the job, the job log can be written to the output file QPJOBLOG so that it can be printed. After the job log is written to the output file, the job log is deleted. You can prevent a job log from being written to QPJOBLOG for successful completions. See the discussion on preventing job logs later in this chapter.

You can control what information is written in the job log. To do this, you specify the LOG parameter on the Create Job Description (CRTJOBD) command. You can change these levels using the Change Job (CHGJOB) command or the Change Job Description (CHGJOBD) command. The LOG parameter is made up of 3 values: message level, message severity, and message text level. For more information on these commands, see the *Work Management Guide*.

The first value, message level, has the following levels:

Level	Description
0	No data is logged.
1	The only information to be logged is all messages sent to the job's external message queue with a severity greater than or equal to the message severity specified. Messages of this type indicate when the job started, when it ended, and its status at completion.
2	The following information is logged: • Logging level 1 information. • Any requests entered on a command line or commands being logged from a CL program for which high-level messages are issued with a severity greater than or equal to the severity specified. If the request or command is logged, all its associated messages are also logged.
3	The following information is logged: • Logging level 1 information. • All requests or commands being logged from a CL program. • If any high-level messages associated with a request or command have a severity greater than or equal to the severity specified, then all the messages associated with the request or command are logged.
4	The following information is logged: • All requests or commands being logged from a CL program. • Only messages with a severity code greater than or equal to the severity specified.

Note: A high-level message is one that is sent to the program message queue of the program that receives the request or command being logged from a CL program.

The second value, message severity, specifies the minimum severity level that causes error messages to be entered in the job log. Values 0 through 99 are allowed. Only those messages with a severity greater than or equal to this value are entered in the job log.

The third value in the LOG parameter, message text level, specifies the level of message text that is written in the job log. The values are:

***MSG** Only message text is written to the job log (message help is not included).

***SECLVL** The message and the message help are written to the job log.

***NOLIST** No job log is produced if the job ends normally. If the job end code is 20 or greater, a job log is produced with the message and message help included.

Before each new request is received by a request processing program, message filtering occurs. **Message filtering** is the process of removing messages from the job log based on the message logging level set for the job.

Filtering does not occur after every CL command is called within a program. Therefore, if a CL program is run interactively or submitted to batch, the filtering runs once after the program ends because the program is not a request processor.

Note: Since *NOLIST specifies that no job log is spooled for jobs that end normally, it is a waste of system resource in batch jobs to remove the messages from this log by specifying log level 0.

The following example shows how the logging level affects the information that is stored in the job message queue and, therefore, written to the job log, if one is requested. The example also shows that when the command is run interactively, filtering occurs after each command.

Note: Both high-level and detailed message logging levels are included in the examples. High-level messages are identified as *Message*; detailed messages are identified as *Detailed Message*.

1. The CHGJOB command specifies a logging level of 2 and a message severity of 50, and that only messages are to be written to the job log (*MSG).

```
                              Command Entry                        SYSTEM1
                                                     Request level:   1
Previous commands and messages:
     > CHGJOB LOG(2 50 *MSG)
```

2. PGMA sends three informational messages with severity codes of 20, 50, and 60 to its own program message queue and to the program message queue of the program called before the specified call (*PRV). The messages that PGMA sends to its own program message queue are called detailed messages. **Detailed messages** are those messages that are sent to the program message queue of the lower-level program call.

PGMB sends two informational messages with severity codes of 40 and 50 to its own program message queue. These are detailed messages. PGMB also sends one informational message with a severity code of 10 to *PRV.

Note that the CHGJOB command no longer appears on the display. According to logging level 2, only requests for which a message has been issued with a severity equal to or greater than that specified are saved for the job log, and no messages were issued for this request. If such a message had been issued, any detailed messages that had been issued would be saved for the job log and could be displayed by pressing F10.

```
                              Command Entry                      SYSTEM1
                                                    Request level:   1
Previous commands and messages:
      > CALL PGMA
        Message sev 20 - PGMA
        Message sev 50 - PGMA
        Message sev 60 - PGMA
      > CALL PGMB
        Message sev 10 - PGMB









                                                                   Bottom
Type command, press Enter.
===> ____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
 F3=Exit   F4=Prompt   F9=Retrieve   F10=Include detailed messages
 F11=Display full      F12=Cancel     F13=Information Assistant   F24=More keys
```

3. When F10=Include detailed messages is pressed from the Command Entry display, all the messages associated with the request are displayed. Press F10 again to exclude detailed messages.

```
                              Command Entry                      SYSTEM1
                                                    Request level:   1
All previous commands and messages:
   > CALL PGMA
     Detailed message sev  20 - PGMA
     Detailed message sev  50 - PGMA
     Detailed message sev  60 - PGMA
     Message sev 20 - PGMA
     Message sev 50 - PGMA
     Message sev 60 - PGMA
   > CALL PGMB
     Detailed message sev  40 - PGMB
     Detailed message sev  50 - PGMB
     Message sev 10 - PGMB

                                                                   Bottom
Type command, press Enter.
===> ____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
 F3=Exit   F4=Prompt   F9=Retrieve   F10=Exclude detailed messages
 F11=Display full      F12=Cancel     F13=Information Assistant    F24=More Keys
```

4. When another command is entered (in this example, CHGJOB), the CALL PGMB command and all messages (including detailed messages) are removed. They

are removed because the severity code for the high-level message associated with this request was not equal to or greater than the severity code specified in the CHGJOB command. The CALL PGMA command and its associated messages remain because at least one of the high-level messages issued for that request has a severity code equal to or greater than that specified.

On the following display, the CHGJOB command specifies a logging level of 3, a message severity of 40, and that both the first- and second-level text of a message are to be written to the job log. When another command is entered, the CHGJOB command remains on the display because logging level 3 logs all requests.

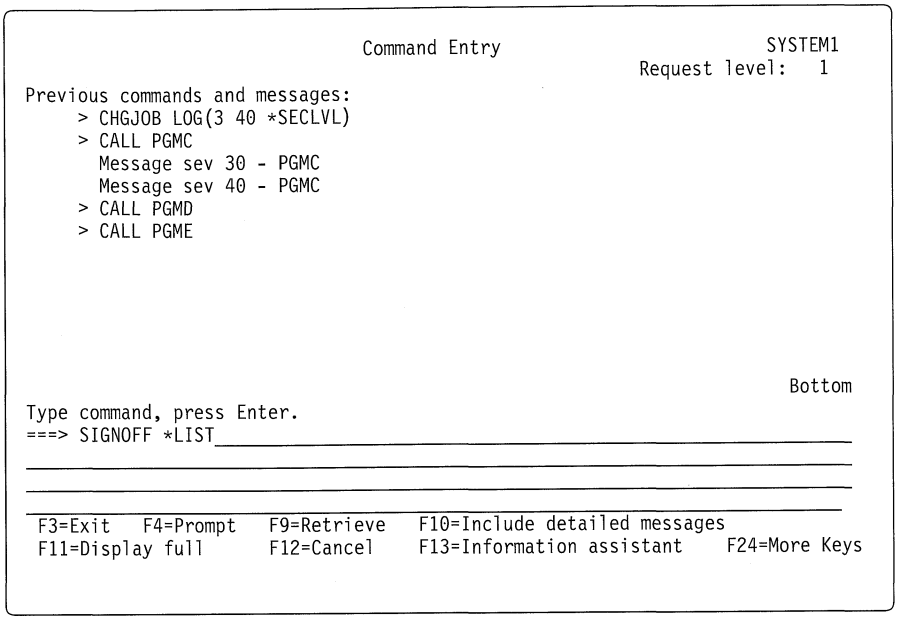
PGMC sends two messages with severity codes of 30 and 40 to the program message queue of the program called before the specified call (*PRV).

PGMD sends a message with a severity of 10 to *PRV.

```
                                Command Entry                       SYSTEM1
                                                        Request level:   1
Previous commands and messages:
     > CALL PGMA
       Message sev 20 - PGMA
       Message sev 50 - PGMA
       Message sev 60 - PGMA
     > CHGJOB LOG(3 40 *SECLVL)
     > CALL PGMC
       Message sev 30 - PGMC
       Message sev 40 - PGMC
     > CALL PGMD
       Message sev 10 - PGMD


                                                                    Bottom
Type command, press Enter.
===> ____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
 F3=Exit   F4=Prompt   F9=Retrieve   F10=Include detailed messages
 F11=Display full      F12=Cancel     F13=Information Assistant    F24=More Keys
```

5. When another command is entered after the CALL PGMD command was entered, the CALL PGMD command remains on the display, but its associated message is deleted. The message is deleted because its severity code is not equal to or greater than the severity code specified on the LOG parameter of the CHGJOB command.

   The command SIGNOFF *LIST is entered to print the job log.



The job log, which follows, contains all the requests and all the messages that have remained on the Command Entry display. In addition, the job log contains the message help associated with each message, as specified by the CHGJOB command. Notice that the job log contains the message help of any message issued during the job, not just for the messages issued since the second CHGJOB command was entered.

```
 5738SS1 V2R3M0 920925                          Job Log                          RCHAS727 12/12/92 07:58:53          Page    1
  Job name . . . . . :   QPADEV0007      User . . . . . :   SIMPSON      Number . . . . :   004201
  Job description  . . . . . :   QDFTJOBD        Library . . . . . :   QGPL
MSGID      TYPE                SEV   DATE       TIME       FROM PGM       LIBRARY     INST     TO PGM       LIBRARY      INST
CPF1124    Information         00    12/12/92   07:57:16   QWTPIIPP       QSYS        04FC     *EXT                      0000
                                 Message . . . . :   Job 004201/SIMPSON/QPADEV0007 started on 12/12/92 at
                                   07:57:16 in subsystem QINTER in QSYS. Job entered system on 12/12/92 at
                                   07:57:16.
*NONE      Request                   12/12/92   07:57:50   QMHGSD         QSYS        0322     QCMD         QSYS         00B6
                                 Message . . . . :  -call pgma
CPF1001    Information         20    12/12/92   07:57:50   PGMA           SIMPSON     000C     PGMA         SIMPSON      000C
                                 Message . . . . :   Detailed message sev 20 - PGMA
                                 CPF1001 second level text - PGMA
CPF1002    Information         50    12/12/92   07:57:50   PGMA           SIMPSON     0010     PGMA         SIMPSON      0010
                                 Message . . . . :   Detailed message sev 50 - PGMA
                                 CPF1002 second level text - PGMA
CPF1003    Information         60    12/12/92   07:57:50   PGMA           SIMPSON     0014     PGMA         SIMPSON      0014
                                 Message . . . . :   Detailed message sev 60 - PGMA
                                 CPF1003 second level text - PGMA
CPF1004    Information         20    12/12/92   07:57:50   PGMA           SIMPSON     0018     QCMD         QSYS         00DE
                                 Message . . . . :   Message sev 20 - PGMA
                                 CPF1004 second level text - PGMA
CPF1005    Information         50    12/12/92   07:57:50   PGMA           SIMPSON     001C     QCMD         QSYS         00DE
                                 Message . . . . :   Message sev 50 - PGMA
                                 CPF1005 second level text - PGMA
CPF1006    Information         60    12/12/92   07:57:50   PGMA           SIMPSON     0020     QCMD         QSYS         00DE
                                 Message . . . . :   Message sev 60 - PGMA
                                 CPF1006 second level text - PGMA
*NONE      Request                   12/12/92   07:58:31   QMHGSD         QSYS        0322     QCMD         QSYS         00B6
                                 Message . . . . :  -chgjob log(3 40 *seclvl)
*NONE      Request                   12/12/92   07:58:34   QMHGSD         QSYS        0322     QCMD         QSYS         00B6
                                 Message . . . . :  -call pgmc
CPF100F    Information         30    12/12/92   07:58:34   PGMC           SIMPSON     000C     QCMD         QSYS         00DE
                                 Message . . . . :   Message sev 30 - PGMC
                                 CPF100F second level text - PGMC
CPF1010    Information         40    12/12/92   07:58:34   PGMC           SIMPSON     0010     QCMD         QSYS         00DE
                                 Message . . . . :   Message sev 40 - PGMC
                                 CPF1010 second level text - PGMC
*NONE      Request                   12/12/92   07:58:38   QMHGSD         QSYS        0322     QCMD         QSYS         00B6
                                 Message . . . . :  -call pgmd
*NONE      Request                   12/12/92   07:58:45   QMHGSD         QSYS        0322     QCMD         QSYS         00B6
                                 Message . . . . :  -call pgme
*NONE      Request                   12/12/92   07:58:52   QMHGSD         QSYS        0322     QCMD         QSYS         00B6
                                 Message . . . . :  -signoff *list
CPF1164    Completion          00    12/12/92   07:58:52   QWTMCEOJ       QSYS        01EE     *EXT                      0000
                                 Message . . . . :   Job 004201/SIMPSON/QPADEV0007 ended on 12/12/92 at
                                   07:58:52; 3 seconds used; end code 0 .
                                 Cause . . . . . :   Job 004201/SIMPSON/QPADEV0007 completed on 12/12/92 at
                                   07:58:52 after it used 3 seconds processing unit time.  The job had ending
                                   code 0. The job ended after 1 routing steps with a secondary ending code of
                                   0.  The job ending codes and their meanings are as follows:  0 - The job
                                   completed normally. 10 - The job completed normally during controlled ending
                                   or controlled subsystem ending. 20 - The job exceeded end severity (ENDSEV
                                   job attribute). 30 - The job ended abnormally. 40 - The job ended before
                                   becoming active. 50 - The job ended while the job was active. 60 - The
                                   subsystem ended abnormally while the job was active. 70 - The system ended
                                   abnormally while the job was active. 80 - The job ended (ENDJOBABN command).
                                   90 - The job was forced to end after the time limit ended (ENDJOBABN
                                   command). Recovery  . . . :   For more information, see the Work Management
                                   Guide, SC41-8078.
```

The headings at the top of each page of the printed job log identify the job to which the job log applies and the characteristics of each entry:

- The fully qualified name of the job (job name, user name, and job number).
- The name of the job description used to start the job.
- The date and time the job started.
- The message identifier.
- The message type.
- The message severity.

- The date and time each message was sent. This is not included for request messages.
- The message. If the logging level specifies that second-level text is to be included, the second-level text appears on subsequent lines below the message.
- The program or procedure from which the message or request was sent.
- The instruction number for the machine interface or higher-level statement number for the program or procedure from which the message was sent.
- The program or procedure to which the message or request was sent.
- The instruction number for the machine interface or the higher-level language statement number to which the program or procedure was sent.

Sending or Receiving a Program or Procedure

When the sender or receiver is an ILE procedure, the message entry contains the full name of the procedure (procedure name, module name, and ILE program name). When the sender or receiver is an original program model (OPM) program, only the OPM program name is shown.

If the sender or receiver is an OPM program, the corresponding instruction number requests an instruction number. There is only one such number. If the sender or receiver is an ILE procedure, the instruction number represents a high level language statement number rather than an MI instruction number. If the ILE procedure has been optimized (maximum efficiency), there may be up to three numbers. It is not always possible to determine a single statement number for an optimized procedure. If there is more than one number given, each number represents a potential point where the procedure was when the message was sent. It is also possible that no number can be determined. If this the case, *N appears in the message rather than a number.

The logging levels affect a batch job log in the same way as shown in the preceding example. If the job uses APPC, the heading contains a line showing the unit of work identifier for APPC. See the *APPC Programmer's Guide* for more information on APPC.

Displaying the Job Log

The way to display a job log depends on the status of the job.

- If the job has ended and the job log is not yet printed, use the Display Spooled File (DSPSPLF) command, as follows:

  ```
  DSPSPLF FILE(QPJOBLOG) JOB(001293/FRED/WS3)
  ```

  to display the job logs for job number 001293 associated with user FRED at display station WS3.

- If the job is still active (batch or interactive jobs) or is on a job queue and has not yet started, use the Display Job Log (DSPJOBLOG) command. For example, to display the job log of the interactive job for user JSMITH at display station WS1, enter:

  ```
  DSPJOBLOG JOB(nnnnnn/JSMITH/WS1)
  ```

  where `nnnnnn` is the job number.

To display the job log of your own interactive job, do one of the following:

- Enter the following command:

  ```
  DSPJOBLOG
  ```

- Enter the WRKJOB command and select option 10 (Display job log) from the Work with Job display.
- Press F10=Include detailed messages from the Command Entry display (this key displays the messages that are shown in the job log).
- If the input-inhibited light on your display station is on and remains on, do the following:
  1. Press the System Request key, then press the Enter key.
  2. On the System Request menu, select option 3 (Display current job).
  3. On the Display Job menu, select option 10 (Display Job log, if active or on job queue).
  4. On the Job Log display, DSPJOB appears as the processing request. Press F10 (Display detailed messages).
  5. On the Display All Messages display, press the Roll Down key to see messages that were received before you pressed the System Request key.
- Sign off the work station, specifying LOG(*LIST) on the SIGNOFF command.

When you use the Display Job Log (DSPJOBLOG) command, you see the Job Log display. This display shows program names with special symbols, as follows:

>>	The running command or the next command to be run. For example, if a CL or HLL program was called, the call to the program is shown.
>	The command has completed processing.
. .	The command has not yet been processed.
?	Reply message. This symbol marks both those messages needing a reply and those that have been answered.

On the Job Log display, you can do the following:

- Press F10 to display detailed messages. This display shows the commands or operations that were run within an HLL program or within a CL program for which LOGCLPGM is activated.
- Use the cursor movement keys to get to the end of the job log. To get to the end of the job log quickly, press F18 (Bottom). After pressing F18, you might need to roll down to see the command that is running.
- Use the cursor movement keys to get to the top of the job log. To get to the top of the job log quickly, press F17 (Top).

Preventing the Production of Job Logs

To prevent a job log from being produced at the completion of a batch job, you can specify *NOLIST for the message text-level value of the LOG parameter on the Batch Job (BCHJOB), Submit Job (SBMJOB), Change Job (CHGJOB), Create Job Description (CRTJOBD), or Change Job Description (CHGJOBD) command. If you specify *NOLIST for the message level value of the LOG parameter, the job log is not produced at the end of a job unless the job end code is 20 or greater. If the job end is 20 or greater, the job log is produced.

For an interactive job, the value specified for the LOG parameter on the SIGNOFF command takes precedence over the LOG parameter value specified for the job.

Job Log Considerations

The following suggestions apply to using job logs:

- To change the output queue for all jobs on the system, use the OUTQ or DEV parameter on the Change Printer File (CHGPRTF) command to change the file QSYS/QPJOBLOG. The following are two examples using each of the parameters:

  ```
  CHGPRTF FILE(QSYS/QPJOBLOG)
          DEV (USRPRT)

  or

  CHGPRTF FILE(QSYS/QPJOBLOG)
          OUTQ(USROUTQ)
  ```

- To change the QPJOBLOG printer file to use output queue QEZJOBLOG, use the Operational Assistant cleanup function. When you want to use automatic cleanup of the job logs, the printer files must be directed to this output queue. For more information on the Operational Assistant cleanup function, see the *Operator's Guide*.

- To specify the output queue to which a job's job log is written, make sure that file QPJOBLOG has OUTQ(*JOB) specified. You can use the OUTQ parameter on any of the following commands: BCHJOB, CRTJOBD, CHGJOBD, or CHGJOB. The following is an example:

  ```
  CHGJOB OUTQ(*JOB)
  ```

  If you change the default OUTQ at the beginning of the job, all spooled files are affected. If you change it just before job completion, only the job log is affected. You cannot use the Override with Printer File (OVRPRTF) command to affect the job log.

- If the output queue for a job cannot be found, no job log is produced.

- To hold all job logs, specify HOLD(*YES) on the CHGPRTF command for the file QSYS/QPJOBLOG. The job logs are then released to the writer when the Release Spooled File (RLSSPLF) command is run. The following is an example:

  ```
  CHGPRTF FILE(QSYS/QPJOBLOG)
          HOLD(*YES)
  ```

- If the system abnormally ends, the start prompt allows the system operator to specify whether the job logs are to be printed for any jobs that were active at the time of the abnormal end.

- To delete a job log, use the Delete Spooled File (DLTSPLF) command or the Delete option on the output queue display.

- If you used the USRDTA parameter on the Change Print File (CHGPRTF) command to change the user data value for the QSYS/QPJOBLOG file, the value specified will not be shown on the Work with Output Queue or Work with All Spooled Files displays. The value shown in the user data column is the job name of the job whose job log has printed.

Considerations for Interactive Job Logs

The IBM-supplied job descriptions QCTL, QINTER, and QPGMR all have a log level of LOG(4 0 *NOLIST); therefore, all messages and both first- and second-level text for the messages are written to the job log. However, the job logs are not printed unless you specify *LIST on the SIGNOFF command. To change the log level for interactive jobs, you can use the CHGJOB or CHGJOBD command.

If a display station user uses an IBM-supplied menu or the command entry display, all error messages are displayed. If the display station user uses a user-written initial program, any unmonitored message causes the initial program to end and a job log to be produced. However, if the initial program monitors for messages, it receives control when a message is received. In this case, it may be important to ensure that the job log is produced so you can determine the specific error that occurred. For example, assume that the initial program displays a menu that includes a sign-off option, which defaults to *NOLIST. The initial program monitors for all exceptions and includes a Change Variable (CHGVAR) command that changes the sign-off option to *LIST if an exception occurs:

```
         PGM
         DCLF MENU
         DCL &SIGNOFFOPT TYPE(*CHAR) LEN(7) VALUE(*NOLIST)
         .
         .
         .
         MONMSG MSG(CPF0000) EXEC(GOTO ERROR)
PROMPT:  SNDRCVF RCDFMT(PROMPT)
         CHGVAR &IN41 '0'
         .
         .
         .
         IF (&OPTION *EQ '90') SIGNOFF LOG(&SIGNOFFOPT)
         .
         .
         .
         GOTO PROMPT
ERROR:   CHGVAR &SIGNOFFOPT '*LIST'
         CHGVAR &IN41 '1'
         GOTO PROMPT
         ENDPGM
```

If an exception occurs in the previous example, the CHGVAR command changes the option on the SIGNOFF command to *LIST and sets on an indicator. This indicator could be used to condition a constant that displays a message informing the display station user that an unexpected event has occurred and telling him what to do.

If the interactive job is running a CL program, the CL program commands are logged only if the log level is 3 or 4 and one of the following is true:

- LOG(*YES) was specified on the Create Control Language Program (CRTCLPGM) command.
- LOG(*JOB) was specified on the Create Control Language Program (CRTCLPGM) command and (*YES) is the current LOGCLPGM job attribute.

The LOGCLPGM job attribute can be set and changed by using the LOGCLPGM parameter on the SBMJOB, CRTJOBD, CRTJOBD, and CHGJOBD commands.

Considerations for Batch Job Logs

For your batch applications, you may want to change the amount of information logged. The log level (LOG(4 0 *NOLIST)) specified in the job description for the IBM-supplied subsystem QBATCH supplies a complete log if the job abnormally ends. If the job completes normally, no job log will be produced.

If you want to print the job log in all cases, use the Change Job Description (CHGJOBD) command to change the job description, or specify a different LOG value on the BCHJOB or SBMJOB command. See "Job Log" on page 8-37 for a description of logging levels.

If the batch job is running a CL program, the CL program commands are logged only if LOG(*YES) is specified on the Create Control Language Program (CRTCLPGM) command or LOGCLPGM(*YES) is specified on the Change Program (CHGPGM) command.

QHST History Log

The history log (QHST) consists of a message queue and a physical file known as a log-version. Messages sent to the history log message queue are written by the system to the current log version physical file.

- History log (QHST). Contains a high-level trace of system activities such as system, subsystem, and job information, device status, and system operator messages. Its message queue is QHST.

When a log-version is full, a new version of the log is automatically created. Each version is a physical file that is named in the following way:

```
Qxxxyydddn
```

where:

xxx	Is a 3-character description of the log type (HST)
yyddd	Is the Julian date on which the log-version was created
n	Is a sequence number within the Julian date (0 through 9 or A through Z)

Note: The number of records in each version of the history log is specified in the system value QHSTLOGSIZ.

You can also write a program to process history log records. Because several versions of each log may be available, you must select the log-version to be processed. To determine the available log-versions, use the Display Object Description (DSPOBJD) command. For example, the following DSPOBJD command displays what versions of the history log are available:

```
DSPOBJD   OBJ(QSYS/QHST*)   OBJTYPE(*FILE)
```

You can delete logs on your system using the delete option from the display presented on the Work with Objects (WRKOBJ) command. For an automatic method of deleting QHST logs, see the DLTLOG command in QUSRTOOL.

You can display or print the information in a log using the Display Log (DSPLOG) command. You can select the information you want displayed or printed by specifying any combination of the following:

- Period of time
- Name of job that sent the log entry
- Message identifiers of entries

The following DSPLOG command displays all the available entries for the job OEDAILY in the current day:

```
DSPLOG JOB(OEDAILY)
```

The resulting display is:

```
                        Display History Log Contents

Job OEDAILY started
Database file OEMSTR in library OELIB expired
Job OEDAILY abnormally ended
Job OEDAILY started
Job OEDAILY ended









                                                                    Bottom
Press Enter to continue.

F3=Exit    F10=Display all    F12=Cancel
```

If you have reset the system date or time to an earlier setting, a system log-version can contain entries that are not in chronological order and, therefore, when you try to display the log-version, some entries may be missed. For example, if the log-version contains entries dated 1988 followed by entries dated 1987, and you want to display those 1987 entries, you specify the 1987 dates on the PERIOD parameter on the DSPLOG command but the expected entries are not displayed. You should always use the system date (QDATE) and the system time (QTIME), or you should specify the PERIOD parameter as follows:

```
PERIOD((start-time start-date) (*AVAIL *END))
```

The system writes the messages sent to a log message queue to the current version physical file when the message queue is full or when the DSPLOG command was used. If you want to ensure the current version is up-to-date, specify a fictitious message identifier, such as ###0000, on the DSPLOG command. No messages are displayed, but the log-version physical file is made current.

If you print the information in a log using the Display Log (DSPLOG) command, only 105 characters of message text is shown. Any characters after 105 characters are truncated at the right.

Format of the History Log

A database file is used to store the messages sent to a log on the system. Because all records in a physical file have the same length and messages sent to a log have different lengths, the messages can span more than one record. Each record for a message has three fields:

- System date and time (a character field of length 8). This is an internal field. The converted date and time also are in the message.
- Record number (a 2-byte field). For example, the field contains hex `0001` for the first record, hex `0002` for the second record, and so on.
- Data (a character field of length 132).

The third field (data) of the first record has the following format:

Contents	Type	Length	Positions in Record
Job name	Character	26	11-36
Converted date and time[1]	Character	13	37-49
Message ID	Character	7	50-56
Message file name	Character	10	57-66
Library name	Character	10	67-76
Message type[2]	Character	2	77-78
Severity code	Character	2	79-80
Sending program name[3]	Character	12	81-92
Sending program instruction number[4]	Character	4	93-96
Receiving program name[3]	Character	10	97-106
Receiving program instruction number[4]	Character	4	107-110
Message text length	Binary	2	111-112
Message data length	Binary	2	113-114
Reserved	Character	28	115-142

1 The format is: `cyymmddhhmmss`
where:

`c`	Is the century digit (c=0 if yy ≥ 40, c = 1 if yy < 40)
`yymmdd`	Is the year, month, and day that the message is sent
`hhmmss`	Is the hour, minute, and second that the message is sent

2 This has the same value as the RTNTYPE parameter on the Receive Message (RCVMSG) command.

3 If the sender or receiver is an ILE procedure, the entry in the history log contains only the ILE program name. The module name and procedure name are not included in the history log.

4 If the sender or receiver is an ILE procedure, the sending or receiving instruction number is 0.

The third field (data) of the remaining records has the following format:

Contents	Type	Length
Message	Character	Variable[1]
Message data	Character	Variable[2]

1 This length is specified in the first record (positions 111 and 112) and cannot exceed 132.

2 This length is specified in the first record (positions 113 and 114).

A message is never split when a new version of a log is started. The first and last records of a message are always in the same QHST version.

For a description of the message data for a message, see "Defining Substitution Variables" on page 7-8.

Processing the QHST File

If you use an HLL program to process the QHST file, keep in mind that the length of the message can vary with each occurrence of a message. Because the message includes replaceable variables, the actual length of the message varies; therefore, the message data begins at a variable location for each use of the same message.

QHST Job Start and Completion Messages

The system performs special formatting of the job start and job completion messages. For message CPF1124 (job start) and message CPF1164 (job completion), the message data always begins in position 11 of the third record.

Job accounting provides more information than CPF1124 and CPF1164. For simple job accounting functions, use the CPF1164 message.

If you are interested in processing the information in QHST, use the CVTQHST command in QUSRTOOL which creates a fixed-length externally-described file for QHST information.

Performance information is not displayed as text on message CPF1164. Because the message is in the QHST log, users can write application programs to retrieve this data. The format of this performance information is as follows.

The performance information is passed as a variable length replacement text value. This means that the data is in a structure with the first entry being the length of the data. The size of the length field is not included in the length. The first data fields in the structure are the times and dates that the job entered the system and when the first routing step for the job was started. The times are in the format 'hh:mm:ss'. The separators are always colons. The dates are in the format defined in the system value QDATFMT and the separators are in the system value QDATSEP. The time and date the job entered the system precede the job start time and date in the structure.

The time and date the job entered the system are when the system becomes aware of a job to be initiated (a job structure is set aside for the job). For an interactive job, the job entry time is the time the password is recognized by the system. For a batch job, it is the time the BCHJOB or SBMJOB command is processed.

For a monitor job, reader or writer, it is the time the corresponding start command is processed, and for autostart jobs it is during the start of the subsystem.

Following the times and dates are the total response time and the number of transactions. The total response time is in seconds and contains the accumulated value of all the intervals the job was processing between pressing the Enter key at the work station and when the next display is shown. This information is similar to that shown on the WRKACTJOB display. This field is only meaningful for interactive jobs.

It is also possible in the case of a system failure or abnormal job end that the last transaction will not be included in the total. The job end code in this case would be a 40 or greater. The transaction count is also only meaningful for interactive jobs other than the console job and is the number of response time intervals counted by the system during the job.

The number of synchronous auxiliary I/O operations follows the number of transactions. This is the same as the AUXIO field that appears on the WRKACTJOB display except that this value is the total for the job. If the job ends with a end code of 70, this value may not contain the count for the final routing step. Additionally, if a job exists across an IPL (using a TFRBCHJOB command) it is ended before becoming active following an IPL, the value will be 0.

The final field in the performance statistics is the job type. Values for this field are:

A Automatically started job

B Batch job

I Interactive job

M Subsystem monitor

R Spooling reader

S System job

W Spooling writer

X Start job

For messages in which the message data begins in a variable position, you can access the message data by doing the following:

- Determine the length of the variables in the message. For example, assume that a message uses the following five variables:

```
Job name    *CHAR 10
User name   *CHAR 10
Job number  *CHAR 6
Time        *CHAR 8
Date        *CHAR 8
```

  These variables are fixed in the first 42 positions of the message data.

- To find the location of the message data, consider that:
  - The message always begins in position 11 of the second record.
  - The length of the message is stored in a 2-position field beginning at position 111 of the first record. This length is stored in a binary value so if the message length is 60, the field contains hex 003C.

Then, by using the length of the message and the start position of the message, you can determine the location of the message data.

Example of Processing the QHST File

You can use an RPG/400 program that processes the QHST file for several messages and the job completion message CPF1164. See the member PRTQHSTANL in file QATTINFO in library QUSRTOOL for documentation and example source for processing QHST files.

Deleting QHST Files

Log-version physical files accumulate on a system and you should periodically delete old logs that are not needed. A log-version is created such that only the security officer is authorized to delete it.

The Operational Assistant* provides a cleanup function which includes the deletion of old QHST files. Other alternatives are:

- As the security officer, specify:

  ```
  WRKOBJ  OBJ(QSYS/QHST*)  OBJTYPE(*FILE)
  ```

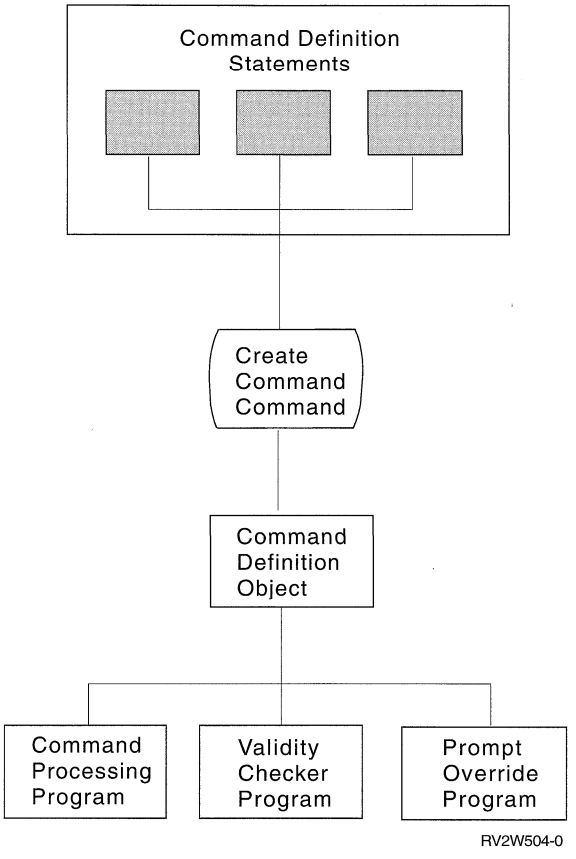
  Use option 4 to delete old unneeded files.
- The DLTQHST tool in QUSRTOOL provides a batch method of cleaning up old QHST files. See the member DLTQHST in file QATTINFO in library USRTOOL for documentation about this tool.

Chapter 9. Defining Commands

A CL command is a statement that requests that the system perform a function. The function is performed by a program that is run when the command is entered. CL commands allow you to request a broad range of functions. You can use these commands as they have been supplied by IBM, change the default values supplied by IBM, or you can define your own commands. This chapter describes how you can define and create your own commands.

Overview of How to Define Commands

The following illustration shows the steps to create a command. The text that follows the illustration describes each step.



Writing your own validity checking and prompt override programs are optional steps.

Command Definition Statements

The command definition statements contain the information that is necessary to prompt the work station user for input, to validate that input, and to define the values to be passed to the program that is called when the command is run.

Command definition statements may exist in any file supported as input to the CRTCMD command. For example, source entry utility (SEU) source files, diskette files, and other device files may contain command definition statements. They are

usually entered in a source file by SEU. Table 9-1 on page 9-2 contains the statements used for defining commands.

Table 9-1. Statements for Defining CL Commands

Statement Type	Statement Name	Description
Command	CMD	Specifies the prompt text, if any, for the command name
Parameter	PARM	Defines a parameter or key parameter for a command
Element	ELEM	Defines an element in a list used as a parameter value
Qualifier	QUAL	Defines a qualifier of a name used as a parameter
Dependent	DEP	Defines the relationship among parameters
Prompt Control	PMTCTL	Defines the conditions under which certain parameters are prompted.

Create Command (CRTCMD) Command

The CRTCMD command processes the command definition statements to create the command definition object. The CRTCMD command may be run interactively or in a batch job.

Command Definition Object

The command definition object is the object that is checked by a system program to ensure that the command is valid and that the proper parameters were entered.

Validity Checking

The system performs validity checking on commands. You may also write your own validity checking program although it is not required.

The validity checking performed by the system ensures that:

- Values for the required parameters are entered.
- Each parameter value meets data type and length requirements.
- Each parameter value meets optional requirements specified in the command definition of:
  - A list of valid values
  - A range of values
  - A relational comparison to a value
- Conflicting parameters are not entered.

The system performs validity checking when:

- Commands are entered interactively from a display station.
- Commands are entered from a batch input stream using spooling.
- Commands are entered into a database file through the source entry utility (SEU).
- A command is passed to the QCMDEXC or the QCMDCHK program by a call from a HLL. See Chapter 6 for more information on the QCMDEXC program.
- A CL program is created.
- Commands are run by a CL program or REXX procedure.

If you need more validity checking than the system performs, you can write a program called a *validity checking program* (see "Writing a Validity Checking

Program" on page 9-54) or you can include the checking in the command processing program. Some validity checking you may want to do is check for the existence of an object or check the contents of a data area. You specify the names of both the command processing and validity checking programs on the CRTCMD command.

If you write a validity checking program, the command parameter values are passed to the validity checking program before being passed to the command processing program. If all required parameters have constants specified, the program you write is also called during syntax checking of spooled input streams and when SEU is used to enter your commands into a database file. If an error is found, a message is issued to the user so errors can be corrected immediately. The command processing program can assume that the data passed to it is correct. For a validity checking program to send a system message, it must receive the message from the message queue and put it into the substitution variable &2 in message CPD0006. The operating system uses the first four characters of variable &1 of the message.

Prompt Override Program

Prompt override programs can be written to supply current values for parameter defaults when the command is prompted. See "Using Key Parameters and a Prompt Override Program" on page 9-34 for more details. A prompt override program is optional.

Providing Help Information for Commands

To provide online help information for your command, you can use help panel groups. A panel group is an object with type *PNLGRP. For more information on help panel groups, see the *Guide to Programming Displays*.

Command Processing Program

The command processing program (CPP) is the program that the command calls to perform the function requested. The CPP can be a CL, REXX, or an HLL program. For example, it can be an application program that your command calls, or it can be a CL or REXX program that contains a system command or series of commands.

The CPP must accept the parameters as defined by the command definition statements.

Authority Needed for the Commands You Define

For users to use a command you create, they must have operational authority to the commands and data authority to the command processing program and optional validity checking program. They also must have read authority to the library containing the command, to the command processing program, and to the validity checking program. If other commands are run in the command processing program or if files are opened, the user must also have the proper authority to these command processing programs or files.

Example of Creating a Command

If you want to create a command to allow the system operator to call a program to start the system, you would do the following. (This example assumes you are using IBM-supplied source files.)

1. Enter the command definition source statement into the source file QCMDSRC using the member name of STARTUP.

   ```
   CMD PROMPT('S Command for STARTUP')
   ```

2. Create the command by entering the following command.

   ```
   CRTCMD CMD(S) PGM(STARTUP) SRCMBR(STARTUP)
   ```

3. Enter the source statements for the STARTUP program (the command processing program).

   ```
   PGM
   STRSBS QINTER
   STRSBS QBATCH
   STRSBS QSPL
   STRPRTWTR DEV(QSYSPRT) OUTQ(QPRINT) WTR(WTR)
   STRPRTWTR DEV(WSPR2) OUTQ(WSPRINT) WTR(WTR2)
   SNDPGMMSG MSG('STARTUP procedure completed') MSGTYPE(*COMP)
   ENDPGM
   ```

4. Create the program using the Create CL Program (CRTCLPGM) command.

   ```
   CRTCLPGM STARTUP
   ```

In the previous example, S is the name of the new command (specified by the CMD parameter). STARTUP is the name of the command processing program (specified by the PGM parameter) and also the name of the source member that contains the command definition statement (specified by the SRCMBR parameter). Now the system operator can either enter `S` to call the command or `CALL STARTUP` to call the command processing program.

How to Define Commands

To create a command, you must first define the command through command definition statements, which are described in detail in the *CL Reference*. The general format of the command definition statements and a summary of the coding rules follow.

Statement	Coding Rules
CMD	One and only one CMD statement must be used. The CMD statement can be placed anywhere in the source file.
PARM	A maximum of 75 PARM statements is allowed. The order in which you enter the PARM statements into the source file determines the order in which the parameters must be specified at processing time. One PARM statement is required for each parameter that is to be passed to the command processing program. To specify a parameter as a key parameter, you must specify KEYPARM(*YES) for the PARM statement. The number of parameters coded with KEYPARM(*YES) should be limited to the number needed to uniquely define the object to be changed. To use key parameters, the prompt override program must be specified when creating the command. Key parameters are not allowed with prompt control.

Statement	Coding Rules
ELEM	A maximum of 300 ELEM statements is allowed in one list. The order in which you enter the ELEM statements into the source file determines the order of the elements in the list. The first ELEM statement must have a statement label that matches the statement label on the TYPE parameter on the PARM or ELEM statement for the list.
QUAL	A maximum of 300 qualifiers is allowed for a qualified name. The order in which you enter the QUAL statements into the source file determines the order in which the qualifiers must be specified and the order in which they are passed to the validity checking program and command processing program.
DEP	The DEP statement must be placed after all PARM statements it refers to. Therefore, the DEP statements are normally placed near the end of the source file.
PMTCTL	The PMTCTL statement must be placed after all PARM statements it refers to. Therefore, the PMTCTL statements are normally placed at the end of the source file.

At least one PARM statement must precede any ELEM or QUAL statements in the source file. The source file in which you enter the command definition statements is used by the CRTCMD command when you create a command. For information on entering statements into a source file, see the *Database Guide*.

Using the CMD Statement

When you define a command, you must include one and only one CMD statement with your command definition statements.

When you define a command, you can provide command prompt text for the user. If the user chooses to be prompted for the command instead of entering the entire command, the user types in the command name and presses F4 (Prompt). The command prompt is then displayed with the command name and the heading prompt text on line 1 of the display.

If you want to specify prompt text for the command, use the PROMPT parameter on the CMD statement to specify the heading for the prompt. You then specify the prompts for the parameters, elements of a list, and qualifiers on the PROMPT parameters for the PARM, ELEM, and QUAL statements.

On the PROMPT parameter for the CMD statement, you can specify the actual prompt heading text as a character string 30 characters maximum, or you can specify the message identifier of a message description. In the following example, a character string is specified for the command ORDENTRY.

```
CMD PROMPT('Order Entry')
```

Line 1 of the prompt looks like this after the user types in the command name and presses F4.

```
Order Entry (ORDENTRY)
```

If you do not provide prompt text for the command you are defining, you only need to use the word CMD for the CMD statement. However, you may want to use the PROMPT keyword for documentation purposes.

Defining Parameters

You can define as many as 75 parameters for each command. To define a parameter, you must use the PARM statement.

On the PARM statement, you specify the following:

- Name of the keyword for the parameter
- Whether or not the parameter is a key parameter
- Type of parameter value that can be passed
- Length of the value
- If needed, the default value for the parameter.

In addition, you must consider the following information when defining parameters. (The associated PARM statement parameter is given in parentheses.)

- Whether a value is returned by the command processing program (RTNVAL). If RTNVAL (*YES) is specified, a return variable must be coded on the command when it is called, if you want to have the value returned. If no variable is specified for a RTNVAL(*YES) parameter, a null pointer is passed to the command processing program.
- Whether the parameter is not to appear on the prompt to the user but is to be passed to the command processing program as a constant (CONSTANT).
- Whether the parameter is restricted (RSTD) to specific values (specified on the VALUES, SPCVAL, or SNGVAL parameter) or can include any value that matches the parameter type, length, value range, and a specified relationship.
- What the specific valid parameter values are (VALUES, SPCVAL, and SNGVAL).
- What tests should be performed on the parameter value to determine its validity (REL and RANGE).
- Whether the parameter is optional or required (MIN).
- How many values can be specified for a parameter that requires a simple list (MIN and MAX).
- Whether unprintable data (any character with a value of hexadecimal `00` through `3F` or `FF` can be entered for the parameter value (ALWUNPRT).
- Whether a variable name can be entered for the parameter value (ALWVAR).
- Whether the value is a program name (PGM).
- Whether the value is a data area name (DTAARA).
- Whether the value is a file name (FILE).
- Whether the value must be the exact length specified (FULL).
- Whether the length of the value should be given with the value (VARY).
- Whether expressions can be specified for a parameter value (EXPR).
- Whether attribute information should be given about the value passed for the parameter (PASSATR).
- Whether to pass a value to the command processing program and/or validity checking program if the parameter being defined is not specified (PASSVAL).
- What the message identifier is or what the prompt text for the parameter is (PROMPT).

- What valid values are shown in the possible choices field on the prompt display (CHOICE).
- Whether the choice values are provided by a program (CHOICEPGM).
- Whether prompting for a parameter is controlled by another parameter (PMTCTL).
- Whether values for a PMTCTL statement are provided by a program (for parameters referred to in CTL keywords) (PMTCTLPGM).
- Whether the value is to be hidden in the job log or hidden when the command is being prompted (DSPINPUT).

Naming the Keyword for the Parameter

The name of the keyword you choose for a parameter should be descriptive of the information being requested in the parameter value. For example, USER for user name, CMPVAL for compare value, and OETYPE for order entry type. The keyword can be as long as 10 alphanumeric characters, the first of which must be alphabetic.

Parameter Types

The basic parameter types are (parameter TYPE value given in parentheses):

- Decimal (*DEC). The parameter value is a decimal number, which is passed to the command processing program as a packed decimal value of the length specified on the LEN parameter. Values specified with more fractional digits than defined for the parameter are truncated.
- Logical (*LGL). The parameter value is a logical value, '1' or '0', which is passed to the command processing program as a character string of length 1 (F1 or F0).
- Character (*CHAR). The parameter value is a character string, which can be enclosed in apostrophes and which is passed to the command processing program as a character string of the length specified on the LEN parameter. The value is passed with its apostrophes removed, is left-justified, and is padded with blanks.
- Name (*NAME). The parameter value is a character string of which the first character is alphabetic (A-Z), $, #, or @, and the remaining characters are alphanumeric or (***) or a string of special characters enclosed in apostrophes (') or quotation marks ("). Periods and underscores are also valid for type *NAME. The value is passed to the command processing program as a character string of the length specified in the LEN parameter. The value is left-justified and is padded with blanks. The *NAME type is normally used for object names. If a special value such as *LIBL or *NONE can be entered for the name parameter value, you must describe the special value on the SPCVAL parameter. Then, if the display station user enters a special value for the name parameter values, the rules for name verification are bypassed.
- Simple name (*SNAME). The parameter value is a character string that follows the same naming rules as *NAME, except that no periods (.) are allowed.
- Communications name (*CNAME). The parameter value is a character string that follows the same naming rules as *NAME, except that no periods (.) or underscores (_) are allowed.

- Generic name (*GENERIC). The parameter value is a generic name, which ends with an asterisk (*). If the name does not end with an asterisk, then the generic name is assumed to be a complete object name. A generic name identifies a group of objects whose names all begin with the characters preceding the asterisk. For example, INV* identifies the objects whose names begin with INV, such as INV, INVOICE, and INVENTORY. The generic name is passed to the command processing program so that it can find the object names beginning with the characters in the generic name.
- Date (*DATE). The parameter value is a character string, which is passed to the command processing program in the format `cyymmdd` (`c` = century digit, `y` = year, `m` = month, `d` = day). The system sets the century digit based on the year in the specified date. The century digit is 0 if `yy` equals a number from 40 through 99; it is 1 if `yy` equals a number from 00 through 39. The user must enter the date for the command in the format specified by the date format (DATFMT) job attribute. The date separator (DATSEP) job attribute determines the optional separator character to be used when the date is entered. The DATFMT and DATSEP job attributes can be changed with the Change Job (CHGJOB) command.
- Time (*TIME). The parameter value is a character string, which is passed to the command processing program in the format `hhmmss` (`h` = hour, `m` = minute, `s` = second).
- Hexadecimal (*HEX). The parameter value is a hexadecimal value. The characters specified must be 0 through F. The value is passed to the CPP as hexadecimal (EBCDIC) characters (2 hexadecimal digits per byte), and is right adjusted and padded with zeros. If the value is enclosed in apostrophes, an even number of digits is required.
- Zero elements (*ZEROELEM). The parameter value is considered to be a list of zero elements for which no value can be specified in the command. This parameter type is used to prevent a value from being entered for a parameter that is a list even though the command processing program (CPP) expects a value. For example, if two commands use the same CPP, one command could pass a list for a parameter, and the other command may not have any values to pass. The parameter for the second command would be defined with TYPE(*ZEROELEM).
- Integer (*INT2 or *INT4). The parameter value is an integer passed as a 2-byte or 4-byte signed binary number. CL programs do not support binary values in variables.
- Null (*NULL). The parameter value is a null pointer, which is always passed to the command processing program as a place holder. The only PARM keywords valid for this parameter type are KWD, MIN, and MAX.
- Command string (*CMDSTR). The parameter value is a command. It is passed to the CPP as a command string. Command parameters of type *CMDSTR do not allow CL variables for input.
- Statement label. The statement label identifies the first of a series of QUAL or ELEM statements that further describe the qualified name or the mixed list being defined by this PARM statement.

The following parameter types are for IBM-supplied commands only.

- Expression (*X). The parameter value is a character string, variable name, or numeric value. The value is passed as a numeric value if it contains only

digits, a plus or minus sign, and/or a decimal point; otherwise, it is passed as a character string.

- Variable name (*VARNAME). The parameter value is a variable name, which is passed to the command processing program as a character string. The value is left-justified and is padded with blanks. A variable is a name that refers to an actual data value during processing. A variable name can be as long as 10 alphanumeric characters (the first of which must be alphabetic) preceded by an ampersand (&); for example, &PARM. If the name of your variable does not follow the naming convention used on the AS/400 system, you must enclose the name in apostrophes.
- Command (*CMD). The parameter value is a command. For example, the CL command IF has a parameter named THEN whose value must be another command.

Length of Parameter Value

You can also specify a length (LEN parameter) for parameter values of the following types. For parameter types of date or time, date is always 7 characters long and time is always 6 characters long. The following shows the maximum length for each parameter type and the default length for each parameter type for which you can specify a length.

Data Type	Maximum Length	Default Length
*DEC	24 (9 decimal positions)	15 (5 decimal positions)
*LGL	1	1
*CHAR	3000	32
*NAME	256	10
*SNAME	256	10
*CNAME	256	10
*GENERIC	256	10
*HEX	256	1
*X	(256 24 9)	(1 15 5)
*VARNAME	11	11
*CMDSTR	6000	256

The maximum length shown here is the maximum length allowed for these parameter types when the command is run. However, the maximum length allowed for character constants in the command definition statements is 32 characters. This restriction applies to the CONSTANT, DFT, VALUES, REL, RANGE, SPCVAL, and SNGVAL parameters. There are specific lengths for input fields available when prompting for a CL command. The input field lengths are 1 through 12 characters and 17, 25, 32, 50, 80, 132, 256, and 512 characters. If a particular parameter has a length other than those allowed, the input field is displayed with the next-larger field length.

Default Values

If you are defining an optional parameter, you can define a value on the DFT parameter to be used if the user does not enter the parameter value on the command. This value is called a *default value*. The default value must meet all the value requirements for that parameter (such as type, length, and special values). If you do not specify a default value for an optional parameter, the following default values are used.

Data Type	Default Value
*DEC	0
*INT2	0
*INT4	0
*LGL	'0'
*CHAR	Blanks
*NAME	Blanks
*SNAME	Blanks
*CNAME	Blanks
*GENERIC	Blanks
*DATE	Zeros ('F0')
*TIME	Zeros ('F0')
*ZEROELEM	0
*HEX	Zeros ('00')
*NULL	Null
*CMDSTR	Blanks

Example of Defining a Parameter

The following example defines a parameter OETYPE for a command to call an order entry application.

```
PARM    KWD(OETYPE)  TYPE(*CHAR)  RSTD(*YES) +
        VALUES(DAILY WEEKLY MONTHLY)  MIN(1) +
        PROMPT('Type of order entry:')
```

The OETYPE parameter is required (MIN parameter is 1) and its value is restricted (RSTD parameter is *YES) to the values DAILY, WEEKLY, or MONTHLY. The PROMPT parameter contains the prompt text for the parameter. Since no LEN keyword is specified and TYPE(*CHAR) is defined, a length of 32 is the default.

Data Type and Parameter Restrictions

The following figure shows the valid combinations of parameters according to the parameter type. An X indicates that the combination is valid, a number refers to a restriction noted at the bottom of the table.

	LEN	RTNVAL	CONSTANT	RSTD	DFT	VALUES	REL	RANGE	SPCVAL	SNGVAL	MIN	MAX	ALWUNPRT	ALWVAR	PGM	DTAARA	FILE	FULL	EXPR	VARY	PASSTR	PASSVAL	DSPINPUT	CHOICE	CHOICEPGM	PMTCTL	PMTCTLPGM	PROMPT
*DEC	X	4	X	X	X	X	X	X	6	1	X	X		X					X		5	X	X	X	X	X	X	X
*LGL	X	4	X	X	X	X			6	1	X	X		X				X	X	5	5	X	X	X	X	X	X	X
*CHAR	X	4	X	X	X	X	X	X	6	1	X	X	X	X	X	X	X	X	X	5	5	X	X	X	X	X	X	X
*NAME	X		X	X	X	X	X	X	6	1	X	X		X	X	X	X	X	X	5	5	X	X	X	X	X	X	X
*SNAME	X		X	X	X	X	X	X	6	1	X	X		X	X	X	X	X	X	5	5	X	X	X	X	X	X	X
*CNAME	X		X	X	X	X	X	X	6	1	X	X		X	X	X	X	X	X	5	5	X	X	X	X	X	X	X
*GENERIC	X		X	X	X	X	X	X	6	1	X	X		X	X	X	X	X	X	5	5	X	X	X	X	X	X	X
*DATE			X	X	X	X	X	X	6	1	X	X		X					X		5	X	X	X	X	X	X	X
*TIME			X	X	X	X	X	X	6	1	X	X		X					X		5	X	X	X	X	X	X	X
*HEX	X		X	X	X	X	X	X	6	1	X	X		X				X	X		5	X	X	X	X	X	X	X
*ZEROELEM											X	X																
*INT2			X	X	X	X	X	X	6	1	X	X		X					X		5	X	X	X	X	X	X	X
*INT4			X	X	X	X	X	X	6	1	X	X		X					X		5	X	X	X	X	X	X	X
*CMDSTR	X		X		X						2	3		8						5	5		X	X	X	X	X	X
*NULL	X										2	3																
stmt label			X		X					X	X	X			X	X	X					7		X	X	X	X	X

Notes:

1 Valid only if the value for MAX is greater than 1. Also, To-values are ignored when CPP is a REXX procedure. Values passed as REXX procedure parameters are the values typed or the defaults for each parameter.
2 The value for MIN cannot exceed 1 for TYPE(*NULL).
3 The value for MAX cannot exceed 1 for TYPE(*NULL) or TYPE(*CMDSTR).
4 Not valid when the command CPP is a REXX procedure.
5 Parameter is ignored when CPP is a REXX procedure.
6 To-values are ignored when CPP is a REXX procedure. Values passed as REXX procedure parameters are the values typed or the default values for each parameter.
7 PASSVAL passes a keyword with no blanks or other characters between parentheses when CPP is a REXX procedure.
8 The ALWVAR value is ignored for this type of parameter. CL variables are not allowed when the parameter type is *CMDSTR.

The next figure shows the valid parameter combinations and restrictions for the PARM, ELEM, and QUAL statements. For example, the intersection of the row for LEN and the column for DFT are blank; therefore, there are no restrictions and combination of LEN(XX) and DFT(XX) is valid. However, the intersection of the row for DFT and the column for CONSTANT contains a 4 which refers to a note at the bottom of the table describing the restriction.

	LEN	RTNVAL	CONSTANT	RSTD	DFT	VALUES	REL	RANGE	SPCVAL	SNGVAL	MIN	MAX	ALWUNPRT	ALWVAR	PGM	DTAARA	FILE	FULL	EXPR	VARY	PASSTR	PASSVAL	DSPINPUT	CHOICE	CHOICEPGM	PMTCTL	PMTCTLPGM	PROMPT
LEN																												
RTNVAL			1	1	1	1	1	1	1	1		2		13	1	1	1	1	1	3	3	15						
CONSTANT		1			4					21		2							5				20	16		18	18	6
RSTD		1				7	9	9	7	7																		
DFT		1	4								8																	
VALUES		1		7																								
REL		1		9				9																				
RANGE		1		9			9															12						
SPCVAL		1		7																								
SNGVAL		1	21	7								11																

	LEN	RTNVAL	CONSTANT	RSTD	DFT	VALUES	REL	RANGE	SPCVAL	SNGVAL	MIN	MAX	ALWUNPRT	ALWVAR	PGM	DTAARA	FILE	FULL	EXPR	VARY	PASSATR	PASSVAL	DSPINPUT	CHOICE	CHOICEPGM	PMTCTL	PMTCTLPGM	PROMPT
MIN					8							10										15				19		
MAX		2	2							11	10																	
ALWUNPRT																												
ALWVAR		13																										
PGM		1														14	14											
DTAARA		1													14		14											
FILE		1													14	14												
FULL		1																										
EXPR		1	5																									
VARY		3																			3							
PASSATR		3																		3								
PASSVAL		15						12			15																	
CHOICE			16																					17				
CHOICEPGM																									17			
PMTCTL			18								19																	
PMTCTLPGM			18																									
PROMPT			6																									

Notes:

1 The RTNVAL parameter cannot be used with any of the following parameters: CONSTANT, RSTD, DFT, VALUES, REL, RANGE, SPCVAL, SNGVAL, PGM, DTAARA, FILE, FULL, or EXPR. The RTNVAL parameter cannot be used on any command using a REXX procedure as a CPP.

2 A MAX value greater than 1 is not allowed.

3 If PASSATR(*YES) and RTNVAL(*YES) are specified, VARY(*YES) must also be specified.

4 The CONSTANT and DFT parameters are mutually exclusive.

5 The EXPR(*YES) and CONSTANT parameters are mutually exclusive.

6 The PROMPT parameter is not allowed.

7 If the RSTD parameter is specified, one of the following parameters must also be specified: VALUES, SPCVAL, or SNGVAL.

8 The MIN value must be 0.

9 The REL, RANGE, and RSTD(*YES) parameters are mutually exclusive.

10 The value specified for the MIN parameter must not exceed the value specified for the MAX parameter.

11 Either the MAX value must be greater than 1 or the parameter type must be a statement label, or both.

12 The parameter may not refer to a parameter defined with the parameter PASSVAL(*NULL). A range between parameters is not valid on a PARM statement defined with PASSVAL(*NULL).

13 If RTNVAL(*YES) is specified, ALWVAR(*NO) cannot be specified.

14 PGM(*YES), DTAARA(*YES), and a value other than *NO for the FILE parameters are mutually exclusive.

15 PASSVAL(*NULL) is not allowed with RTNVAL(*YES) or a value greater than 0 for MIN.

16 The CHOICE and CONSTANT parameters are mutually exclusive.

17 CHOICE(*PGM) requires a name for CHOICEPGM.

18 CONSTANT is mutually exclusive with the PMTCTL and PMTCTLPGM parameters.

19 PMTCTL is not allowed with a value greater than 0 for MIN.

20 CONSTANT is mutually exclusive with DSPINPUT(*NO) and DSPINPUT(*PROMPT).

21 The CONSTANT parameter cannot be defined on the ELEM/QUAL statement if a SNGVAL parameter is defined on the PARM statement.

Defining Lists for Parameters

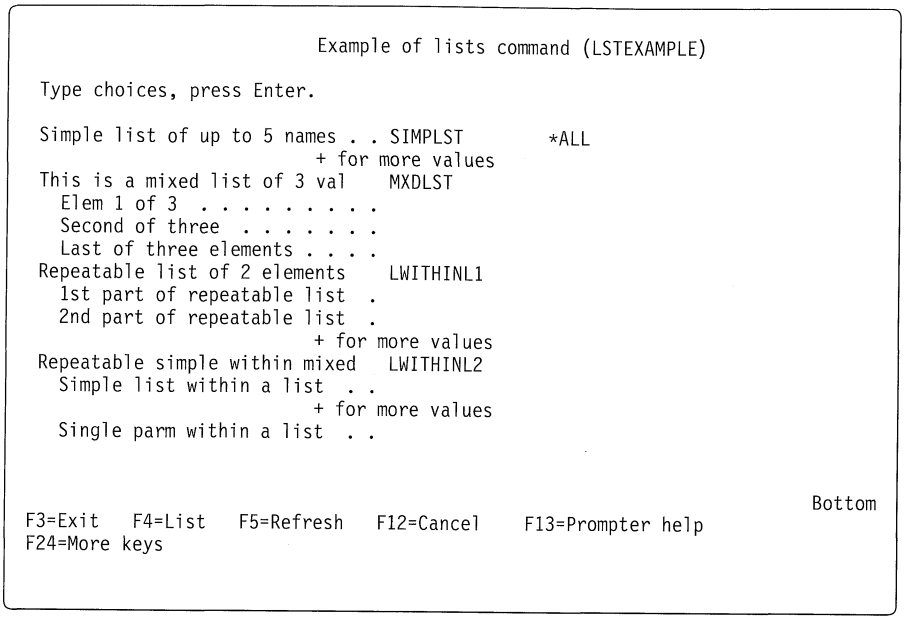
You can define a parameter to accept a list of values instead of just a single value. You can define the following types of lists:

- A simple list, which allows one or more values of the same type to be specified for a parameter
- A mixed list, which allows a set of separately defined values to be specified for a parameter
- A list within a list, which allows a list to be specified more than once for a parameter or which allows a list to be specified for a value within a mixed list

The following sample command source illustrates the different types of lists:

```
             CMD        PROMPT('Example of lists command')


  /* THE FOLLOWING PARAMETER IS A SIMPLE LIST. IT WILL ACCEPT UP TO   */
  /* 5 NAMES.                                                         */
             PARM       KWD(SIMPLST) TYPE(*NAME) LEN(10) DFT(*ALL) +
                         SPCVAL((*ALL)) MAX(5) PROMPT('Simple list +
                         of up to 5 names')


  /* THE FOLLOWING PARAMETER IS A MIXED LIST OF 3 VALUES, EACH OF A   */
  /* DIFFERENT TYPE AND/OR LENGTH. EACH ELEMENT MAY NOT BE REPEATED.  */
             PARM       KWD(MXDLST) TYPE(MLSPEC) PROMPT('This is a +
                  mixed list of 3 val')
MLSPEC:      ELEM       TYPE(*CHAR) LEN(4) PROMPT('Elem 1 of 3')
             ELEM       TYPE(*DEC) LEN(3 0) PROMPT('Second of three')
             ELEM       TYPE(*CHAR) LEN(10) PROMPT('Last of three +
                          elements')


/* THE FOLLOWING PARAMETER IS A LIST WITHIN A LIST. IT CONTAINS A   */
/* LIST OF UP TO 2 ELEMENTS, WHICH MAY BE REPEATED UP TO 3 TIMES.   */
             PARM       KWD(LWITHINL1) TYPE(LWLSPECA) MAX(3) +
                          PROMPT('Repeatable list of 2 elements')
LWLSPECA:    ELEM         TYPE(*CHAR) LEN(10) PROMPT('1st part of +
                            repeatable list')
             ELEM         TYPE(*DEC) LEN(5 0) PROMPT('2nd part of +
                            repeatable list')


/* THE FOLLOWING PARAMETER IS A LIST WITHIN A LIST. IT CONTAINS A   */
/* LIST OF UP TO 2 ELEMENTS, THE FIRST OF WHICH MAY BE REPEATED     */
/* UP TO 3 TIMES.                                                   */
             PARM       KWD(LWITHINL2) TYPE(LWLSPECB) MAX(1) +
                          PROMPT('Repeated simple within mixed')
LWLSPECB:    ELEM       TYPE(*CHAR) LEN(10) MAX(3) PROMPT('Simple +
                          list within a list')
             ELEM       TYPE(*DEC) LEN(5 0) PROMPT('Single parm +
                          within a list')
```

The following display shows the prompt for the preceding sample command:



Defining a Simple List

A simple list can accept one or more values of the type specified by the parameter. For example, if the parameter is for the user name, a simple list means that more than one user name can be specified on that parameter.

```
USER(JONES SMITH MILLER)
```

If a parameter's value is a simple list, you specify the maximum number of elements the list can accept using the MAX parameter on the PARM statement. For a simple list, no command definition statements other than the PARM statement need be specified.

The following example defines a parameter USER for which the display station user can specify up to five user names (a simple list).

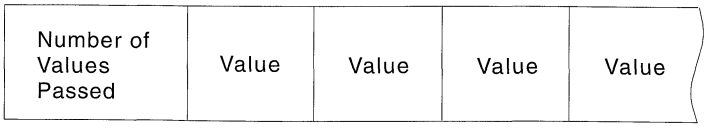
```
PARM      KWD(USER) TYPE(*NAME) LEN(10) MIN(0) MAX(5) +
          SPCVAL(*ALL) DFT(*ALL)
```

The parameter is an optional parameter as specified by MIN(0) and the default value is *ALL as specified by DFT(*ALL).

When the elements in a simple list are passed to the command processing program, the format varies depending on whether you are using CL or HLL, or REXX. The following section describes how the elements used in the previous example are passed using CL and HLL. For an explanation of the differences when using REXX, see "Using REXX for Simple Lists" on page 9-17.

Using CL or HLL for Simple Lists

When the command is run using CL or HLL, the elements in a simple list are passed to the command processing program in the following format.



RV2W282-0

The number of values passed is specified by a binary value that is two characters long. This number indicates how many values were actually entered (are being passed), not how many can be specified. The values are passed by the type of parameter just as a value of a single parameter is passed (as described under "Defining Parameters" on page 9-6). For example, if two user names (BJONES and TBROWN) are specified for the USER parameter, the following is passed.

RV2W283-0

The user names are passed as 10-character values that are left-adjusted and padded with blanks.

When a simple list is passed, only the number of elements specified on the command are passed. The storage immediately following the last element passed is not part of the list and must not be referred to as part of the list. Therefore, when the command processing program (CPP) processes a simple list, it uses the number of elements passed to determine how many elements can be processed.

Figure 9-1 on page 9-16 shows an example of a CL program using the binary built-in function to process a simple list.

```
PGM PARM (...&USER...)
.
.
.
/* Declare space for a simple list of up to five */
/* 10-character values to be received            */
DCL VAR(&USER) TYPE(*CHAR) LEN(52)
.
DCL VAR(&CT)    TYPE(*DEC)  LEN(3 0)
DCL VAR(&USER1) TYPE(*CHAR) LEN(10)
DCL VAR(&USER2) TYPE(*CHAR) LEN(10)
DCL VAR(&USER3) TYPE(*CHAR) LEN(10)
DCL VAR(&USER4) TYPE(*CHAR) LEN(10)
DCL VAR(&USER5) TYPE(*CHAR) LEN(10)
.
.
.
CHGVAR  VAR(&CT) VALUE(%BINARY(&USER 1 2))
.
IF (&CT > 0) THEN(CHGVAR &USER1 %SST(&USER 3 10))
IF (&CT > 1) THEN(CHGVAR &USER2 %SST(&USER 13 10))
IF (&CT > 2) THEN(CHGVAR &USER3 %SST(&USER 23 10))
IF (&CT > 3) THEN(CHGVAR &USER4 %SST(&USER 33 10))
IF (&CT > 4) THEN(CHGVAR &USER5 %SST(&USER 43 10))
IF (&CT > 5) THEN(DO)
/*  If CT is greater than 5, the values passed     */
/*  is greater than the program expects, and error */
/*  logic should be performed                      */
.
.
.
ENDDO
ELSE DO
/* The correct number of values are passed */
/* and the program can continue processing */
.
.
.
ENDDO
ENDPGM
```

Figure 9-1. Simple List Example

This same technique can be used to process other lists in a CL program.

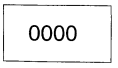
For a simple list, a single value such as *ALL or *NONE can be entered on the command instead of the list. Single values are passed as an individual value. Similarly, if no values are specified for a parameter, the default value, if any is defined, is passed as the only value in the list. For example, if the default value *ALL is used for the USER parameter, the following is passed.

0001	*ALL

RV2W284-0

*ALL is passed as a 10-character value that is left-adjusted and padded with blanks.

If no default value is defined for an optional simple list parameter, the following is passed:



RV2W285-0

Using REXX for Simple Lists

When the same command is run, the elements in a simple list are passed to the REXX procedure in the argument string in the following format:

```
. . . USER(value1 value2  . . . valueN) . . .
```

where `valueN` is the last value in the simple list.

For example, if two user names (BJONES and TBROWN) are specified for the USER parameter, the following is passed:

```
. . . USER(BJONES TBROWN) . . .
```

When a simple list is passed, only the number of elements specified on the command are passed. Therefore, when the CPP processes a simple list, it uses the number of elements passed to determine how many elements can be processed.

The REXX example in Figure 9-2 produces the same result as the CL program in Figure 9-1 on page 9-16:

```
.
.
.
PARSE ARG . 'USER(' user ')' .
.
.
CT = WORDS(user)
IF CT > 0 THEN user1 = WORD(user,1) else user1 = ''
IF CT > 1 THEN user2 = WORD(user,2) else user2 = ''
IF CT > 2 THEN user3 = WORD(user,3) else user3 = ''
IF CT > 3 THEN user4 = WORD(user,4) else user4 = ''
IF CT > 4 THEN user5 = WORD(user,5) else user5 = ''
IF CT > 5 THEN
  DO
    /* If CT is greater than 5, the values passed
       is greater than the program expects, and error
       logic should be performed */
.
.
.
  END
ELSE
  DO
    /* The correct number of values are passed
       and the program can continue processing */
  END
EXIT
```

Figure 9-2. REXX Simple List Example

This same procedure can be used to process other lists in a REXX program.

For a simple list, a single value such as *ALL or *NONE can be entered on the command instead of the list. Single values are passed as an individual value.

Similarly, if no values are specified for a parameter, the default value, if any is defined, is passed as the only value in the list. For example, if the default value *ALL is used for the USER parameter, the following is passed:

```
. . . USER(*ALL) . . .
```

If no default value is defined for an optional simple list parameter, the following is passed:

```
. . . USER() . . .
```

For more information about REXX procedures, see the *REXX/400 Programmer's Guide* and the *REXX/400 Reference*.

Defining a Mixed List

A mixed list accepts a set of separately defined values that usually have different meanings, are of different types, and are in a fixed position in the list. For example, `LOG(4 0 *SECLVL)` could specify a mixed list. The first value, `4`, identifies the message level to be logged; the second value, `0`, is the lowest message severity to be logged. The third value, `*SECLVL`, specifies the amount of information to be logged (both first- and second-level messages). If a parameter's value is a mixed list, the elements of the list must be defined separately using an Element (ELEM) statement for each element.

The TYPE parameter on the associated PARM statement must have a label that refers to the first ELEM statement for the list.

```
         PARM    KWD(LOG)    TYPE(LOGLST) ...

LOGLST:  ELEM    TYPE(*INT2)      ...
         ELEM    TYPE(*INT2)      ...
         ELEM    TYPE(*CHAR)      LEN(7)
```

The first ELEM statement is the only ELEM statement that can have a label. Specify the ELEM statements in the order in which the elements occur in the list.

Note that when the MAX parameter has a value greater than 1 on the PARM statement, and the TYPE parameter refers to ELEM statements, the parameter being defined is a list within a list.

Parameters that you can specify on the ELEM statement include TYPE, LEN, CONSTANT, RSTD, DFT, VALUES, REL, RANGE, SPCVAL, SNGVAL, MIN, MAX, ALWUNPRT, ALWVAR, PGM, DTAARA, FILE, FULL, EXPR, VARY, PASSATR, CHOICE, CHOICEPGM, and PROMPT.

In the following example, a parameter CMPVAL is defined for which the display station user can specify a comparison value and a starting position for the comparison (a mixed list).

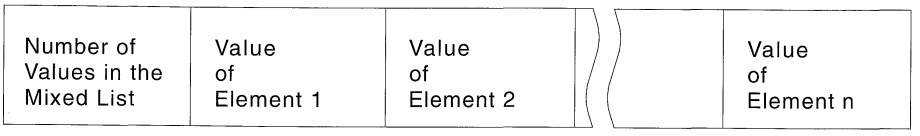
```
      PARM   KWD(CMPVAL) TYPE(CMP) SNGVAL(*ANY) DFT(*ANY) +
               MIN(0)
CMP:  ELEM   TYPE(*CHAR) LEN(80) MIN(1)
      ELEM   TYPE(*DEC) LEN(2 0) RANGE(1 80) DFT(1)
```

When the elements in a mixed list are passed to the command processing program, the format varies depending on whether you are using CL or HLL, or REXX. The following section describes how the elements used in the previous

example are passed using CL and HLL. For an explanation of the differences when using REXX, see "Using REXX for Mixed Lists" on page 9-20.

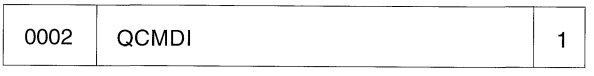
Using CL or HLL for Mixed Lists

When a command is run using CL or HLL, the elements in a mixed list are passed to the command processing program in the following format:



RV2W286-0

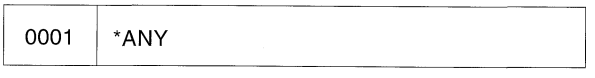
The number of values in the mixed list is passed as a binary value of length 2. This value always indicates how many values have been defined for the mixed list, not how many were actually entered on the command. This value may be 1 if the SNGVAL parameter is entered or is passed as the default value. If the user does not enter a value for an element, a default value is passed. The elements are passed by their types just as single parameter values are passed (as described under "Defining Parameters" on page 9-6). For example, if, in the previous example the user enters a comparison value of QCMDI for the CMPVAL parameter, but does not enter a value for the starting position, whose default value is 1, the following is passed.



RV2W287-0

The data QCMDI is passed as an 80-character value that is left-adjusted and padded with blanks. The number of elements is sent as a binary value of length 2.

When the display station user enters a single value or when a single value is the default for a mixed list, the value is passed as the first element in the list. For example, if the display station user enters *ANY as a single value for the parameter, the following is passed.

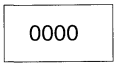


RV2W288-0

*ANY is passed as an 80-character value that is left-adjusted and padded with blanks.

Mixed lists can be processed in CL programs. Unlike simple lists, the binary value does not need to be tested to determine how many values are in the list because this value is always the same for a given mixed list unless the SNGVAL parameter was passed to the command processing program. In this case, the value is 1. If the command is entered with a single value for the parameter, only that one value is passed. To process the mixed list in a CL program, you must use the substring built-in function (see Chapter 2).

In one case, only a binary value of 0000 is passed as the number of values for a mixed list. If no default value is defined on the PARM statement for an optional parameter and the first value of the list is required (MIN(1)), then the parameter itself is not required; but if any element is specified the first element is required. In this case, if the command is entered without specifying a value for the parameter, the following is passed.



RV2W285-0

An example of such a parameter is:

```
      PARM  KWD(KWD1)     TYPE(E1) MIN(0)
E1:   ELEM  TYPE(*CHAR)   LEN(10)  MIN(1)
      ELEM  TYPE(*CHAR)   LEN(2)   MIN(0)
```

If this parameter were to be processed by a CL program, the parameter value could be received into a 14-character CL variable. The first 2 characters could be compared to a 2-character variable initialized to hex 0000 using the %SUBSTRING function.

A standard method of processing mixed lists is by using the EXTLST command in QUSRTOOL.

Using REXX for Mixed Lists

When a command is run using REXX, the elements in a mixed list are passed to the command processing program in the following format:

```
. . . CMPVAL(value1 value2  . . . valueN) . . .
```

where `valueN` is the last value in the mixed list.

If the user does not enter a value for an element, a default value is passed. For example, if in the previous example, the user enters a comparison value of QCMDI for the CMPVAL parameter, but does not enter a value for the starting position, whose default value is 1, the following is passed:

```
. . . CMPVAL(QCMDI 1)  . . .
```

Note that trailing blanks are not passed with REXX values.

When a display station user enters a single value or when a single value is the default for a mixed list, the value is passed as the first element in the list. For example, if the display station user enters *ANY as a single value for the parameter, the following is passed:

```
. . . CMPVAL(*ANY) . . .
```

Again note that trailing blanks are not passed with REXX values.

If no default value is defined on the PARM statement for an optional parameter and the first value of the list is required (MIN(1)), then the parameter itself is not required. But if any element is specified, the first element is required. In this case, if the command is entered without specifying a value for the parameter, the following is passed:

```
. . . CMPVAL() . . .
```

Defining Lists within Lists

A list within a list can be:

- A list that can be specified more than once for a parameter (simple or mixed list)
- A list that can be specified for a value within a mixed list

The following is an example of lists within a list.

```
STMT((START RESPND) (ADDDSP CONFRM))
```

The outside set of parentheses enclose the list that can be specified for the parameter (the outer list) while each set of inner parentheses encloses a list within a list (an inner list).

In the following example, a mixed list is defined within a simple list. A mixed list is specified, and the MAX value on the PARM statement is greater than 1; therefore, the mixed list can be specified up to the number of times specified on the MAX parameter.

```
        PARM KWD(PARM1) TYPE(LIST1) MAX(5)
LIST1:  ELEM TYPE(*CHAR) LEN(10)
        ELEM TYPE(*DEC) LEN(3 0)
```

In this example, the two elements can be specified up to five times. When a value is entered for this parameter, it could appear as follows:

```
PARM1((VAL1 1.0) (VAR2 2.0) (VAR3 3.0))
```

In the following example, a simple list is specified as a value in a mixed list. In this example, the MAX value on the ELEM statement is greater than 1; therefore, the element can be repeated up to the number of times specified on the MAX parameter.

```
        PARM KWD(PARM2) TYPE(LIST2)
LIST2:  ELEM TYPE(*CHAR) LEN(10) MAX(5)
        ELEM TYPE(*DEC) LEN(3 0)
```

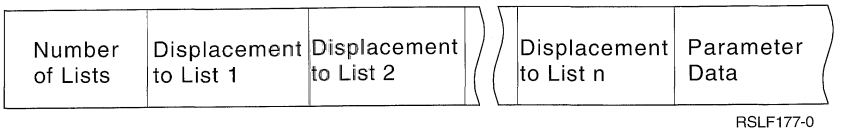
In this example, the first element can be specified up to five times, but the second element can be specified only once. When a value is entered for this parameter, it could appear as follows.

```
PARM2((NAME1 NAME2 NAME3) 123.0)
```

When lists within lists are passed to the command processing program, the format varies depending on whether you are using CL or HLL, or REXX. The following section describes how elements are passed using CL and HLL. For an explanation of the differences when using REXX, see "Using REXX for Lists within Lists" on page 9-24.

Using CL or HLL for Lists within Lists

When a command is run using CL or HLL, a list within a list is passed to the command processing program in the following format:



The number of lists is passed as a binary value of length 2. Following the number of lists, the displacement to the lists is passed (not the values that were entered in the lists). Each displacement is passed as a binary value of length 2.

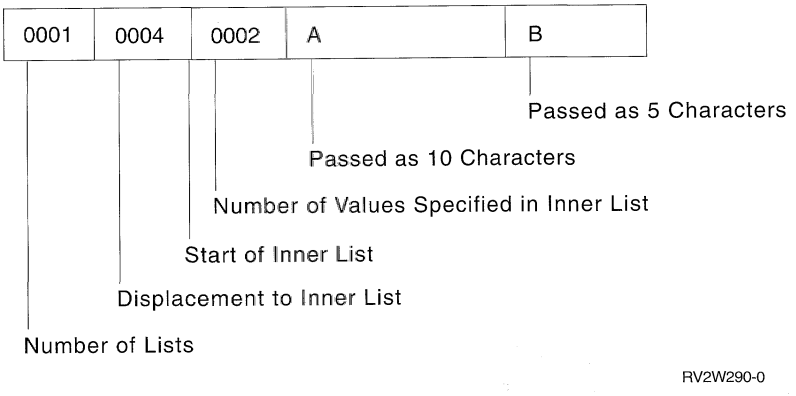
The following example shows a definition for a parameter KWD2 (which is a mixed list within a simple list) how the parameter can be specified by the display station user, and what is passed. The parameter definition is:

```
       PARM    KWD(KWD2)     TYPE(LIST) MAX(20) MIN(0) +
               DFT(*NONE)    SNGVAL(*NONE)
LIST:  ELEM    TYPE(*CHAR)   LEN(10) MIN(1)       /*From value*/
       ELEM    TYPE(*CHAR)   LEN(5) MIN(0)        /*To value*/
```

The display station user enters the KWD2 parameter as:

```
KWD2((A B))
```

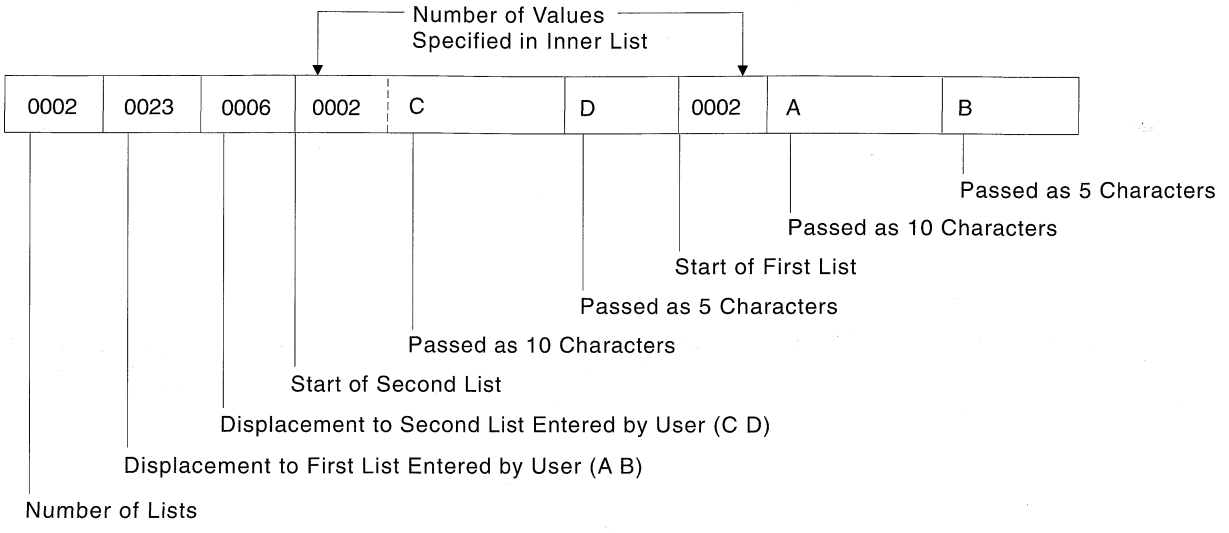
The following is passed to the command processing program:



If the display station user enters the following instead:

```
KWD2((A B) (C D))
```

the following is passed to the command processing program:



RV2W291 0

Lists within a list are passed to the command processing program in the order n (the last one entered by the display station user) to 1 (the first one entered by the display station user). The displacements, however, are passed from 1 to n.

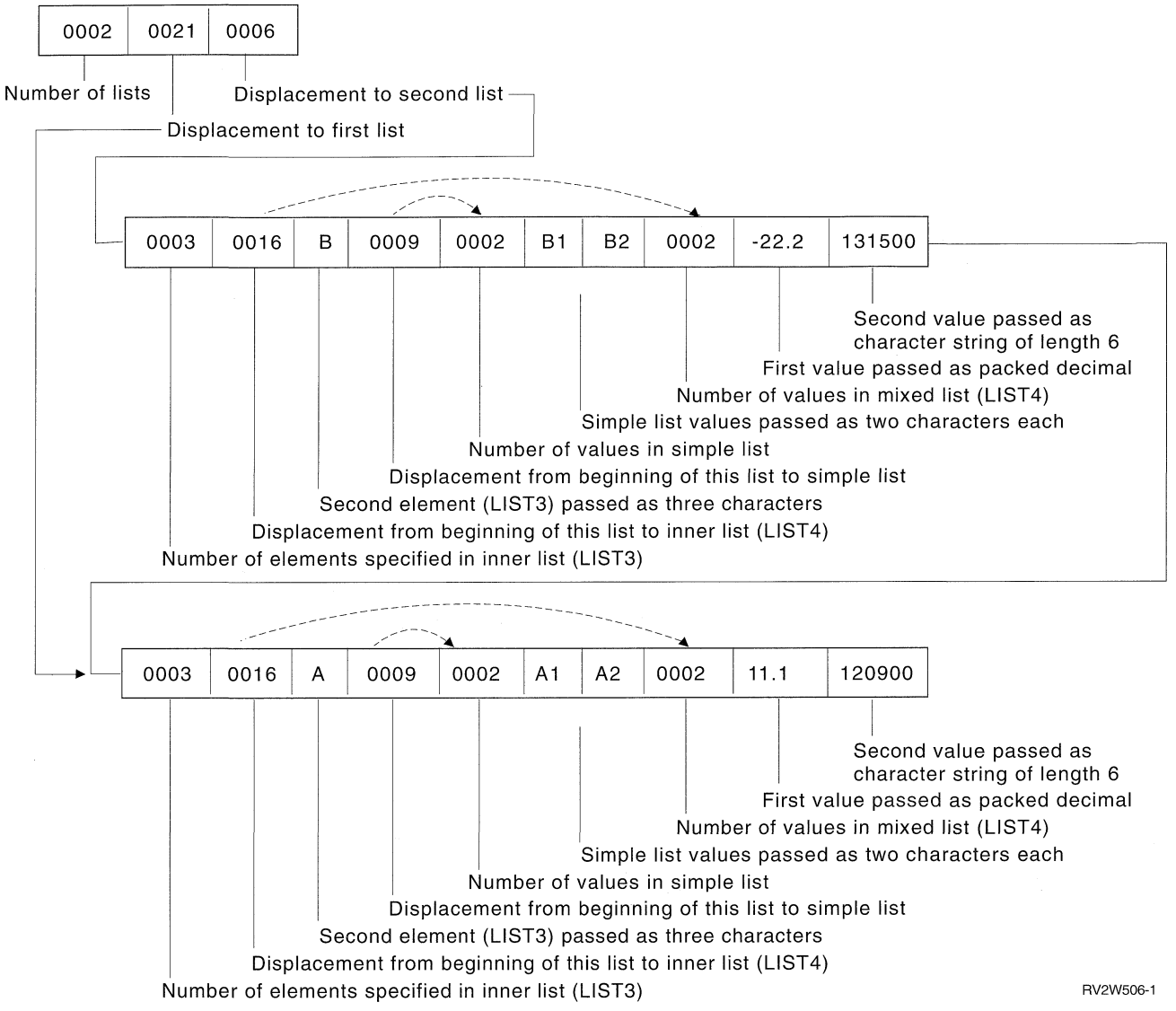
The following is a more complex example of lists within lists. The parameter definition is:

```
        PARM    KWD(PARM1)  TYPE(LIST3)  MAX(25)
LIST3:  ELEM    TYPE(LIST4)
        ELEM    TYPE(*CHAR)  LEN(3)
        ELEM    TYPE(*NAME)  LEN(2)  MAX(5)
LIST4:  ELEM    TYPE(*DEC) LEN(7 2)
        ELEM    TYPE(*TIME)
```

If the display station user enters the PARM1 parameter as:

```
PARM1(((11.1  120900)  A  (A1  A2))  ((-22.2  131500)  B  (B1  B2)))
```

the following is passed to the command processing program:



Using REXX for Lists within Lists

When a command is run using REXX, a list within a list is passed to the command processing program just as the values are entered for the parameters. Trailing blanks are not passed.

The following example shows a definition for a parameter KWD2, which is a mixed list within a simple list, how the parameter can be specified by the display station user, and what is passed. The parameter definition is:

```
       PARM    KWD(KWD2)     TYPE(LIST) MAX(20) MIN(0) +
               DFT(*NONE)  SNGVAL(*NONE)
LIST:  ELEM    TYPE(*CHAR)  LEN(10) MIN(1)       /*From value*/
       ELEM    TYPE(*CHAR)  LEN(5) MIN(0)        /*To value*/
```

The display station user enters the KWD2 parameter as:

```
KWD2((A B))
```

The following is passed to the command processing program:

```
KWD2(A B)
```

If the display station user enters the following instead:

```
KWD2((A B) (C D))
```

The following is passed to the command processing program:

```
KWD2((A B) (C D))
```

The following is a more complex example of lists within lists. The parameter definition is:

```
        PARM    KWD(PARM1)  TYPE(LIST3)  MAX(25)
LIST3:  ELEM    TYPE(LIST4)
        ELEM    TYPE(*CHAR)  LEN(3)
        ELEM    TYPE(*NAME)  LEN(2)  MAX(5)
LIST4:  ELEM    TYPE(*DEC) LEN(7 2)
        ELEM    TYPE(*TIME)
```

The display station user enters the PARM1 parameter as:

```
PARM1(((11.1  12D900)  A  (A1  A2))  ((-22.2  131500)  B  (B1  B2)))
```

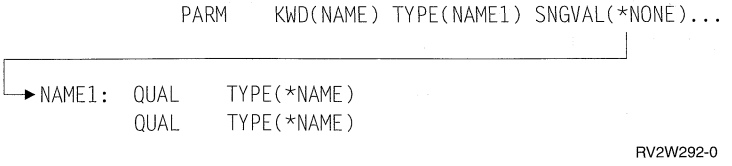
The following is passed to the command processing program:

```
PARM1(((11.1  12D900)  A  (A1  A2))  ((-22.2  131500)  B  (B1  B2)))
```

Defining a Qualified Name

A qualified name is the name of an object preceded by the name of the library in which the object is stored. If a parameter value or list item is a qualified name, you must define the name separately using Qualifier (QUAL) statements. Each part of the qualified name must be defined with a QUAL statement. The parts of a qualified name must be described in the order in which they occur in the qualified name. You must specify *NAME or *GENERIC in the first QUAL statement. The associated PARM or ELEM statement must identify the label that refers to the first QUAL statement for the qualified name.

The following command definition statements define the most common qualified name. A qualified object consists of the library name which contains an object followed by the name of the object itself. The QUAL statements must appear in the order in which they are to occur in the qualified name.



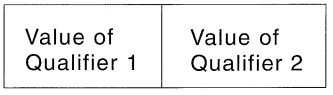
Many of the parameters that can be specified for the QUAL statement are the same as those described for the PARM statement (see "Defining Parameters" on page 9-6). However, only the following values can be specified for the TYPE parameter:

- *NAME
- *GENERIC
- *CHAR
- *INT2
- *INT4

When a qualified name is passed to the command processing program, the format varies depending on whether you are using CL or HLL, or REXX. The following section describes how qualified names are passed using CL and HLL. For an explanation of the differences when using REXX, see "Using REXX for a Qualified Name" on page 9-28.

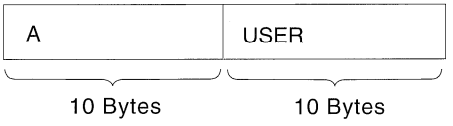
Using CL or HLL for a Qualified Name

A qualified name is passed to the command processing program in the following format when using CL or HLL:



RV2W293-0

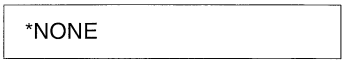
For example, if the display station user enters `NAME(USER/A)` for the previously defined QUAL statements, the name is passed to the command processing program as follows:



RV2W294-0

Qualifiers are passed to the command processing program consecutively by their types and length just as single parameter values are passed (as described under "Defining Parameters" on page 9-6). The separator characters (/) are not passed. This applies regardless of whether a single parameter, an element of a mixed list, or a simple list of qualified names is passed.

If the display station user enters a single value for a qualified name, the length of the value passed is the total of the length of the parts of the qualified name. For example, if you define a qualified name with two values each of length 10, and if the display station user enters a single value, the single value passed is left-adjusted and padded to the right with blanks so that a total of 20 characters is passed. If the display station user enters *NONE as the single value, the following 20-character value is passed:



RV2W295-0

Qualified names can be processed in CL programs using the Substring built-in function as shown in the following example.

The substring built-in function (%SUBSTRING or %SST) is used to separate the qualified name into two values.

```
PGM PARM(&QLFDNAM)
DCL &QLFDNAM TYPE(*CHAR) LEN(20)
DCL &OBJ TYPE(*CHAR) LEN(10)
DCL &LIB TYPE(*CHAR) LEN(10)
CHGVAR &OBJ %SUBSTRING(&QLFDNAM 1 10) /* First 10 */
CHGVAR &LIB %SST(&QLFDNAM 11 10) /* Second 10 */
 .
 .
 .
ENDPGM
```

You can then specify the qualified name in the proper CL syntax. For example, `OBJ(&LIB/&OBJ)`.

You can also separate the qualified name into two values using the following method:

```
PGM PARM(&QLFDNAM)
DCL &QLFDNAM TYPE(*CHAR) LEN(20)
CHKOBJ (%SST(&QLFDNAM 11 10)/%SST(&QLFDNAM 1 10)) *PGM
 .
 .
 .
ENDPGM
```

A simple list of qualified names is passed to the command processing program in the following format:

Number of Qualified Names	Value 1 Qualifier 1	Value 1 Qualifier 2	Value 2 Qualifier 1	Value 2 Qualifier 2	. . .

RV2W296-0

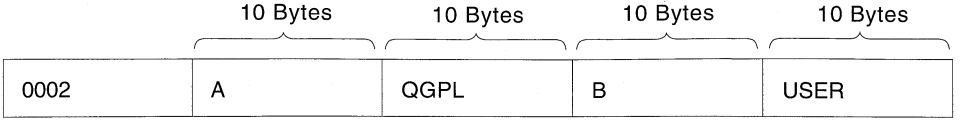
For example, assume that MAX(3) were added as follows to the PARM statement for the NAME parameter.

```
        PARM   KWD(NAME) TYPE(NAME1) SNGVAL(*NONE) MAX(3)
NAME1:  QUAL   TYPE(*NAME)
        QUAL   TYPE(*NAME)
```

If the display station user enters the following:

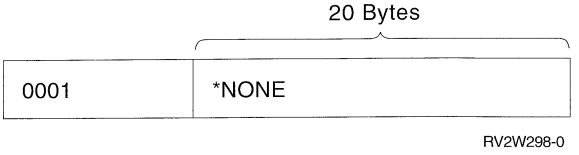
```
NAME(QGPL/A USER/B)
```

then the name parameter would be passed to the command processing program as follows.



RV2W297-0

If the display station user enters the single value NAME(*NONE), the name parameter is passed as follows.



Using REXX for a Qualified Name

When a command is run using REXX, a qualified name is passed to the command processing program just as the value is entered for the parameter. Trailing blanks are not passed.

For example, if a display station user enters the following for the QUAL statements defined previously in this section:

```
NAME(USER/A)
```

the qualified name is passed to the command processing program in the following format:

```
NAME(USER/A)
```

Qualifiers are passed to the command processing program consecutively by their types and length just as single parameter values are passed (as described under "Defining Parameters" on page 9-6).

If the display station user enters *NONE as the single value, the following 20-character value is passed:

```
NAME(*NONE)
```

The following example shows how a display station user would enter a simple list of qualified names:

```
NAME(QGPL/A USER/B)
```

Using REXX, the name parameter would be passed to the command processing program as the following:

```
NAME(QGPL/A USER/B)
```

Defining a Dependent Relationship

If a required relationship exists between parameters and if parameter values must be checked when the command is run, use the Dependent (DEP) statement to define that relationship. Using the DEP statement, you can.

- Specify the controlling conditions that must be true before the parameter relationships defined in the PARM parameter need to be true (CTL)
- Specify the parameter relationships that must be tested if the controlling conditions defined by CTL are true (PARM)
- Specify the number of parameter relationships defined on the associated PARM statement that must be true if the control condition is true (NBRTRUE)

- Specify the message identifier of an error message in a message file that is to be sent to the display station user if the parameter dependencies have not been satisfied

In the following example, if the display station user specifies the TYPE(LIST) parameter, the display station user must also specify the ELEMLIST parameter.

```
DEP CTL(&TYPE *EQ LIST) PARM(ELEMLIST)
```

In the following example, the parameter &WRITER must never be equal to the parameter &NEWWTR. If this condition is not true, message USR0001 is issued to the display station user.

```
DEP CTL(*ALWAYS) PARM((&WRITER *NE &NEWWTR)) MSGID(USR0001)
```

In the following example, if the display station user specifies the FILE parameter, the display station user must also specify both the VOL and LABEL parameters.

```
DEP CTL(FILE) PARM(VOL LABEL) NBRTRUE(*EQ 2)
```

Possible Choices and Values

The prompter will display possible choices for parameters to the right of the input field on the prompt displays. The text to be displayed can be created automatically, specified in the command definition source, or created dynamically by an exit program. Text describing possible choices can be defined for any PARM, ELEM, or QUAL statement, but because of limitations in the display format, the text will be displayed only for values with a field length of 12 or less, 10 or less for all but the first qualifier in a group.

The text for possible choices is defined by the CHOICE parameter. The default for this parameter is *VALUES, which indicates that the text is to be created automatically from the values specified for the TYPE, RANGE, VALUES, SPCVAL, and SNGVAL keywords. The text is limited to 30 characters; if there are more values than can fit in this size, an ellipsis (...) is added to the end of the text to indicate that it is incomplete.

You can specify that no possible choices should be displayed (*NONE), or you can specify either a text string to be displayed or the ID of a text message which will be retrieved from the message file specified in the PMTFILE parameter of the CRTCMD command.

You can also specify that an exit program should be run during prompting to provide the possible choices text. This could be done if, for example, you want to show the user a list of objects that currently exist on the system. The same exit program can be used to provide the values shown on the Specify Value for Parameter display. To specify an exit program, specify *PGM for the CHOICE parameter, and the qualified name of the exit program in the CHOICEPGM parameter on the PARM, ELEM, or QUAL statement.

The exit program must accept the following two parameters:

- **Parameter 1**: A 21-byte field that is passed by the prompter to the choice program, and contains the following:

Positions	Descriptions
1–10	Command name. Specifies the name of the command being processed that causes the program to run.
11–20	Keyword name. Specifies the keyword for which possible choices or permissible values are being requested.
21	C or P character indicating the data to be returned. The letter C indicates that this is a 30-byte field into which the text for possible choices is to be returned. The letter P indicates that this a 2000-byte field into which a permissible values list is to be returned.

- **Parameter 2**: A 30- or 2000-byte field for returning one of the following:
  - If C is in byte 21 of the first parameter (indicating that the text for possible choices is to be returned), this is a 30-byte field into which the program is to place the text.
  - If P is in byte 21 of the first parameter (indicating that a permissible values list is to be returned), this is a 2000-byte field into which the program is to place the list. The first two bytes of the list must contain the number of entries (in binary) in the list. This value is followed by entries that consist of a 2-byte binary length followed by the value, which must be 1 to 32 characters long.

  If a binary zero value is returned in the first two bytes, no permissible values are displayed.

  If a binary negative value is returned in the first two bytes, the list of permissible values is taken from the command.

  If any exception occurs when the program is called, the possible choices text is left blank, and the list of permissible values is taken from the command.

Using Prompt Control

You can control which parameters are displayed for a command during prompting by using prompt control specifications. This control can simplify prompting for a command by displaying only the parameters that you want to see.

You can specify that a parameter be displayed depending on the value specified for other parameters. This specification is useful when a parameter has meaning only when another parameter (called a controlling parameter) has a certain value.

You can also specify that a parameter be selected for prompting only if additional parameters are requested by pressing a function key during prompting. This specification can be used for parameters that are seldom specified by the user, either because the default is normally used or because they control seldom-used functions.

If you want to show all parameters for a command that has prompt control specified, you can request that all parameters be displayed by pressing F9 during prompting.

Conditional Prompting

When prompting the user for a command, a parameter which is conditioned by other parameters will be displayed if:

- It is selected by the value specified for the controlling parameter.
- The value specified for the controlling parameter is in error.
- A value was specified for the conditioned parameter.
- A function key was pressed during prompting to request that all parameters be displayed.

When a user is to be prompted for a conditioned parameter and no value has yet been specified for its controlling parameter, all parameters previously selected are displayed. When the user presses the Enter key, the controlling parameter is then tested to determine if the conditioned parameter should be displayed or not.

To specify conditional prompting in the command definition source, specify a label name in the PMTCTL parameter on the PARM statement for each parameter that is conditioned by another parameter. The label specified must be defined on a PMTCTL statement which specifies the controlling parameter and the condition being tested to select the parameter for prompting. More than one PARM statement can refer to the same label.

On the PMTCTL statement, specify the name of the controlling parameter, one or more conditions to be tested, and the number of conditions that must be true to select the conditioned parameters for prompting. If the controlling parameter has special value mapping, the value entered on the PMTCTL statement must be the to-value. If the controlling parameter is a list or qualified name, only the first list item or qualifier is compared.

In the following example, parameters OUTFILE and OUTMBR will be selected only if *OUTFILE is specified for the OUTPUT parameter, and parameter OUTQ will be selected only if *PRINT is specified for the OUTPUT parameter.

```
     PARM OUTPUT TYPE(*CHAR) LEN(1) DFT(*) RSTD(*YES) +
            SPCVAL((*) (*PRINT P) (*OUTFILE F))
     PARM OUTFILE TYPE(Q1) PMTCTL(OUTFILE)
     PARM OUTMBR TYPE(*NAME) LEN(10) PMTCTL(OUTFILE)
     PARM OUTLINK TYPE(*CHAR) LEN(10)
     PARM OUTQ TYPE(Q1) PMTCTL(PRINT)
     Q1: QUAL TYPE(*NAME) LEN(10)
         QUAL TYPE(*NAME) LEN(10) SPCVAL(*LIBL) DFT(*LIBL)
OUTFILE: PMTCTL CTL(OUTPUT) COND((*EQ F)) NBRTRUE(*EQ 1)
PRINT:   PMTCTL CTL(OUTPUT) COND((*EQ P)) NBRTRUE(*EQ 1)
```

In this previous example, the user is prompted for the OUTLINK parameter after the condition for OUTMBR parameter has been tested. In some cases, the user should be prompted for the OUTLINK parameter before the OUTMBR parameter is tested. To specify a different prompt order, either reorder the parameters in the command definition source or use the PROMPT keyword on the PARM statement for the OUTLINK parameter.

A label can refer to a group of PMTCTL statements. This allows you to condition a parameter with more than one controlling parameter. To specify a group of PMTCTL statements, enter the label on the first statement in the group. No other statements can be placed between the PMTCTL statements in the group.

Use the LGLREL parameter to specify the logical relationship between the statements in the group. The LGLREL parameter is not allowed on the first PMTCTL statement in a group. For subsequent PMTCTL statements, the LGLREL parameter specifies the logical relationship (*AND or *OR) to the PMTCTL statement or statements preceding it. Statements in a group can be logically related in any combination of *AND and *OR relationships (*AND relationships are checked first, then *OR relationships).

The following example shows how the logical relationship is used to group multiple PMTCTL statements. In this example, parameter P3 is selected when any one of the following conditions exists:

- *ALL is specified for P1.
- *SOME is specified for P1 and *ALL is specified for P2.
- *NONE is specified for P1 and *ALL is not specified for P2.

```
PARM P1 TYPE(*CHAR) LEN(5) RSTD(*YES) VALUES(*ALL *SOME *NONE)
PARM P2 TYPE(*NAME) LEN(10) SPCVAL(*ALL)
PARM P3 TYPE(*CHAR) LEN(10) PMTCTL(PMTCTL1)
PMTCTL1:PMTCTL CTL(P1) COND((*EQ *ALL))
        PMTCTL CTL(P1) COND((*EQ *SOME)) LGLREL(*OR)
        PMTCTL CTL(P2) COND((*EQ *ALL)) LGLREL(*AND)
        PMTCTL CTL(P1) COND((*EQ *NONE)) LGLREL(*OR)
        PMTCTL CTL(P2) COND((*NE *ALL)) LGLREL(*AND)
```

An exit program can be specified to perform additional processing on a controlling parameter before it is tested. The exit program can be used to condition prompting based on:

- The type or other attribute of an object
- A list item or qualifier other than the first one
- An entire list or qualified name

To specify an exit program, specify the qualified name of the program in the PMTCTLPGM parameter on the PARM statement for the controlling parameter. The exit program is run during prompting when checking a parameter. The conditions on the PMTCTL statement are compared with the value returned by the exit program rather than the value specified for the controlling parameter.

If the exit program cannot be found or does not run successfully, a single asterisk is placed in the return value. The exit program should be written to return a value of a single asterisk when it detects an error. Consider this when coding the PMTCTL statements; for example, displaying all parameters conditioned by that parameter when an error occurs.

The exit program must be written to accept three parameters:

- A 20-character field. The prompter passes the name of the command in the first 10 characters and the name of the controlling parameter in the last 10 characters. This field should not be changed.
- The value of the controlling parameter. This field is in the same format as it will be when passed to the command processing program and should not be changed.
- A 32-character field into which the exit program places the value to be tested in the PMTCTL statements.

The value being tested in the PMTCTL statement must be returned in the same format as the declared data type.

In the following example, OBJ is a qualified name which may be the name of a command, program, or file. The exit program determines the object type and returns the type in the variable &RTNVAL:

```
PARM OBJ TYPE(Q1) PMTCTLPGM(CNVTYPE)
Q1: QUAL TYPE(*NAME) LEN(10)
    QUAL TYPE(*NAME) LEN(10) SPCVAL(*LIBL) DFT(*LIBL)
PARM CMDPARM TYPE(*CHAR) LEN(10) PMTCTL(CMD)
PARM PGMPARM TYPE(*CHAR) LEN(10) PMTCTL(PGM)
PARM FILEPARM TYPE(*CHAR) LEN(10) PMTCTL(FILE)
CMD: PMTCTL CTL(OBJ) COND((*EQ *CMD) (*EQ *)) NBRTRUE(*EQ 1)
PGM: PMTCTL CTL(OBJ) COND((*EQ *PGM) (*EQ *)) NBRTRUE(*EQ 1)
FILE: PMTCTL CTL(OBJ) COND((*EQ *FILE) (*EQ *)) NBRTRUE(*EQ 1)
```

The source for the exit program is shown here:

```
PGM PARM(&CMD &PARMVAL &RTNVAL)
DCL &CMD *CHAR 20               /* Command and parameter name      */
DCL &PARMVAL *CHAR 20           /* Parameter value                 */
DCL &RTNVAL *CHAR 32            /* Return value                    */
DCL &OBJNAM *CHAR 10            /* Object name                     */
DCL &OBJLIB *CHAR 10            /* Object type                     */
CHGVAR &OBJNAM %SST(&PARMVAL 1 10)
CHGVAR &OBJLIB %SST(&PARMVAL 11 10)
CHGVAR &RTNVAL '*'              /* Initialize return value to error*/
CHKOBJ &OBJLIB/&OBJNAM *CMD     /* See if command exists           */
MONMSG CPF9801 EXEC(GOTO NOTCMD) /* Skip if no command             */
CHGVAR &RTNVAL '*CMD'           /* Indicate object is a command    */
RETURN                          /* Exit                            */
NOTCMD:
CHKOBJ &OBJLIB/&OBJNAM *PGM     /* See if program exists           */
MONMSG CPF9801 EXEC(GOTO NOTPGM) /* Skip if no program             */
CHGVAR &RTNVAL '*PGM'           /* Indicate object is a program    */
RETURN                          /* Exit                            */
NOTPGM:
CHKOBJ &OBJLIB/&OBJNAM *FILE    /* See if file exists              */
MONMSG CPF9801 EXEC(RETURN)     /* Exit if no file                 */
CHGVAR &RTNVAL '*FILE'          /* Indicate object is a file       */
ENDPGM
```

Additional Parameters

You can specify that a parameter which is not frequently used will not be prompted for unless the user requests additional parameters by pressing a function key during prompting. This is done by specifying PMTCTL(*PMTRQS) on the PARM statement for the parameter. When prompting for a command, parameters with PMTCTL(*PMTRQS) coded will not be prompted unless a value was specified for them or the user presses F10 to request the additional parameters.

The prompter displays a separator line before the parameters with PMTCTL(*PMTRQS) to distinguish them from the other parameters. By default, all parameters with PMTCTL(*PMTRQS) are prompted last, even though they are not defined in that order in the command definition source. You can override this by specifying a relative prompt number in the PROMPT keyword. If you do this, however, it can be difficult to see what parameters were added to the prompt when F10 is pressed.

Using Key Parameters and a Prompt Override Program

The prompt override program allows current values rather than defaults to be displayed when a command is prompted.

If a prompt override program is defined for a command, you can see the results of calling the prompt override program in the following two ways:

- Type the name of the command without parameters on any command line and press F4=Prompt. The next screen shows the key parameters for the command. Key parameters are parameters, such as the name of an object, that uniquely identify the object.

  Complete all fields shown and press the Enter key. The next screen shows all command parameters, and the parameter fields that are not key parameter fields contain current values rather than defaults (such as *SAME and *PRV).

  For example, if you type `CHGLIB` on a command line and press F4=Prompt, you see only the Library parameter. If you then type `*CURLIB` and press the Enter key, the current values for your current library are displayed.

- Type the name of the command and the values for all key parameters on any command line. Press F4=Prompt. The next screen shows all command parameters, and the parameter fields that are not key parameter fields will contain current values rather than defaults (such as *SAME and *PRV).

  For example, if you type `CHGLIB LIB(*CURLIB)` on a command line and press F4=Prompt, the current values for your current library are displayed.

When F10=Additional parameters is pressed, any parameters defined with PMTCTL(*PMTRQS) will be displayed with current values. For more information about additional parameters, see "Additional Parameters" on page 9-33.

To exit the command prompt, press F3=Exit.

Procedure for Using Prompt Override Programs

To use a prompt override program, do the following:

1. Specify any parameters that are to be key parameters on the PARM statement in the command definition source. For information about the KEYPARM parameter, see the following section, "Identifying Key Parameters."
2. Write a prompt override program. For information about creating prompt override programs, see "Writing a Prompt Override Program" on page 9-35.
3. Specify the name of the prompt override program on the PMTOVRPGM parameter when you create or change the command. For information about creating or changing commands that use the prompt override program, see "Specifying the Prompt Override Program When Creating or Changing Commands" on page 9-38.

Identifying Key Parameters

The number of key parameters should be limited to the number of parameters needed to uniquely define the object to be changed.

To ensure a key parameter is coded correctly in the command definition source, do the following:

- Specify KEYPARM(*YES) on the PARM statement in the command definition source.
- Define all parameters that specify KEYPARM(*YES) before all parameters that specify KEYPARM(*NO).

  Note: If a PARM statement specifies KEYPARM(*YES) after a PARM statement that specifies KEYPARM(*NO), the parameter is not treated as a key parameter and a warning message is issued.
- Do not specify a MAX value greater than one in the PARM statement.
- Do not specify a MAX value greater than one for ELEM statements associated with key parameters.
- Do not specify *PMTRQS or a prompt control statement for the PMTCTL keyword on the PARM statement.
- Place key parameters in the command definition source in the same order you want them to appear when prompted.

Writing a Prompt Override Program

A prompt override program needs to be passed certain information to return current values when a command is prompted. You must consider both the passed information and the returned values when you write a prompt override program.

For an example of CL source for a prompt override program, see "CL Sample for Using the Prompt Override Program" on page 9-38.

Information Passed to the Prompt Override Program: The prompt override program is passed the following:

- A 20-character field. The first 10 characters of the field contain the name of the command and the last 10 characters contain the name of the library.
- The value for each key parameter, if any. If more than one key parameter is defined, the values are passed in the order that the parameters are defined in the command definition source.
- A 5700-byte space to hold the command string created by the prompt override program. The first two bytes of this field must contain the length of the command string being returned. The actual command string follows the first two bytes.

Information Returned from the Prompt Override Program: Based on the values passed, the prompt override program retrieves the current values for the parameters that are not key parameters. These values are placed into a command string, where the length of the string is determined and returned.

Use the following guidelines to ensure your command string is correctly defined:

- Use the keyword format for the command string just as you would on the command line.
- Do not include the command name and the key parameters in the command string.
- Precede each keyword with a selective prompt character to define how to display the parameter and what value to pass to the CPP. For information about using selective prompt characters, see "Selective Prompting for CL Commands" on page 6-14.

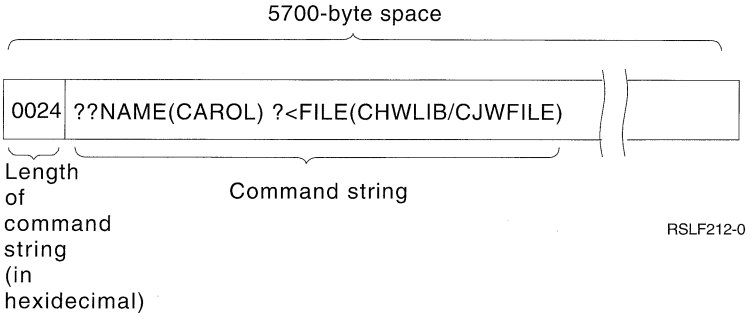
When using selective prompts, do the following:

- If a parameter is defined as MIN(1) in the command definition source (that is, the parameter is required), you must use the ?? selective prompt character for that keyword in the command string from the prompt override program.
- Do not use the ?- selective prompt character in the prompt override program command string.

The following example shows a command string returned from a prompt override program:

```
??Number(123456) ?<Qualifier(CLIB/CFILE) ?<LIST(ITEM1 ITEM2 ITEM3) ?<TEXT('Carol"s file')
```

- Make sure the value specified in the first two bytes of the space passed to the program is the actual length of the command string and does not include the first two bytes of space.



- Include only the parameters in the command string whose current values you want displayed when the command is prompted. Parameters not included in the command string have their defaults displayed.
- Use character form for any numbers that appear in the command string. Do not use binary or packed form. Do not include any hexadecimal numbers in the command string.
- Do not put blank spaces between the library and the qualifier or the qualifier and the object. For example:

```
??KWD1(library   /object)      Not valid
??KWD1(library/  object)       Not valid
??KWD1(library/object)         Valid
??KWD1(  library/object  )     Valid
```

- If you use special values or single values, make sure they are translated into the from-value defined in the command definition source.

  For example, a keyword has a special value defined as SPCVAL(*SPECIAL *) in the command definition source. *SPECIAL is the from-value and * is the to-value. When the current value is retrieved for this keyword, * is the value retrieved, but *SPECIAL must appear in the command string returned from the prompt override program. The correct from-value must be placed into the command string since more than one special value or single value can have the same to-value. For example, if `KWD1 SPCVAL((*SPC *) (*SPECIAL *))` is specified, the prompt override program must determine whether * is the to-value for *SPC or *SPECIAL.

- Define the length of fields used to retrieve text as follows:

```
(2*(field length defined in command definition source)) + 2
```

This length allows for the maximum number of quotation marks allowed in the text field. For example, if the TEXT parameter on the CHGxxx command is defined in the command definition source as LEN(50), then the parameter is declared as CHAR(102) in its prompt override program. For an example of how to define the length of fields used to retrieve text, see "CL Sample for Using the Prompt Override Program" on page 9-38.

If the parameter for a text field is not correctly defined in the prompt override program and the text string retrieved by the prompt override program contains a quote, the command does not prompt correctly.

- Make sure any embedded apostrophes are defined as quotation marks, for example:

```
?<TEXT('Carol"s library')
```

Some commands can only be run in certain modes (such as DEBUG) or job status (such as *BATCH) but can still be prompted for from other modes or job statuses. When the command is prompted, the prompt override program is called regardless of the user's environment. If the prompt override program is called in a mode or environment that is not valid for the command, the defaults are displayed for the command and a value of 0 is returned for the length. Using the debug commands Change Debug (CHGDBG) and Add Program (ADDPGM) when not in debug mode are examples of this condition.

Allowing for Errors in a Prompt Override Program: If the prompt override program detects an error, it should do the following:

- Set the command string length to zero so that the defaults rather than current values are displayed when the command is prompted.
- Send a diagnostic message to the previous call.
- Send escape message CPF0011.

For example, if you need a message saying that a library does not exist, add a message description similar to the following:

```
ADDMSGD      MSG('Library &2 does not exist') +
             MSGID(USR0012) +
             MSGF(QGPL/ACTMSG) +
             SEV(40) +
             FMT((*CHAR 4) (*CHAR 10))
```

Note: The substitution variable &1 is not in the message but is defined in the FMT parameter as 4 characters. &1 is reserved for use by the system and must always be 4 characters. If the substitution variable &1 is the only substitution variable defined in the message, you must ensure that the fourth byte of the message data does not contain a blank when you send the message. The fourth byte is used by the system to manage messages during command processing and prompting.

This message can be sent to the calling program of the prompt override program by specifying the following in the prompt override program:

```
SNDPGMMSG    MSGID(USR0012) MSGF(QGPL/ACTMSG) +
             MSGDTA('0000' || &libname) MSGTYPE(*DIAG)
```

After the prompt override program sends all the necessary diagnostic messages, it should then send message CPF0011. To send message CPF0011, use the Send Program Message (SNDPGMMSG) command as follows:

```
SNDPGMMSG     MSGID(CPF0011) MSGF(QCPFMSG) +
              MSGTYPE(*ESCAPE)
```

When message CPF0011 is received, message CPD680A is sent to the calling program and displayed on the prompt screen to indicate that errors have been found. All diagnostic messages are placed in the user's job log.

Specifying the Prompt Override Program When Creating or Changing Commands

To use a prompt override program for a command you want to create, specify the program name when you use the Create Command (CRTCMD) command. You can also specify the program name when you change the command using the Change Command (CHGCMD) command. For both commands, specify the name of the prompt override program on the PMTOVRPGM parameter.

If key parameters are defined in the command definition source but the prompt override program is not specified when the command is created or changed, warning message CPD029B results. The key parameters are ignored, and when the command is prompted, it is displayed using the defaults specified in the command definition source.

Sometimes a prompt override program is specified when a command is created but when no key parameters are defined in the command definition source. In these cases, the prompt override program is called before the command is prompted; informational message CPD029A is sent when the command is created or changed.

CL Sample for Using the Prompt Override Program

The following example shows the command source for a command and the prompt override program. This command allows the ownership and text description of a library to be changed. The prompt override program for this command receives the name of the library; retrieves the current value of the library owner and the text description; and then places these values into a command string and returns it.

Sample Command Source

```
CHGLIBATR: CMD   PROMPT('Change Library Attributes')
           PARM  KWD(LIB) +
                   TYPE(*CHAR) MIN(1) MAX(1) LEN(10) +
                   KEYPARM(*YES) +
                   PROMPT('Library to be changed')
           PARM  KWD(OWNER) +
                   TYPE(*CHAR) LEN(10) MIN(0) MAX(1) +
                   KEYPARM(*NO) +
                   PROMPT('Library owner')
           PARM  KWD(TEXT) +
                   TYPE(*CHAR) MIN(0) MAX(1) LEN(50) +
                   KEYPARM(*NO) +
                   PROMPT('Text description')
```

Sample Prompt Override Program

```
  PGM PARM(&cmdname &keyparm1 &rtnstring)
/*************************************************************************/
/*                                                                       */
/*  Declarations of parameters passed to the prompt override program */
/*                                                                       */
/*************************************************************************/
 DCL  VAR(&cmdname)   TYPE(*CHAR) LEN(20)
 DCL  VAR(&keyparm1)   TYPE(*CHAR) LEN(10)
 DCL  VAR(&rtnstring) TYPE(*CHAR) LEN(5700)

/*************************************************************************/
/*                                                                       */
/* Return command string structure declaration                           */
/*                                                                       */
/*************************************************************************/

                     /* Length of command string generated         */
 DCL  VAR(&stringlen) TYPE(*DEC)  LEN(5 0) VALUE(131)
 DCL  VAR(&binlen)    TYPE(*CHAR) LEN(2)
                     /* OWNER keyword                              */
 DCL  VAR(&ownerkwd)  TYPE(*CHAR) LEN(8)  VALUE('?<OWNER(')
 DCL  VAR(&name)      TYPE(*CHAR) LEN(10)
                     /* TEXT keyword                               */
 DCL  VAR(&textkwd)   TYPE(*CHAR) LEN(8)  VALUE(' ?<TEXT(')
 DCL  VAR(&descript)  TYPE(*CHAR) LEN(102)

/*************************************************************************/
/*                                                                       */
/* Variables related to command string declarations                      */
/*                                                                       */
/*************************************************************************/
 DCL  VAR(&quote)      TYPE(*CHAR) LEN(1) VALUE('''')
 DCL  VAR(&closparen)  TYPE(*CHAR) LEN(1) VALUE(')')
```

```
/*************************************************************************/
/*                                                                       */
/*                  Start of operable code                               */
/*                                                                       */
/*************************************************************************/
/*************************************************************************/
/*                                                                       */
/* Monitor for exceptions                                                */
/*                                                                       */
/*************************************************************************/
    MONMSG  MSGID(CPF0000) +
            EXEC(GOTO CMDLBL(error))

/*************************************************************************/
/*                                                                       */
/* Retrieve the owner and text description for the library specified*/
/* on the LIB parameter.  Note:  This program assumes there are     */
/* no apostrophes in the TEXT description, such as (Carol''s)  */
/*                                                                       */
/*************************************************************************/
    RTVOBJD OBJ(&keyparm1) OBJTYPE(*LIB) OWNER(&name) TEXT(&descript)

    CHGVAR VAR(%BIN(&binlen)) VALUE(&STRINGLIN)

/*************************************************************************/
/*                                                                       */
/* Build the command string                                              */
/*                                                                       */
/*************************************************************************/
    CHGVAR VAR(&rtnstring) VALUE(&binlen)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &ownerkwd)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &name)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &closparen)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &textkwd)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &quote)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &descript)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &quote)
    CHGVAR VAR(&rtnstring) VALUE(&rtnstring *TCAT &closparen)

    GOTO CMDLBL(pgmend)

    CHGVAR VAR(&stringlen) VALUE(0)
    CHGVAR VAR(%BIN(&binlen)) VALUE(&STRINGLIN)
    CHGVAR VAR(&rtnstring) VALUE(&binlen)
```

```
/*************************************************************************/
/*                                                                       */
/* Send error message(s)                                                 */
/*                                                                       */
/* NOTE: If you wish to send a diagnostic message as well as CPF0011*/
/*       you will have to enter a valid error message ID in the     */
/*       MSGID parameter and a valid message file in the MSGF       */
/*       parameter for the first SNGPGMMSG command listed below.    */
/*       If you do not wish to send a diagnostic message, do not    */
/*       include the first SNDPGMMSG your program.  However, in     */
/*       error conditions, you must ALWAYS send CPF0011 so the      */
/*       second SNDPGMMSG command must be included in your program. */
/*                                                                       */
/*************************************************************************/
    SNDPGMMSG MSGID(XXXXXXX) MSGF(MSGLIB/MSGFILE) MSGTYPE(*DIAG)
    SNDPGMMSG MSGID(CPF0011) MSGF(QCPFMSG) MSGTYPE(*ESCAPE)

PGMEND:
ENDPGM
```

Creating Commands

After you have defined your command through the command definition statements, you use the Create Command (CRTCMD) command to create the command. Besides specifying the command name, library name, and command processing program name for CL or high-level languages (HLL), or the source member, source file, command environment, and exit program for REXX, you can define the following attributes of the command:

- The validity checking used by the command
- The modes in which the command can be run
  - Production
  - Debug
  - Service
- Where the command can be used
  - Batch job
  - Interactive job
  - CL program in a batch job
  - CL program in an interactive job
  - REXX procedure in a batch job
  - REXX procedure in an interactive job
  - As a command interpretively processed by the system through a call to QCMDEXC (see Chapter 6, for information about QCMDEXC)
- The maximum number of parameters that can be specified by position
- The message file containing the prompt text
- The help panel group that is used as help for promptable parameters
- The help identifier name for the general help module used on this command
- The message file containing the messages identified on the DEP statement
- The current library to be active during command processing
- The product library to be active during command processing

- Whether an existing command with the same name, type, and library is replaced if REPLACE(*YES) is specified.
- The authority given to the public for the command and its description
- Text that briefly describes the command and its function

For commands with REXX CPPs, you can also specify the following:

- The initial command environment to handle commands when the procedure is started
- Exit programs to control running of your procedure

The following example defines a command named ORDENTRY to call an order entry application. The CRTCMD command defines the preceding attributes for ORDENTRY and creates the command using the parameter definitions contained in the member ORDENTRY in the IBM-supplied source file QCMDSRC. ORDENTRY contains the PARM statement used in the example under "Example of Defining a Parameter" on page 9-10.

```
CRTCMD      CMD(DSTPRODLB/ORDENTRY) +
            PGM(*LIBL/ORDENT) +
            TEXT('Calls order entry application')
```

The resulting command is:

```
ORDENTRY  OETYPE(value)
```

where the value can be DAILY, WEEKLY, or MONTHLY.

Once you have created a command, you can:

- Display the attributes of the command by using the Display Command (DSPCMD) command
- Change the attributes of the command by using the Change Command (CHGCMD) command
- DLTMCD)

  Delete the command by using the Delete Command (DLTCMD) command

Command Definition Source Listing

When you create a command, a source list is produced. The following shows a sample source list. The numbers refer to descriptions following the list.

```
           1                                                                                          2               3
 5738SS1 V2R1M0   910524               Command Definition               DSTPRODLB/ORDENTRY  06/17/88 16:35:46        Page    1
 Command name . . . . . . . . . . . . . . . . . :   ORDENTRY
   Library . . . . . . . . . . . . . . . . . . . :     DSTPRODLB
 Command processing program . . . . . . . . . . :   ORDENT    4
   Library . . . . . . . . . . . . . . . . . . . :     DSTPRODLB
 Source file . . . . . . . . . . . . . . . . . . :   QCMDSRC
   Library . . . . . . . . . . . . . . . . . . . :     QGPL
 Source file member  . . . . . . . . . . . . . . :   ORDENTRY      06/15/88  16:35:31
 Validity checking program . . . . . . . . . . . :    *NONE
 Mode in which valid . . . . . . . . . . . . . . :   *PROD
                                                     *DEBUG
                                                     *SERVICE
 Environment allowed . . . . . . . . . . . . . . :   *IREXX
                                                     *BREXX
                                                     *BPGM
                                                     *IPGM
                                                     *EXEC
                                                     *INTERACT
                                                     *BATCH
 Allow limited user  . . . . . . . . . . . . . . :   *NO
 Max positional parameters . . . . . . . . . . . :   *NOMAX
 Prompt file . . . . . . . . . . . . . . . . . . :   *NONE
 Message file  . . . . . . . . . . . . . . . . . :   QCPFMSG
   Library . . . . . . . . . . . . . . . . . . . :     *LIBL
 Help panel group  . . . . . . . . . . . . . . . :   HLPORDEN
   Library . . . . . . . . . . . . . . . . . . . :     *LIBL
entry application
 Authority . . . . . . . . . . . . . . . . . . . :   *USE
 Text  . . . . . . . . . . . . . . . . . . . . . :   Calls order  Help identifier . . . . . . . . . . . . . . . . :     HIDORDEN
 Current library . . . . . . . . . . . . . . . . :   *NOCHG
 Product library . . . . . . . . . . . . . . . . :   *NOCHG
 Compiler  . . . . . . . . . . . . . . . . . . . :   IBM AS/400 Command Definition Compiler  5
   6                                         Command Definition Source
 SEQNBR  *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ... +... 6 ...+... 7 ...+... 8 ...+... 9 ...+.  DATE  8
    100-        CMD PROMPT('Order Entry Command')          7                                            05/15/88
    200-        PARM   KWD(OETYPE) TYPE(*CHAR) RSTD(*YES) +                                             05/15/88
    300-        VALUES(DAILY WEEKLY MONTHLY) MIN(1) +                                                   05/15/88
    400-        PROMPT('Type of order entry:')                                                          05/15/88
* * * * *   E N D   O F   S O U R C E   * * * * *
 5738SS1 V2R1M0  910524                Command Definition               DSTPRODLB/ORDENTRY     06/15/88 16:35:46        Page 1
                                         Cross Reference
 Defined Keywords   9
 Keyword              Number          Defined       References
 OETYPE                 01              200
                              * * * * *   E N D   O F   C R O S S   R E F E R E N C E   * * * * *
 5738SS1 V2R1M0  910524                Command Definition               DSTPRODLB/ORDENTRY     06/15/88 16:35:46        Page 2
                                         Final Messages
 Message               Sequence
 ID                     Number          Sev        Text
* CPD0205                               30         Command              10
                                          Message Summary
 Total          Info          Error
   0              0             0    11
* CPC0202                               00         Command ORDENTRY created in library DSTPRODLB.   12
                                 * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Title:

1 The program number, version, release, modification level, and date of OS/400.

2 The date and time of this run.

3 The page number in the list.

Prologue

4 The parameter values specified (or defaults if not specified) on the CRTCMD command. If the source is not in a database file, the member name, date, and time are omitted.

5 The name of the create command definition compiler.

Source:

6 The sequence number of lines (records) in the source file. A dash following a sequence number indicates that a source statement begins at that sequence number. The absence of a dash indicates that a statement is the continuation of the previous statement. For example, a PARM source statement starts at sequence number 200 and continues at sequence numbers 300 and 400. (Note the continuation character of + on the PARM statement at sequence number 200 and 300.)

Comment source statements are handled like any other source statement and have sequence numbers.

See the *Database Guide* for information about how sequence numbers are assigned.

7 The source statements.

8 The last date the source statement was changed or added. If the statement has not been changed or added, no date is shown. If the source is not in a database file, the date is omitted.

If an error is found during processing of the command definition statements and can be traced to a specific source statement, the error message is printed immediately following the source statement. An asterisk (*) indicates that the line contains an error message. The line contains the message identifier, severity, and the text of the message.

For more information about the command definition errors, see "Errors Encountered when Processing Command Definition Statements" on page 9-45.

Cross-references:

9 The keyword table is a cross-reference list of the keywords validly defined in the command definition. The table lists the keyword, the position of the keyword in the command, the sequence number of the statement where the keyword is defined, and the sequence numbers of statements that refer to the keyword.

If valid labels are defined in the command definition, a cross-reference list of the labels (label table) is provided. The table lists the label, the sequence number of the statement where the label is defined, and the sequence numbers of statements that refer to the label.

Messages:

10 A list of the general error messages not listed in the source section that were encountered during processing of the command definition statements, if any. For each message, this section contains the message identifier, the sequence number of where the error occurred, the severity, and the message.

Message summary:

11 A summary of the number of messages issued during processing of the command definition statements. The total number is given along with totals by severity.

12 A completion message is printed following the message summary.

Errors Encountered when Processing Command Definition Statements

The types of errors that are caught during processing of the command definition statements include syntax errors, references to keywords and labels not defined, and missing statements. The following types of errors detected by the command definition compiler stop the command from being created (severity codes are ignored).

- Value errors
- Syntax errors

Even after an error that stops the command from being created is encountered, the command definition compiler continues to check the source for other errors. Syntax errors and fixed value errors prevent final checking that identifies errors in user names and values or references to keywords or labels. Checking for syntax errors and fixed value errors does continue. This lets you see and correct as many errors as possible before you try to create the command again. To correct errors made in the source statements, see the *Database Guide*.

In the command definition source list, an error condition that relates directly to a specific source statement is listed after that command. See "Command Definition Source Listing" on page 9-43 for an example of these inline messages. Messages that do not relate to a specific source statement but are more general in nature are listed in a messages section of the list, not inline with source statements.

Displaying a Command Definition

You can use the Display Command (DSPCMD) command to display or print the values that were specified as parameters on the CRTCMD command. The DSPCMD command displays the following information for your commands or for IBM-supplied commands:

- Qualified command name. The library name is the name of the library in which the command being displayed is located.
- Qualified name of the command processing program. The library name is the name of the library in which the command processing program resided when the command was created if a library name was specified on the CRTCMD or CHGCMD command. If a library name was not specified, *LIBL is displayed as the library qualifier. If the CPP is a REXX procedure, *REXX is shown.
- Qualified source file name, if the source file was a database file. The library name is the name of the library in which the source file was located when the CRTCMD command was processed. This field is blank if the source file was not a database file.
- Source file member name, if the source file was a database source file.
- If the CPP is a REXX procedure, the following information is shown:
  - REXX procedure member name
  - Qualified REXX source file name where the REXX procedure is located
  - REXX command environment
  - REXX exit programs

- Qualified name of the validity checking program. The library name is the name of the library in which the program resided when the command was created if a library name was specified on the CRTCMD or CHGCMD command. If a library name was not specified, *LIBL is displayed as the library qualifier.
- Valid modes of operation.
- Valid environments in which the command can be run.
- The positional limit for the command. *NOMAX is displayed if no positional limit exists for the command.
- Qualified name of the prompt message file. The library name is the name of the library in which the message file was located when the CRTCMD command was run. *NONE is displayed if no prompt message file exists for the command.
- Qualified name of the message file for the DEP statement. If a library name was specified for the message file when the command was created, that library name is displayed. If the library list was used when the command was created, *LIBL is displayed. *NONE is displayed if no DEP message file exists for the command.
- Qualified name of the help panel group.
- The help identifier name for the command.
- Qualified name for the prompt override program.
- Text associated with the command. Blanks are displayed if no text exists for the command.

Effect of Changing the Command Definition of a Command in a Program

When a CL program is created, the command definitions of the commands in the program are used to generate the program. When the CL program is run, the command definitions are also used. If you specify a library name for the command in the CL program, the command must be in the same library at program creation time and at program run time. If you specify *LIBL for the command in the CL program, the command is found, both at program creation and run time, using the library list (*LIBL).

You can make the following changes to the command definition statements for a command without re-creating the programs that use the command. Some of these changes are made to the command definition statements source, which requires the command to be re-created. Other changes can be made with the Change Command (CHGCMD) command.

- Add an optional parameter in any position. Adding an optional parameter before the positional limit may affect any batch input streams that have the parameters specified in positional form.
- Change the REL and RANGE checks to be less restrictive.
- Add new special values. However, this could change the action of the program if the value could be specified before the change.

- Change the order of the parameters. However, changing the order of the parameters that precede the positional limit *will* affect any batch input streams that have the parameters specified in positional form.
- Increase the number of optional elements in a simple list.
- Change default values. However, this may affect the operation of the program.
- Decrease the number of required list items in a simple list.
- Change a parameter from required to optional.
- Change RSTD from *YES to *NO.
- Increase the length when FULL(*NO) is specified.
- Change FULL from *YES to *NO.
- Change the PROMPT text.
- Change the ALLOW value to be less restrictive.
- Change the name of the command processing program if the new command processing program accepts the proper number and type of parameters.
- Change the name of the validity checking if the new validity checking accepts the proper number and type of parameters.
- Change the mode in which the command can be run as long as the new mode does not affect the old mode of the same command that is used in a CL program.
- Change the TYPE to a compatible and less restrictive value. For example, change the TYPE from *NAME to *CHAR.
- Change the MAX value to greater than 1.
- Change the PASSATR and VARY values.

The following changes can be made to the command definition statements depending on what was specified in the CL program in which the command is used:

- Remove a parameter.
- Change the RANGE and REL values to be more restrictive.
- Remove special values.
- Decrease the number of elements allowed in a list.
- Change the TYPE value to be more restrictive or incompatible with the original TYPE value. For example, change the TYPE value from *CHAR to *NAME.
- Add a SNGVAL parameter that was previously a list item.
- Change the name of an optional parameter.
- Remove a value from a list of values.
- Increase the number of required list items.
- Change a SNGVAL parameter to a SPCVAL parameter.
- Change a simple list to a mixed list of like elements.
- Change an optional parameter to a constant.
- Change RTNVAL from *YES to *NO, or from *NO to *YES.

The following changes can be made to the command definition statements, but may cause the program that uses the command to function differently:

- Change the meaning of a value.
- Change the default value.

- Change a SNGVAL parameter to a SPCVAL parameter.
- Change a value to a SNGVAL parameter.
- Change a list to a list within a list.

The following changes to the command definition statements require that the program using the command be re-created.

- Addition of a new required parameter.
- Removal of a required parameter.
- Changing the name of a required parameter.
- Changing a required parameter to a constant.
- Changing the command processing program to or from *REXX

In addition, if you specify *LIBL as the qualifier on the name of the command processing program or the validity checking when the command is created or changed, you can move the command processing program or the validity checking to another library in the library list without changing the command definition statements.

Changing Command Defaults

You can change the default value of a command keyword by using the Change Command Default (CHGCMDDFT) command described in the *CL Reference*. The keyword must have an existing default in order to allow a change to a new default value. The command being changed can be either an IBM-supplied command or a user-written command. Caution must be used when changing defaults for IBM-supplied commands. The following are recommendations for changing defaults:

1. If the command to be changed is an IBM-supplied command, you should use the Create Duplicate Object (CRTDUPOBJ) command to create a duplicate of the command to be changed in a user library. This allows other users on the system to use the IBM-supplied defaults if necessary.

   Use the Change System Library List (CHGSYSLIBL) command to move the user library ahead of QSYS or any other system-supplied libraries in the library list. This will allow the user to use the changed command without using the library qualifier.

   Changes to commands that are needed on a system-wide basis should be made in a user library and the user library name should be added to the QSYSLIBL system value ahead of QSYS. The changed command will be used system-wide. If you need to run an application using the IBM-supplied default, you can do so by using the Change System Library List (CHGSYSLIBL) command to remove the special library or library qualifier of the affected commands.

2. When a new release of a licensed program is installed, all IBM-supplied commands for the licensed program are replaced on the machine. Therefore, you should use a CL program to make changes to commands so when a new release is installed, you can run the CL program to duplicate the new commands to pick up any new keywords and make the command default changes.

   If an IBM-supplied command has new keywords, a copy of the command from a previous release may not run properly.

   The following is an example of a CL program used to delete the old version and create the new changed command:

```
PGM
DLTCMD USRQSYS/SIGNOFF
CRTDUPOBJ OBJ(SIGNOFF) FROMLIB(QSYS) OBJTYPE(*CMD) +
          TOLIB(USRQSYS) NEWOBJ(*SAME)
CHGCMDDFT CMD(USRQSYS/SIGNOFF) NEWDFT('LOG(*LIST)')
 .
 .
Repeat the DLTCMD, CRTDUPOBJ and CHGCMDDFT for each
command you want changed
 .
 .
ENDPGM
```

The following steps can be used to build the NEWDFT command string for the CHGCMDDFT command. The USRQSYS/CRTCLPGM command is used in this example.

1. Create a duplicate copy of the command to be changed in a user library with the following command:

   ```
   CRTDUPOBJ OBJ(CRTCLPGM) FROMLIB(QSYS) OBJTYPE(*CMD) +
             TOLIB(USRQSYS)  NEWOBJ(*SAME)
   ```

2. Enter the command name to be changed in a source file referred to by the Source Entry Utility (SEU).
3. Press F4 to call the command prompter.
4. Enter any new default values for the keywords to be changed. In this example, `AUT(*EXCLUDE)` and `TEXT('Isn't this nice text')` is entered.
5. Required keywords cannot have a default value; however, in order to get the command string in the source file, a valid value must be specified for each required keyword. Specify PGM1 for the PGM parameter.
6. Press the Enter key to put the command string into the source file. The command string returned would look like this:

   ```
   USRQSYS/CRTCLPGM PGM(PGM1) AUT(*EXCLUDE) +
   TEXT('Isn''t this nice text')
   ```

7. Remove the required keywords from the command string:

   ```
   USRQSYS/CRTCLPGM  AUT(*EXCLUDE) +
   TEXT('Isn''t this nice text')
   ```

   Remember that only parameters, elements, or qualifiers that have existing default values may be changed. If a value is specified for a parameter, element, or qualifier that does not have an existing default value, no default changes will be made.

8. Insert the CHGCMDDFT at the beginning as shown:

   ```
   CHGCMDDFT USRQSYS/CRTCLPGM AUT(*EXCLUDE) +
   TEXT('Isn''t this nice text')
   ```

9. The input for the NEWDFT keyword must be quoted as shown:

   ```
   CHGCMDDFT USRQSYS/CRTCLPGM 'AUT(*EXCLUDE) +
   TEXT('Isn''t this nice text')'
   ```

10. Since there are embedded apostrophes in the NEWDFT value, they must be doubled to run properly:

```
CHGCMDDFT USRQSYS/CRTCLPGM 'AUT(*EXCLUDE) +
TEXT(''Isn''''t this nice text'')'
```

11. Now if you press F4 to call the command prompter, then F11 to request keyword prompting, you will see the following display:

```
Command . . . . . :   CMD         R   CRTCLPGM
  Library . . . . . :                   USRQSYS
New default parameter string:   NEWDFT      R   'AUT(*EXCLUDE)
TEXT(''Isn''''t this nice text'')'
```

12. Now if you press the Enter key, the CHGCMDDFT command string will be:

```
CHGCMDDFT CMD(USRQSYS/CRTCLPGM) NEWDFT('AUT(*EXCLUDE) +
          TEXT(''Isn''''t  this nice text'')')
```

13. Press F1 to exit SEU and create and run the CL program.

14. The USRQSYS/CRTCLPGM will have default values of `AUT *EXCLUDE` and `'Isn''t this nice text'` for TEXT.

Example 1

To provide a default value of *NOMAX for the MAXMBRS keyword of command CRTPF, do the following:

```
CRTPF FILE(FILE1) RCDLEN(96) MAXMBRS(1)
  .
  .
CHGCMDDFT CMD(CRTPF) NEWDFT('MAXMBRS(*NOMAX)')
```

Example 2

To provide a default value of 10 for the MAXMBRS keyword of the command CRTPF, do the following:

```
CRTPF FILE(FILE1) RCDLEN(96) MAXMBRS(*NOMAX)
  .
  .
CHGCMDDFT CMD(CRTPF) NEWDFT('MAXMBRS(10)')
```

Example 3

The following allows you to provide a default value of LIB001 for the first qualifier of the SRCFILE keyword and FILE001 for the second qualifier of the SRCFILE keyword for the command CRTCLPGM. The AUT keyword now have a default value of *EXCLUDE.

```
CRTCLPGM PGM(PROGRAM1) SRCFILE(*LIBL/QCMDSRC)
  .
  .
CHGCMDDFT CMD(CRTCLPGM) +
          NEWDFT('SRCFILE(LIB001/FILE001) AUT(*EXCLUDE)')
```

Example 4

The following provides a default value of 'Isn"t this print text' for the PRTTXT keyword of the command CHGJOB. Since the NEWDFT keyword has embedded apostrophes these apostrophes must be doubled to run correctly.

```
CHGJOB PRTTXT('Isn''t this nice text')
  .
  .
CHGCMDDFT CMD(CHGJOB) +
          NEWDFT('PRTTXT(''Isn''''t this print text'')')
```

Example 5

The following provides a default value of QGPL for the first qualifier (library name) of the first list item of the DTAMBRS keyword for the command CRTLF. The new default value for the second list item of the DTAMBRS keyword (member name) is MBR1.

```
CRTLF FILE(FILE1) DTAMBRS(*ALL)
  .
  .
CHGCMDDFT CMD(CRTLF) +
          NEWDFT('DTAMBRS((QGPL/*N (MBR1)))')
```

Since *ALL is a SNGVAL (single value) for the entire DTAMBRS list, the defaults of *CURRENT for the library name and *NONE for the member name do not show up on the original command prompt display. The defaults *CURRENT and *NONE can be changed to a new default value but do not show up on the original prompt display because of the *ALL single value for the entire DTAMBRS list.

Writing a Command Processing Program or Procedure

A command processing program (CPP) can be a CL or HLL program, or a REXX procedure. Programs written in CL or HLL can also be called directly with the CALL CL command. REXX procedures can be called directly using the Start REXX Procedure (STRREXPRC) command. The command processing program does not need to exist when the Create Command (CRTCMD) command is run. If *LIBL is used as the library qualifier, the library list is used to find the command processing program when the created command is run.

Messages issued as a result of running the command processing program can be sent to the job message queue and automatically displayed or printed. You can send displays to the requesting display station.

Notes:

1. The parameters defined on the command are passed individually in the order they were defined (the PARM statement order).
2. Decimal values are passed to HLL and CL programs as packed decimal values of the length specified in the PARM statement.
3. Character, name, and logical values are passed to HLL and CL programs as a character string of the length defined in the PARM statement.

Writing a CL or HLL Command Processing Program

Figure 9-3 on page 9-52 shows the relationship between the Create Command (CRTCMD) command, the command definition statements, and the command processing program.

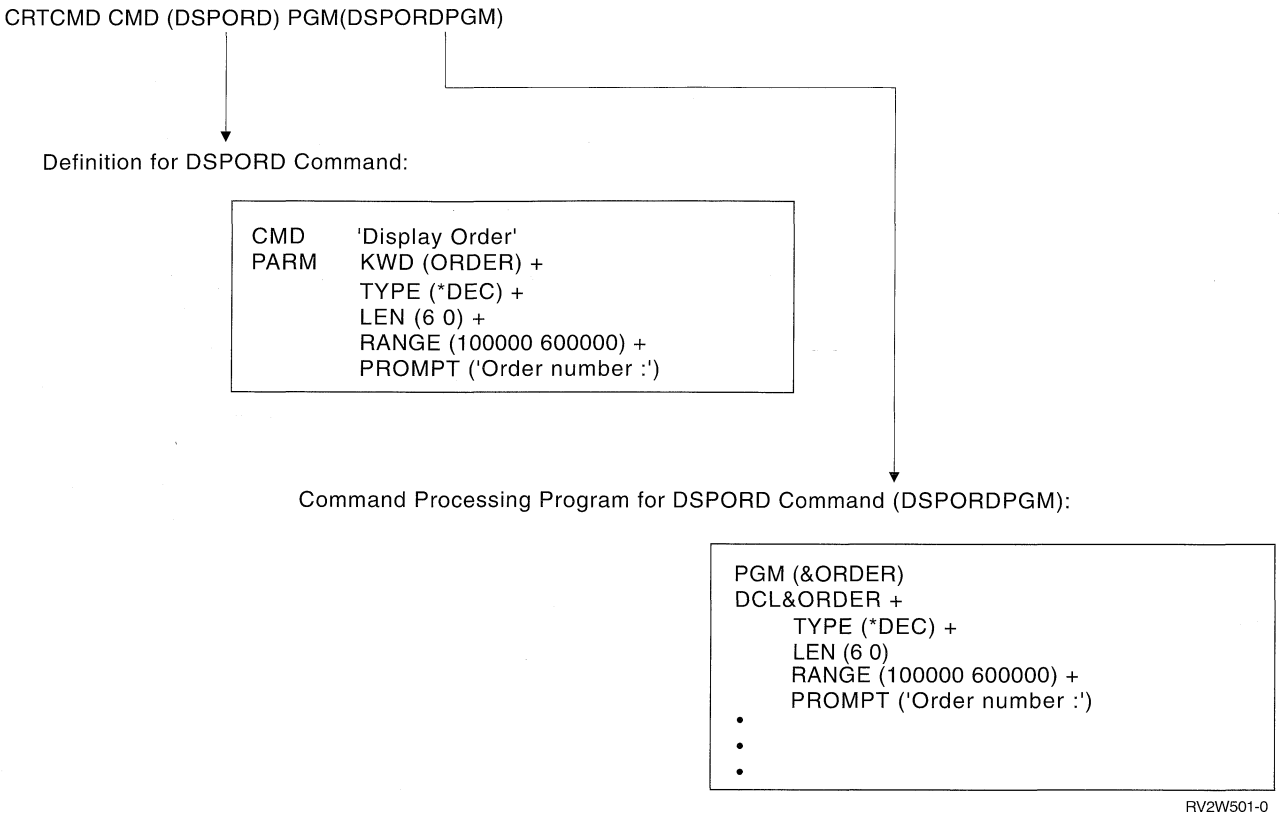


Figure 9-3. Command Relationships for CL and HLL

If the command processing program is a CL program, the variables that receive the parameter values must be declared to correspond to the type and length specified for each PARM statement. The following shows this correspondence. (Note the declare for the parameter ORDER in Figure 9-3.)

PARM Statement Type	**PARM Statement Length**	**Declared Variable Type**	**Declared Variable Length**
*DEC	x y[1]	*DEC	x y[1]
*LGL	1	*LGL	1
*CHAR	n	*CHAR	≤n[2]
*NAME	n	*CHAR	≤n[2]
*CNAME	n	*CHAR	≤n[2]
*SNAME	n	*CHAR	≤n[2]
*GENERIC	n	*CHAR	≤n[2]
*CMDSTR	n	*CHAR	≤n[2]
*DATE	7	*CHAR	7
*TIME	6	*CHAR	6
*INT2	n	*CHAR	2

PARM Statement Type	PARM Statement Length	Declared Variable Type	Declared Variable Length
*INT4	n	*CHAR	4

1 x equals the length and y is the number of decimal positions.

2 For character variables, if the length of the value passed is greater than the length declared, the value is truncated to the length declared. If RTNVAL(*YES) is specified, the length declared must equal the length defined on the PARM statement.

A CL program used as a command processing program can process binary values (such as *INT2 or *INT4). The CL program should receive these values as character fields. The binary built-in function (%BINARY) can be used to convert them to decimal values.

For examples of command processing programs, see "Examples of Defining and Creating Commands" on page 9-55.

Writing a REXX Command Processing Procedure

Figure 9-4 shows the relationship between the Create Command (CRTCMD) command, the command definition statements, and the command processing procedure for REXX.

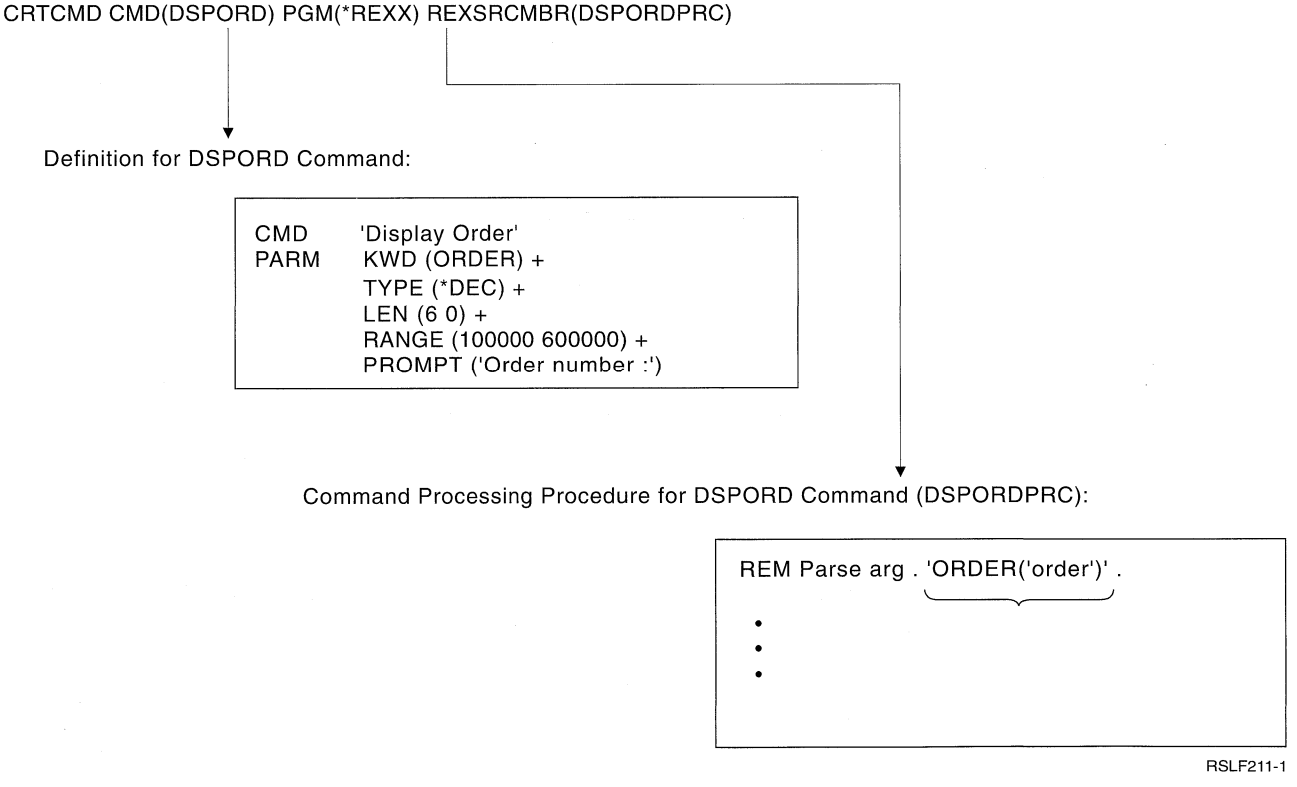


Figure 9-4. Command Relationships for REXX

Writing a Validity Checking Program

If you write a validity checking program for your command, specify the name of the validity checking program on the VLDCKR parameter on the Create Command (CRTCMD) command. The program does not have to exist when the CRTCMD command is run. If *LIBL is used as the library qualifier, the library list is used to find the validity checking program when the created command is run.

The validity checking program is called only if the command syntax is correct. All parameters are passed to the program the same as they are passed to a command processing program. This section describes how to send messages from a validity checking program that is a CL program to the system.

If the validity checking program detects an error, it should send a diagnostic message to the previous call and then send escape message CPF0002. For example, if you need a message saying that an account number is no longer valid, you add a message description similar to the following to a message file:

```
ADDMSGD      MSG('Account number &2 no longer valid') +
             MSGID(USR0012) +
             MSGF(QGPL/ACTMSG) +
             SEV(40) +
             FMT((*CHAR 4) (*CHAR 6))
```

Note that the substitution variable &1 is not in the message but is defined in the FMT parameter as 4 characters. &1 is reserved for use by the system and must always be 4 characters. If the substitution variable &1 is the only substitution variable defined in the message, you must ensure that the fourth byte of the message data does not contain a blank when you send the message.

This message can be sent to the system by specifying the following in the validity checking:

```
SNDPGMMSG    MSGID(USR0012) MSGF(QGPL/ACTMSG) +
             MSGDTA('0000' || &ACCOUNT) MSGTYPE(*DIAG)
```

After the validity checking has sent all the necessary diagnostic messages, it should then send message CPF0002. The Send Program Message (SNDPGMMSG) command to send message CPF0002 looks like this:

```
SNDPGMMSG    MSGID(CPF0002) MSGF(QCPFMSG) +
             MSGTYPE(*ESCAPE)
```

When the system receives message CPF0002, it sends message CPF0001 to the calling program to indicate that errors have been found.

Message CPD0006 has been defined for use by the user-defined validity checking programs. An immediate message can be sent in the message data. Note in the following example that the message must be preceded by four character zeros.

The following shows an example of a validity checking:

```
PGM PARM(&PARM01)
DCL VAR(&PARM01) TYPE(*CHAR) LEN(10)
IF COND(&PARM01 *EQ 'ERROR') THEN(DO)
SNDPGMMSG MSGID(CPD0006) MSGF(QCPFMSG) +
          MSGDTA('0000 DIAGNOSTIC MESSAGE FROM USER-DEFINED +
          VALIDITY CHECKER INDICATING THAT PARM01 IS IN ERROR.') +
          MSGTYPE(*DIAG)
SNDPGMMSG MSGID(CPF0002) MSGF(QCPFMSG) MSGTYPE(*ESCAPE)
ENDDO
ELSE
 .
 .
 .
ENDPGM
```

Examples of Defining and Creating Commands

This section contains examples of defining and creating commands.

Calling Application Programs

You can create commands to call application programs. If you create a command to call an application program, OS/400 performs validity checking on the parameters passed to the program. However, if you use the CALL command to call an application program, the application program must perform the validity checking.

For example, a label writing program (LBLWRT) writes any number of labels for a specific customer on either 1- or 2-part forms. When the LBLWRT program is run, it requires three parameters: the customer number, the number of labels, and the type of form to be used (ONE or TWO).

If the program were called directly from the display, the second parameter would be in the wrong format for the program. A numeric constant on the CALL command is always 15 digits with 5 decimal positions, and the LBLWRT program expects a 3-digit number with no decimal positions. A command can be created that provides the data in the format required by the program.

The command definition statements for a command to call the LBLWRT program are:

```
CMD PROMPT('Label Writing Program')
PARM  KWD(CUSNBR) TYPE(*CHAR) LEN(5) MIN(1) +
      PROMPT('Customer Number')
PARM  KWD(COUNT) TYPE(*DEC) LEN(3) DFT(20) RANGE(10 150) +
      PROMPT('Number of Labels')
PARM  KWD(FRMTYP) TYPE(*CHAR) LEN(3) DFT('TWO') RSTD(*YES) +
      SPCVAL(('ONE') ('TWO') ('1' 'ONE') ('2' 'TWO')) +
      PROMPT('Form Type')
```

For the second parameter, COUNT, a default value of 20 is specified and the RANGE parameter allows only values from 10 to 150 to be entered for the number of labels.

For the third parameter, FRMTYP, the SPCVAL parameter allows the display station user to enter `'ONE'`, `'TWO'`, `'1'`, or `'2'` for this parameter. The program

expects the value 'ONE' or 'TWO'; however, if the display station user enters '1' or '2', the command makes the necessary substitution for the FRMTYP parameter.

The command processing program for this command is the application program LBLWRT. If the application program were an RPG/400 program, the following specifications would be made in the program to receive the parameters:

```
*ENTRY    PLIST
          PARM    CUST   5
          PARM    COUNT  30
          PARM    FORM   3
```

The CRTCMD command is:

```
CRTCMD CMD(LBLWRT) PGM(LBLWRT) SRCMBR(LBLWRT)
```

Substituting a Default Value

You can create a command that provides defaults for an IBM-supplied command and reduces the entries that the display station user must make. For example, you could create a Save Library on Tape (SAVLIBTAP) command that initializes a tape and saves a library on the tape device TAPE1. This command provides defaults for the standard Save Library (SAVLIB) command parameters and requires the display station user to specify only the library name.

The command definition statements for the SAVLIBTAP command are:

```
CMD PROMPT('Save Library to Tape')
PARM KWD(LIB) TYPE(*NAME) LEN(10) MIN(1) +
  PROMPT('Library Name')
```

The command processing program is:

```
PGM PARM(&LIB)
DCL &LIB TYPE(*CHAR) LEN(10)
INZTAP DEV(TAPE1) CHECK(*NO)
SAVLIB LIB(&LIB) DEV(TAPE1)
ENDPGM
```

The CRTCMD command is:

```
CRTCMD CMD(SAVLIBTAP) PGM(SAVLIBTAP) SRCMBR(SAVLIBTAP)
```

Displaying an Output Queue

You can create a command to display an output queue that defaults to display the output queue PGMR. The following command, DSPOQ, also allows the display station user to display any queue on the library list and provides a print option.

The command definition statements for the DSPOQ command are:

```
CMD PROMPT('WRKOUTQ.-Default to PGMR')
PARM  KWD(OUTQ) TYPE(*NAME) LEN(10) DFT(PGMR) +
      PROMPT('Output queue:')
PARM  KWD(OUTPUT) TYPE(*CHAR) LEN(6) DFT(*) RSTD(*YES)
      VALUES(* *PRINT) PROMPT ('Output')
```

The RSTD parameter on the second PARM statement specifies that the entry can only be one of the list of values.

The command processing program for the DSPOQ command is:

```
PGM PARM(&OUTQ &OUTPUT)
DCL &OUTQ TYPE(*CHAR) LEN(10)
DCL &OUTPUT TYPE(*CHAR) LEN(6)
WRKOUTQ OUTQ(*LIBL/&OUTQ) OUTPUT(&OUTPUT)
ENDPGM
```

The CRTCMD command is:

```
CRTCMD CMD(DSPOQ) PGM(DSPOQ) SRCMBR(DSPOQ)
```

The following command, DSPOQ1, is a variation of the preceding command. This command allows the work station user to enter a qualified name for the output queue name, and the command defaults to *LIBL for the library name.

The command definition statements for the DSPOQ1 command are:

```
         CMD PROMPT('WRKOUTQ.-Default to PGMR')
         PARM    KWD(OUTQ) TYPE(QUAL1) +
                 PROMPT('Output queue:')
         PARM    KWD(OUTPUT) TYPE(*CHAR) LEN(6) RSTD(*YES) +
                 VALUES(* *PRINT) DFT(*) +
                 PROMPT('Output')
QUAL1:   QUAL TYPE(*NAME) LEN(10) DFT(PGMR)
         QUAL TYPE(*NAME) LEN(10) DFT(*LIBL) +
         SPCVAL(*LIBL)
```

The QUAL statements are used to define the qualified name that the user can enter for the OUTQ parameter. If the user does not enter a name, *LIBL/PGMR is used. The SPCVAL parameter is used because any library name must follow the rules for a valid name (for example, begin with A through Z), and the value *LIBL breaks these rules. The SPCVAL parameter specifies that if *LIBL is entered, OS/400 is to ignore the name validation rules.

The command processing program for the DSPOQ1 command is:

```
PGM PARM(&OUTQ &OUTPUT)
DCL &OUTQ TYPE(*CHAR) LEN(20)
DCL &OBJNAM TYPE(*CHAR) LEN(10)
DCL &LIB TYPE(*CHAR) LEN(10)
DCL &OUTPUT TYPE(*CHAR) LEN(6)
CHGVAR &OBJNAM %SUBSTRING(&OUTQ 1 10)
CHGVAR &LIB %SUBSTRING(&OUTQ 11 10)
WRKOUTQ OUTQ(&LIB/&OBJNAM) OUTPUT(&OUTPUT)
ENDPGM
```

Because a qualified name is passed from a command as a 20-character variable, the substring built-in function (%SUBSTRING or %SST) must be used in this program to put the qualified name in the proper CL syntax.

Displaying Messages from IBM Commands More Than Once

The CLROUTQ command issues the completion message CPF3417, which describes the number of entries deleted, the number not deleted, and the name of the output queue. If the CLROUTQ command is run within a CPP, the message is still issued but it becomes a detailed message because it is not issued directly by the CPP. For example, if a user-defined CLROUTQ command was issued from the

Programmer Menu, the message would not be displayed. You can, however, receive an IBM message and reissue it from your CPP.

For example, you create a command named CQ2 to clear the output queue QPRINT2.

The command definition statements for the CQ2 command are:

```
CMD PROMPT ('Clear QPRINT2 output queue')
```

The CRTCMD command is:

```
CRTCMD CMD(CQ2) PGM(CQ2)
```

The CPP, which receives the completion message and displays it, is as follows:

```
PGM /* Clear QPRINT2 output queue CPP */
DCL &MSGID TYPE(*CHAR) LEN(7)
DCL &MSGDTA TYPE(*CHAR) LEN(100)
CLROUTQ QPRINT2
RCVMSG MSGID(&MSGID) MSGDTA(&MSGDTA) MSGTYPE(*COMP)
SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGDTA(&MSGDTA) MSGTYPE(*COMP)
ENDPGM
```

The MSGDTA length for message CPF3417 is 28 bytes. However, by defining the variable &MSGDTA as 100 bytes, the same approach can be used on most messages because any unused positions are ignored.

Creating Abbreviated Commands

Example 1

You can create your own commands to simplify or abbreviate IBM-supplied commands. For example, to reduce the entries necessary for the Work with System Status (WRKSYSSTS) command, you could create a command called DX.

The command definition source statement is:

```
CMD /* Shortened WRKSYSSTS command */
```

The command processing program is:

```
PGM
WRKSYSSTS OUTPUT(*)
ENDPGM
```

The CRTCMD command is:

```
CRTCMD CMD(DX) PGM(DX) SRCMBR(DX)
```

Example 2

You could create an abbreviated command called DW1 to start the printer writer W1.

The command definition statement is:

```
CMD /* Start printer writer command */
```

The command processing program is:

```
PGM
STRPRTWTR DEV(QSYSPRT) OUTQ(QPRINT) WTR(W1)
ENDPGM
```

The CRTCMD command is:

```
CRTCMD CMD(DW1) PGM(DW1) SRCMBR(DW1)
```

Adding or Subtracting a Value to a Date

You can create a command that adds or subtracts a user-specified number of days from a date and returns the new date as a variable. See the member ADDDAT in file QATTINFO in library QUSRTOOL for further information.

Deleting Files and Source Members

You can create a command to delete files and their corresponding source members in QDDSSRC.

The command definition statements for the command named DFS are:

```
CMD PROMPT('Delete File and Source')
PARM KWD(FILE) TYPE(*NAME) LEN(10) PROMPT('File Name')
```

The command processing program is written assuming that the name of the file and the source file member are the same. The program also assumes that both the file and the source file are on the library list. If the program cannot delete the file, an information message is sent and the command attempts to remove the source member. If the source member does not exist, an escape message is sent.

The command processing program is:

```
PGM PARM(&FILE)
DCL &FILE TYPE(*CHAR) LEN(10)
DCL &MSGID TYPE(*CHAR) LEN(7)
DCL &MSGDTA TYPE(*CHAR) LEN(80)
DCL &SRCFILE TYPE(*CHAR) LEN(10)
MONMSG MSGID(CPF0000) EXEC(GOTO ERROR) /* CATCH ALL */
DLTF &FILE
MONMSG MSGID(CPF2105) EXEC(DO) /* NOT FOUND */
RCVMSG MSGTYPE(*EXCP) MSGID(&MSGID) MSGDTA(&MSGDTA)
SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*INFO) +
      MSGDTA(&MSGDTA)
GOTO TRYDDS
ENDDO
RCVMSG MSGTYPE(*COMP) MSGID(&MSGID) MSGDTA(&MSGDTA)
    /* DELETE FILE COMPLETED */
SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*COMP) +
          MSGDTA(&MSGDTA) /* TRY IN QDDSSRC FILE */
TRYDDS:   CHKOBJ QDDSSRC OBJTYPE(*FILE) MBR(&FILE)
          RMVM QDDSSRC MBR(&FILE)
          CHGVAR &SRCFILE 'QDDSSRC'
          GOTO END
END:      RCVMSG MSGTYPE(*COMP) MSGID(&MSGID) MSGDTA(&MSGDTA)
              /* REMOVE MEMBER COMPLETED */
          SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*COMP) +
          MSGDTA(&MSGDTA)
          RETURN
ERROR:    RCVMSG MSGTYPE(*EXCP) MSGID(&MSGID) MSGDTA(&MSGDTA)
              /* ESCAPE MESSAGE */
          SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*ESCAPE) +
               MSGDTA(&MSGDTA)
ENDPGM
```

Deleting Program Objects

You can create a command to delete HLL programs and their corresponding source members.

The command definition statements for the command named DPS are:

```
CMD PROMPT ('Delete Program and Source')
PARM KWD(PGM) TYPE(*NAME) LEN(10) PROMPT('Program Name')
```

The command processing program is written assuming that the name of the program and the source file member are the same and that the IBM-supplied source files (QCLSRC, QRPGSRC, and QCBLSRC) have been used. The program also assumes that both the program and the source file are on the library list. If the program cannot be deleted, an information message is sent, and the command attempts to remove the source member. If the source member does not exist, an escape message is sent. The command processing program is:

```
PGM PARM(&PGM)
DCL &PGM TYPE(*CHAR) LEN(10)
DCL &MSGID TYPE(*CHAR) LEN(7)
DCL &MSGDTA TYPE(*CHAR) LEN(80)
DCL &SRCFILE TYPE(*CHAR) LEN(10)
MONMSG MSGID(CPF0000) EXEC(GOTO ERROR) /* CATCH ALL */
DLTPGM &PGM
MONMSG MSGID(CPF2105) EXEC(DO) /* NOT FOUND*/
RCVMSG MSGTYPE(*EXCP) MSGID(&MSGID) MSGDTA(&MSGDTA)
SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*INFO) +
      MSGDTA(&MSGDTA)
GOTO TRYCL  /* TRY TO DELETE SOURCE MEMBER */
ENDDO
RCVMSG MSGTYPE(*COMP) MSGID(&MSGID) MSGDTA(&MSGDTA)
    /* DELETE PROGRAM COMPLETED */
SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*COMP) +
     MSGDTA(&MSGDTA) /* TRY IN QCLSRC */
TRYCL:   CHKOBJ QCLSRC OBJTYPE(*FILE) MBR(&PGM)
         MONMSG MSGID(CPF9815) EXEC(GOTO TRYRPG) /* NO CL MEMBER */
         RMVM QCLSRC MBR(&PGM)
         CHGVAR &SRCFILE 'QCLSRC'
         GOTO END
TRYRPG:   /* TRY IN QRPGSRC FILE */
         CHKOBJ QRPGSRC OBJTYPE(*FILE) MBR(&PGM)
         MONMSG MSGID(CPF9815) EXEC(GOTO TRYCBL) /* NO RPG MEMBER */
         RMVM QRPGSRC MBR(&PGM)
         CHGVAR &SRCFILE 'QRPGSRC'
         GOTO END
TRYCBL:   /* TRY IN QCBLSRC FILE */
         CHKOBJ QCBLSRC OBJTYPE(*FILE) MBR(&PGM)
         /* ON LAST SOURCE FILE LET CPF0000 OCCUR FOR A NOT FOUND +
         CONDITION */
         RMVM QCBLSRC MBR(&PGM)
         CHGVAR &SRCFILE 'QCBLSRC'
         GOTO END
TRYNXT:   /* INSERT ANY ADDITIONAL SOURCE FILES */
          /* ADD MONMSG AFTER CHKOBJ IN TRYCBL AS WAS +
            DONE IN TRYCL AND TRYRPG */
END:      RCVMSG MSGTYPE(*COMP) MSGID(&MSGID) MSGDTA(&MSGDTA)
               /*REMOVE MEMBER COMPLETED */
          SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*COMP) +
             MSGDTA(&MSGDTA)
          RETURN
ERROR:    RCVMSG MSGTYPE(*EXCP) MSGID(&MSGID) MSGDTA(&MSGDTA)
              /* ESCAPE MESSAGE */
          SNDPGMMSG MSGID(&MSGID) MSGF(QCPFMSG) MSGTYPE(*ESCAPE) +
               MSGDTA(&MSGDTA)
          ENDPGM
```

Chapter 10. Testing Functions

Testing functions are designed to help you write and maintain your applications. It lets you run your programs in a special testing environment while closely observing and controlling the processing of these programs in the testing environment. You can interact with your programs using the testing functions described in this chapter. These functions are available through a set of commands that can be used interactively or in a batch job. The functions allow you to:

- Trace a program's processing sequence and show the statements processed and the values of program variables at each point in the sequence.
- Stop at any statement in a program (called a breakpoint) and receive control to perform a function such as displaying or changing a variable value or calling another user-defined program.

No special commands specifically for testing are contained in the program being tested. The same program being tested can be run normally without changes. All test commands are specified within the job the program is in, not as a permanent part of the program being tested. With the testing commands, you interact with the programs symbolically in the same terms as the high-level language (HLL) program was written in. You refer to variables by their names and statements by their numbers. (These are the numbers used in the program's source list.) In addition, the test functions are only applicable to the job they are set up in. The same program can be used at the same time in another job without being affected by the testing functions set up.

Debug Mode

To begin testing, your program must be put in debug mode. Debug mode is a special environment in which the testing functions can be used in addition to the normal system functions. Testing functions cannot be used outside debug mode. To start debug mode, you must use the Start Debug (STRDBG) command. In addition to placing your program in debug mode, the STRDBG command lets you specify certain testing information such as the programs that are being debugged. Your program remains in debug mode until an End Debug (ENDDBG) or Remove Program (RMVPGM) command is encountered or your current routing step ends.

The following STRDBG command places the job in debug mode and adds program CUS310 as the program to be debugged.

```
STRDBG  PGM(CUS310)
```

Adding Programs to Debug Mode

Any program can be run in debug mode, but before you can debug it, you must put it in debug mode. You can place a program in debug mode by specifying it in the PGM parameter on the STRDBG command or by adding it to the debugging session with an Add Program (ADDPGM) command. You can specify as many as 10 programs to be debugged simultaneously in a job. You must have *CHANGE authority to add a program to debug mode.

If you specified 10 programs for debug mode (using either the STRDBG or ADDPGM command or both commands) and you want to add more programs to the debug job, you must remove some of the previously specified programs. Use

the Remove Program (RMVPGM) command. When debug mode ends, all programs are automatically removed from debug mode.

When you start debug mode, you can specify that a program be a default program. By specifying a default program, you can use any debug command that has the PGM parameter without having to specify a program name each time a command is used. This is helpful if you are only debugging one program. For example, in the Add Breakpoint (ADDBKP) command, you would not specify a program name on the PGM parameter because the default program is assumed to be the program the breakpoint is being added to. The default program name must be specified in the list of programs to be debugged (PGM parameter). If more than one program is listed to be debugged, you can specify the default program on the DFTPGM parameter. If you do not, the first program in the list on the PGM parameter on the STRDBG command is assumed to be the default program.

The default program can be changed any time during testing by using object'.programs either the Change Debug (CHGDBG) or the ADDPGM command.

Note: If a program that is in debug mode is deleted, re-created, or saved with storage freed, references made to that program (except a RMVPGM command) may result in a function check. You must either remove the program using a RMVPGM command or end debug mode using an ENDDBG command. If you want to change the program and then debug it, you must remove it from debug mode and after it is re-created, add it to debug mode (ADDPGM command).

Preventing Updates to Database Files in Production Libraries

You can use files in production libraries while you are in debug mode. To prevent database files in production libraries from being unintentionally changed, you can specify UPDPROD(*NO) or default to *NO on the STRDBG command. Then, only files in test libraries can be opened for updating or adding new records. If you want to open database files in production libraries for updating or adding new records or if you want to delete members from production physical files, you can specify UPDPROD(*YES).

You can use this function with the library list. In the library list for your debug job, you can place a test library before a production library. You should have copies of the production files that might be updated by the program being debugged in the test library. Then, when the program runs, it uses the files in the test library. Therefore, production files cannot be unintentionally updated.

The Call Stack

You can use the Display Debug (DSPDBG) command to display the call stack, which indicates:

- Which programs are currently being debugged
- The instruction number of the calling instruction or the instruction number of each breakpoint at which program processing is stopped
- The program recursion level
- The names of the programs that are in debug mode but have not been called

A call of a program is the allocation of *automatic* storage for the program and the transfer of machine processing to the program. A series of calls is placed in a call stack. When a program finishes processing or transfers control, it is removed from the call stack. For more information about the call stack, see Chapter 3.

A program may be called a number of times while the first call is still in the call stack. Each call of a program is a recursion level of the program.

When a call is ended (the program returns or transfers control), automatic storage is returned to the system.

Notes:

1. CL programs can be recursive; that is, a CL program can call itself either directly or indirectly through a program it has called.
2. Some high-level languages do not allow recursive program calls. Other languages allow not only programs to be recursive, but also procedures within a program to be recursive. (In this guide, the term *recursion level* refers to the number of times the program has been called in the call stack. A procedure's recursion level is referred to explicitly as the procedure recursion level.)
3. All CL commands and displays make use of only the program qualified name recursion level.

Program Activations

An activation of a program is the allocation of static storage for the program. An activation is always ended when one of the following happens:

- The current routing step ends.
- The request that activated the program is canceled.
- The Reclaim Resources (RCLRSC) command is run such that the last (or only) call of a program is ended.

In addition, an activation can be destroyed by actions taken during a program call. These actions are dependent on the language (HLL or CL) in which the program is written.

When a program is deactivated, static storage is returned to the system. The language (HLL or CL) in which the program is written determines when the program is normally deactivated. A CL program is always deactivated when the program ends.

An RPG/400 program is deactivated when the last record indicator (LR) is set on before the program ends. If there is a return operation and LR is off, the program is not deactivated.

Handling Unmonitored Messages

Normally, if a program receives an unmonitored escape message, the system sends the function check message (CPF9999) to the program's program message queue and the program stops processing. However, HLL program compilers may insert monitors for the function check message or for messages that may occur in the program. (An inquiry message will be sent to the program messages display.) This allows you to end the program the way you want. In an interactive debug job, when a function check occurs, the system provides default handling and gives you

control instead of stopping the program. The system displays the following on the unmonitored message display:

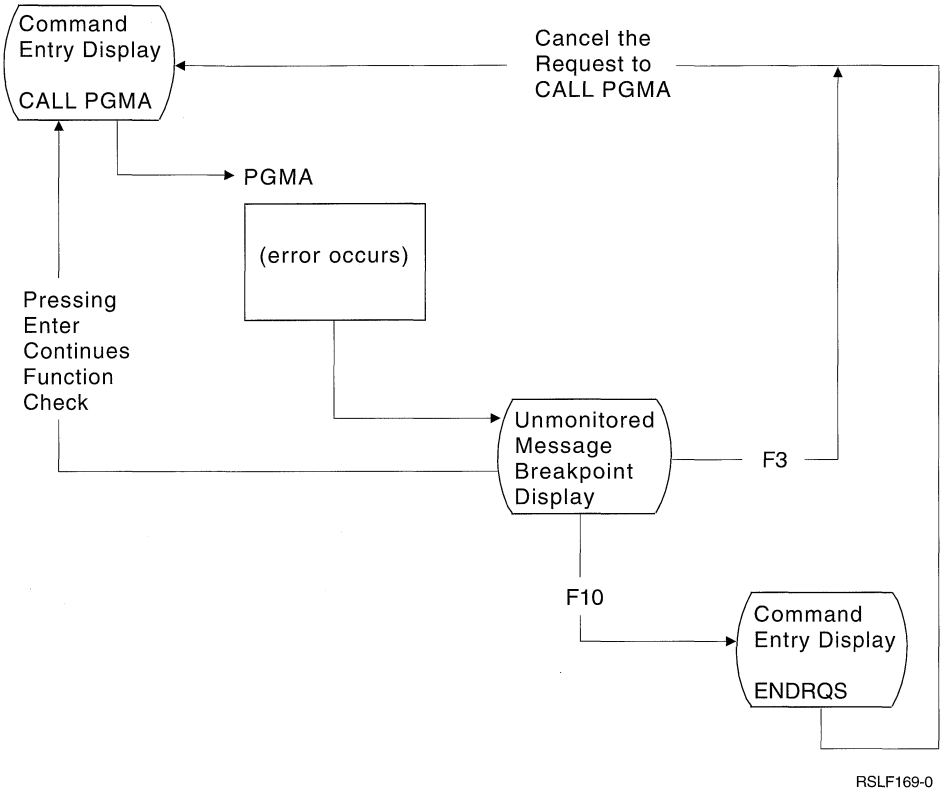
- The message
- The MI instruction number and HLL statement identifier, if available, to which the message was sent
- The name and recursion level of the program to which the message was sent

The following is an example of an unmonitored message breakpoint display:

```
                Display Unmonitored Message Breakpoint

 Statement/Instruction . . . . . :   440 /0077
 Program . . . . . . . . . . . . :   TETEST
 Recursion level . . . . . . . . :   1

Errors occurred on command.









Press Enter to continue.

F3=Exit program   F10=Command Entry
```

You can try to isolate the source of the error by using the testing functions. However, the original request in error is still stopped at the point where the error occurred. To remove the request in error from the call stack, you must use the End Request (ENDRQS) command or press F3 when the unmonitored message breakpoint display is shown. You can let the usual function check processing continue by pressing the Enter key when the unmonitored message breakpoint display is shown. If you press F10 to call the command entry display, you must press F3 to return to the unmonitored message breakpoint display.

The following shows how a ENDRQS command works:



Program calls are destroyed when a ENDRQS command is entered. (In the previous diagram, the program call of PGMA is destroyed.)

Breakpoints

A breakpoint is a place in a program at which the system stops program processing and gives control to you at a display station (interactive mode) or to a program specified on the BKPPGM parameter in the Add Breakpoint (ADDBKP) command (batch mode).

Adding Breakpoints to Programs

Use the ADDBKP command to add breakpoints to the program you want debugged. You can specify up to 10 statement identifiers on the one ADDBKP command. The program variables specified on an ADDBKP command apply only to the breakpoints specified on that command. Up to 10 variables can be specified in one ADDBKP command.

You can also specify the name of the program to which the breakpoint is to be added. If you do not specify the name of the program that you want the breakpoint added to, the breakpoint is added to the default program specified on the STRDBG, CHGDBG, or ADDPGM command.

For more information about breakpoint commands, see the *CL Reference*.

To add a breakpoint to a program, specify a statement identifier, which can be:

- A statement label
- A statement number
- A machine interface (MI) instruction number

When you add a breakpoint to a program, you can also specify program variables whose values or partial values you want to display when the breakpoint is reached. These variables can be shown in character or hexadecimal format.

Program processing stops at a breakpoint *before* the instruction is processed. For an interactive job, the system displays what breakpoint the program has stopped at and, if requested, the values of the program variables.

In high-level language programs, different statements and labels may be mapped to the same internal instruction. This happens when there are several inoperable statements (such as DO and ENDDO) following one another in a program. You can use the IRP list to determine which statements or labels are mapped to the same instruction.

The result of different statements being mapped to the same instruction is that a breakpoint being added may redefine a previous breakpoint that was added for a different statement. When this occurs, a new breakpoint replaces the previously added breakpoint, that is, the previous breakpoint is removed and the new breakpoint is added. After this information is displayed, you can do any of the following:

- End the most recent request by pressing F3.
- Continue program processing by pressing Enter.
- Go to the command entry display at the next request level by pressing F10. From this display, you can:
  - Enter any CL command that can be used in an interactive debug environment. You may display or change the values of variables in your program, add or remove programs from debug mode, or perform other debug commands.
  - Continue processing the program by entering the Resume Breakpoint (RSMBKP) command.
  - Return to the breakpoint display by pressing F3.
  - Return to the command entry display at the previous request level by entering the End Request (ENDRQS) command.

For a batch job, a breakpoint program can be called when a breakpoint is reached. You must create this breakpoint program to handle the breakpoint information. The breakpoint information is passed to the breakpoint program. The breakpoint program is another program such as a CL program that can contain the same commands (requests for function) that you would have entered interactively for an interactive job. For example, the program can display and change variables or add and

remove breakpoints. Any function valid in a batch job can be requested. When the breakpoint program completes processing, the program being debugged continues.

A message is recorded in the job log for every breakpoint for the debug job.

The following ADDBKP commands add breakpoints to the program CUS310. CUS310 is the default program, so it does not have to be specified. The value of the variable &ARBAL is shown when the second breakpoint is reached.

```
ADDBKP  STMT(900)
ADDBKP  STMT(2200)  PGMVAR('&ARBAL')
```

Note: A CL variable must be entered with surrounding apostrophes.

The source for CUS310 looks like this:

```
5728PW1 R01M00  880101                SEU SOURCE LISTING

SOURCE FILE . . . . . .  QGPL/QCLSRC
MEMBER  . . . . . . . .  CUS310

SEQNBR*...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 ...
  100 PGM   PARM(&NBRITEMS &ITEMPRC &PARBAL &PTOTBAL)
  200   DCL VAR(&PARBAL)   TYPE(*DEC) LEN(15 5) /* INPUT AREA INV BALANCE */
  300   DCL VAR(&PTOTBAL)  TYPE(*DEC) LEN(15 5) /* INPUT TOTAL INV BALANCE*/
  400   DCL VAR(&NBRITEMS) TYPE(*DEC) LEN(15 5) /* NUMBER OF ITEMS        */
  500   DCL VAR(&ITEMPRC)  TYPE(*DEC) LEN(15 5) /* PRICE OF THE ITEM      */
  600   DCL VAR(&ARBAL)    TYPE(*DEC) LEN(5 2)  /* AREA INVENTORY BALANCE */
  700   DCL VAR(&TOTBAL)   TYPE(*DEC) LEN(5 2)  /* TOTAL INVENTORY BALANCE*/
  800   DCL VAR(&TOTITEM)  TYPE(*DEC) LEN(5 2)  /* TOTAL PRICE OF ITEMS   */
  900   CHGVAR     VAR(&ARBAL) VALUE(&PARBAL)
 1000   CHGVAR     VAR(&TOTBAL) VALUE(&PTOTBAL)
 1100   IF COND(&NBRITEMS *EQ 0) THEN(DO)
 1200      SNDPGMMSG  MSG('The number of items is zero.  This item +
 1300                   should be ordered.') TOMSGQ(INVLIB/INVQUEUE)
 1400      GOTO       CMDLBL(EXIT)
 1500   ENDDO
 1600   CHGVAR     VAR(&TOTITEM) VALUE(&NBRITEMS * &ITEMPRC)
 1700   IF COND(&NBRITEMS *GT 50) THEN(DO)
 1800      SNDPGMMSG  MSG('Too much inventory for this item.') +
 1900                 TOMSGQ(INVLIB/INVQUEUE)
 2000   ENDDO
 2100   CHGVAR     VAR(&ARBAL)   VALUE(&ARBAL + &TOTITEM)
 2200   IF COND(&ARBAL *GT 1000) THEN(DO)
 2300      SNDPGMMSG  MSG('The area has too much money in +
 2400                   inventory.') TOMSGQ(INVLIB/INVQUEUE)
 2500   ENDDO
 2600   CHGVAR     VAR(&TOTBAL)  VALUE(&TOTBAL + &TOTITEM)
 2700   EXIT:      ENDPGM
```

The following is displayed as a result of reaching the first breakpoint:

```
                          Display Breakpoint

Statement/Instruction . . . . . :   900 /0009
Program . . . . . . . . . . . . :   CUS310
Recursion level . . . . . . . . :   1









Press Enter to continue.

F3=Exit program   F10=Command entry
```

The following is displayed as a result of reaching the second breakpoint:

```
                          Display Breakpoint

Statement/Instruction . . . . . :   2200 /0022
Program . . . . . . . . . . . . :   CUS310
Recursion level . . . . . . . . :   1
Start position  . . . . . . . . :   1
Format  . . . . . . . . . . . . :   *CHAR
Length  . . . . . . . . . . . . :   *DCL

Variable  . . . . . . . . . . . :   &ARBAL
  Type  . . . . . . . . . . . . :     PACKED
  Length  . . . . . . . . . . . :     5 2
 '610.00'









Press Enter to continue.

F3=Exit program   F10=Command entry
```

The variable &ARBAL is shown. (Note that the value of &ARBAL will vary depending on the parameter values passed to the program.) You can press F10 to display the command entry display so that you could change the value of the variable &ARBAL to alter your program's processing. You use the Change Program Variable (CHGPGMVAR) command to change the value of a variable.

Conditional Breakpoints

You may add a conditional breakpoint to a program that is being debugged. Use the Add Breakpoint (ADDBKP) command to specify the statement and condition. If the condition is met, the system stops the program processing at the specified statement.

You may specify a skip value on the ADDBKP command. A **skip value** is a number that indicates how many times a statement should be processed before the system stops the program. For example, to stop a program at statement 1200 after the statement has been processed 100 times, enter the following command:

```
ADDBKP STMT(1200) SKIP(100)
```

If you specify multiple statements when the SKIP parameter is specified, each statement has a separate count. The following command causes your program to stop on statement 150 or 200, but only after the statement has processed 400 times:

```
ADDBKP STMT(150 200) SKIP(400)
```

If statement 150 has processed 400 times but statement 200 has processed only 300 times, then the program does not stop on statement 200.

If a statement has not processed as many times as was specified on the SKIP parameter, the Display Breakpoint (DSPBKP) command can be used to show how many times the statement was processed. To reset the SKIP count for a statement to zero, enter the breakpoint again for that statement.

You can specify a more general breakpoint condition on the ADDBKP command. This expression uses a program variable, an operator, and another variable or constant as the operands. For example, to stop a program at statement 1500 when variable &X is greater than 1000, enter the following command:

```
ADDBKP STMT(1500) PGMVAR('&X') BKPCOND(*PGMVAR1 *GT 1000)
```

The BKPCOND parameter requires three values:

- In the example, the first value specifies the first variable specified on the PGMVAR parameter. (To specify the third variable, you would use *PGMVAR3.)
- The second value must be an operator. For a list of all valid operators, see the *CL Reference*.
- The third value may be a constant or another variable. A constant may be a number, character string, or bit string, and must be the same type as the program variable specified in the first value.

The SKIP and BKPCOND parameters can be used together to specify a complex breakpoint condition. For example, to stop a program on statement 1000 after the statement has been processed 50 times **and** only when the character string &STR is TRUE, enter the following command:

```
ADDBKP STMT(1000) PGMVAR('&STR') SKIP(50)
       BKPCOND(*PGMVAR1 *EQ 'TRUE ')
```

Removing Breakpoints from Programs

To remove breakpoints from a program, use the Remove Breakpoint (RMVBKP) command. To remove a breakpoint you must specify the statement number of the statement for which the breakpoint has been defined.

Traces

A trace is the process of recording the sequence in which the statements in a program are processed. A trace differs from a breakpoint in that you are not given control during the trace. The system records the traced statements that were processed. However, the trace information is not automatically displayed when the program completes processing. You must request the display of trace information using the Display Trace Data (DSPTRCDTA) command. The display shows the sequence in which the statements were processed and, if requested, the values of the variables specified on the Add Trace (ADDTRC) command.

Adding Traces to Programs

Adding a trace consists of specifying what statements are to be traced and, if you want, the names of program variables. Before a traced statement processes, the value of the variable is recorded. Also, you can specify that the values of the variables are to be recorded only if they have changed from the last time a traced statement was processed. These variables can be displayed in character format or hexadecimal format.

To specify which statements are to be traced, you can specify:

- The statement identifier at which the trace is to start and the statement identifier at which the trace is to stop
- That all statements in the program are to be traced
- A single statement identifier of a statement to be traced

On the STRDBG or CHGDBG command, you can specify how many statement traces can be recorded for a job and what action the system should take when the maximum is reached. When the maximum is reached, the system performs one of the following actions (depending on what you specify):

- For an interactive job, either of the following can be done:
  - Stop the trace (*STOPTRC). Control is given to you (a breakpoint occurs), and you can remove some of the trace definitions (RMVTRC command), clear the trace data (CLRTRCDTA command), or change the maximum (MAXTRC parameter on the CHGDBG command).
  - Continue the trace (*WRAP). Previously recorded trace data is overlaid with trace data recorded after this point.
- For a batch job, either of the following can be done:
  - Stop the trace (*STOPTRC). The trace definitions are removed and the program continues processing.
  - Continue the trace (*WRAP). Previously recorded trace data is overlaid with trace data recorded after this point.

You can change the maximum and the default action any time during the debug job using the Change Debug (CHGDBG) command. However, the change does not affect traces that have already been recorded.

You can only specify a total of five statement ranges for a single program at any one time, which is a total taken from all the Add Trace (ADDTRC) commands for the program. In addition, only 10 variables can be specified for each statement range.

In high-level language programs, different statements and labels may be mapped to the same internal instruction. This happens when there are several inoperable statements (such as DO, END) following one another in a program. You can use the IRP list to determine which statements or labels are mapped to the same instruction.

When you specify CL variables, you must enclose the & and the variable name in single apostrophes. For example:

```
ADDTRC PGMVAR('&IN01')
```

When you specify a statement range, the source statement number for the stop statement is ordinarily larger than the number for the start statement. Tracing, however, is performed with machine interface (MI) instructions, and some compilers (notably RPG/400) generate programs in which the order of MI instructions is not the same as the order of the source statements. Therefore, in some cases, the MI number of the stop statement may not be larger than the MI number of the start statement, and you will receive message CPF1982.

When you receive this message, you should do one of the following:

- Trace all statements in the program.
- Restrict a statement range to one specification.
- Use MI instruction numbers gotten from an intermediate representation of a program (IRP) list of the program. (See "Debugging at the Machine Interface Level" on page 10-19.)

The following Add Trace (ADDTRC) command adds a trace to the program CUS310. CUS310 is the default program, so it does not have to be specified. The value of the variable &TOTBAL is recorded only if its value changes between the times each traced statement is processed.

```
ADDTRC STMT((900 2700))  PGMVAR('&TOTBAL')  OUTVAR(*CHG)
```

The following displays result from this trace and are displayed using the Display Trace Data (DSPTRCDTA) command. Note that column headers are not supplied for all displays.

```
                          Display Trace Data

                 Statement/
Program          Instruction          Recursion level      Sequence number
CUS310           900                        1                      1

 Start position  . . . . . . . . . . . . . :   1
 Length  . . . . . . . . . . . . . . . . . :   *DCL
 Format  . . . . . . . . . . . . . . . . . :   *CHAR

 Variable  . . . . . . . . . . . . . . . . :   &TOTBAL
   Type  . . . . . . . . . . . . . . . . . :     PACKED
   Length  . . . . . . . . . . . . . . . . :     5 2
  '    .00'

                 Statement/
Program          Instruction          Recursion level      Sequence number
CUS310           1000                       1                      2
CUS310           1100                       1                      3  +

Press Enter to continue.

F3=Exit   F12=Cancel
```

```
                          Display Trace Data


 Start position  . . . . . . . . . . . . . :   1
 Length  . . . . . . . . . . . . . . . . . :   *DCL
 Format  . . . . . . . . . . . . . . . . . :   *CHAR

*Variable  . . . . . . . . . . . . . . . . :   &TOTBAL
   Type  . . . . . . . . . . . . . . . . . :     PACKED
   Length  . . . . . . . . . . . . . . . . :     5 2
  '   1.00'

                 Statement/
Program          Instruction          Recursion level      Sequence number
CUS310           1600                       1                      4
CUS310           1700                       1                      5
CUS310           2100                       1                      6
CUS310           2200                       1                      7
CUS310           2600                       1                      8  +

Press Enter to continue.

F3=Exit   F12=Cancel
```

```
                          Display Trace Data

CUS310          2700                          1                          9

 Start position . . . . . . . . . . . . :  1
 Length . . . . . . . . . . . . . . . . :  *DCL
 Format . . . . . . . . . . . . . . . . :  *CHAR

*Variable . . . . . . . . . . . . . . . :  &TOTBAL
   Type . . . . . . . . . . . . . . . . :    PACKED
   Length . . . . . . . . . . . . . . . :    5 2
  '   2.00'




Press Enter to continue.

F3=Exit   F12=Cancel
```

Instruction Stepping

You can step through the instructions of a program by using the STRDBG or CHGDBG commands and setting the MAXTRC parameter to 1 and the TRCFULL parameter to *STOPTRC. When you specify a trace range (ADDTRC command) and the program processes an instruction within that range, a breakpoint display with an error message appears. If you press Enter, another breakpoint display with the same error message appears for the next instruction processed in the trace range. When tracing is completed, the trace data contains a list of the instructions traced. You can display this data by entering the Display Trace Data (DSPTRCDTA) command.

Using Breakpoints within Traces

Breakpoints can be used within a trace range. At a breakpoint within a trace, you can display the trace data (DSPTRCDTA command) to determine if you need to take some action. The trace data is recorded before the breakpoint occurs. The trace information contains the value of any variables *before* the statement was processed.

Removing Trace Information from the System

On the DSPTRCDTA command, you can specify whether the trace information is removed from the system or left on the system after the information is displayed. If you leave the trace information on the system, any other traces are added to it. The information remains on the system (unless removed) until the debug job ends or the ENDDBG command is submitted. You can also use the Clear Trace Data (CLRTRCDTA) command to remove trace information from the system.

Removing Traces from Programs

The Remove Trace (RMVTRC) command removes all or some of the ranges specified in one or more Add Trace (ADDTRC) commands. Removing a trace range consists of specifying the statement identifiers used on the RMVTRC command, or specifying that all ranges be removed.

You can use the STMT parameter on the RMVTRC command to specify:

- All HLL statements and/or machine instructions in the specified program are not to be traced regardless of how the trace was defined by the ADDTRC command.
- The start and stop trace location of the HLL statements and/or system instructions to be removed.

The RMVPGM and ENDDBG commands also remove traces, but they also remove the program from debug mode.

Display Functions

In debug mode, you can display testing information that lets you review how you have set up your debug job. You can display what programs are in debug mode and what breakpoints and traces have been defined for those programs. In addition, you can display the status of the programs in debug mode.

You can use the following commands to display testing information:

- Display Debug (DSPDBG), which displays the current call stack and the names of the programs that are in debug mode and indicates the following:
  - Which are stopped at a breakpoint
  - Which are currently called
  - The request level of those that are called
  - Debug options selected for the debug job
- Display Breakpoint (DSPBKP), which displays the locations of breakpoints that are currently defined in a program.
- Display Trace (DSPTRC), which displays the statements or statement ranges that are currently defined in a program.

Displaying the Values of Variables

When you are at a breakpoint, you can display the values of program variables. You can have this done automatically on the breakpoint display by specifying the variable names on the ADDBKP command, or you can enter the Display Program Variable (DSPPGMVAR) command at the breakpoint by pressing F10 to show the command entry display. Only 10 variables can be specified on one DSPPGMVAR command. For character and bit variables, you can tell the system to begin displaying the value of the variable starting at a certain position and for a specified length. Variables can be displayed in either character or hexadecimal format.

Notes:

1. If you specify an array variable, you can do one of the following:
   a. Specify the subscript values of the array element you want to display. The subscript values can either be integer values or the names of numeric variables in the program.
   b. Display the entire array by not entering any subscripts.
   c. Display a single-dimension cross-section of the array by specifying values for all subscripts except one, and an asterisk for that one subscript value.

2. Variable names can be specified as simple or qualified names, but must be placed between apostrophes. A qualified name can be specified in either of two ways:
   a. Variable names alternating with the special separator words OF or IN, ordered from lowest to highest qualification level. A blank must separate the variable name and the special separator word.
   b. Variable names separated by periods, ordered from highest to lowest qualification level.

The following DSPPGMVAR command displays the variable ARBAL used in the program CUS310. CUS310 is the default program, so it does not have to be specified. The entire value is to be displayed in character format.

```
DSPPGMVAR  PGMVAR('&ARBAL')
```

The resulting display looks like this:

```
                      Display Program Variables

Program . . . . . :   CUS310
Recursion level . . . . . :   1
Start position  . . . . . :   1
Format  . . . . . :   *CHAR
Length  . . . . . :   *DCL

Variable  . . . . . :   &ARBAL
  Type  . . . . . :   PACKED
  Length  . . . . . :   5 2
 '610.00'









Press Enter to continue.

F3=Exit   F12=Cancel
```

Some HLLs allow variables to be based on a user-specified pointer variable (HLL pointer). If you do not specify an explicit pointer for a based variable, the pointer specified in the HLL declaration (if any) is used. You must specify an explicit basing pointer if one was not specified in the HLL declaration for the based variable. The PGMVAR parameter allows you to specify up to five explicit basing pointers when referring to a based variable. When multiple basing pointers are specified, the first basing pointer specified is used to locate the second basing pointer, the second one is then used to locate the third, and so forth. The last pointer in the list of basing pointers is used to locate the primary variable.

Changing the Values of Variables

To change the value of a program variable, use the Change Program Variable (CHGPGMVAR), the Change HLL Pointer (CHGHLLPTR), or the Change Pointer (CHGPTR) command. Changing the value of a program variable consists of specifying the variable name and a value that is compatible with the data type of the variable. For example, if the variable is character type, you must enter a character value.

When changing the value of variables, you should be aware of whether the variable is an automatic variable or a static variable. The difference between the two is in the storage for the variables. For automatic variables, the storage is associated with the call of the program. Every time a program is called, a new copy of the variable is placed in automatic storage. A change to an automatic variable remains in effect only for the program call the change was made in.

Note: In some languages, the definition of an call is made at the procedure level and not just at the program level. For these languages, storage for automatic variables is associated with the call of the procedure. Every time a procedure is called, a new copy of the variable is gotten. A change to an automatic variable remains in effect only while that procedure is called. Only the automatic variables in the most recent procedure call can be changed. The RCRLVL (recursion level) parameter on the commands applies only on a program basis and not on a procedure basis.

For static variables, the storage is associated with the activation. Only one copy of a static variable exists in storage no matter how many times a program is called. A change to a static variable remains in effect for the duration of the activation.

To determine if a program variable is a static or an automatic variable, request an intermediate representation of a program (IRP) list (*LIST and *XREF on the GENOPT parameter) when the program containing the variables is created.

When changing a variable that is an array, you must specify one element of the array. Consequently, you must specify the subscript values for the array element you want to change.

Using a Job to Debug Another Job

You may want to use a separate job to debug programs running in another job for one of the following reasons:

- Batch jobs can be debugged by an interactive job.
- An interactive job can be debugged from another interactive job. This allows one display to show debug information without interrupting the application program display.
- An interactive or batch job that is looping can be interrupted and put into debug mode.

Debugging Batch Jobs Submitted to a Job Queue

Using a separate job to debug another batch job submitted to the job queue allows you to put the batch job into debug mode and to set breakpoints and traces before the job starts to process. Use the following steps to debug batch jobs to be submitted to a job queue:

1. Submit the batch job using the Submit Job (SBMJOB) command or a program that automatically submits the job with HOLD(*YES).

   ```
   SBMJOB HOLD(*YES)
   ```

2. Determine the qualified job name (number/user/name) that is assigned to the job using the Work with Submitted Jobs (WRKSBMJOB) command or the Work with Job Queues (WRKJOBQ) command. The SBMJOB command also dis-

plays the name in a completion message when the command finishes processing.

The WRKJOBQ (Work With Job Queue) command displays all the jobs waiting to start in a particular job queue. You can show the job name from this display by selecting option 5 for the job.

3. Enter the Start Service Job (STRSRVJOB) command from the display you plan to use to debug the batch job as follows:

   ```
   STRSRVJOB JOB(qualified-job-name)
   ```

4. Enter the STRDBG command and provide the names of all programs to be debugged. No other debug commands can be entered while the job is waiting on the job queue.
5. Use the Release Job Queue (RLSJOBQ) command to release the job queue. A display appears when the job is ready to start, indicating that you may begin debugging the job. Press F10 to show the Command Entry display.
6. Use the Command Entry display to enter any debug commands, such as the Add Breakpoint (ADDBKP) or Add Trace (ADDTRC) commands.
7. Press F3 to leave the Command Entry display, and then press Enter to start the batch job.
8. When the job stops at a breakpoint, you see the normal breakpoint display. When the job finishes, you cannot add breakpoints and traces, or display or change variables. However, you can display any trace data using the Display Trace Data (DSPTRCDTA) command.
9. If you wish to debug another batch job, first end debugging using the End Debug (ENDDBG) command and then end servicing the job using the End Servicing Job (ENDSRVJOB) command.

Debugging Batch Jobs Not Started from Job Queues

Some jobs started on the system are not submitted to a job queue. These jobs cannot be stopped before they start running but they can usually be debugged. To debug jobs not started from a job queue, do the following:

1. Rename the program that is called when the job starts. For example, if the job runs program CUST310, you can rename this program to CUST310DBG.
2. Create a small CL program with the same name as the original program (before the program was renamed). In the small CL program, use the Delay Job (DLYJOB) command to delay for one minute and then use the CALL command to call the renamed program.
3. Allow the batch job to start to force the CL program to be delayed for one minute.
4. Use the Work with Active Jobs (WRKACTJOB) command to find the batch job that is running. When the display appears, enter option 5 next to the job to obtain the qualified job name.
5. Enter the Start Service Job (STRSRVJOB) command as follows:

   ```
   STRSRVJOB JOB(qualified-job-name)
   ```

6. Enter STRDBG and any other debug commands, such as the Add Breakpoint (ADDBKP) or Add Trace (ADDTRC) command. Proceed with debugging as usual.

Debugging a Running Job

You can debug a job that is already running if you know what statements the job will run. For example, you may want to debug a running program if the job is looping or the job has not yet run a program that is to be debugged. The following steps allow you to debug a running job:

1. Use the Work with Active Jobs (WRKACTJOB) command to find the job that is running. When the display appears, enter option 5 next to the job to obtain the qualified job name.
2. Enter the Start Service Job (STRSRVJOB) command as follows:

   ```
   STRSRVJOB JOB(qualified-job-name)
   ```

3. Enter the Start Debug (STRDBG) command. (Entering the command does not stop the job from running.)

   Note: You can use the Display Debug (DSPDBG) command to show the call stack. However, unless the program is stopped for some reason, the stack is correct only for an instant, and the program continues to run.

4. If you know a statement to be run, enter the Add Breakpoint (ADDBKP) command to stop the job at the statement.

   If you do not know what statements are being run, do the following:

   a. Enter the Add Trace (ADDTRC) command.
   b. After a short time, enter the Remove Trace (RMVTRC) command to stop tracing the program.
   c. Enter the Display Trace Data (DSPTRCDTA) command to show what statements have processed. Use the trace data to determine which data statements to process next (for example, statements inside a program loop).
   d. Enter the Add Breakpoint (ADDBKP) command to stop the job at the statement.

5. Enter the desired debug commands when the program is stopped at a breakpoint.

Debugging Another Interactive Job

You can debug a job from another display, whether the job is running or waiting at a menu or command entry display. To debug another interactive job, do the following:

1. Determine the qualified job name of the job to be debugged. To determine the name, either enter the Display Job (DSPJOB) command from the display of the job to be debugged, or use the Work with Active Jobs (WRKACTJOB) command.
2. Enter the Start Service Job (STRSRVJOB) command using the qualified job name.
3. Enter the Start Debug (STRDBG) command and any other debug commands desired. If the job is already running, you may need to enter the Display Debug (DSPDBG) command to determine what statement in the program is processing.

When the job being debugged is stopped at a breakpoint, the display station is locked.

Considerations When Debugging One Job from Another Job

Although most jobs can be debugged from another job, you must take the following into consideration:

- A job being debugged cannot be held or suspended (for example, when running another group job or a secondary job).
- When servicing another job with the Start Service Job (STRSRVJOB) command, you cannot also debug the job doing the servicing. All debug commands apply only to the job being serviced. To debug the job doing the servicing, you must either end the servicing of the other job, or have another job service and debug it.
- Debug commands operate on another job, even if that job is not stopped at a breakpoint. For example, if you are debugging a running job and you enter the Display Program Variable (DSPPGMVAR) command, the variable you specify is shown. Since the job continues to run, the value of the variable may change soon after the command is entered.
- A job being debugged must have enough priority to respond to debug commands. If you are debugging a batch job with a low priority and that job gets no processing time, then any debug command you issue waits for a response from the job. If the job does not respond, the command ends and an error message is displayed.
- You cannot service and debug a job that is debugging itself. However, you can service and debug a job that is servicing and debugging another job.

Debugging at the Machine Interface Level

To debug your programs at the machine interface (MI) level, you can specify an MI object definition vector (ODV) number for the PGMVAR parameter of a command and MI instruction numbers for the STMT parameter of a command. For a breakpoint, the system stops at the MI instruction number just as it would at an HLL statement number. You must always precede the ODV or MI instruction number with a slash (/) and enclose it in apostrophes (for example, `'/1A'`) to signal to the system that you are debugging at the MI level.

The ODV and MI instruction numbers can be obtained from the IRP listing produced by most high-level language compilers. Use the *LIST value of the GENOPT parameter to produce the IRP listing at program creation time.

Note: When you debug at the machine interface level, only the characteristics that are defined at the machine interface level are available; the HLL characteristics that are normally passed to the test environment are not available. These HLL characteristics may include: the variable type, number of fractional digits, length, and array information. For example, a numeric variable in your HLL program may be displayed without the correct decimal alignment or possibly as a character string.

Security Considerations

To debug a program, you must have *CHANGE authority to that program. The *CHANGE authority available by adopting another user's profile is not considered when determining whether a user has authority to debug a program. This prevents users from accessing program data in debug mode by adopting another user's profile.

Additionally, when you are at a user-defined breakpoint of a program that you are debugging with adopted user authority, you have only the authority of your user profile and not the adopted profile authority. You do not have authorities adopted by prior program calls for all breakpoints whether they are added by the Add Breakpoint (ADDBKP) command or are caused by an unmonitored escape message.

Bibliography

The following is a list of the additional manuals and the information to be found in them.

For information about operating the AS/400 system and its display stations, see:

- *New User's Guide*, SC41-8211

  This guide provides general information about using display stations, including function keys, display, command, and help information.
  Short title: *New User's Guide*

- *System Operator's Guide*, SC41-8082

  This guide provides general information about how to run the system, how to send and receive messages and use the display station function keys.
  Short title: *Operator's Guide*

For more information about AS/400 programming, see:

- *Advanced Backup and Recovery Guide*, SC41-8079

  This guide provides information about the different media available to save and protect system data.
  Short title: *Advanced Backup and Recovery Guide*

- *Data Management Guide*, SC41-9658

  This guide provides information about structure and concepts of data management support, overrides and file redirection, copying files, and tailoring a system using double-byte data.
  Short title: *Data Management Guide*

- *Database Guide*, SC41-9659

  This guide provides a detailed discussion of the AS/400 database structure, including information on how to create, describe, and manipulate database files.
  Short title: *Database Guide*

- *Data Description Specifications Reference*, SC41-9620

  This manual provides a detailed description of the entries and keywords needed to externally describe database files and certain device files.
  Short title: *DDS Reference*

- *Guide to Programming Application and Help Displays*, SC41-0011

  This guide provides information about using DDS to create and maintain displays, creating and working with display files, creating online help information, using UIM to define displays, and using panel groups, records, and documents.
  Short title: *Guide to Programming Displays*

- *Guide to Programming for Printing*, SC41-8194

  This guide provides specific information on printing elements and concepts of the AS/400 system, printer file and print spooling support, and printer connectivity.
  Short title: *Guide to Programming for Printing*

- *Guide to Programming for Tape and Diskette*, SC41-0012

  This guide provides information to help users develop and support programs that use tape and diskette drives for I/O. This includes information on device files and descriptions for tape and diskette devices, as well as spooling for diskette devices.
  Short title: *Guide to Programming for Tape and Diskette*

- *National Language Support Planning Guide*, GC41-9877

  This guide provides the data processing manager, system operator and manager, application programmer, end user, IBM marketing representative, and system engineer with information required to understand and use the national language support function on the AS/400 system. This manual prepares the AS/400 user for planning, installing, configuring, and using AS/400 national language support (NLS) and multilingual support of the AS/400 system. It also provides an explanation of the database management of multilingual data and application considerations for a multilingual system.
  Short title: *National Language Support Planning Guide*

- *Programming: Reference Summary*, SX41-0028

  This manual provides quick and easy access to summary information about many of the languages and utilities available on the AS/400 system.
  Short title: *Programming Reference Summary*

- *Programming: Work Management Guide*, SC41-8078

  This guide provides information about creating and changing the work management environment, working with system values, collecting and using performance data to improve system performance.
  Short title: *Work Management Guide*

- *Security Reference*, SC41-8083

  This manual discusses general security concepts and planning for security on the system. It also includes information for all users about resource security.
  Short title: *Security Reference*

For detailed information about CL commands, see:

- *Programming: Control Language Reference*, SC41-0030

  This manual provides a description of the AS/400 control language (CL) commands. Each command is described, including its syntax diagram, parameters, default values, and keywords.
  Short title: *CL Reference*

For more information about AS/400 utilities mentioned in this manual, see:

- *Application Development Tools: Character Generator Utility User's Guide*, SC09-1170

  This guide provides information about using the character generator utility (CGU) to create and maintain a double-byte character set on the AS/400 system.
  Short title: *CGU User's Guide*

- *Application Development Tools: Programming Development Manager User's Guide and Reference*, SC09-1339

  This manual provides information about using the programming development manager (PDM) to work with lists of libraries, objects, members, and user-defined options.
  Short title: *PDM User's Guide and Reference*

- *Application Development Tools: Screen Design Aid User's Guide and Reference*, SC09-1340

  This manual provides information about using the screen design aid (SDA) to design, create, and maintain display formats and menus.
  Short title: *SDA User's Guide and Reference*

- *Application Development Tools: Source Entry Utility User's Guide and Reference*, SC09-1338

  This manual provides information about using the source entry utility (SEU) to create and edit source members.
  Short title: *SEU User's Guide and Reference*

For more information about alerts and problem reporting, see:

Communications and Systems Management Guide (Alerts and Distributed Systems Node Executive), SC41-9661

This guide provides information about using the remote management support (DHCF), change management support (DSNX), and problem management support (alerts).
Short title: *Alerts and DSNX Guide*

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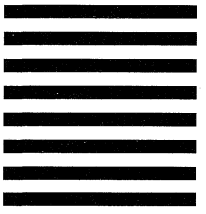

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