Note!

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

First Edition (June 1994)

This edition applies to the IBM* ILE* COBOL/400* licensed program (Program 5763-CB1), Version 3 Release 0 Modification 5, and to all subsequent releases and modifications until otherwise indicated in new editions. Make sure you are using the proper edition for the level of the product.

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Contents

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Programming Interface Information

This publication is intended to help the customer write COBOL/400 programs.

This publication also documents General-Use Programming Interface and Associated Guidance Information.

General-Use programming interfaces allow the customer to write programs that obtain the services of the COBOL/400 compiler.

General-Use Programming Interface and Associated Guidance Information is identified where it occurs, either by an introductory statement to a chapter or section or by the following marking:

General-Use Programming Interface

General-Use Programming Interface and Associated Guidance Information...

End of General-Use Programming Interface

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About This Manual

This manual provides information an application programmer needs to write, compile, test, debug, and run COBOL/400* programs on the IBM* Application System/400* (AS/400*) system.

This manual refers to other IBM publications. These publications are listed in the “Bibliography” on page 383 with their full title and base order number. When they are referred to in text, a shortened version of the title is used.

Who Should Use This Manual

This manual is intended for programmers who have some experience with the COBOL programming language and for the operators who run the programs. It is a guide to programming in the COBOL/400 language for users of the AS/400 system. As a user, you should have a basic understanding of data processing concepts, the COBOL programming language, and the IBM Operating System/400* (OS/400*) operating system.

Using this manual, you will be able to:

- Design COBOL/400 programs
- Code COBOL/400 programs
- Enter, compile, and run COBOL/400 programs
- Test and debug COBOL/400 programs
- Study coded COBOL/400 examples.

Note: You should be familiar with Chapters 1 through 4 of this manual before proceeding to the other chapters.

Use this manual with the *COBOL/400 Reference*, SC09-1813, which describes each component and feature of the COBOL/400 language. The *COBOL/400 User’s Guide*, SC09-1812 and the *COBOL/400 Reference* together describe the COBOL/400 compiler and language.

For information about the complete library of AS/400 documents, consult the *Publications Guide, GC41-9678*, which contains a brief description of the contents of each AS/400 manual.

Before you use this manual, you should be familiar with the following information:

- How to use the controls and indicators on your display and how to use the keys on your keyboard, such as:
  - Cursor movement keys
  - Function keys
  - Field exit keys
  - Insert and Delete keys
  - Error Reset key.

  For information about your display station, refer to:

  - *New User’s Guide, SC41-8211*.

- How to operate your display station when it is linked to the IBM AS/400 system and running AS/400 software. This means knowing how to use the OS/400 operating system and its Control Language (CL) to do such things as:
  - Sign on and sign off the display station
  - Interact with displays
  - Use Help
  - Enter CL commands
  - Use Application Development Tools
  - Respond to messages
  - Perform file management.
- The *Programming: Control Language Programmer's Guide, SC41-8077* which contains the basic concepts of OS/400 CL functions.

  To find out more about the operating system and its control language, refer to these IBM publications:

  - *Programming: Control Language Reference, SC41-0030* (a three-volume manual).
  - *Programming: Work Management Guide, SC41-8078*
  - *Advanced Backup and Recovery Guide, SC41-8079*
- The *Data Management Guide, SC41-9658* which provides information on using data management support to allow an application to work with files.

  The manual includes information on:

  - Fundamental structure and concepts of data management support on the system
  - Data management support for display stations, printers, tapes, and diskettes, as well as spooling support
  - Overrides and file redirection (temporarily making changes to files when an application is run)
  - Copying files by using system commands to copy data from one place to another
  - Tailoring a system using double-byte data.
- How to use the following Application Development Tools:
  - The Screen Design Aid (SDA) is used to design and code displays. Information about this product is contained in *Application Development Tools: Screen Design Aid User's Guide and Reference, SC09-1340*.
  - The Source Entry Utility (SEU) is a full-display editor you can use to enter and update your source members. Information about this product is contained in *Application Development Tools: Source Entry Utility User's Guide and Reference, SC09-1338*.
- The Structured Query Language (SQL) allows you to insert SQL statements into COBOL/400 programs. Information about this product is contained in *Systems Application Architecture* Structured Query Language/400 Reference, SC41-9608* and in *Systems Application Architecture* Structured Query Language/400 Programmer's Guide, SC41-9609*
- The Customer Information Control System/400 (CICS/400*) licensed program allows you to enter transactions at remote work stations, and process them concurrently with user-written application programs. The licensed program

includes functions for building, using, and maintaining databases, and for communicating with CICS on other operating systems.

Information about using this product for application programming is contained in the *CICS/400 Application Programming Guide*. SC33-0822.

Industry Standards Used in Compiler Design

The COBOL/400 compiler is designed according to the following industry standards as understood and interpreted by IBM, as of September, 1987:

- The intermediate subset of the American National Standards Institute (ANSI X3.23-1985) standard.
- The International Standards Organization (ISO) 1989-1985.
- The March 1986 Federal Information Processing Standards Publication (FIPS PUB 21-2) intermediate level. Additional support is provided for many high-level features.

Portions of this manual are copied from *American National Standard Programming Language COBOL, ANSI X3.23-1985, ISO 1989-1985* and reproduced with permission from *American National Standard Programming Language COBOL, ANSI X3.23-1985, ISO 1989-1985* (copyright 1985 by the American National Standards Institute), copies of which you can purchase from the American National Standard Institute at 1430 Broadway, New York, New York, 10018.

The COBOL language is maintained by the Conference On DAta SYstems Languages (CODASYL).

Chapter 1. An Introduction to the COBOL/400 Programming Language

COmmon Business Oriented Language (COBOL) is a programming language that resembles English. As its name suggests, COBOL is especially efficient for processing business problems. It emphasizes describing and handling of data items and of input/output records; thus, it is well adapted for managing large files of data.

The COBOL/400 language delivers many elements of IBM Systems Application Architecture* (SAA*) Common Programming Interface (CPI) COBOL, and is the implementing product on the AS/400 system.

The COBOL/400 Compiler and Library is an IBM licensed program that accepts and runs COBOL programs that follow the ANSI X3.23-1985 (*American National Standard Programming Language COBOL, ANSI X3.23-1985, ISO 1989-1985*) standard. ANSI is an organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States.

Extensions to the ANSI Standard

To help you use COBOL on the AS/400 system, the COBOL/400 licensed program also includes a number of IBM extensions to the ANSI X3.23-1985 standard. Significant extensions include:

- TRANSACTION I/O: You can send or receive records from a work station.
- COPY: You can use externally described files.
- DATABASE I/O: You can use standard COBOL Environment and Data Division entries to specify file identification, field definitions, and data structures. Clauses have been added to the READ, WRITE, REWRITE, DELETE, and START verbs to support the AS/400 database.
- Extended data types: computational-3 (internal decimal or packed decimal), and computational-4 (binary) data types are supported.
- Boolean and pointer data types are supported.
- You have the option to use the apostrophe instead of a quotation mark.
- The compiler-directing statements SKIP1/2/3, EJECT, and TITLE are supported.
- Extended ACCEPT/DISPLAY: Provides support for field-level work station I/O.
- LIKE clause: You can define the characteristics of a data name by copying them from a previously-defined data name.
- Compiler listing suppression: You can selectively suppress portions of the compiler listing by using the *CBL or *CONTROL statement, or the SUPPRESS phrase of the COPY statement.
- Hexadecimal nonnumeric literals are supported.

Features of the COBOL/400 Compiler

The following language-independent features are available with the COBOL/400 compiler:

- Syntax checking:

  The Source Entry Utility (SEU) provides a COBOL syntax checker that checks for errors in lines of code as you enter or change them. Error messages are displayed, allowing you to correct errors before compilation time.

- The cross-reference option:
  - Provides a listing of each Data Division name and Procedure Division paragraph name
  - Indicates the statement numbers of each reference to the item.

- Suppression of diagnostic messages below a user-specified level.

- The Federal Information Processing Standard (FIPS) flagger issues messages identifying obsolete or nonconforming language elements in the COBOL source program. A **source program** is a set of instructions that is written in a programming language and must be translated to machine language before the program can be run.

- SAA flagging to highlight the functions in your program that are not portable to other SAA COBOL environments.

Using COBOL/400 Syntax Notation

In COBOL, basic formats are presented in a uniform system of syntax notation which is explained in the following paragraphs. This notation is designed to assist you in writing COBOL source statements.

- COBOL keywords appear in uppercase letters; for example:

  ```
  PARM1
  ```

  They must be spelled exactly as shown. If any required keyword is missing, the compiler considers it an error.

- Variables representing user-supplied names or values appear in all lowercase letters; for example:

  ```
  parmx
  ```

- For easier text reference, some words are followed by a hyphen and a digit or a letter; for example:

  ```
  identifier-1
  ```

  This suffix does not change the syntactical definition of the word.

- Arithmetic and logical operators (+, -, *, /, **, >, <, =, >=, and <=) that appear in syntax formats are required. These operators are *special character* reserved words. For a complete listing of reserved COBOL/400 words, see the “Reserved Words” section of the *COBOL/400 Reference*.

- All punctuation and other special characters appearing in the diagram are required by the syntax of the format when they are shown; if you leave them out, an error occurs in the program.

- You must write the required clauses and the optional clauses, (when used), in the order shown in the diagram unless the associated rules explicitly state otherwise.

Reading the Syntax Diagrams

Throughout this book, syntax is described using the structure defined below.

- Read the syntax diagrams from left to right, and from top to bottom, following the path of the line:

  ►►─── Indicates the beginning of a statement. Diagrams of syntactical units other than statements, such as clauses, phrases and paragraphs, also start with this symbol.

  ───► Indicates that the statement syntax is continued on the next line.

  ►─── Indicates that a statement is continued from the previous line.

  ───►◄ Indicates the end of a statement. Diagrams of syntactical units other than statements, such as clauses, phrases and paragraphs, also end with this symbol.

  Note: Statements within a diagram of an entire paragraph do not start with ►►─── and end with ───►◄ unless their beginning or ending coincides with that of the paragraph.

- Required items appear on the horizontal line (the main path). Optional items appear below the main path:

```
►►──STATEMENT───────required item──┬───────────────┬──────────────►◄
                                    └─optional item─┘
```

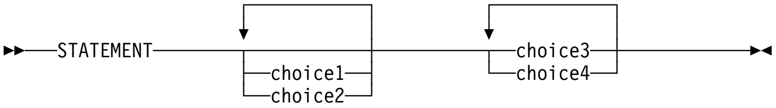
- When you can choose from two or more items, they appear vertically, in a stack. If you *must* choose one of the items, one item of the stack appears on the main path. If choosing an item is optional, the entire stack appears below the main path:

```
►►──STATEMENT──┬─required choice1─┬────┬──────────────────┬────►◄
               └─required choice2─┘    ├─optional choice1─┤
                                       └─optional choice2─┘
```

- An arrow returning to the left above an item indicates that this item can be repeated:

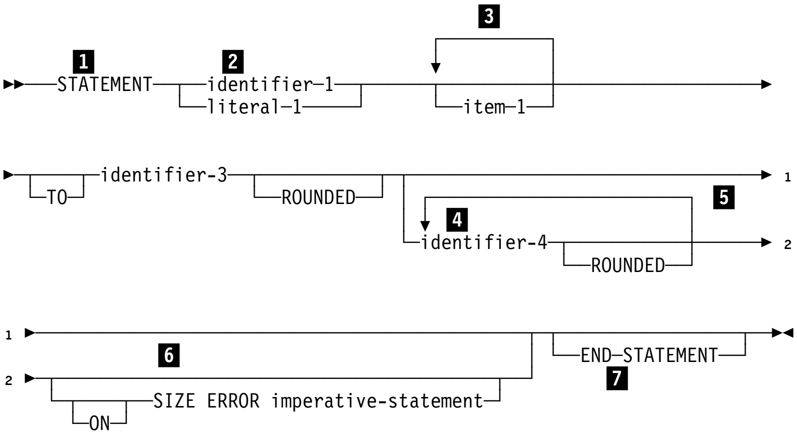
```
              ┌────────────────┐
              ▼                │
►►──STATEMENT───repeatable item─┴──────────────────────────────►◄
```

- A repeat arrow above a stack of required or optional choices indicates that you can make more than one choice from the stacked items, or repeat a single choice:

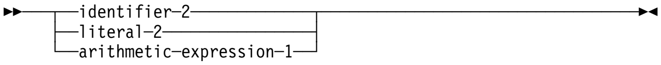


The following example shows how the syntax is used:

Format



where item-1 is:



1 The STATEMENT keyword must be specified and coded as shown.

2 This operand is required. Either *identifier-1* or *literal-1* must be coded.

3 The operand *item-1* is optional. It can be coded or not, as required by the application. If coded, it can be repeated, with each entry separated by one or more blanks. Entry selections allowed for this operand are described at the bottom of the diagram.

4 The operand *identifier-4* is optional. If specified it may be repeated with one or more blanks separating each entry. Each entry may be assigned the keyword ROUNDED.

5 In cases where multiple lines must be continued past the right margin, line order from top to bottom is preserved.

6 The ON keyword is optional to the keyword SIZE ERROR, which is optional itself. If SIZE ERROR is coded, then the operand *imperative-statement* is required.

7 The END-STATEMENT keyword can be coded to end the statement. It is not a required delimiter.

Reading IBM Extensions

An IBM extension generally adds to or contradicts a rule or restriction that immediately precedes it. The standard is presented first, because some programmers use the COBOL/400 language without IBM extensions. The extension is then presented for those who *do* use them.

IBM extensions within figures or tables are shown in boxes unless they are explicitly identified as extensions.

Clauses and statements illustrated within syntax diagrams that are COBOL/400 language extensions to ANSI X3.23-1985 COBOL are enclosed in double lines, as follows:

```
►──RECORD──┬─────┬──┬────┬──┬─╔════════════════════════╗─┬──────►
           └─KEY─┘  └─IS─┘  │ ║EXTERNALLY-DESCRIBED-KEY║ │
                            │ ╚════════════════════════╝ │
                            └─data-name-2────────────────┘
```

IBM Extension

COBOL/400 language extensions to ANSI X3.23-1985 COBOL that are part of the text description are enclosed in IBM Extension bars, like this paragraph.

End of IBM Extension

COBOL clauses and statements illustrated within syntax diagrams that are syntax checked, but are treated as documentation by the COBOL/400 compiler, are enclosed by asterisks, as follows:

```
  ***********************************************
►─┬─────────────────────────────────────┬────────────────►
  * └─RESERVE──integer──┬─────────┬─────┘   *
  *                     ├─AREA────┤         *
  *                     └─AREAS───┘         *
  ***********************************************
```

CL Entry Codes

The box that appears in the lower right corner of each CL syntax diagram contains the entry codes that specify the environment in which the command can be entered. The codes indicate whether or not the command can be:

- Used in a batch or interactive job (outside a compiled program; Job:B or I)
- Used in a batch or interactive compiled program (Pgm:B or I)
- Used in a batch or interactive REXX procedure (REXX:B or I)
- Used as a parameter for the CALL CL command, or passed as a character string to the system program QCMDEXC (Exec).

An Overview of COBOL/400 Programming

You follow four major steps or phases to build your COBOL/400 program:

- Entering your source program
- Compiling your source program
- Debugging your program
- Running your compiled program.

Entering Your COBOL Program

The Source Entry Utility (SEU) provides a special display that corresponds to the standard COBOL coding form to help you enter an accurate COBOL source program into the system. SEU also provides a COBOL syntax checker that checks each line for errors as you enter or change them. For information on entering your COBOL/400 source, refer to Chapter 2, “Entering Your Source Program on the AS/400 System.” For more information on using SEU, see the *SEU User’s Guide and Reference*.

Compiling Your COBOL Program

After you have entered the source program into the system, you need to compile the source program using the Create COBOL Program (CRTCBLPGM) command. The compiler is called to create a COBOL object program and a listing. An **object program** is a set of instructions in machine-usable form. The object program is produced by a compiler from a source program.

You can specify various compiler options by using the CRTCBLPGM command, or by using the PROCESS statement with the desired options. Any options specified in the PROCESS statement override the corresponding options on the CRTCBLPGM command. This process is explained in detail in Chapter 3, “Compiling a COBOL/400 Program.”

Debugging Your COBOL Program

The OS/400 operating system provides the following functions that you can use to test and debug your programs:

- Test library
- Breakpoints
- Traces.

The COBOL/400 compiler provides the following functions for program testing and debugging:

- Debugging features
- Formatted dump.

These features allow you to monitor specific program operations during run time. You must decide what to monitor and what information to retrieve for debugging purposes.

See Chapter 5, “Debugging Your Program” for more information on debugging features.

Running Your COBOL Program

You can run your COBOL program many ways, depending on how the program is written, and who is using it. You can run a COBOL program by calling it from a CL program, from an application program, from another high-level language program, or from a user-created command.

When your program has ended, the system returns control to whoever called the program.

For more information on running your program, see Chapter 4, “Running Your COBOL Program.”

Chapter 2. Entering Your Source Program on the AS/400 System

This chapter provides the information you need to enter your program. This chapter also briefly describes the tools and methodology necessary to complete this step.

There are two ways to enter a COBOL source program into the system:

- You can enter your source program using the Source Entry Utility (SEU). This is the method documented in this chapter.
- You can enter your source program from diskette or tape by using the OS/400 copy function.

  Refer to the *CL Reference* for more information on how to use the COPY function for entry of the source program from diskette or tape.

To enter your COBOL source program using SEU, enter the Start Source Entry Utility (STRSEU) command, and specify CBL for the TYPE parameter. Refer to the *SEU User's Guide and Reference* for further information on the STRSEU command and using SEU.

Designing Your COBOL/400 Program

You can use the skeleton program, Figure 1 on page 10, as a model for developing readable and efficient COBOL programs. Note that not all the entries provided below are required; most are provided for informational purposes only.

```
 IDENTIFICATION DIVISION. 1
   PROGRAM-ID. program-name.
   AUTHOR. comment-entry.
   INSTALLATION. comment-entry.
   DATE-WRITTEN. comment-entry.
   DATE-COMPILED. comment-entry.
   SECURITY.
*     The SECURITY paragraph can be used to contain the program
*     prologue.  The prologue is a description of the program,
*     and it may be as detailed or brief as the guidelines of an
*     installation recommend.  Lowercase letters are recommended
*     for comments; however, because some printers can print
*     only capital letters, the comments may be printed in
*     capitals.  The underscores highlight the comments.

 ENVIRONMENT DIVISION. 2
  CONFIGURATION SECTION. 3
   SOURCE-COMPUTER. IBM-AS400.
   OBJECT-COMPUTER. IBM-AS400.
   SPECIAL-NAMES.   REQUESTOR IS CONSOLE.
  INPUT-OUTPUT SECTION. 4
   FILE-CONTROL.
     SELECT file-name ASSIGN TO DISK-file-name
       ORGANIZATION IS SEQUENTIAL
       ACCESS MODE IS SEQUENTIAL
       FILE STATUS IS data-name.

 DATA DIVISION. 5
  FILE SECTION.
   FD file-name
       BLOCK CONTAINS 2 RECORDS
       RECORD CONTAINS 80 CHARACTERS
       LABEL RECORDS ARE STANDARD
       DATA RECORD IS record-name
  01 record-name  PIC X(132).
  WORKING-STORAGE SECTION.
  77 data-name PIC XX.
  LINKAGE SECTION.

 PROCEDURE DIVISION. 6
  DECLARATIVES
  END DECLARATIVES.
  main-processing SECTION.
   mainline-paragraph.
       COBOL statements.
          STOP RUN.
```

Figure 1. Example of COBOL/400 Program Structure

The Identification Division 1 is the only division that must be included; all other divisions are optional.

The Environment Division 2 is made up of two sections: the Configuration Section 3, which describes the overall specifications of the source and object computers, and the Input-Output Section 4, which defines each file, and specifies information needed for transmission of data between an external medium and the COBOL program.

The Data Division 5 describes the files to be used in the program and the records contained within the files. It also describes any internal working-storage data items that are needed.

The Procedure Division 6 consists of optional declaratives, and procedures that contain sections and/or paragraphs, sentences, and statements.

Source File Format

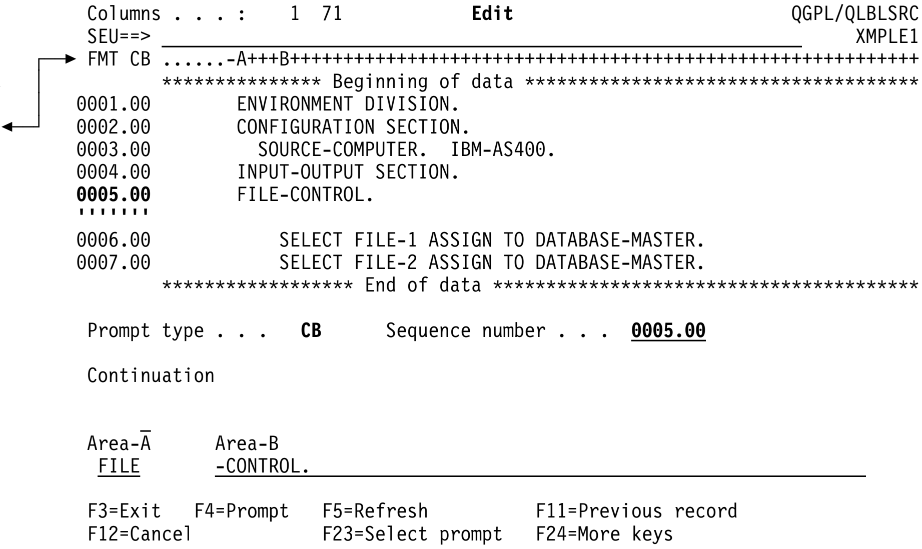
The standard record length of your source files is 92 characters. These 92 characters are made up of a 6-character sequence number, a 6-character date-last-modified area, and an 80-character data field.

The COBOL/400 compiler supports an additional record length of 102; a field of 10 characters containing supplementary information is placed at the end of the record (positions 93-102). This information is not used by the COBOL compiler, but is placed on the extreme right of the compiler listing. You are responsible for placing information into this field. If you want to use this additional field, create a source file with a record length of 102.

IBM supplies a source file where you can store your source records if you do not want to create your own file. This file, named QLBLSRC, is in library QGPL and has a record length of 92 characters.

Entering Source Using SEU

SEU provides special display formats for COBOL. They correspond to the COBOL Coding Form and are designed to help you enter your COBOL source programs. Figure 2 shows a display format, the relationship between the headings on the COBOL Coding Form, and the labels on the display; it also identifies where you enter the source code.



SEU can display a format line to help you make changes or key in entries, position by position.

```
 Columns . . . :    1  71           Edit                        QGPL/QLBLSRC
 SEU==> ____________________________________________________________ XMPLE1
 FMT CB ......-A+++B+++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        *************** Beginning of data ************************************
0001.00        ENVIRONMENT DIVISION.
0002.00        CONFIGURATION SECTION.
0003.00          SOURCE-COMPUTER.  IBM-AS400.
0004.00        INPUT-OUTPUT SECTION.
0005.00        FILE-CONTROL.
'''''''
0006.00            SELECT FILE-1 ASSIGN TO DATABASE-MASTER.
0007.00            SELECT FILE-2 ASSIGN TO DATABASE-MASTER.
        ****************** End of data ****************************************

 Prompt type . . .   CB      Sequence number . . .  0005.00

 Continuation


 Area-A      Area-B
  FILE       -CONTROL.______________________________________________________

 F3=Exit   F4=Prompt   F5=Refresh          F11=Previous record
 F12=Cancel            F23=Select prompt   F24=More keys
```

Figure 2. An SEU Display Format

For a complete description of how to enter a source program using SEU, refer to the *SEU User's Guide and Reference*.

Using the COBOL Syntax Checker in SEU

To use the COBOL syntax checker in SEU, specify the TYPE(CBL) parameter of the STRSEU command. The COBOL syntax checker checks each line for errors as you enter new lines or change existing lines. Incorrect source statements are identified and error messages displayed, allowing you to correct the errors before compiling the program. Because the COBOL syntax checker checks only one statement at a time, independently of statements that precede or follow it, only syntax errors within the source data can be detected. No interrelational errors, such as undefined names and incorrect references to names, are detected. These errors are detected by the COBOL compiler when the program is compiled.

Any time a source line is entered or changed, up to 496 lines of source code can be syntax checked as one unit. The length of a single unit of syntax-checking is determined by extending from an entered or changed line as follows:

A unit of syntax-checking extends towards the beginning of the source member until the first source line, or a line that ends in a period is found.

A unit of syntax-checking extends towards the end of the source member until the last source line, or a line that ends in a period is found.

If this unit spans more than 496 source lines (not including comment lines), the system responds with an appropriate message.

If there is an error in a unit of syntax-checking, the entire unit is presented in reverse image. The message at the bottom of the display refers to the first error in the unit.

Syntax checking occurs line by line as you enter the source code. Error messages are generated by lines consisting of incomplete statements. These disappear when the statements are completed, as in the example:

```
ADD A
TO BCD.
```

An error message is generated after the first line is entered and disappears after the second line is entered, when the statement is completed. A COBOL sentence can span a maximum of 496 lines. Also, if a source line is entered or changed, up to 496 lines of source code can be syntax checked as one unit.

The following regulations apply to syntax checking for COBOL source functions:

- Source code on a line with an asterisk (*) or a slash (/) in column 7 is not syntax checked. An asterisk indicates a comment line; a slash indicates a comment line and page eject.
- No compiler options are honored during syntax checking.

  For example, the syntax checker accepts both quotation marks or apostrophes as nonnumeric delimiters provided they are not mixed within one unit of syntax checking. The syntax checker does not check if the delimiter is the one that will be specified in the CRTCBLPGM command for compiling COBOL source statements, or in the PROCESS statement.
- The first sentence following any of the paragraph headers listed below must begin on the same line as the paragraph header.

  ```
  PROGRAM-ID.
  AUTHOR.
  INSTALLATION.
  DATE-WRITTEN.
  DATE-COMPILED.
  SECURITY.
  SOURCE-COMPUTER.
  OBJECT-COMPUTER.
  SPECIAL-NAMES.
  ```
- Character replacement specified by the CURRENCY and DECIMAL-POINT clauses of the SPECIAL-NAMES paragraph is not honored during interactive syntax checking.
- When using the REPLACING *Identifier-1* BY *Identifier-2* clause of the COPY statement and when either identifier includes reference modification, SEU checks for matching parentheses only. for more information on reference modification, see Chapter 11, “COBOL/400 Programming Considerations.”

Syntax for Structured Query Language (SQL) Statements

The syntax for SQL statements embedded in a COBOL source program is:

```
►──EXEC SQL──sql-statement──END-EXEC.──────────────────────────►◄
```

If the member type for the source program is SQLCBL or CICSSQLCBL, when the COBOL syntax checker encounters an SQL statement, the statement is passed to the SQL syntax checker. If an error is detected, a message is returned.

If an SQL statement is encountered, and if the member type is not SQLCBL or CICSSQLCBL, a COBOL message is returned indicating that a COBOL statement is in error.

If there are errors in the embedded SQL statement as well as errors in the preceding COBOL statements, the SQL error message will only be displayed after the preceding COBOL errors are corrected.

For more information about SQL statements, refer to the *SQL/400* Reference*.

Syntax for Customer Information Control System (CICS) Statements

The syntax for CICS statements embedded in a COBOL source program is:

```
►──EXEC CICS──cics-statement──END-EXEC.──────────────────────────►◄
```

If the member type for the source program is CICSCBL or CICSSQLCBL, when the COBOL syntax checker encounters a CICS statement, the COBOL syntax checker checks for only basic syntax errors.

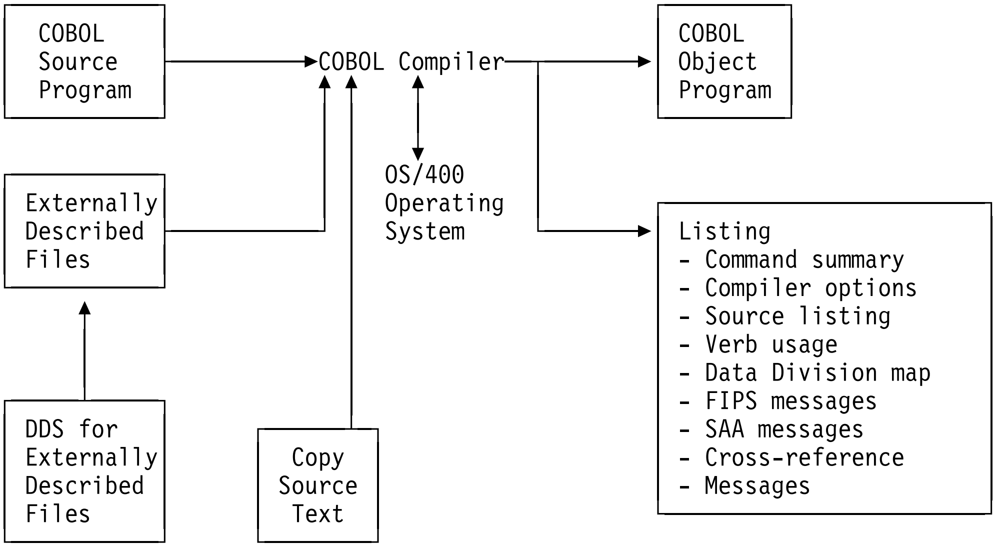
If a CICS statement is encountered, and if the member type is not CICSCBL or CICSSQLCBL, a COBOL message is returned indicating that a COBOL statement is in error.

For more information about CICS/400 statements, refer to the *CICS/400 Application Programming Guide*.

Chapter 3. Compiling a COBOL/400 Program

You need to compile the COBOL/400 source program to produce a usable object program. You do this using the Create COBOL Program (CRTCBLPGM) command. The result of the compilation is a COBOL object program and a listing.

You can specify various compiler options by using the CRTCBLPGM command, or from within the program using the PROCESS statement. Any options specified in the PROCESS statement override the corresponding options on the CRTCBLPGM command. The PROCESS statement is discussed later in “Using the PROCESS Statement to Specify Compiler Options” on page 32.



During compilation, the compiler checks the syntax of the COBOL source program line by line, and also checks the relationships between the lines.

Using the Create COBOL Program (CRTCBLPGM) Command

To compile a COBOL/400 source program into an object program, you must enter the CRTCBLPGM command. This calls the COBOL/400 compiler. You can use the CRTCBLPGM command interactively, or in batch jobs, or from other programs on the AS/400 system.

Programming Note: The number of entries in the Object Definition Table (ODT) and the amount of storage required by a COBOL program varies with the number and kinds of COBOL statements used in the program. A combination of these factors can cause the AS/400 internal size limits for the program to be exceeded. If this occurs, try using the *NOUNREF option of the GENOPT parameter. If the problem persists, the program must be rewritten.

When the *NOUNREF option is specified, only names that are referenced or are needed for data structuring are defined. This option is useful when the program contains many unreferenced identifiers.

If you do not specify CBL as the source member type, the compiler issues a warning.

If the Format 2 COPY statement is used in the program to access externally described files, the operating system provides information about the externally described files to the compiled program.

If the COBOL compiler stops, the message LBL9001

```
Compile failed. Program not created.
```

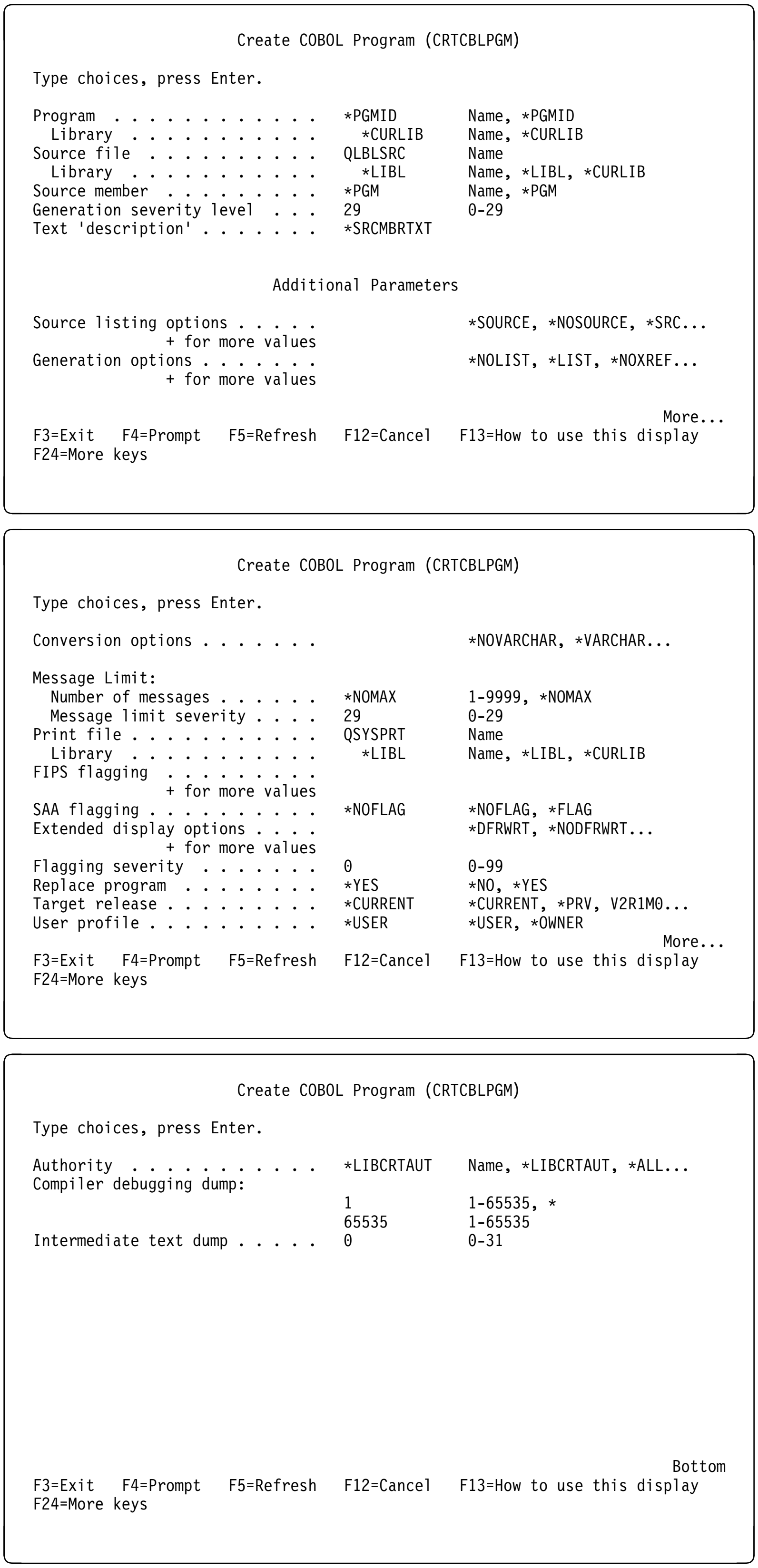
is issued. You can use a control language program that can monitor for this exception by using the control language Monitor Message (MONMSG) command.

Using the CRTCBLPGM Prompt Displays

To enter the CRTCBLPGM command from the CRTCBLPGM prompt displays, type `CRTCBLPGM` and press F4 (Prompt) to show the first display. The parameters and options are described in the order they appear on these displays, on pages 18 through 27. The default values are explained first, and are underlined.

Each parameter on this display shows a default value. Move the cursor past the items where you want default values to apply. Type over any items to set different values or options. If you are unsure about the setting of a parameter value, type a question mark (?) in the first position of the field and press Enter, or F4 (Prompt), to receive more detailed information. The question mark must be followed by a blank.

Figure 3 shows the CRTCBLPGM prompt displays. When you see the first CRTCBLPGM prompt display, you see only the required parameters prompted. To see the additional parameters, press F10. You see the first display shown in Figure 3. To see the remainder of the parameters, as shown in the second and third displays in Figure 3, page forward.



```
                       Create COBOL Program (CRTCBLPGM)

 Type choices, press Enter.

 Program  . . . . . . . . . . .   *PGMID        Name, *PGMID
   Library  . . . . . . . . . .     *CURLIB     Name, *CURLIB
 Source file  . . . . . . . . .   QLBLSRC       Name
   Library  . . . . . . . . . .     *LIBL       Name, *LIBL, *CURLIB
 Source member  . . . . . . . .   *PGM          Name, *PGM
 Generation severity level  . .   29            0-29
 Text 'description' . . . . . .   *SRCMBRTXT


                           Additional Parameters

 Source listing options . . . .                 *SOURCE, *NOSOURCE, *SRC...
               + for more values
 Generation options . . . . . .                 *NOLIST, *LIST, *NOXREF...
               + for more values

                                                                     More...
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys
```

```
                       Create COBOL Program (CRTCBLPGM)

 Type choices, press Enter.

 Conversion options . . . . . .                 *NOVARCHAR, *VARCHAR...

 Message Limit:
   Number of messages . . . . .   *NOMAX        1-9999, *NOMAX
   Message limit severity . . .   29            0-29
 Print file . . . . . . . . . .   QSYSPRT       Name
   Library  . . . . . . . . . .     *LIBL       Name, *LIBL, *CURLIB
 FIPS flagging  . . . . . . . .
               + for more values
 SAA flagging . . . . . . . . .   *NOFLAG       *NOFLAG, *FLAG
 Extended display options . . .                 *DFRWRT, *NODFRWRT...
               + for more values
 Flagging severity  . . . . . .   0             0-99
 Replace program  . . . . . . .   *YES          *NO, *YES
 Target release . . . . . . . .   *CURRENT      *CURRENT, *PRV, V2R1M0...
 User profile . . . . . . . . .   *USER         *USER, *OWNER
                                                                     More...
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys
```

```
                       Create COBOL Program (CRTCBLPGM)

 Type choices, press Enter.

 Authority  . . . . . . . . . .   *LIBCRTAUT    Name, *LIBCRTAUT, *ALL...
 Compiler debugging dump:
                                  1             1-65535, *
                                  65535         1-65535
 Intermediate text dump . . . .   0             0-31












                                                                      Bottom
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys
```

Figure 3. The CRTCBLPGM Prompt Displays

Parameters of the CRTCBLPGM Command

A description of the parameters for the CRTCBLPGM command follows. The default values are explained first, and are underscored for identification. The parameters and options are described in the order they appear on the prompt displays.

All object names specified for the CRTCBLPGM command must follow AS/400 naming conventions: the names may be basic names, 10 characters in length, composed of alphanumeric characters, the first of which must be alphabetic; or the names may be quoted names, 8 characters in length, enclosed in double quotes.

If you want to relate these parameter descriptions to the CRTCBLPGM syntax diagram, refer to Figure 4 on page 29.

PGM Parameter:

Specifies the program name and library name for the COBOL program object you are creating. The possible values are:

***PGMID**

The name for the program object is taken from the PROGRAM-ID paragraph in the COBOL source program.

program-name

Enter a name to identify the compiled COBOL program. If you specify a program name for this parameter, and run the compilation in batch mode, the first program in the batch job uses this name; any other programs use the name specified in the PROGRAM-ID paragraph in the source program.

The possible library values are:

***CURLIB**

If you do not specify a library name, the current library is used. If you have not assigned a library as the current library, QGPL is used.

library-name

Enter the name of the library to contain the created program object.

SRCFILE Parameter:

Specifies the name of the source file that contains the COBOL source to be compiled. The possible values are:

QLBLSRC

Specifies that the source file, QLBLSRC, contains the COBOL source to be compiled.

source-file-name

Enter the name of the source file that contains the COBOL source to be compiled. This source file should have a record length of 92.

The possible library values are:

***LIBL**

If you do not specify a library name, the system searches the library list to find the library where the source file is located.

***CURLIB**

The current library is used. If you have not assigned a library as the current library, QGPL is used.

library-name

Enter the name of the library where the source file is located.

SRCMBR Parameter:

Specifies the name of the member that contains the COBOL source to be compiled. You can specify this parameter only if the source file referenced in the SRCFILE parameter is a database file. The possible values are:

***PGM**

If you specified a program name for the PGM parameter, the compiler looks for the source program in a member having the same name as the program, and creates an object program with the same name as the program and member.

If you did not specify a program name for the PGM parameter, the compiler looks for the program source in the first member of the database source file, and creates an object program using the name specified in the PROGRAM-ID paragraph.

source-file-member-name
Enter the name of the member that contains the COBOL source.

GENLVL Parameter:
Specifies the severity level that determines if a program object is created. The severity level corresponds to the severity level of the messages produced during compilation of the program. If the severity level of error messages is greater than the value you specify, a program object is not created. For example, if you specify 19 for this parameter, a program object is not created if the severity level of any of the messages is 20 or greater.

The possible values are:

29 If errors occur with a severity level greater than 29, no program object is created.

severity-level
Specify a one or two-digit number, 0 through 29. If errors occur with a severity level greater than this level, no program object is created.

TEXT Parameter:
Allows you to enter text that briefly describes the program and its function.

***SRCMBRTXT**
Use the same text for the program object as that which describes the database file member containing the COBOL source. If the source comes from a device or in-line file, specifying *SRCMBRTXT has the same effect as specifying *BLANK.

***BLANK**
No text is specified.

text-description
Enter the text that briefly describes the program and its function. The text can be a maximum of 50 characters in length and must be enclosed in apostrophes. The apostrophes are not part of the 50-character string.

OPTION Parameter:
Specifies the options to use when the COBOL source is compiled. The possible values are:

***SOURCE or *SRC**
The compiler produces a source listing, consisting of the COBOL source input and all compilation-time error messages.

***NOSOURCE or *NOSRC**
The compiler does not produce the source part of the listing. If you do not require a source listing, you should use this option because compilation may take less time.

***NOXREF**
The compiler does not produce a cross-reference listing for the source program.

***XREF**
The compiler produces a cross-reference listing for the source program.

***GEN**
The compiler creates a program object after the program is compiled.

***NOGEN**
The compiler does not create a program object after the source program is compiled. You might specify this option if you want only error listings at this time.

***NOSEQUENCE**
The reference numbers are not checked for sequence errors.

***SEQUENCE**
The reference numbers are checked for sequence errors. Sequence errors do not occur if the *LINENUMBER option is specified.

***NOVBSUM**
Verb usage counts are not printed.

***VBSUM**
Verb usage counts are printed.

***NONUMBER**
The source-file sequence numbers are used for reference numbers.

***NUMBER**
The user-supplied sequence numbers (columns 1 through 6) are used for reference numbers.

***LINENUMBER**

The sequence numbers created by the compiler are used for reference numbers. This option combines program source code and source code introduced by COPY statements into one consecutively numbered sequence. Use this option if you specify FIPS (Federal Information Processing Standards) flagging or SAA* flagging.

***NOMAP**

The compiler does not list the Data Division map.

***MAP**

The compiler lists the Data Division map.

***NOOPTIONS**

Options in effect are not listed for this compilation.

***OPTIONS**

Options in effect are listed for this compilation.

***QUOTE**

Specifies that the delimiter quotation mark (") is used for nonnumeric literals and Boolean literals. This also specifies that the value of the figurative constant QUOTE has the EBCDIC value of a quotation mark.

Note: Boolean data is a category of data items that are limited to a value of 1 or 0. A Boolean literal is a literal composed of a Boolean character enclosed in quotation marks and preceded by a B; for example: B"1".

***APOST**

Specifies that the delimiter apostrophe (') is used for nonnumeric literals and Boolean literals. This also specifies that the value of the figurative constant QUOTE has the EBCDIC value of an apostrophe.

***NOSECLVL**

Second level message text is not listed for this compilation.

***SECLVL**

Second level message text is listed for this compilation, along with the first-level error text.

Note: The first-level error text is printed each time the error occurs.

***PRTCORR**

The compiler inserts comment lines in the compiler listing indicating which elementary items were included as a result of the use of the CORRESPONDING phrase.

***NOPRTCORR**

The compiler does not insert comment lines in the compiler listing when the CORRESPONDING phrase is used.

***NOSRCDBG**

This option determines the kind of information you see on your programmable work station when using the CoOperative Development Environment/400 to compile your COBOL programs. See the note on page 21 for further information.

The compiler does not produce source-level debugging information. If *NOLSTDBG is also in effect, the compiler does not produce source-level error information either.

***SRCDBG**

This option determines the kind of information you see on your programmable work station when using the CoOperative Development Environment/400 product to compile your COBOL programs. See the note on page 21 for further information.

The compiler produces source-level error information and source-level debugging information.

You cannot specify *SRCDBG and *LSTDBG together. Specify one or the other.

***NOLSTDBG**

This option determines the kind of information you see on your programmable work station when using the CoOperative Development Environment/400 product to compile your COBOL programs. See the note on page 21 for further information.

The compiler does not produce a listing view, source-level error information, or listing-level debugging information.

***LSTDBG**

This option determines the kind of information you see on your programmable work station when using the CoOperative Development Environment/400 product to compile your COBOL programs. See the note on page 21 for further information.

The compiler produces a listing view, and listing-level debugging information. If *NOSRCDBG is also in effect, the compiler does not produce source-level error information either.

You cannot specify *SRCDBG and *LSTDBG together. Specify one or the other.

Note: You can only use the *NOSRCDBG, *SRCDBG, *NOLSTDBG and *LSTDBG options if you are using the AD/Cycle CoOperative Development Environment/400 product to compile your program. If you specify one or more of these options but do not have the CODE/400 product installed, the COBOL/400 compiler will not continue processing and an error message is issued. For more information on these options, see the *CODE Debug Tool User's Guide and Reference*, SC09-1622.

***PRINT**

The compiler produces a spool listing.

***NOPRINT**

The compiler does not produce a spool listing.

GENOPT Parameter:

Specifies the options to use when the program object is created. The listings could be required if a problem occurs in COBOL. The possible values are:

***NOLIST**

No IRP (intermediate representation of program), associated hexadecimal code, or error messages are listed.

***LIST**

The IRP, its associated hexadecimal code, and any error messages are listed.

***NOXREF**

Does not produce a cross-reference listing of the objects defined in the IRP.

***XREF**

Produces a cross-reference listing of all objects defined in the IRP.

***NOPATCH**

Does not reserve space in the compiled program for a program patch area.

***PATCH**

Reserves space in the compiled program for a program patch area. The program patch area can be used for debugging purposes.

***NODUMP**

Does not list the program template.

***DUMP**

Lists the program template.

***NOATR**

Does not list the attributes for the IRP source.

***ATR**

Lists the attributes for the IRP source.

***RANGE**

At runtime, the system verifies that subscripts are within the correct ranges, but does not verify index ranges. It also checks for reference modification and compiler-generated substring operations.

***NORANGE**
Does not verify ranges at run-time.

Note: The *RANGE option generates code for checking subscript ranges. For example, it ensures that you are not attempting to access the 21st element of a 20-element array.

The *NORANGE option does not generate code to check subscript ranges.

These options do not eliminate the zero subscript checking performed by the operating system. If zero subscripts occur, the operating system will not permit their use and issues message MCH0603.

***UNREF**
Includes unreferenced data items in the compiled program.

***NOUNREF**
Does not include unreferenced data items in the compiled program. This reduces the number of ODT (object definition table) entries used, allowing a larger program to be compiled. The unreferenced data items still appear in the cross-reference listings produced by specifying OPTION (*XREF).

***NOOPTIMIZE**
The compiler performs only standard optimizations for the program.

***OPTIMIZE**
The compiler attempts to create a program that operates more efficiently and uses less storage. However, specifying *OPTIMIZE can substantially increase the time required to compile a program.

***NODDSFILLER**
If no matching fields are found by a COPY DDS statement, no field descriptions are generated.

***DDSFILLER**
When no matching fields are found by a COPY DDS statement, a single character FILLER field description, "07 FILLER PIC X", is always created.

***NOSYNC**
The SYNCHRONIZED clause is syntax checked.

***SYNC**
The SYNCHRONIZED clause causes the alignment of an elementary item on a natural boundary in storage.

***NOCRTF**
Files that are unavailable at the time of an OPEN operation are not created dynamically.

***CRTF**
Files that are unavailable at the time of an OPEN operation are created dynamically. When created, the file will inherit authority from the job profile. (See the discussion of the OPEN statement in the *COBOL/400 Reference* manual for the conditions under which dynamic file creation can occur.)

Note: The maximum record length for a file that will be created dynamically is 32 766.

***NODUPKEYCHK**
Does not check for duplicate keys for INDEXED files.

***DUPKEYCHK**
Checks for duplicate keys for INDEXED files. (See the discussion of the READ statement in the *COBOL/400 Reference* manual for the conditions under which the existence of records with duplicate keys will be signalled to a program.

Warning: Specifying this option can result in a loss in compiler performance.

***STDERR**
Standard error handling is used. See Chapter 6, “COBOL/400 Exception and

Error Handling" on page 69 for more information.

***NOSTDERR**
The error handling method of Version 1, Releases 1 and 2, is used.

***NOEXTACCDSP**
The compiler does not allow extended ACCEPT or DISPLAY statements.

***EXTACCDSP**
The compiler allows extended ACCEPT and DISPLAY statements. Refer to Appendix E of the *COBOL/400 Reference* for changes to the reserved word list that occur when you use this option.

***NOINZDLT**
Relative files with sequential access are not initialized with deleted records during the CLOSE operation if the files have been opened for OUTPUT. That is, the record boundary is determined by the number of records written. Subsequent OPEN operations allow access only up to the record boundary.

***INZDLT**
Relative files with sequential access are initialized with deleted records during the CLOSE operation if the files were opened for OUTPUT. Active records in the files are not affected. That is, the record boundary is defined as the file size for subsequent I/O operations.

***NOBLK**
The compiler allows blocking only of SEQUENTIAL access files with no START statement.

If a BLOCK CONTAINS clause is specified, the BLOCK CONTAINS clause is ignored, except for tape files.

***BLK**
When used with BLOCK CONTAINS, the compiler allows blocking from DYNAMIC access files and SEQUENTIAL access files with a START statement. Blocking is not allowed for RELATIVE files opened for output operations.

The BLOCK CONTAINS clause controls the number of records to be blocked.

When no BLOCK CONTAINS clause is specified, the compiler allows blocking only of SEQUENTIAL access files with no START statement. The operating system determines the number of records to be blocked.

***STDINZ**
The compiler initializes user data items to system defaults, provided that the items are not subject to a VALUE clause.

***NOSTDINZ**
For those user items with no VALUE clause, the compiler does not initialize data items to system defaults.

***FS21DUPKY**
The compiler reports a file status of 21 when processing an indexed file with duplicate keys in random or dynamic access mode, if the value of the key is changed between the mandatory READ statement and a following REWRITE or DELETE statement.

***NOFS21DUPKY**
The compiler does not report a file status of 21 when processing an indexed file with duplicate keys in random or dynamic access mode. A REWRITE statement can change the key of a record.

CVTOPT Parameter:
Specifies how the compiler handles SAA date, time, and timestamp data types, DBCS-graphic data types, and variable-length character fields passed from externally-described files to your program through COPY DDS. The possible values are:

***NOVARCHAR**
Variable-length fields are ignored, and are declared as FILLER fields.

***VARCHAR**
Variable-length fields are declared as fixed-length group items, and are accessible to the program. For more information on variable-length fields, refer to

"Declaring Data Items Using CVTOPT Data Types" on page 130.

***NODATETIME**
Date, time, and timestamp data types are ignored, and are declared as FILLER fields.

***DATETIME**
Date, time, and timestamp data types are declared as fixed-length character fields, and are accessible to the program.

***NOGRAPHIC**
DBCS-graphic data types are ignored, and are declared as FILLER fields.

***GRAPHIC**
Fixed-length DBCS-graphic data types are declared as fixed-length alphanumeric fields, and are accessible to the program.

When the *VARCHAR option is also in use, variable-length DBCS-graphic data types are declared as fixed-length group items, and are accessible to the program. For more information on DBCS-graphic data types, refer to "DBCS-Graphic Fields" on page 133.

MSGLMT Parameter:
Controls compilation by indicating the maximum number of error messages of a given error severity level that can occur before compilation stops.

For example, you can stop compilation if more than three errors with a severity level of 20 or higher occur. In this example, you would specify 3 for the maximum number of error messages, and 20 for the maximum error severity level. If three errors of severity level 20 or higher occur, compilation continues, but when a fourth is encountered, compilation stops. If no messages equal or exceed the maximum severity level, compilation continues regardless of the number of errors encountered.

message-limit
The possible values for the maximum number of error messages are:

***NOMAX**
Compilation continues until normal completion regardless of the number of errors encountered.

1-9999
Compilation stops if the number of errors of the specified severity level or higher exceeds the number you specify. If no messages equal or exceed the maximum severity level, compilation continues regardless of the number of errors encountered.

message-severity
The possible values for the maximum error severity level are:

29 Compilation stops if the number of errors with severity level 29 or higher exceeds the maximum number of error messages specified.

maximum-severity-level
Specify a one or two-digit number, 0 through 29. Compilation stops if the number of errors with the specified severity level or higher exceeds the maximum number of error messages you specify.

PRTFILE Parameter:
Specifies the name of the file to which the compiler listing is directed and the library where the file is located. The file should have a minimum record length of 132. If a file with a record length less than 132 is specified, information is lost.

The possible values are:

QSYSPRT
If you do not specify a file name, the compiler listing is directed to QSYSPRT, an IBM-supplied file.

file-name
Enter the name of the file to which the compiler listing is directed.

The possible library values are:

***LIBL**
If a library-name is not specified, the system searches the library list, *LIBL, to find the library where the file is located.

***CURLIB**
The current library is used. If you have not assigned a library as the current library, QGPL is used.

library-name
Enter the name of the library where the file is located.

FLAGSTD Parameter:
Specifies the options for FIPS flagging. (Select the *LINENUMBER option to ensure that the reference numbers used in the FIPS messages are unique.) The possible values are:

***NOFIPS**
The source program is not FIPS flagged.

***MINIMUM**
FIPS flag for minimum subset and higher.

***INTERMEDIATE**
FIPS flag for intermediate subset and higher.

***HIGH**
FIPS flag for high subset.

***NOSEG**
The optional module SEGMENTATION is not FIPS flagged.

***SEG1**
FIPS flag for optional module SEGMENTATION level 1 and higher.

***SEG2**
FIPS flag for optional module SEGMENTATION level 2.

***NODEB**
The optional module DEBUG is not FIPS flagged.

***DEB1**
FIPS flag for optional module DEBUG level 1 and higher.

***DEB2**
FIPS flag for optional module DEBUG level 2.

***NOOBSOLETE**
Obsolete language elements are not flagged.

***OBSOLETE**
Obsolete language elements are flagged.

SAAFLAG Parameter:
Specifies if you want flagging of COBOL/400* functions that are not supported by SAA COBOL. (Select the *LINENUMBER option to ensure that the reference numbers used in the SAA COBOL messages are unique.) The possible values are:

***NOFLAG**
SAA COBOL flagging is not performed.

***FLAG**
SAA COBOL flagging is performed.

EXTDSPOPT Parameter:
Specifies the options to use for extended ACCEPT and extended DISPLAY statements for work station I/O. The possible values are:

***DFRWRT**
Extended DISPLAY statements are held in a buffer until an extended ACCEPT statement is encountered, or until the buffer is filled.

If an extended ACCEPT statement is not encountered before the buffer is filled, the contents of the buffer are written to the display. When an extended ACCEPT statement is encountered, the current contents of the buffer are written to the display.

***NODFRWRT**
Each extended DISPLAY statement is performed as it is encountered.

***UNDSPCHR**
Displayable and undisplayable characters are handled by extended ACCEPT and extended DISPLAY statements.

***NOUNDSPCHR**
Use this option when the data to be displayed contains extended DBCS characters. Only displayable characters are handled by extended ACCEPT and extended DISPLAY statements.

Although you must use this option for display stations attached to remote 3174 and 3274 controllers, you can also use it for local work stations. If you do use this option, your data must contain displayable characters. If the data contains values less than hexadecimal 20, the results are not predictable, ranging from unexpected display formats to severe errors.

***ACCUPDALL**

All types of data are predisplayed in the extended ACCEPT statements regardless of the existence of the UPDATE phrase.

***ACCUPDNE**

Only numeric edited data are predisplayed in the extended ACCEPT statements that do not contain the UPDATE phrase.

FLAG Parameter:

Specifies the minimum severity level of messages to be printed. The possible values are:

0 All messages are printed.

severity-level

Enter a one or two-digit number that specifies the minimum severity level of messages to be printed. Messages that have severity levels of the specified value or higher are listed.

REPLACE Parameter:

Specifies if a new program object is created when a program object of the same name in the same library already exists. The possible values are:

***YES**

A new program object is created and any existing program object of the same name in the specified library is moved to library QRPLOBJ.

***NO**

A new program object is not created if a program object of the same name already exists in the specified library.

TGTRLS Parameter:

Specifies the release of the operating system on which you intend to use the object being created. You can specify an exact release level in the format VxRxMx, where Vx is the version, Rx is the release, and Mx is the modification level. For example, V2R2M0 is version 2, release 2, modification level 0.

Note: To use the object on the target system, you must save the object to the target release level specified on the create command and then restore it on the target system.

The possible values are:

***CURRENT**

The object is to be used on the release of the operating system currently running on your system. You can also use the object on a system with any subsequent release of the operating system installed.

***PRV**

The object is to be used on the previous release with modification level 0 of the operating system. You can also use the object on a system with any subsequent release of the operating system installed.

release-level

Specify the release in the format VxRxMx. The object can be used on a system with the specified release or with any subsequent release of the operating system installed.

Valid values depend on the current version, release, and modification level, and they change with each new release.

USRPRF Parameter:

Specifies the user profile that will run the compiled COBOL program. The profile of the program owner or the program user is used to run the program and control which objects can be used by the program (including the authority the program has for each object). This parameter is not updated if the program already exists. To change the value of USRPRF, delete the program and recompile using the correct value.

The possible values are:

***USER**

The user profile of the program user is to be used when the program is run.

***OWNER**

The user profiles of both the program's owner and user are to be used when the program is run. The collective sets of object authority in both user profiles are to be used to find and access objects during the running of the program. Any objects that are created during the program are owned by the program's user.

Note: Specify the USRPRF parameter to reflect the security requirements of your installation. The security facilities available on the AS/400 system are described in detail in the *Security Reference*.

AUT Parameter:

Specifies the authority given to users who do not have specific authority to the program object, who are not on the authorization list, or whose group has no specific authority to the program object. You can alter the authority for all users, or for specific users after the program object is created by using the GRTOBJAUT (Grant Object Authority) or RVKOBJAUT (Revoke Object Authority) commands.

The possible values are:

<u>*LIBCRTAUT</u>

The public authority for the object is taken from the CRTAUT keyword of the target library (the library that is to contain the created program object). This value is determined when the program object is created. If the CRTAUT value for the library changes after the program object is created, the new value does NOT affect any existing objects.

***ALL**

Provides authority for all operations on the program object except those limited to the owner or controlled by authorization list management authority. The user can control the program object's existence, specify security for it, change it, and perform basic functions on it, but cannot transfer its ownership.

***CHANGE**

Provides all data authority and the authority for performing all operations on the program object except those limited to the owner or controlled by object authority and object management authority. The user can change the object and perform basic functions on it, such as running and debugging the program object.

***USE**

Provides object operational authority and read authority; authority for basic operations on the program object such as running the program. The user is prevented from changing the object.

***EXCLUDE**

The user cannot access the program object.

authorization-list-name

Enter the name of an authorization list of users and authorities to which the program is added. The program object is secured by this authorization list, and the public authority for the program object is set to *AUTL. The authorization list must exist on the system when the CRTCBLPGM command is issued. Use the Create Authorization List (CRTAUTL) command to create your own authorization list.

Note: Specify the AUT parameter to reflect the security requirements of your installation. The security facilities available on the AS/400 system are described in detail in *Security Reference*.

DUMP Parameter:

An IBM COBOL/400 debugging aid for IBM service personnel.

ITDUMP (n) Parameter:

An IBM debugging aid provided for IBM service personnel. This parameter makes the compiler dump the internal text at certain times during the compilation of the source program.

Entering CRTCBLPGM from the Command Line

You can enter the CRTCBLPGM command from the command line. Type `CRTCBLPGM` followed by the appropriate parameters to compile your program. Refer to the Figure 4 on page 29 for the correct syntax. If you are unsure about the parameters and their meanings, refer to the parameter and option descriptions on pages 18 through 27. Refer to the following examples of the syntax you would use to enter the CRTCBLPGM command from the command line.

Example 1

```
CRTCBLPGM SRCFILE(QGPL/QLBLSRC) SRCMBR(SAMPLE) SAAFLAG(*FLAG)
```

Partial Source for Member SAMPLE

```
ID DIVISION.
PROGRAM-ID. EXAMPLE.
```

The preceding example creates a COBOL/400 program from the source member SAMPLE in file QLBLSRC and library QGPL. The resulting program is called EXAMPLE. Specifying *FLAG for the SAAFLAG parameter tells the compiler to identify any functions that are not supported by SAA COBOL. In this example, all parameter defaults were used with the exception of the SRCFILE, SRCMBR, and SAAFLAG parameters.

Example 2

```
CRTCBLPGM PGM(TEST) SRCFILE(SOURCE1) CVTOPT(*GRAPHIC)
```

In the preceding example, the compiler looks for the file SOURCE1 in the library list, and looks for the member called TEST within that file. (The value for the SRCMBR parameter defaulted to *PGM, specifying to look for a member with the same name as the program to be created.) The compiler creates a COBOL/400 program called TEST from the source program found in the member TEST in the file SOURCE1. Specifying *GRAPHIC for the CVTOPT parameter indicates that if the DDS contains DBCS-graphic data types, you want the COBOL program to be able to reference them as alphanumeric fields.

Entering CRTCBLPGM from a CL Program

When you issue the CRTCBLPGM command from a CL program, you can use concatenation expressions for all parameter values. See the *CL Reference* for more information about concatenation expressions. Also, see the *CL Reference* for a detailed description of OS/400 object naming rules and for a complete description of OS/400 command syntax.

General-Use Programming Interface

You can use this command in QCMDEXC.

End of General-Use Programming Interface

Syntax of the CRTCBLPGM Command

Figure 4 shows the syntax of the CRTCBLPGM command.

```
►►──CRTCBLPGM───PGM──(──┬─*CURLIB/──────┬──┬─*PGMID───────┬─)──────────────────►
                        └─library-name/─┘  └─program-name─┘

►──┬───────────────────────────────────────────────────────────────────┬───────►
   └─SRCFILE──(──┬─*LIBL/──────────────────┬─QLBLSRC──────────┬─)─┘
                 ├─*CURLIB/────────┤        └─source-file-name─┘
                 └─library-name/───┘

►──┬────────────────────────────────────────────┬──────────────────────────────►
   └─SRCMBR──(──┬─*PGM──────────────────────┬─)─┘
                └─source-file-member-name───┘

►──┬────────────────────────────────┬──┬──────────────────────────────┬────────►
   └─OPTION──(─option-details─)─────┘  └─GENOPT──(─genopt-details─)───┘

►──┬──────────────────────────────────────────────────────────────────────┬────►
   └─CVTOPT────(──┬─*NOVARCHAR─┬──┬─*NODATETIME─┬──┬─*NOGRAPHIC─┬─)───────┘
                  └─*VARCHAR───┘  └─*DATETIME───┘  └─*GRAPHIC───┘

►──┬──────────────────────────────────────────────────────────────┬────────────►
   └─MSGLMT──(──┬─*NOMAX─────────┬────┬─29─────────────────┬─)─────┘
                └─message-limit──┘    └─max-severity-level─┘

►──┬───────────────────────────────────────┬───────────────────────────────────►
   └─GENLVL──(──┬─29─────────────┬─)───────┘
                └─severity-level─┘

►──┬──────────────────────────────────────────────────────┬────────────────────►
   └─PRTFILE──(──┬─*LIBL/──────────────────┬─QSYSPRT────┬─)─┘
                 ├─*CURLIB/────────┤        └─file-name──┘
                 └─library-name/───┘

►──┬───────────────────────────────────────────────────────────────────────────┬►
   └─FLAGSTD─(──┬─*NOFIPS────────┬──┬─*NOSEG─┬──┬─*NODEB─┬──┬─*NOOBSOLETE─┬─)─┘
                ├─*MINIMUM───────┤  ├─*SEG1──┤  ├─*DEB1──┤  └─*OBSOLETE───┘
                ├─*INTERMEDIATE──┤  └─*SEG2──┘  └─*DEB2──┘
                └─*HIGH──────────┘

►──┬─────────────────────────────────────┬─────────────────────────────────────►
   └─SAAFLAG──(──┬─*NOFLAG─┬─)───────────┘
                 └─*FLAG───┘

►──┬───────────────────────────────────────────────────────────────────────┬───►
   └─EXTDSPOPT─(──┬─*DFRWRT───┬──┬─*UNDSPCHR───┬──┬─*ACCUPDALL─┬─)─────────┘
                  └─*NODFRWRT─┘  └─*NOUNDSPCHR─┘  └─*ACCUPDNE──┘

►──┬──────────────────────────────────┬──┬──────────────────────────┬──────────►
   └─FLAG──(──┬─0──────────────┬─)────┘  └─REPLACE─(──┬─*YES─┬─)────┘
              └─severity-level─┘                      └─*NO──┘
```

Figure 4 (Part 1 of 5). Syntax of the CRTCBLPGM Command

```
►──┬────────────────────────────────────┬──────┬─────────────────────────┬──►
   └─TGTRLS─(─┬─*CURRENT──────────────┬─┘      └─USRPRF─(─┬─*USER──┬─)─┘
              ├─*PRV──────────────┤                       └─*OWNER─┘
              └─release-level─────┘

►──┬──────────────────────────────────────────┬──────────────────────────────►
   └─AUT──(─┬─*LIBCRTAUT──────────────────┬─)─┘
            ├─*ALL────────────────────────┤
            ├─*CHANGE─────────────────────┤
            ├─*USE────────────────────────┤
            ├─*EXCLUDE────────────────────┤
            └─authorization-list-name─────┘

►──┬──────────────────────────────────────────┬──────────────────────────────►
   └─TEXT──(─┬─*SRCMBRTXT───────────────┬─)───┘
             ├─*BLANK───────────────────┤
             └─'description-text'───────┘

►──┬─────────────────────────────────────────────────────────────┬───────────►
   └─DUMP──(──starting-statement───────ending-statement──)──────┘

►──┬──────────────────────────────┬─────────────────────────────────────────►◄
   └─ITDUMP─(─dump-option─)───────┘
```

```
                                        Job: B,I  Pgm: B,I  REXX: B,I  Exec
```

OPTION Details:

```
►──┬─*SRC───────┬──┬─*NOXREF─┬──┬─*GEN───┬──┬─*NOSEQUENCE─┬──┬─*NOVBSUM─┬──►
   ├─*SOURCE────┤  └─*XREF───┘  └─*NOGEN─┘  └─*SEQUENCE───┘  └─*VBSUM───┘
   ├─*NOSRC─────┤
   └─*NOSOURCE──┘

►──┬─*NONUMBER────┬──┬─*NOMAP─┬──┬─*NOOPTIONS─┬──┬─*QUOTE─┬──┬─*NOSECLVL─┬──►
   ├─*NUMBER──────┤  └─*MAP───┘  └─*OPTIONS───┘  └─*APOST─┘  └─*SECLVL───┘
   └─*LINENUMBER──┘

►──┬─*PRTCORR───┬──┬─*NOSRCDBG─┬──┬─*NOLSTDBG─┬──┬─*PRINT───┬───────────────►
   └─*NOPRTCORR─┘  └─*SRCDBG───┘  └─*LSTDBG───┘  └─*NOPRINT─┘
```

GENOPT Details:

```
►──┬─*NOLIST─┬──┬─*NOXREF─┬──┬─*NOPATCH─┬──┬─*NODUMP─┬──┬─*NOATR─┬──────────►
   └─*LIST───┘  └─*XREF───┘  └─*PATCH───┘  └─*DUMP───┘  └─*ATR───┘
```

Figure 4 (Part 2 of 5). Syntax of the CRTCBLPGM Command

```
►──┬─*RANGE───┬─┬─*UNREF───┬─┬─*NOOPTIMIZE─┬─┬─*NODDSFILLER─┬──┬─*NOSYNC─┬──►
   └─*NORANGE─┘ └─*NOUNREF─┘ └─*OPTIMIZE───┘ └─*DDSFILLER───┘  └─*SYNC───┘
```

Figure 4 (Part 3 of 5). Syntax of the CRTCBLPGM Command

```
►──┬─*NOCRTF─┬──┬─*NODUPKEYCHK─┬──┬─*STDERR───┬──┬─*NOEXTACCDSP─┬──────────►
   └─*CRTF───┘  └─*DUPKEYCHK───┘  └─*NOSTDERR─┘  └─*EXTACCDSP───┘
```

Figure 4 (Part 4 of 5). Syntax of the CRTCBLPGM Command

```
►──┬─*NOINZDLT─┬──┬─*NOBLK─┬──┬─*STDINZ───┬──┬─*FS21DUPKY───┬──────────────►
   └─*INZDLT───┘  └─*BLK───┘  └─*NOSTDINZ─┘  └─*NOFS21DUPKY─┘
```

Figure 4 (Part 5 of 5). Syntax of the CRTCBLPGM Command

Compiling Your Source Program For the Previous Release

You can compile a COBOL/400 program on an AS/400 system using the current release of the OS/400 operating system and restore it on an AS/400 system that uses a previous release of the operating system.

The Target Release (TGTRLS) parameter of the CRTCBLPGM command allows you to specify the release level on which you intend to use the object program. The TGTRLS parameter has three possible values: *CURRENT, *PRV and *release-level*:

> Specify *CURRENT if the object program is to be used on the release of the operating system currently running on your system. For example, if V2R2M0 is running on the system, *CURRENT means you intend to use the program on a system with V2R2M0 installed. This value is the default.
>
> Specify *PRV if the object program is to be used on the previous release with modification level 0 of the operating system. For example, if V2R2M0 is running on your system, *PRV means you intend to use the program on a system with V2R1M0 installed.
>
> *release-level* allows you to specify the release level on which you intend to use the object program. The values you can enter for this parameter depend on the current version, release, and modification level, and they change with each new release.

For more information about the TGTRLS parameter, see page 26.

You should be aware of the following limitations:

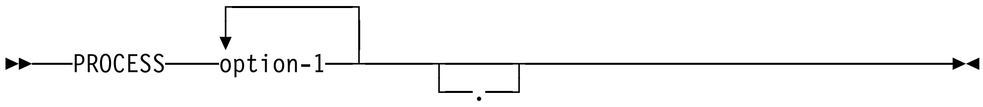
- Support to compile for use with the previous release is only available when you use the TGTRLS parameter of the CRTCBLPGM command. You must specify *PRV or the release level when you compile the program; you must then save the program, using the Save Object (SAVOBJ) or the Save Library (SAVLIB) CL command, in order to successfully restore it to the previous release of the operating system.
- You cannot use the TGTRLS parameter for COBOL programs created in the System/38 environment.
- You can restore an object program to the previous release or to a subsequent release. You cannot restore an object program on a system that is more than one release lower. That is, only one release of downward compatibility is provided.
- You cannot use functions that are new to the current release of the operating system in a program that you compile for use at the previous release level.
- Programs may be retranslated when they are restored to the previous release; therefore, you cannot delete observability if the programs are to be retranslated.
- No product library should be in the system portion of your library list.

Using the PROCESS Statement to Specify Compiler Options

The PROCESS statement is an optional part of the COBOL source program. You can use the PROCESS statement to specify options you would normally specify at compilation time. Options specified in the PROCESS statement override the corresponding options specified in the CRTCBLPGM CL command.

The format of the PROCESS statement is as follows:

Format



The following rules apply:

- The statement must be placed before the first source statement in the COBOL program immediately preceding the IDENTIFICATION DIVISION header.
- The statement begins with the word PROCESS. Options can appear on more than one line; however, only the first line can contain the word PROCESS.
- The word PROCESS and all options must appear within positions 8 through 72. Position 7 must be left blank. The remaining positions can be used as in COBOL source statements: positions 1 through 6 for sequence numbers, positions 73 through 80 for identification purposes.
- The options must be separated by blanks and/or commas.
- Options can appear in any order. If conflicting options are specified, for example, LIST and NOLIST, the last option encountered takes precedence.
- If the option keyword is correct and the suboption is in error, the default suboption is assumed.

Not every CRTCBLPGM parameter has a corresponding option in the PROCESS statement. Refer to the following tables which indicate the allowable PROCESS statement options and the equivalent CRTCBLPGM command parameters and options. Defaults are underlined. Descriptions of the PROCESS statement options correspond to the parameter and option descriptions that start on page 18.

PROCESS Statement Option	**CRTCBLPGM**
	GENLVL Parameter Option
GENLVL(nn)	nn

PROCESS Statement Options	CRTCBLPGM
	OPTION Parameter Options
GEN NOGEN	*GEN *NOGEN
NOMAP MAP	*NOMAP *MAP
NONUMBER NUMBER LINENUMBER	*NONUMBER *NUMBER *LINENUMBER
NOSECLVL SECLVL	*NOSECLVL *SECLVL
NOOPTIONS OPTIONS	*NOOPTIONS *OPTIONS
QUOTE APOST	*QUOTE *APOST
NOSEQUENCE SEQUENCE	*NOSEQUENCE *SEQUENCE
SOURCE (or SRC) NOSOURCE (or NOSRC)	*SOURCE (or *SRC) *NOSOURCE (or *NOSRC)
NOVBSUM VBSUM	*NOVBSUM *VBSUM
NOXREF XREF	*NOXREF *XREF
PRTCORR NOPRTCORR	*PRTCORR *NOPRTCORR

PROCESS Statement Options	CRTCBLPGM
	GENOPT Parameter Options
NOINZDLT INZDLT	*NOINZDLT *INZDLT
NOLIST LIST	*NOLIST *LIST
STDERR NOSTDERR	*STDERR *NOSTDERR
NODDSFILLER DDSFILLER	*NODDSFILLER *DDSFILLER
NOSYNC SYNC	*NOSYNC *SYNC
NOCRTF CRTF	*NOCRTF *CRTF
NODUPKEYCHK DUPKEYCHK	*NODUPKEYCHK *DUPKEYCHK
NOEXTACCDSP EXTACCDSP	*NOEXTACCDSP *EXTACCDSP
NOBLK BLK	*NOBLK *BLK
STDINZ NOSTDINZ	*STDINZ *NOSTDINZ
FS21DUPKEY NOFS21DUPKEY	*FS21DUPKY *NOFS21DUPKY
RANGE NORANGE	*RANGE *NORANGE
UNREF NOUNREF	*UNREF *NOUNREF

PROCESS Statement Options	CRTCBLPGM
	CVTOPT Parameter Options
NOVARCHAR VARCHAR	*NOVARCHAR *VARCHAR
NODATETIME DATETIME	*NODATETIME *DATETIME
NOCVTGRAPHIC CVTGRAPHIC	*NOGRAPHIC *GRAPHIC

PROCESS Statement Options	CRTCBLPGM
	FLAGSTD Parameter Options
NOFIPS MINIMUM INTERMEDIATE HIGH	*NOFIPS *MINIMUM *INTERMEDIATE *HIGH
NOSEG SEG1 SEG2	*NOSEG *SEG1 *SEG2
NODEB DEB1 DEB2	*NODEB *DEB1 *DEB2
NOOBSOLETE OBSOLETE	*NOOBSOLETE *OBSOLETE

PROCESS Statement Options EXTDSPOPT(*a b c*)	CRTCBLPGM
	EXTDSPOPT Parameter Options
DFRWRT NODFRWRT	*DFRWRT *NODFRWRT
UNDSPCHR NOUNDSPCHR	*UNDSPCHR *NOUNDSPCHR
ACCUPDALL ACCUPDNE	*ACCUPDALL *ACCUPDNE

PROCESS Statement Options	CRTCBLPGM
	SAAFLAG Parameter Options
NOSAAFLAG SAAFLAG	*NOFLAG *FLAG

PROCESS Statement Option	CRTCBLPGM
	FLAG Parameter Option
FLAG(nn)	nn

PROCESS Statement Options	CRTCBLPGM
NOFS9MTO0M FS9MTO0M	not applicable
NOGRAPHIC GRAPHIC	not applicable

FS9MTO0M changes a file status of 9M to a file status of 0M.

The GRAPHIC option of the PROCESS statement is available for processing DBCS characters in DBCS literals. See Appendix F, "Supporting International Languages with Double-Byte Character Sets" on page 337 for information about DBCS support.

The EXTDSPOPT option on the PROCESS statement should be coded with the associated options in brackets similar to `FLAG(nn)` syntax. You can specify more than one option within the brackets for the EXTDSPOPT option. For example, to specify DFRWRT and UNDSPCHR, type

```
EXTDSPOPT(DFRWRT UNDSPCHR)
```

It is also valid to specify `EXTDSPOPT` or `EXTDSPOPT( )`.

When EXTDSPOPT alone is specified in the PROCESS statement, then all the default values for the additional options are in effect.

If you specify `EXTDSPOPT( )`, it has no effect on your program.

If conflicting options are specified, the last option specified overrides the others.

Compiling Multiple Programs

The PROCESS statement can be used to separate multiple programs and/or subprograms to be compiled with a single invocation of the compiler. (A **subprogram** is a called program that is combined with the calling program at run time to produce a run unit.) When compiling multiple programs, all compiler options specified on the CRTCBLPGM command statement, plus all default options, plus the options specified on the last PROCESS statement preceding the program will be in effect for the compilation of that program. All compiler output is directed to the destinations specified by the CRTCBLPGM command statement.

All object programs are stored in the library specified on the PGM parameter. If program-name is specified for the PGM parameter, the first program in the batch job has that name, and all other programs use the name specified in the PROGRAM-ID paragraph in the source program.

Using COPY within the PROCESS Statement

A COPY statement can be used in the source program wherever a character-string or separator can be used. Each COPY statement must be preceded by a space and followed by a period and a space. For more information on the COPY statement, refer to the "COPY Statement" section of the *COBOL/400 Reference*.

The Format 1 COPY statement can be used within the PROCESS statement to retrieve compiler options previously stored in a source library, and include them in the PROCESS statement. COPY can be used to include options that override those specified as defaults by the compiler. Any PROCESS statement options can be retrieved with the COPY statement.

Compiler options can both precede and follow the COPY statement within the PROCESS statement. The last encountered occurrence of an option overrides all preceding occurrences of that option.

The following example shows the use of the COPY statement within the PROCESS statement. The COPY statement must be followed by a period. Notice also that, in this example, NOMAP overrides the corresponding option in the library member:

```
000001  PROCESS XREF              MYPROG
000002  COPY DEFLTS.              MYPROG
        MAP, SOURCE, LIST         DEFLTS
000004  NOMAP, FLAG(20)           MYPROG
000010  IDENTIFICATION DIVISION.  MYPROG
```

Understanding Compiler Output

Compiler output can include:

- A summary of command options
- An options listing: a listing of options in effect for the compilation. Use OPTION(*OPTIONS).
- A source listing: a listing of the statements contained in the source program. Use OPTION(*SOURCE or *SRC).
- A verb usage listing: a listing of the COBOL verbs and the number of times each verb is used. Use OPTION(*VBSUM).
- A Data Division map: a glossary of compiler-generated information about the data. Use OPTION(*MAP). Also included is a mapping of user-supplied names to compiler-generated internal names.
- SAA flagging: a list of the functions in your program that are not portable to other SAA COBOL environments. Use SAAFLAG(*FLAG).
- FIPS messages: a list of messages for a FIPS COBOL subset, for any of the optional modules, for all of the obsolete language elements, or for a combination of a FIPS COBOL subset, optional modules and all obsolete elements. Refer to the information on the “FLAGSTD Parameter” on page 25 for the specific options available for FIPS flagging.
- A cross-reference listing. Use OPTION(*XREF).
- Compiler messages (including diagnostic statistics).
- Compilation statistics.
- A listing of the generated program in symbolic form.
- An object program.

The presence or absence of some of these types of compiler output is determined by options specified in the PROCESS statement or through the CRTCBLPGM command. The level of diagnostic messages printed depends upon the FLAG option.

Specifying the Format of Your Listing

A slash (/) in the indicator area (column 7) of a line results in page ejection of the source program listing. The slash (/) comment line prints on the first line of the next page.

IBM Extension

If you specify the EJECT statement in your program, the next source statement prints at the top of the next page in the compiler listing. This statement may be written anywhere in Area A or Area B and must be the only statement on the line.

The SKIP1/2/3 statement causes blank lines to be inserted in the compiler listing. A SKIP1/2/3 statement can be written anywhere in Area A or B. It must be the only statement on the line.

- SKIP1 inserts a single blank line (double spacing).
- SKIP2 inserts two blank lines (triple spacing).
- SKIP3 inserts three blank lines (quadruple spacing).

Each of the above SKIP statements causes a single insertion of one, two, or three lines.

A TITLE statement places a title on each indicated page.

You can selectively list or suppress your COBOL source statements by using the *CONTROL, *CBL, or COPY statements:

- *CONTROL NOSOURCE and *CBL NOSOURCE suppress the listing of source statements.
- *CONTROL SOURCE and *CBL SOURCE continue the listing of source statements.
- A COPY statement bearing the SUPPRESS phrase suppresses the listing of copied statements. For its duration, this statement overrides any *CONTROL or *CBL statement. If the copied member contains *CONTROL or *CBL statements, the last one runs once the COPY member has been processed.

Refer to the *COBOL/400 Reference* for additional information about the EJECT, SKIP1/2/3, *CONTROL, *CBL, COPY, and TITLE statements.

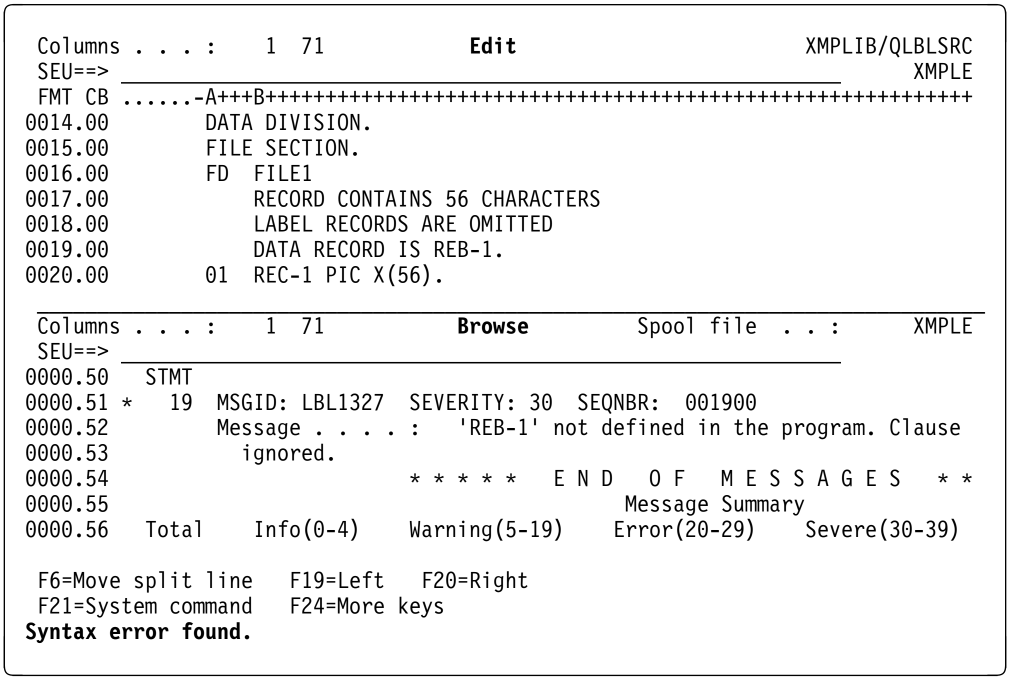
End of IBM Extension

Time-Separation Characters

The TIMSEP parameter of job-related commands (such as CHGJOB) now specifies the time-separation character used in the time stamps that appear on compiler listings. In the absence of a TIMSEP value, the system value QTIMSEP is used by default.

Browsing Your Compiler Listing Using SEU

The Source Entry Utility (SEU) allows you to browse through a compiler listing in an output queue. You can review the results of a previous compilation while making the required changes to your source code. Figure 5 shows the split-display in SEU that allows you to browse through the listing from a work station.



```
 Columns . . . :    1  71           Edit                    XMPLIB/QLBLSRC
 SEU==> ____________________________________________________________  XMPLE
 FMT CB ......-A+++B++++++++++++++++++++++++++++++++++++++++++++++++++++++++
0014.00       DATA DIVISION.
0015.00       FILE SECTION.
0016.00       FD  FILE1
0017.00           RECORD CONTAINS 56 CHARACTERS
0018.00           LABEL RECORDS ARE OMITTED
0019.00           DATA RECORD IS REB-1.
0020.00       01  REC-1 PIC X(56).
 ___________________________________________________________________________
 Columns . . . :    1  71           Browse        Spool file  . . :      XMPLE
 SEU==> ____________________________________________________________
0000.50   STMT
0000.51 *   19  MSGID: LBL1327  SEVERITY: 30  SEQNBR:  001900
0000.52        Message . . . . :   'REB-1' not defined in the program. Clause
0000.53          ignored.
0000.54                         * * * * *   E N D   O F   M E S S A G E S   * *
0000.55                                           Message Summary
0000.56   Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)

 F6=Move split line   F19=Left   F20=Right
 F21=System command   F24=More keys
Syntax error found.
```

Figure 5. SEU Split Edit/Browse Display

While browsing the compiler listing, you can scan for errors and correct those source statements that have errors. To scan for errors, type `F *ERR` on the SEU command line.

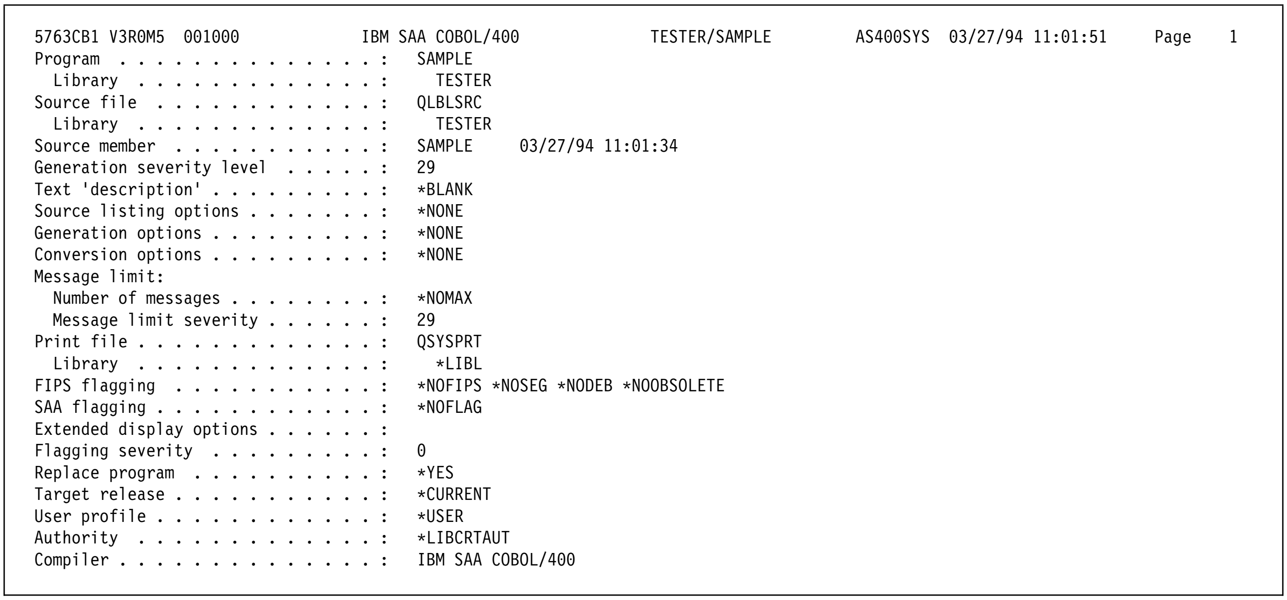
For complete information on browsing through a compiler listing, see the *SEU User's Guide and Reference*.

A Sample Program and Listing

The following pages illustrate the compiler options and source listing produced for the program example. References to the figures are made throughout the following text. These references are indexed by the reverse printing of letters on a black background, for example (Z). The reverse letters in the text correspond to the letters found in the figures.

Command Summary

This summary, which is produced as a result of compilation, lists all options specified in the CRTCBLPGM command. Refer to “Using the Create COBOL Program (CRTCBLPGM) Command” on page 15 for more information about user-defined options.

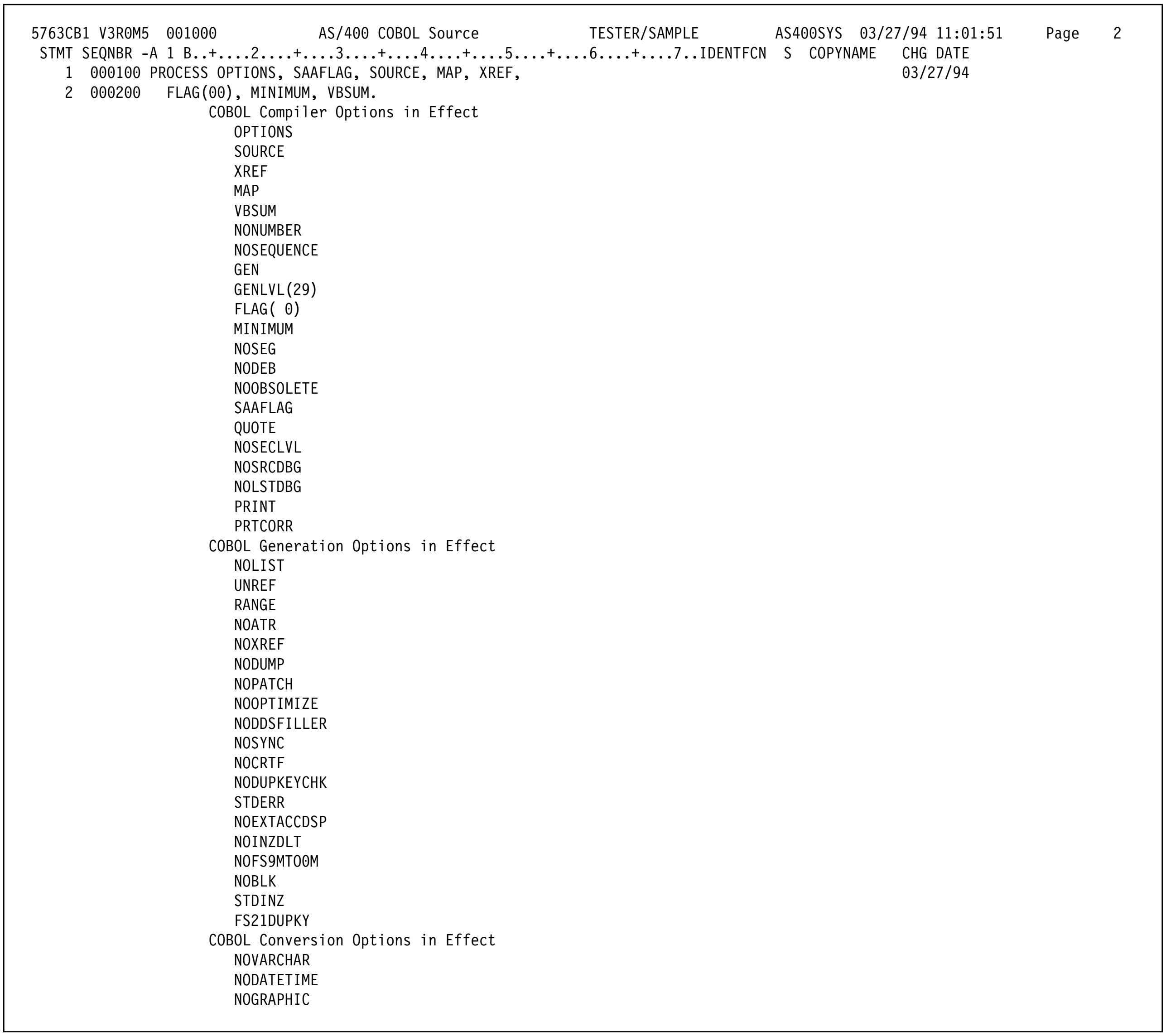


```
 5763CB1 V3R0M5  001000           IBM SAA COBOL/400             TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page    1
 Program . . . . . . . . . . . . . . :   SAMPLE
   Library  . . . . . . . . . . . . . :     TESTER
 Source file  . . . . . . . . . . . . :   QLBLSRC
   Library  . . . . . . . . . . . . . :     TESTER
 Source member  . . . . . . . . . . . :   SAMPLE     03/27/94 11:01:34
 Generation severity level  . . . . . :   29
 Text 'description' . . . . . . . . . :   *BLANK
 Source listing options . . . . . . . :   *NONE
 Generation options . . . . . . . . . :   *NONE
 Conversion options . . . . . . . . . :   *NONE
 Message limit:
   Number of messages . . . . . . . . :   *NOMAX
   Message limit severity . . . . . . :   29
 Print file . . . . . . . . . . . . . :   QSYSPRT
   Library  . . . . . . . . . . . . . :     *LIBL
 FIPS flagging  . . . . . . . . . . . :   *NOFIPS *NOSEG *NODEB *NOOBSOLETE
 SAA flagging . . . . . . . . . . . . :   *NOFLAG
 Extended display options . . . . . . :
 Flagging severity  . . . . . . . . . :   0
 Replace program  . . . . . . . . . . :   *YES
 Target release . . . . . . . . . . . :   *CURRENT
 User profile . . . . . . . . . . . . :   *USER
 Authority  . . . . . . . . . . . . . :   *LIBCRTAUT
 Compiler . . . . . . . . . . . . . . :   IBM SAA COBOL/400
```

Figure 6. Command Summary Listing

Identifying the Compiler Options in Effect

The PROCESS statement, if specified, is printed first. Figure 7 is a list of all options in effect for the compilation of the program example: the options specified in the CRTCBLPGM command, as modified by the PROCESS statement. Compiler options are listed at the beginning of all compiler output when the OPTIONS parameter is specified.

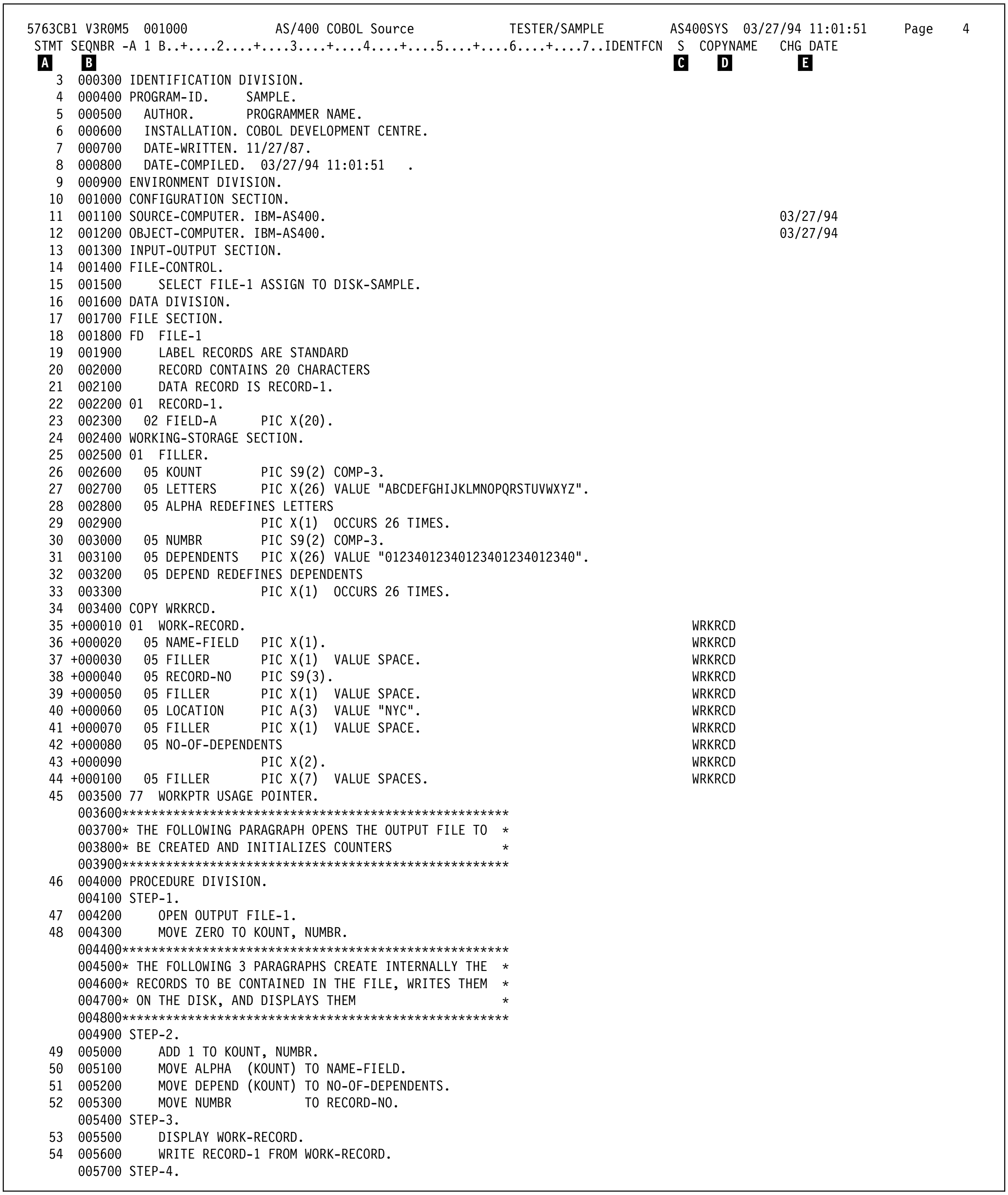


```
 5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page    2
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000100 PROCESS OPTIONS, SAAFLAG, SOURCE, MAP, XREF,                                              03/27/94
     2  000200   FLAG(00), MINIMUM, VBSUM.
                        COBOL Compiler Options in Effect
                           OPTIONS
                           SOURCE
                           XREF
                           MAP
                           VBSUM
                           NONUMBER
                           NOSEQUENCE
                           GEN
                           GENLVL(29)
                           FLAG( 0)
                           MINIMUM
                           NOSEG
                           NODEB
                           NOOBSOLETE
                           SAAFLAG
                           QUOTE
                           NOSECLVL
                           NOSRCDBG
                           NOLSTDBG
                           PRINT
                           PRTCORR
                        COBOL Generation Options in Effect
                           NOLIST
                           UNREF
                           RANGE
                           NOATR
                           NOXREF
                           NODUMP
                           NOPATCH
                           NOOPTIMIZE
                           NODDSFILLER
                           NOSYNC
                           NOCRTF
                           NODUPKEYCHK
                           STDERR
                           NOEXTACCDSP
                           NOINZDLT
                           NOFS9MTO0M
                           NOBLK
                           STDINZ
                           FS21DUPKY
                        COBOL Conversion Options in Effect
                           NOVARCHAR
                           NODATETIME
                           NOGRAPHIC
```

Figure 7. List of Options in Effect

Source Listing

Figure 8 illustrates a source listing. The statements in the source program are listed exactly as submitted. The source is not listed if the NOSOURCE option is specified. After the page in which the PROGRAM-ID paragraph is listed, all compiler output pages have the program-id name listed in the heading before the system name.



```
 5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/SAMPLE         AS400SYS  03/27/94 11:01:51     Page    4
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  A     B                                                                                 C     D          E
    3  000300 IDENTIFICATION DIVISION.
    4  000400 PROGRAM-ID.     SAMPLE.
    5  000500   AUTHOR.       PROGRAMMER NAME.
    6  000600   INSTALLATION. COBOL DEVELOPMENT CENTRE.
    7  000700   DATE-WRITTEN. 11/27/87.
    8  000800   DATE-COMPILED.  03/27/94 11:01:51   .
    9  000900 ENVIRONMENT DIVISION.
   10  001000 CONFIGURATION SECTION.
   11  001100 SOURCE-COMPUTER. IBM-AS400.                                                              03/27/94
   12  001200 OBJECT-COMPUTER. IBM-AS400.                                                              03/27/94
   13  001300 INPUT-OUTPUT SECTION.
   14  001400 FILE-CONTROL.
   15  001500     SELECT FILE-1 ASSIGN TO DISK-SAMPLE.
   16  001600 DATA DIVISION.
   17  001700 FILE SECTION.
   18  001800 FD  FILE-1
   19  001900     LABEL RECORDS ARE STANDARD
   20  002000     RECORD CONTAINS 20 CHARACTERS
   21  002100     DATA RECORD IS RECORD-1.
   22  002200 01  RECORD-1.
   23  002300   02 FIELD-A      PIC X(20).
   24  002400 WORKING-STORAGE SECTION.
   25  002500 01  FILLER.
   26  002600   05 KOUNT        PIC S9(2) COMP-3.
   27  002700   05 LETTERS      PIC X(26) VALUE "ABCDEFGHIJKLMNOPQRSTUVWXYZ".
   28  002800   05 ALPHA REDEFINES LETTERS
   29  002900                   PIC X(1)  OCCURS 26 TIMES.
   30  003000   05 NUMBR        PIC S9(2) COMP-3.
   31  003100   05 DEPENDENTS   PIC X(26) VALUE "01234012340123401234012340".
   32  003200   05 DEPEND REDEFINES DEPENDENTS
   33  003300                   PIC X(1)  OCCURS 26 TIMES.
   34  003400 COPY WRKRCD.
   35 +000010 01  WORK-RECORD.                                                             WRKRCD
   36 +000020   05 NAME-FIELD   PIC X(1).                                                  WRKRCD
   37 +000030   05 FILLER       PIC X(1)  VALUE SPACE.                                     WRKRCD
   38 +000040   05 RECORD-NO    PIC S9(3).                                                 WRKRCD
   39 +000050   05 FILLER       PIC X(1)  VALUE SPACE.                                     WRKRCD
   40 +000060   05 LOCATION     PIC A(3)  VALUE "NYC".                                     WRKRCD
   41 +000070   05 FILLER       PIC X(1)  VALUE SPACE.                                     WRKRCD
   42 +000080   05 NO-OF-DEPENDENTS                                                        WRKRCD
   43 +000090                   PIC X(2).                                                  WRKRCD
   44 +000100   05 FILLER       PIC X(7)  VALUE SPACES.                                    WRKRCD
   45  003500 77  WORKPTR USAGE POINTER.
       003600*****************************************************
       003700* THE FOLLOWING PARAGRAPH OPENS THE OUTPUT FILE TO  *
       003800* BE CREATED AND INITIALIZES COUNTERS               *
       003900*****************************************************
   46  004000 PROCEDURE DIVISION.
       004100 STEP-1.
   47  004200     OPEN OUTPUT FILE-1.
   48  004300     MOVE ZERO TO KOUNT, NUMBR.
       004400*****************************************************
       004500* THE FOLLOWING 3 PARAGRAPHS CREATE INTERNALLY THE  *
       004600* RECORDS TO BE CONTAINED IN THE FILE, WRITES THEM  *
       004700* ON THE DISK, AND DISPLAYS THEM                    *
       004800*****************************************************
       004900 STEP-2.
   49  005000     ADD 1 TO KOUNT, NUMBR.
   50  005100     MOVE ALPHA  (KOUNT) TO NAME-FIELD.
   51  005200     MOVE DEPEND (KOUNT) TO NO-OF-DEPENDENTS.
   52  005300     MOVE NUMBR          TO RECORD-NO.
       005400 STEP-3.
   53  005500     DISPLAY WORK-RECORD.
   54  005600     WRITE RECORD-1 FROM WORK-RECORD.
       005700 STEP-4.
```

Figure 8 (Part 1 of 2). An Example of a COBOL/400 Source Listing

```
   55  005800     PERFORM STEP-2 THRU STEP-3 UNTIL KOUNT IS EQUAL TO 26.
       005900*****************************************************
       006000* THE FOLLOWING PARAGRAPH CLOSES FILE OPENED FOR    *
       006100* OUTPUT AND RE-OPENS IT FOR INPUT                  *
       006200*****************************************************
       006300 STEP-5.
   56  006400     CLOSE FILE-1.
   57  006500     OPEN INPUT FILE-1.
       006600*****************************************************
       006700* THE FOLLOWING PARAGRAPHS READS BACK THE FILE AND  *
       006800* SINGLES OUT EMPLOYEES WITH NO DEPENDENTS          *
       006900*****************************************************
       007000 STEP-6.
   58  007100     READ FILE-1 RECORD INTO WORK-RECORD
   59  007200       AT END GO TO STEP-8.
       007300 STEP-7.
   60  007400     IF NO-OF-DEPENDENTS IS EQUAL TO "0"
   61  007500       MOVE "Z" TO NO-OF-DEPENDENTS.
   62  007600     GO TO STEP-6.
       007700 STEP-8.
   63  007800     CLOSE FILE-1.
   64  007900     STOP RUN.
                          * * * * *  E N D   O F   S O U R C E   * * * * *
```

Figure 8 (Part 2 of 2). An Example of a COBOL/400 Source Listing

Figure 8 displays the following fields:

A *Compiler-generated statement number:* The numbers appear to the left of the source program listing. These numbers are referenced in all compiler output listings except for FIPS messages listings. A statement number can span several lines, and a line can contain more than one statement.

B *Reference number:* The numbers appear to the left of the source statements. The numbers that appear in this field and the column heading (shown as SEQNBR in this listing) are determined by an option specified in the CRTCBLPGM command or in the PROCESS statement, as shown in the following table:

Option	Heading	Origin
NONUMBER	SEQNBR	Source-file sequence numbers
NUMBER	NUMBER	Standard COBOL sequence numbers
LINENUMBER	LINNBR	Compiler-generated sequence numbers

C *Sequence error indicator column:* An S in this column indicates that the line is out of sequence. Sequence checking is performed on the reference number field only if the SEQUENCE option is specified.

D *Copyname:* The copyname, as specified in the COBOL COPY statement, is listed here for all records included in the source program by that COPY statement. If the DDS-ALL-FORMATS phrase is used, the name `<--ALL-FMTS` appears under COPYNAME.

E *Change/date field:* The date the line was last modified is listed here.

Verb Usage by Count Listing

Figure 9 shows the alphabetic list that is produced of all verbs used in the source program. A count of how many times each verb was used is also included. This listing is produced when the VBSUM option is specified.

```
 5763CB1 V3R0M5  001000     AS/400 COBOL Verb Usage By Count       TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page    6
 VERB                   COUNT
 ADD                        1
 CLOSE                      2
 DISPLAY                    1
 GO                         2
 IF                         1
 MOVE                       5
 OPEN                       2
 PERFORM                    1
 READ                       1
 STOP                       1
 WRITE                      1
                   * * * * *  E N D   O F   V E R B   U S A G E   B Y   C O U N T   * * * * *
```

Figure 9. Verb Usage by Count Listing

Data Division Map

The Data Division map is listed when the MAP option is specified. It contains information about names in the COBOL source program. The number of bytes required for the File Section and Working-Storage Section is given at the end of the Data Division map.

```
 5763CB1 V3R0M5  001000      AS/400 COBOL Data Division Map        TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page    7
  STMT LVL  SOURCE NAME                   SECTION    DISP    LENGTH  TYPE   I-NAME    ATTRIBUTES
   F    G     H                              I         J       K       L      M          N
    18  FD  FILE-1                           FS                              .F01      DEVICE DISK, ORGANIZATION SEQUENTIAL,
                                                                                       ACCESS SEQUENTIAL, RECORD CONTAINS 20
                                                                                       CHARACTERS, LABEL RECORDS STANDARD
    22  01  RECORD-1                         FS  00000000       20  GROUP  .D00633C
    23  02  FIELD-A                          FS  00000000       20  AN     .D0063AE
    25  01  FILLER                           WS  00000000       56  GROUP  .D006420
    26  02  KOUNT                            WS  00000000        2  PACKED .D006490
    27  02  LETTERS                          WS  00000002       26  AN     .D006512  VALUE
    28  02  ALPHA                            WS  00000002        1  AN     .D0065B0  REDEFINES .D006512, DIMENSION(26)
    30  02  NUMBR                            WS  00000028        2  PACKED .D006632
    31  02  DEPENDENTS                       WS  00000030       26  AN     .D0066B4  VALUE
    32  02  DEPEND                           WS  00000030        1  AN     .D006754  REDEFINES .D0066B4, DIMENSION(26)
    35  01  WORK-RECORD                      WS  00000000       19  GROUP  .D0067D6
    36  02  NAME-FIELD                       WS  00000000        1  AN     .D00684C
    37  02  FILLER                           WS  00000001        1  AN     .D0068C0  VALUE
    38  02  RECORD-NO                        WS  00000002        3  ZONED  .D00693C
    39  02  FILLER                           WS  00000005        1  AN     .D0069C2  VALUE
    40  02  LOCATION                         WS  00000006        3  A      .D007A98  VALUE
    41  02  FILLER                           WS  00000009        1  AN     .D007B20  VALUE
    42  02  NO-OF-DEPENDENTS                 WS  00000010        2  AN     .D007B9C
    44  02  FILLER                           WS  00000012        7  AN     .D007C16  VALUE
    45  77  WORKPTR                          WS  00000000       16  POINTR .D007C92
FILE SECTION uses 20 bytes of storage
WORKING-STORAGE SECTION uses 75 bytes of storage
                   * * * * *  E N D   O F   D A T A   D I V I S I O N   M A P   * * * * *
```

Figure 10. Data Division Map

The Data Division map displays the following fields:

F *Statement number:* The compiler-generated statement number where the data item was defined is listed for each data item in the Data Division map.

G *Level of data item:* The level number of the data item, as specified in the source program, is listed here. Index-names are identified by an *IX* in the level-number and a blank type field.

H *Source name:* The data name, as specified in the source program, is listed here.

I *Section:* The section where the item was defined is shown here through the use of the following codes:

```
FS  File Section
WS  Working-Storage Section
LS  Linkage Section
SM  Sort/Merge Section
SR  Special Register.
```

J *Displacement:* The offset, in bytes, of the item from the level-01 group item is given here.

K *Length:* The decimal length of the item is listed here.

L *Type:* The data class type for the item is shown here through the use of the following codes:

GROUP	Group Item
A	Alphabetic
AN	Alphanumeric
ANE	Alphanumeric edited
INDEX	Index data item (USAGE INDEX)
BOOLN	Boolean
ZONED	Zoned decimal (external decimal)
PACKED	Packed decimal (internal decimal) (USAGE COMP, COMP-3 or PACKED-DECIMAL)
BINARY	Binary (USAGE COMP-4 or BINARY)
NE	Numeric edited
POINTR	Pointer data item (USAGE POINTER)

M *Internal name:* The compiler-generated internal names are listed here and are assigned as follows:

File names
The internal name uses the form `.Fnn`, where `.F` indicates a file name, and `nn` is a unique two-digit number.

Data names
The internal name uses the form `.Dxxxxxx`, where `.D` indicates a data name or index name, and `xxxxxx` is a unique six-digit hex value. These names appear in the IRP listing if generated.

N *Attributes:* The attributes of the item are listed here as follows:

- For files, the following information can be given:

  Device type
  ORGANIZATION
  ACCESS MODE
  BLOCK CONTAINS information
  RECORD CONTAINS information
  LABEL information
  RERUN is indicated
  SAME AREA is indicated
  CODE-SET is indicated
  SAME RECORD AREA is indicated
  LINAGE is indicated.

- For data items, the attributes indicate if the following information was specified for the item:

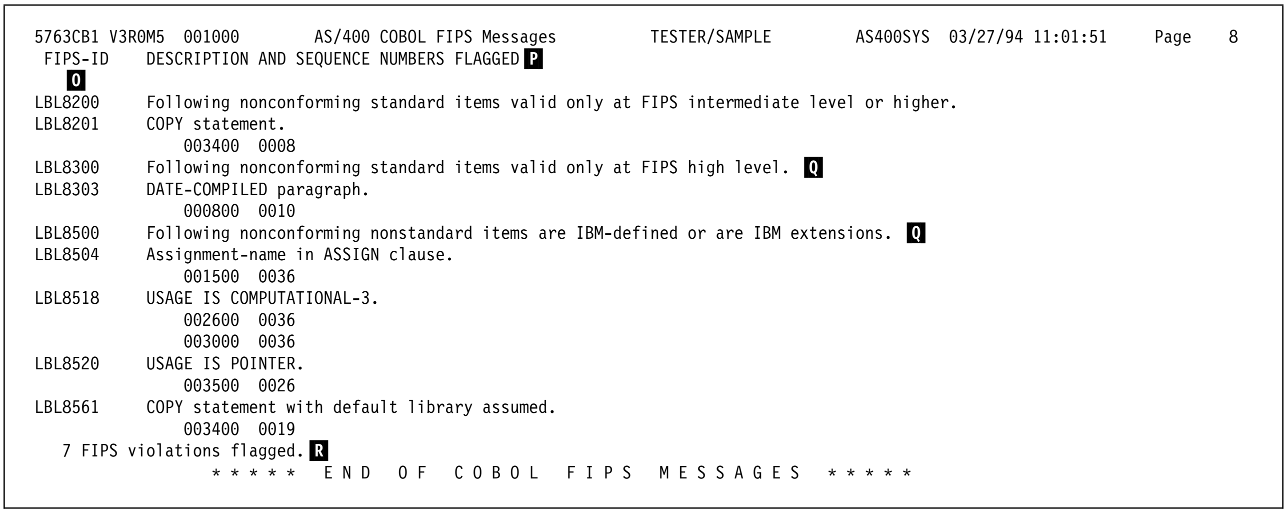
  REDEFINES
  VALUE
  JUSTIFIED
  SYNCHRONIZED
  BLANK WHEN ZERO
  SIGN IS LEADING
  SIGN IS LEADING SEPARATE
  SIGN IS SEPARATE
  INDICATORS.

- For table items, the dimensions for the item are listed here in the form `DIMENSION (nn)`. For each dimension, a maximum OCCURS value is given. When a dimension is a variable, it is listed as such, giving the lowest and highest OCCURS values.

FIPS Messages

The FIPS messages, Figure 11, are listed when the FLAGSTD parameter is specified. See page 25 for more information about specifying the option for FIPS flagging. Only messages for the requested FIPS subset, optional modules and/or obsolete elements are listed.

Note: The sequence number and column number are given for each time the message is issued.



```
5763CB1 V3R0M5  001000       AS/400 COBOL FIPS Messages         TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page    8
 FIPS-ID    DESCRIPTION AND SEQUENCE NUMBERS FLAGGED P
   O
LBL8200     Following nonconforming standard items valid only at FIPS intermediate level or higher.
LBL8201     COPY statement.
                003400  0008
LBL8300     Following nonconforming standard items valid only at FIPS high level.  Q
LBL8303     DATE-COMPILED paragraph.
                000800  0010
LBL8500     Following nonconforming nonstandard items are IBM-defined or are IBM extensions.  Q
LBL8504     Assignment-name in ASSIGN clause.
                001500  0036
LBL8518     USAGE IS COMPUTATIONAL-3.
                002600  0036
                003000  0036
LBL8520     USAGE IS POINTER.
                003500  0026
LBL8561     COPY statement with default library assumed.
                003400  0019
   7 FIPS violations flagged. R
                   * * * * *   E N D   O F   C O B O L   F I P S   M E S S A G E S   * * * * *
```

Figure 11. FIPS Messages

The FIPS messages consist of the following fields:

O *FIPS-ID*: This field lists the FIPS message number.

P *Description and reference numbers flagged:* This field lists a description of the condition flagged, followed by a list of the reference numbers from the source program where this condition is found.

The type of reference numbers used, and their names in the heading (shown as SEQUENCE NUMBERS in this listing) are determined by an option specified in the CRTCBLPGM command or in the PROCESS statement, as shown in the following table:

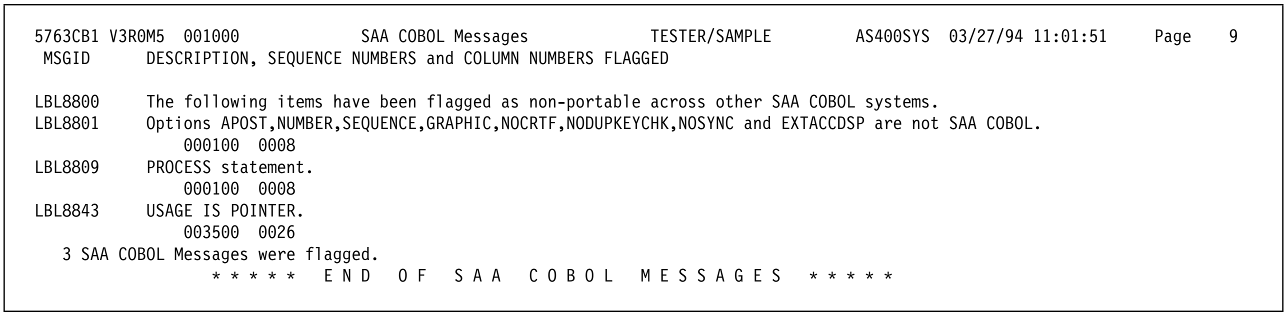
Option	Heading
NONUMBER	DESCRIPTION AND SEQUENCE NUMBERS FLAGGED
NUMBER	DESCRIPTION AND USER-SUPPLIED NUMBERS FLAGGED
LINENUMBER	DESCRIPTION AND LINE NUMBERS FLAGGED

Q *Items grouped by level:* These headings subdivide the FIPS messages by level and category.

R *FIPS violations flagged:* The total number of FIPS violations flagged is included at the end of the FIPS listing.

SAA Messages

Figure 12 shows the SAA messages that are listed when you specify the SAA flagging option. See the SAAFLAG parameter on page 25 or “Using the PROCESS Statement to Specify Compiler Options” on page 32 for more information about specifying this option.



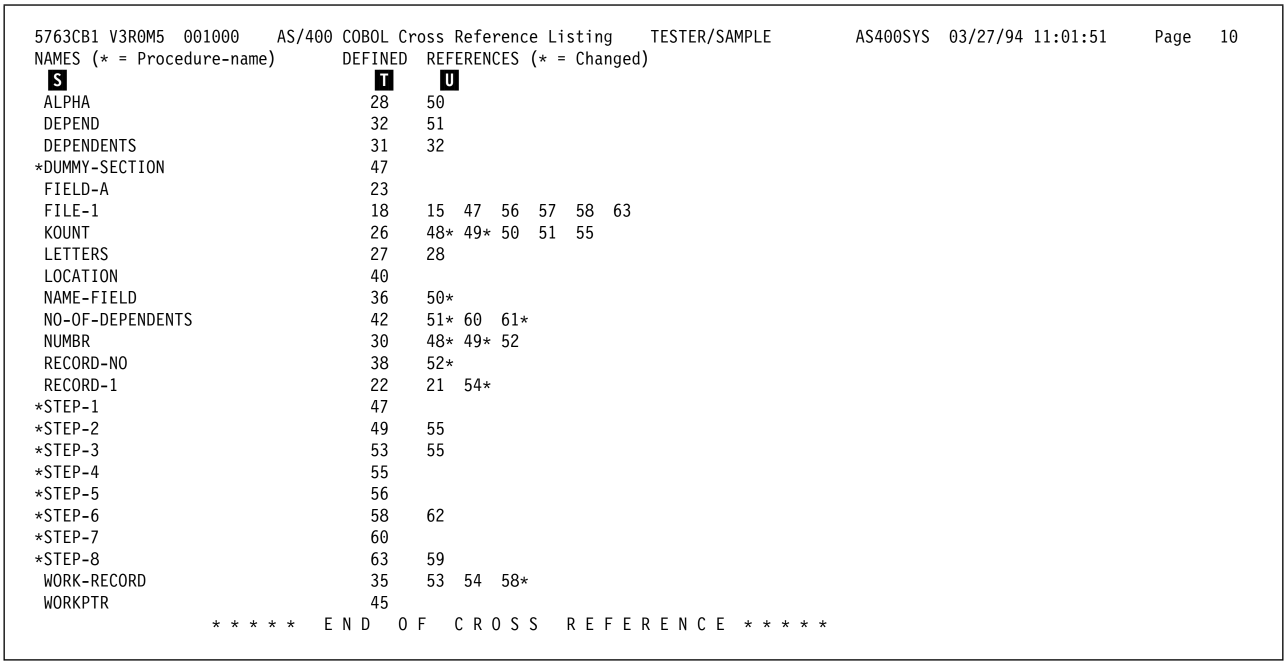
```
 5763CB1 V3R0M5  001000            SAA COBOL Messages            TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page    9
  MSGID      DESCRIPTION, SEQUENCE NUMBERS and COLUMN NUMBERS FLAGGED

 LBL8800     The following items have been flagged as non-portable across other SAA COBOL systems.
 LBL8801     Options APOST,NUMBER,SEQUENCE,GRAPHIC,NOCRTF,NODUPKEYCHK,NOSYNC and EXTACCDSP are not SAA COBOL.
                 000100  0008
 LBL8809     PROCESS statement.
                 000100  0008
 LBL8843     USAGE IS POINTER.
                 003500  0026
    3 SAA COBOL Messages were flagged.
                    * * * * *  E N D   O F   S A A   C O B O L   M E S S A G E S   * * * * *
```

Figure 12. SAA Messages

For more information about SAA flagging, see “SAA Flagging” on page 333.

Cross-Reference Listing

Figure 13 shows the cross-reference listing, which is produced when the XREF option is specified. It provides a list of all data references and procedure-name references, by statement number, within the source program.



```
5763CB1 V3R0M5  001000    AS/400 COBOL Cross Reference Listing    TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page   10
NAMES (* = Procedure-name)       DEFINED  REFERENCES (* = Changed)
 S                                  T     U
 ALPHA                            28    50
 DEPEND                           32    51
 DEPENDENTS                       31    32
*DUMMY-SECTION                    47
 FIELD-A                          23
 FILE-1                           18    15  47  56  57  58  63
 KOUNT                            26    48* 49* 50  51  55
 LETTERS                          27    28
 LOCATION                         40
 NAME-FIELD                       36    50*
 NO-OF-DEPENDENTS                 42    51* 60  61*
 NUMBR                            30    48* 49* 52
 RECORD-NO                        38    52*
 RECORD-1                         22    21  54*
*STEP-1                           47
*STEP-2                           49    55
*STEP-3                           53    55
*STEP-4                           55
*STEP-5                           56
*STEP-6                           58    62
*STEP-7                           60
*STEP-8                           63    59
 WORK-RECORD                      35    53  54  58*
 WORKPTR                          45
                   * * * * *  E N D   O F   C R O S S   R E F E R E N C E * * * * *
```

Figure 13. Cross-Reference Listing

The cross-reference listing displays the following fields:

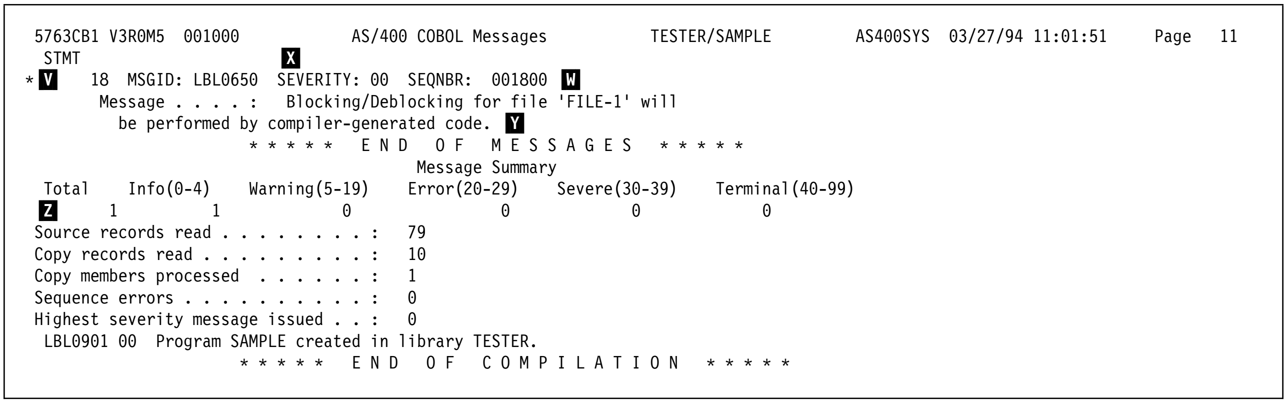
S *Names field:* The data name or procedure name referenced is listed here. All procedure names are flagged with an * before the name. The names are listed alphabetically.

T *Defined field:* The statement number where the name was defined within the source program is listed here.

U *References field:* All statement numbers are listed in the same sequence as the name is referenced in the source program. An * following a statement number indicates that the item was modified in that statement.

Messages

Figure 14 shows the messages that are generated during program compilation.



```
5763CB1 V3R0M5  001000           AS/400 COBOL Messages          TESTER/SAMPLE        AS400SYS  03/27/94 11:01:51     Page   11
 STMT                        X
*V   18  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  001800  W
       Message . . . . :   Blocking/Deblocking for file 'FILE-1' will
         be performed by compiler-generated code.  Y
                      * * * * *  E N D   O F   M E S S A G E S   * * * * *
                                          Message Summary
 Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
 Z     1         1            0                0             0              0
Source records read . . . . . . . . :   79
Copy records read . . . . . . . . . :   10
Copy members processed  . . . . . . :   1
Sequence errors . . . . . . . . . . :   0
Highest severity message issued . . :   0
 LBL0901 00  Program SAMPLE created in library TESTER.
                     * * * * *  E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 14. Diagnostic Messages

The fields displayed are:

V *Statement number:* This field lists the compiler-generated statement number associated with the statement in the source program for which the message was issued.[1]

W *Reference number:* The reference number is issued here.[1] The numbers that appear in this field and the column heading (shown here as SEQNBR) are determined by an option specified in the CRTCBLPGM command or in the PROCESS statement, as shown in the following table:

Option	Heading	Origin
NONUMBER	SEQNBR	Source-file sequence numbers
NUMBER	NUMBER	User-supplied sequence numbers
LINENUMBER	LINNBR	Compiler-generated sequence numbers

When a message is issued for a record from a copy file, the number is preceded by a +.

X *MSGID* and *Severity Level:* These fields contain the message number and its associated severity level. Severity levels are defined as follows:

00	Informational
10	Warning
20	Error
30	Severe Error
40	Unrecoverable (usually a user error)
50	Unrecoverable (usually a compiler error)

Y *Message:* The message identifies the condition and indicates the action taken by the compiler.

Z *Message statistics:* This field lists the total number of messages and the number of messages by severity level.

The totals listed are the number of messages generated for each severity by the compiler and are not always the number listed. For example, if FLAG(10) is specified, no messages of severity less than 10 are listed. The counts, however, do indicate the number that would have been printed if they had not been suppressed.

[1] The statement number and the reference number do not appear on certain messages that reference missing items. For example, if the PROGRAM-ID paragraph is missing, message LBL0031 appears on the listing with no statement or reference number listed.

Chapter 4. Running Your COBOL Program

This chapter provides the information you need to run your COBOL/400 program.

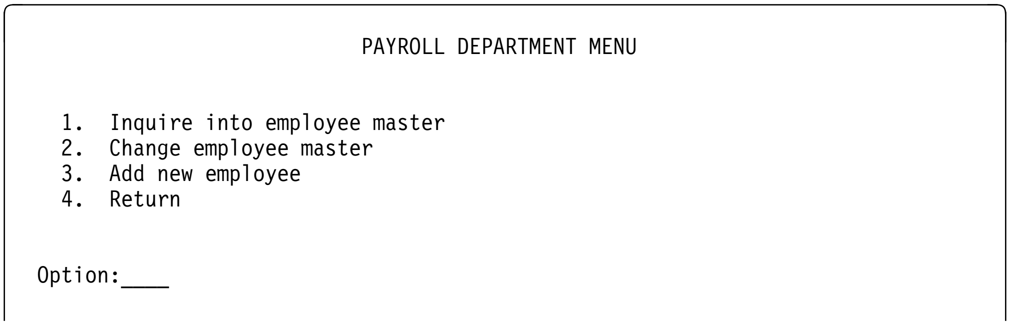
The most common ways to run a COBOL program are:

- Using a Control Language (CL) CALL command
- Using the COBOL CALL statement
- Using a menu-driven application program
- Issuing a user-created command.

You can use a CL CALL command interactively, as part of a batch job, or include it in a CL program. An example of a CL CALL command is CALL PAYROLL. PAYROLL is the name of a COBOL program that is called and run.

Any COBOL program can call another program with the COBOL CALL statement. (See the "CALL Statement" section of the *COBOL/400 Reference* for more information.)

Another way to run a COBOL program is from a menu-driven application. The work station user selects an option from a menu, calling the appropriate program. The following figure illustrates an example of an application menu.



```
                              PAYROLL DEPARTMENT MENU


     1.  Inquire into employee master
     2.  Change employee master
     3.  Add new employee
     4.  Return


  Option:____
```

Figure 15. Example of an Application Menu

The menu shown in this figure is normally displayed by a CL program in which each option calls a separate COBOL program.

You can also create a command yourself to run a COBOL program by using a command definition. A **command definition** is an object that contains the definition of a command (including the command name, parameter descriptions, and validity-checking information), and identifies the program that performs the function requested by the command. The system-recognized identifier for the object is *CMD.

For example, you can create a command, PAY, that calls a program, PAYROLL. PAYROLL is the name of a COBOL program that is called and run. You can enter the command interactively, or in a batch job. See the *CL Programmer's Guide* for further information about using the command definition.

When a COBOL program ends normally, the system returns control to the caller. The caller could be a work station user, a CL program (such as the menu-handling program), or another COBOL program.

If a COBOL program ends abnormally during run time, the escape message LBE9001

```
Error message-id caused program to end.
```

is issued. A CL program can monitor for this exception by using the Monitor Message (MONMSG) command. See the *CL Reference* for more information about control language commands.

If a program ends for any reason other than by the use of the STOP statement or by falling through to the end of the program, the return code is set to 2. See the RTVJOBA and DSPJOB commands in the *CL Programmer's Guide* for more information about return codes.

When you are running a batch job that uses the ACCEPT statement, the input data is taken from the job stream. This data must be placed immediately following the CL CALL for the COBOL program. It is your responsibility to request (through multiple ACCEPT statements) the same amount of data as is available. See the "ACCEPT Statement" section of the *COBOL/400 Reference* for more information.

Note: If more data is requested than is available, the CL command following the data is treated as input data. If more data is available than is requested, each extra line of data is treated as a CL command. In each instance, undesirable results can occur.

Replying to Run-Time Inquiry Messages

When you run a COBOL program, run-time inquiry messages may be generated. The messages require a response before the program continues running.

You can add the inquiry messages to a system reply list to provide automatic replies to the messages. The replies for these messages may be specified individually or generally. This method of replying to inquiry messages is especially suitable for batch programs, which would otherwise require an operator to issue replies.

You can add the following COBOL/400 inquiry messages to the system reply list:

LBE7200
LBE7201
LBE7203
LBE7204
LBE7205
LBE7206
LBE7207
LBE7208
LBE7209
LBE7210
LBE7211
LBE7604.

The reply list is only used when an inquiry message is sent by a job that has the Inquiry Message Reply (INQMSGRPY) attribute specified as `INQMSGRPY(*SYSRPYL)`.

The INQMSGRPY parameter occurs on the following CL commands:

- Change Job (CHGJOB)
- Change Job Description (CHGJOBD)

- Create Job Description (CRTJOBD)
- Submit Job (SBMJOB).

You can select one of four reply modes by specifying one of the following values for the INQMSGRPY parameter:

SAME No change is made in the way that replies are sent to inquiry messages

RQD All inquiry messages require a reply by the receiver of the inquiry messages

DFT A default reply is issued

SYSRPYL The system reply list is checked for a matching reply list entry. If a match occurs, the reply value in that entry is used. If no entry exists for that inquiry message, a reply is required.

You can use the Add Reply List Entry (ADDRPYLE) command to add entries to the system reply list, or the Work with Reply List Entry (WRKRPYLE) command to change or remove entries in the system reply list. See the *CL Reference* for details of the ADDRPYLE and WRKRPYLE commands. You can also reply to runtime inquiry messages with a user-defined error-handler. For more information about error-handling APIs, refer to the *System Programmer's Interface Reference*.

Chapter 5. Debugging Your Program

The COBOL/400 language and the OS/400 operating system provide functions for debugging the programs you develop. This chapter describes those functions that allow you to debug your programs.

OS/400 Functions	COBOL/400 Functions
Breakpoints	Debugging features
Traces	Formatted dump

The OS/400 functions let you test programs while protecting your production files, and let you observe and debug operations as a program runs. No special source code is required for using the OS/400 functions.

The COBOL functions can be used independently of the OS/400 functions or in combination with them to:

- Debug a program
- Produce a formatted dump of the contents of fields, data structures, arrays, and tables.

Source code is required for using COBOL debugging features and formatted dump capability. A formatted dump can also be obtained by a user's response to a run-time message.

OPEN-FEEDBACK and I-O-FEEDBACK contents can provide additional debugging information. The method for obtaining this information is described later in this chapter in "File Status and Feedback Areas" on page 103.

While testing your programs, ensure that your library list is changed to direct the programs to a test library containing test data so that any existing real data is not affected.

To prevent database files in production libraries from being modified unintentionally, you can specify UPDPROD(*NO) on the Start Debug (STRDBG) command or by using the Change Debug (CHGDBG) command. See the *CL Reference* for more information.

Note: Refer to the *CL Programmer's Guide* for the CL commands required for testing and debugging programs.

No special statements for testing are contained in the program being tested. The program can be run normally without modification. All testing functions are specified in the job that contains the program, not in the actual program.

Testing functions apply only to the job in which they are specified. A program can be used concurrently in two jobs: one job that is in a test environment and another that is in a normal processing environment.

Testing functions allow you to observe the operations being performed while the program is running. These functions include using breakpoints and traces. (See "Using Breakpoints" on page 57 and "Using a Trace" on page 64 for more information.)

Avoiding Common Coding Errors

The errors made most frequently by COBOL programmers fall into two classes: compilation-time errors and run-time errors.

The compiler can detect errors when compiling your source program. While it makes corrections based on assumptions about certain errors it finds, you still need to correct the source and compile again if you have errors.

Common coding mistakes include:

- Unmatched record descriptions with externally described files
- Missing copy files
- Misspellings
- Faulty punctuation, especially missing periods
- Incorrect or incomplete syntax
- Misuse of reserved words.

The following errors appear only when you run your program:

- Failing to match the record description in your source program with the format of the actual records on the file to be read. This can either be an error by you (the records are correct, but your description is incorrect) or an error by the person who created the records your program reads. (For example, your description is correct, but one or more records were entered incorrectly.)
- Moving a data item whose subscript or index is too large, is negative, or is 0. Such a move could overlay and destroy part of your code or could fetch faulty data.
- Forgetting to define a sign field for items that can hold negative values. (In such a case, the sign is lost, and the negative number mistakenly becomes positive.)
- Moving data into an area too small for it, causing unwanted truncation.
- Forgetting to initialize the data items in the Working-Storage section before they are used. This may result in a decimal data error.
- In a called program, incorrectly matching the data descriptions in the Linkage Section with those of the caller. Or, in the calling program, incorrectly identifying the data to be passed.
- Moving a group item to another group item when the subordinate data descriptions are incompatible.
- Specifying USAGE for a redefined data item that is different from the USAGE originally specified for the redefined item, and then forgetting about the change once the redefinition takes place.
- Including a GO TO statement with no procedure name, and failing to initialize it with an ALTER statement before the running program reaches that point.
- Failing to include the AT END or INVALID KEY clauses or the USE procedures on files described in the program.
- Failing to match the TRANSACTION file source record description with the display format record description.

Using Breakpoints

A breakpoint is a statement number or a label in your program that stops program processing, and gives control to the display station user or to a specified program. If you use a statement number, it can be a statement number that appears on the compiler listing of the COBOL source program. If you use a label as a breakpoint, the label can be:

- Associated with a function performed by your COBOL program. For example,

  ```
  .OPEN
  ```

  indicates the open file function.

- An internal COBOL compiler generated label. For example,

  ```
  .L000001
  ```

  indicates the first internally generated label.

Note: To determine the internally generated labels for your program, use the GENOPT parameter on the CRTCBLPGM command to get an IRP listing of the program.

When a breakpoint statement is about to be run for an interactive job, the system displays the breakpoint at which the program has stopped and, if requested, the values of program variables. After you get this information (in a display), you can go to a Command Entry display and then enter OS/400 commands to request other functions (such as displaying or changing a variable, adding a breakpoint, or adding a trace). See the *CL Programmer's Guide* for more information on breakpoint concepts.

For a batch job, a breakpoint program can be called when a breakpoint is reached. The breakpoint information is passed to the breakpoint program.

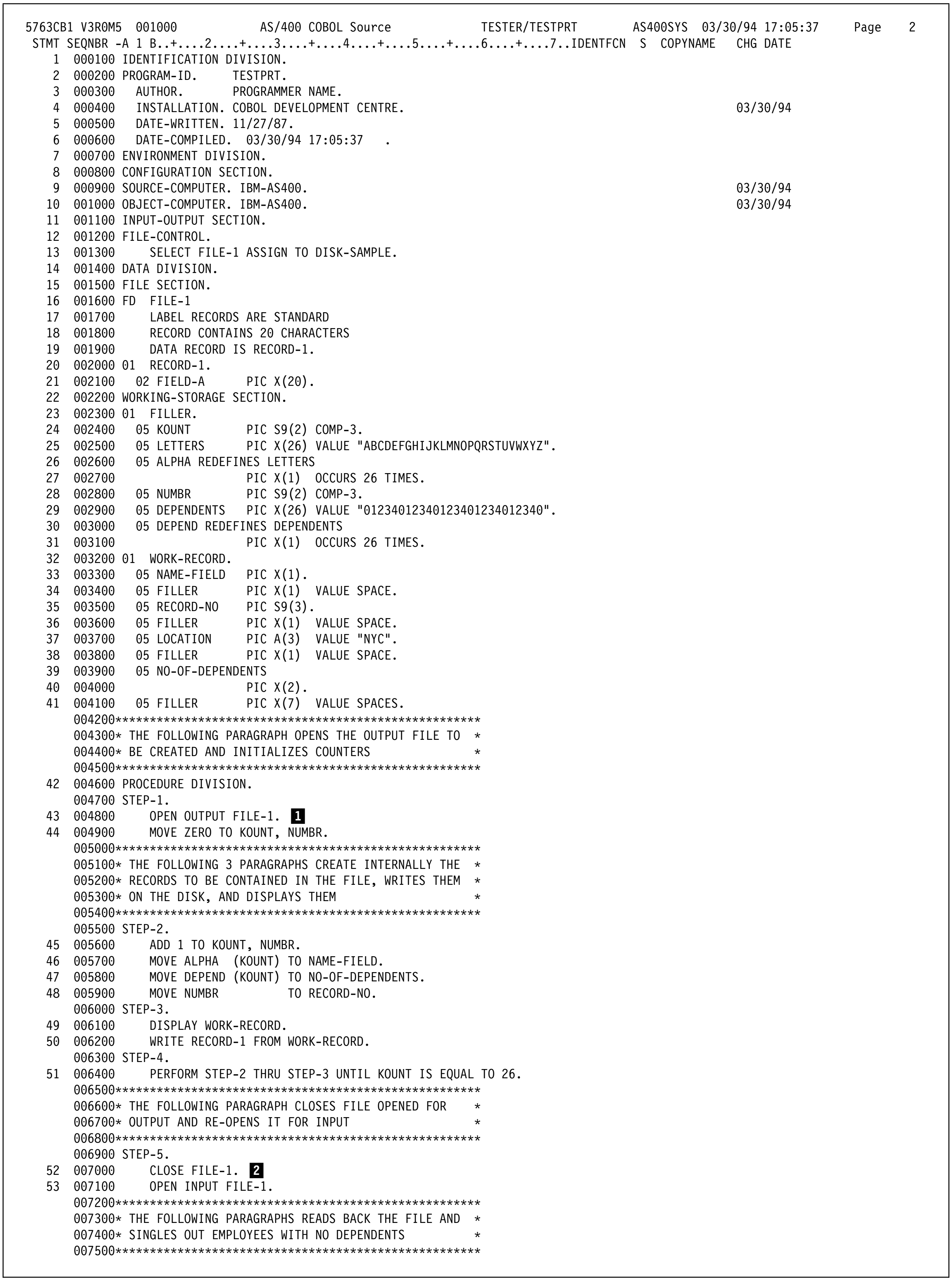
Example of a Program Using Breakpoints

Figure 16 shows an example of a COBOL program using breakpoints. The following OS/400 commands add breakpoints at statements 43 and 52. The value of variable KOUNT is displayed when the breakpoint at statement 52 is reached.

OS/400 Commands:

```
STRDBG     TESTPRT
ADDBKP     STMT(43)
ADDBKP     STMT(52)
           PGMVAR(KOUNT)
```

The OS/400 commands are explained in the *CL Reference.*



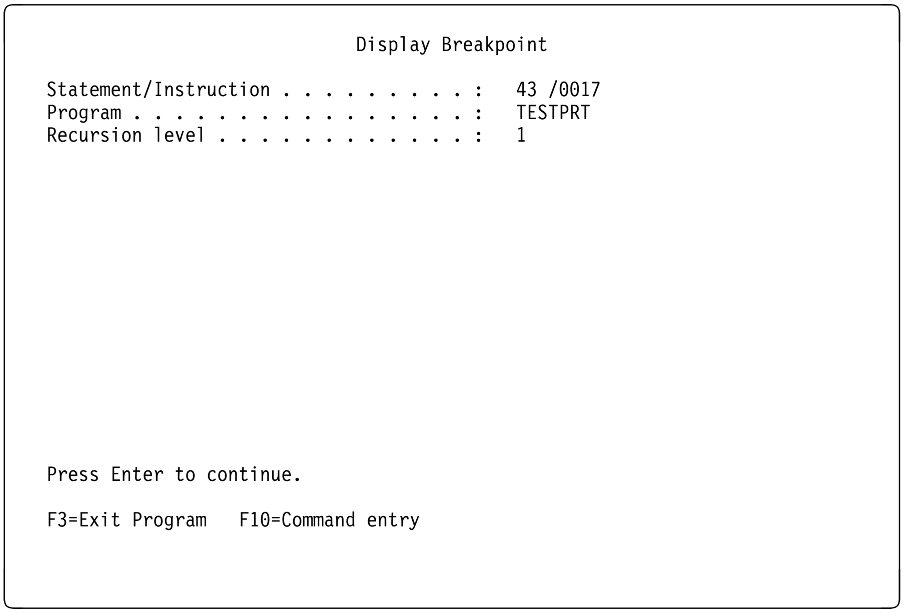
```
5763CB1 V3R0M5  001000           AS/400 COBOL Source             TESTER/TESTPRT        AS400SYS  03/30/94 17:05:37     Page    2
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1 000100 IDENTIFICATION DIVISION.
    2 000200 PROGRAM-ID.     TESTPRT.
    3 000300   AUTHOR.       PROGRAMMER NAME.
    4 000400   INSTALLATION. COBOL DEVELOPMENT CENTRE.                                               03/30/94
    5 000500   DATE-WRITTEN. 11/27/87.
    6 000600   DATE-COMPILED.  03/30/94 17:05:37   .
    7 000700 ENVIRONMENT DIVISION.
    8 000800 CONFIGURATION SECTION.
    9 000900 SOURCE-COMPUTER. IBM-AS400.                                                             03/30/94
   10 001000 OBJECT-COMPUTER. IBM-AS400.                                                             03/30/94
   11 001100 INPUT-OUTPUT SECTION.
   12 001200 FILE-CONTROL.
   13 001300     SELECT FILE-1 ASSIGN TO DISK-SAMPLE.
   14 001400 DATA DIVISION.
   15 001500 FILE SECTION.
   16 001600 FD  FILE-1
   17 001700     LABEL RECORDS ARE STANDARD
   18 001800     RECORD CONTAINS 20 CHARACTERS
   19 001900     DATA RECORD IS RECORD-1.
   20 002000 01  RECORD-1.
   21 002100   02 FIELD-A      PIC X(20).
   22 002200 WORKING-STORAGE SECTION.
   23 002300 01  FILLER.
   24 002400   05 KOUNT        PIC S9(2) COMP-3.
   25 002500   05 LETTERS      PIC X(26) VALUE "ABCDEFGHIJKLMNOPQRSTUVWXYZ".
   26 002600   05 ALPHA REDEFINES LETTERS
   27 002700                   PIC X(1)  OCCURS 26 TIMES.
   28 002800   05 NUMBR        PIC S9(2) COMP-3.
   29 002900   05 DEPENDENTS   PIC X(26) VALUE "01234012340123401234012340".
   30 003000   05 DEPEND REDEFINES DEPENDENTS
   31 003100                   PIC X(1)  OCCURS 26 TIMES.
   32 003200 01  WORK-RECORD.
   33 003300   05 NAME-FIELD   PIC X(1).
   34 003400   05 FILLER       PIC X(1)  VALUE SPACE.
   35 003500   05 RECORD-NO    PIC S9(3).
   36 003600   05 FILLER       PIC X(1)  VALUE SPACE.
   37 003700   05 LOCATION     PIC A(3)  VALUE "NYC".
   38 003800   05 FILLER       PIC X(1)  VALUE SPACE.
   39 003900   05 NO-OF-DEPENDENTS
   40 004000                   PIC X(2).
   41 004100   05 FILLER       PIC X(7)  VALUE SPACES.
      004200*****************************************************
      004300* THE FOLLOWING PARAGRAPH OPENS THE OUTPUT FILE TO  *
      004400* BE CREATED AND INITIALIZES COUNTERS               *
      004500*****************************************************
   42 004600 PROCEDURE DIVISION.
      004700 STEP-1.
   43 004800     OPEN OUTPUT FILE-1. 1
   44 004900     MOVE ZERO TO KOUNT, NUMBR.
      005000*****************************************************
      005100* THE FOLLOWING 3 PARAGRAPHS CREATE INTERNALLY THE  *
      005200* RECORDS TO BE CONTAINED IN THE FILE, WRITES THEM  *
      005300* ON THE DISK, AND DISPLAYS THEM                    *
      005400*****************************************************
      005500 STEP-2.
   45 005600     ADD 1 TO KOUNT, NUMBR.
   46 005700     MOVE ALPHA  (KOUNT) TO NAME-FIELD.
   47 005800     MOVE DEPEND (KOUNT) TO NO-OF-DEPENDENTS.
   48 005900     MOVE NUMBR          TO RECORD-NO.
      006000 STEP-3.
   49 006100     DISPLAY WORK-RECORD.
   50 006200     WRITE RECORD-1 FROM WORK-RECORD.
      006300 STEP-4.
   51 006400     PERFORM STEP-2 THRU STEP-3 UNTIL KOUNT IS EQUAL TO 26.
      006500*****************************************************
      006600* THE FOLLOWING PARAGRAPH CLOSES FILE OPENED FOR    *
      006700* OUTPUT AND RE-OPENS IT FOR INPUT                  *
      006800*****************************************************
      006900 STEP-5.
   52 007000     CLOSE FILE-1. 2
   53 007100     OPEN INPUT FILE-1.
      007200*****************************************************
      007300* THE FOLLOWING PARAGRAPHS READS BACK THE FILE AND  *
      007400* SINGLES OUT EMPLOYEES WITH NO DEPENDENTS          *
      007500*****************************************************
```

Figure 16 (Part 1 of 2). Example of a COBOL Program Using Breakpoints

```
 5763CB1 V3R0M5  001000            AS/400 COBOL Source             TESTER/TESTPRT        AS400SYS  03/30/94 17:05:37     Page    2
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        007600 STEP-6.
    54  007700     READ FILE-1 RECORD INTO WORK-RECORD
    55  007800       AT END GO TO STEP-8.
        007900 STEP-7.
    56  008000     IF NO-OF-DEPENDENTS IS EQUAL TO "0"
    57  008100       MOVE "Z" TO NO-OF-DEPENDENTS.
    58  008200     GO TO STEP-6.
        008300 STEP-8.
    59  008400     CLOSE FILE-1.
    60  008500     STOP RUN.
                          * * * * *   E N D   O F   S O U R C E   * * * * *
```

Figure 16 (Part 2 of 2). Example of a COBOL Program Using Breakpoints

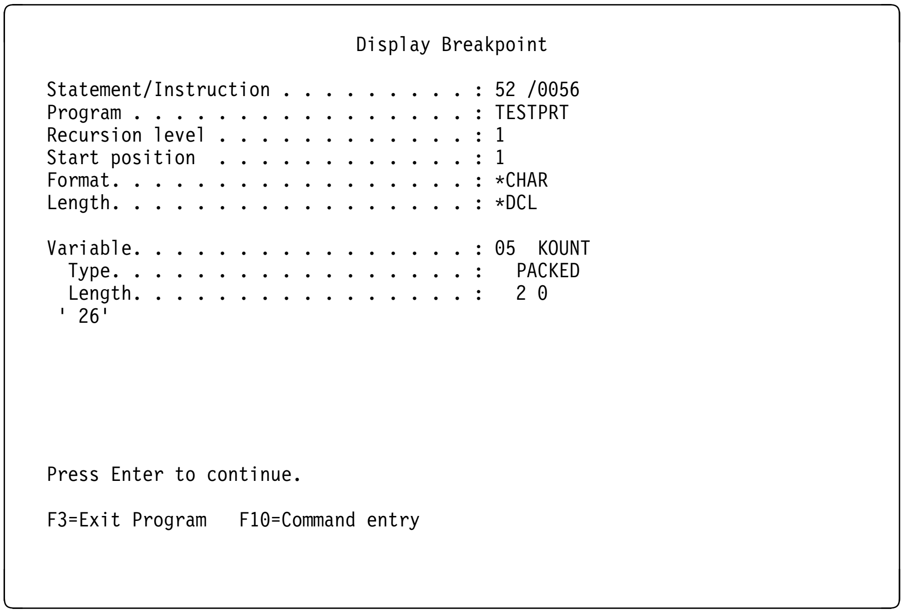
1 The first breakpoint shows you where you are in the program. The following information is displayed when the break occurs:



```
                               Display Breakpoint

 Statement/Instruction . . . . . . . . . :   43 /0017
 Program . . . . . . . . . . . . . . . . :   TESTPRT
 Recursion level . . . . . . . . . . . . :   1









 Press Enter to continue.

 F3=Exit Program   F10=Command entry
```

Figure 17. First Breakpoint Displayed

2 The following information is displayed as a result of reaching the second breakpoint:



```
                              Display Breakpoint

Statement/Instruction . . . . . . . . . : 52 /0056
Program . . . . . . . . . . . . . . . . : TESTPRT
Recursion level . . . . . . . . . . . . : 1
Start position  . . . . . . . . . . . . : 1
Format. . . . . . . . . . . . . . . . . : *CHAR
Length. . . . . . . . . . . . . . . . . : *DCL

Variable. . . . . . . . . . . . . . . . : 05  KOUNT
  Type. . . . . . . . . . . . . . . . . :   PACKED
  Length. . . . . . . . . . . . . . . . :   2 0
 ' 26'






Press Enter to continue.

F3=Exit Program   F10=Command entry
```

Figure 18. Second Breakpoint Displayed

To specify a variable for the PGMVAR parameter, begin every name you enter with an alphanumeric character (A through Z, $, #, or @). It can be followed by the characters (A through Z, 0 though 9, $, #, @, or _).

The following example shows how to display a COBOL variable, RECORD-NO, in the program example. Because the hyphen is treated by the OS/400 operating system as a special character, RECORD-NO must be enclosed in quotation marks.

```
STRDBG       TESTPRT
ADDBKP       STMT(58)
             PGMVAR('RECORD-NO')
```

To display the value of a table element, enter the appropriate occurrence numbers (subscripts) with the variable name. Up to seven dimensions of subscripting are allowed, and the subscripts must be separated by commas.

Do not use an index-name or index data-item as a subscript. When an index is entered as a subscript, the operating system uses the internal value of the index as the subscript, and undesirable results can occur.

The following example shows how to specify the COBOL variable TABLE1 with three dimensions.

```
PGMVAR('TABLE1(SUB1, SUB2, SUB3)')
```

One or more blanks are allowed after each comma separating subscripts, but the total length of the variable plus subscripts, parentheses, commas, and blanks specified with the PGMVAR keyword cannot exceed 132 characters. For more information on how to code variables in CL commands, see the *CL Reference*.

Variable names can be qualified in the PGMVAR parameter. For example:

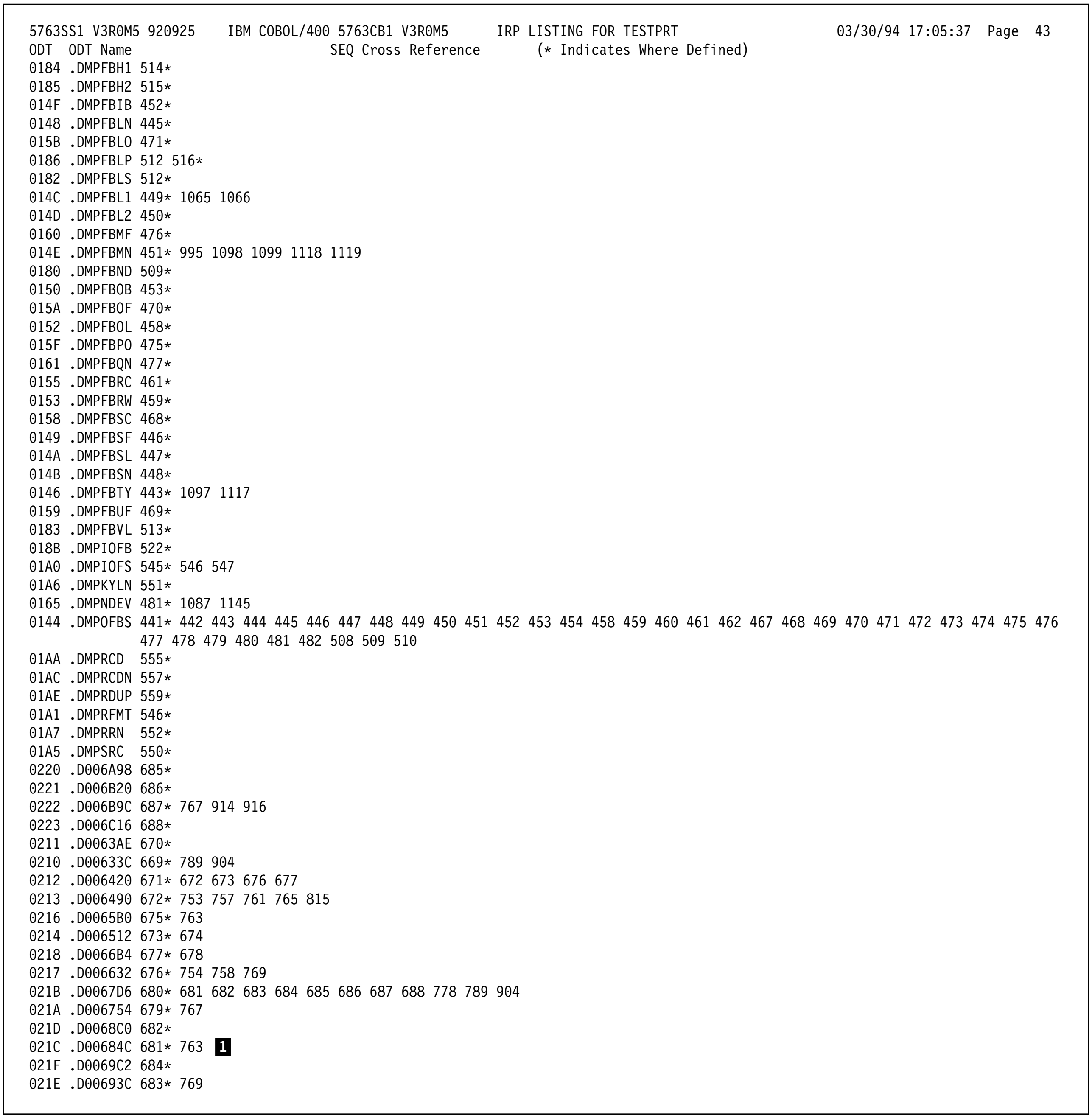
```
PGMVAR('NAME-FIELD OF WORK-RECORD')
```

Another technique can be used to display variables that are not elements of a multi-dimensional table. For example, to display the field NAME-FIELD, you can use the COBOL Data Division map to find its COBOL internal name (I-NAME). Next, use the IRP cross-reference listing to find the Object Definition Table (ODT) number for the internal-name. (See “Using the PROCESS Statement to Specify Compiler Options” on page 32 for information on how to obtain these listings.) Figure 19 shows the Data Division map, and Figure 20 on page 62 shows the cross-reference listing for the program example, TESTPRT.

```
  5763CB1 V3R0M5  001000      AS/400 COBOL Data Division Map        TESTER/TESTPRT        AS400SYS  03/30/94 17:05:37     Page    4
   STMT LVL  SOURCE NAME                   SECTION    DISP   LENGTH  TYPE   I-NAME    ATTRIBUTES
     16  FD  FILE-1                          FS                             .F01      DEVICE DISK, ORGANIZATION SEQUENTIAL,
                                                                                      ACCESS SEQUENTIAL, RECORD CONTAINS 20
                                                                                      CHARACTERS, LABEL RECORDS STANDARD
     20  01  RECORD-1                        FS  00000000       20  GROUP  .D00633C
     21  02  FIELD-A                         FS  00000000       20  AN     .D0063AE
     23  01  FILLER                          WS  00000000       56  GROUP  .D006420
     24  02  KOUNT                           WS  00000000        2  PACKED .D006490
     25  02  LETTERS                         WS  00000002       26  AN     .D006512  VALUE
     26  02  ALPHA                           WS  00000002        1  AN     .D0065B0  REDEFINES .D006512, DIMENSION(26)
     28  02  NUMBR                           WS  00000028        2  PACKED .D006632
     29  02  DEPENDENTS                      WS  00000030       26  AN     .D0066B4  VALUE
     30  02  DEPEND                          WS  00000030        1  AN     .D006754  REDEFINES .D0066B4, DIMENSION(26)
     32  01  WORK-RECORD                     WS  00000000       19  GROUP  .D0067D6
     33  02  NAME-FIELD                      WS  00000000        1  AN     .D00684C  1
     34  02  FILLER                          WS  00000001        1  AN     .D0068C0  VALUE
     35  02  RECORD-NO                       WS  00000002        3  ZONED  .D00693C
     36  02  FILLER                          WS  00000005        1  AN     .D0069C2  VALUE
     37  02  LOCATION                        WS  00000006        3  A      .D006A98  VALUE
     38  02  FILLER                          WS  00000009        1  AN     .D006B20  VALUE
     39  02  NO-OF-DEPENDENTS                WS  00000010        2  AN     .D006B9C
     41  02  FILLER                          WS  00000012        7  AN     .D006C16  VALUE
 FILE SECTION uses 20 bytes of storage
 WORKING-STORAGE SECTION uses 75 bytes of storage
                    * * * * *  END  OF  DATA  DIVISION  MAP  * * * * *
```

Figure 19. Data Division Map for TESTPRT

1 The I-NAME for NAME-FIELD



```
5763SS1 V3R0M5 920925    IBM COBOL/400 5763CB1 V3R0M5      IRP LISTING FOR TESTPRT                   03/30/94 17:05:37  Page  43
ODT  ODT Name                      SEQ Cross Reference       (* Indicates Where Defined)
0184 .DMPFBH1 514*
0185 .DMPFBH2 515*
014F .DMPFBIB 452*
0148 .DMPFBLN 445*
015B .DMPFBLO 471*
0186 .DMPFBLP 512 516*
0182 .DMPFBLS 512*
014C .DMPFBL1 449* 1065 1066
014D .DMPFBL2 450*
0160 .DMPFBMF 476*
014E .DMPFBMN 451* 995 1098 1099 1118 1119
0180 .DMPFBND 509*
0150 .DMPFBOB 453*
015A .DMPFBOF 470*
0152 .DMPFBOL 458*
015F .DMPFBPO 475*
0161 .DMPFBQN 477*
0155 .DMPFBRC 461*
0153 .DMPFBRW 459*
0158 .DMPFBSC 468*
0149 .DMPFBSF 446*
014A .DMPFBSL 447*
014B .DMPFBSN 448*
0146 .DMPFBTY 443* 1097 1117
0159 .DMPFBUF 469*
0183 .DMPFBVL 513*
018B .DMPIOFB 522*
01A0 .DMPIOFS 545* 546 547
01A6 .DMPKYLN 551*
0165 .DMPNDEV 481* 1087 1145
0144 .DMPOFBS 441* 442 443 444 445 446 447 448 449 450 451 452 453 454 458 459 460 461 462 467 468 469 470 471 472 473 474 475 476
              477 478 479 480 481 482 508 509 510
01AA .DMPRCD  555*
01AC .DMPRCDN 557*
01AE .DMPRDUP 559*
01A1 .DMPRFMT 546*
01A7 .DMPRRN  552*
01A5 .DMPSRC  550*
0220 .D006A98 685*
0221 .D006B20 686*
0222 .D006B9C 687* 767 914 916
0223 .D006C16 688*
0211 .D0063AE 670*
0210 .D00633C 669* 789 904
0212 .D006420 671* 672 673 676 677
0213 .D006490 672* 753 757 761 765 815
0216 .D0065B0 675* 763
0214 .D006512 673* 674
0218 .D0066B4 677* 678
0217 .D006632 676* 754 758 769
021B .D0067D6 680* 681 682 683 684 685 686 687 688 778 789 904
021A .D006754 679* 767
021D .D0068C0 682*
021C .D00684C 681* 763  1
021F .D0069C2 684*
021E .D00693C 683* 769
```

Figure 20. Section of IRP Cross-Reference Listing for TESTPRT

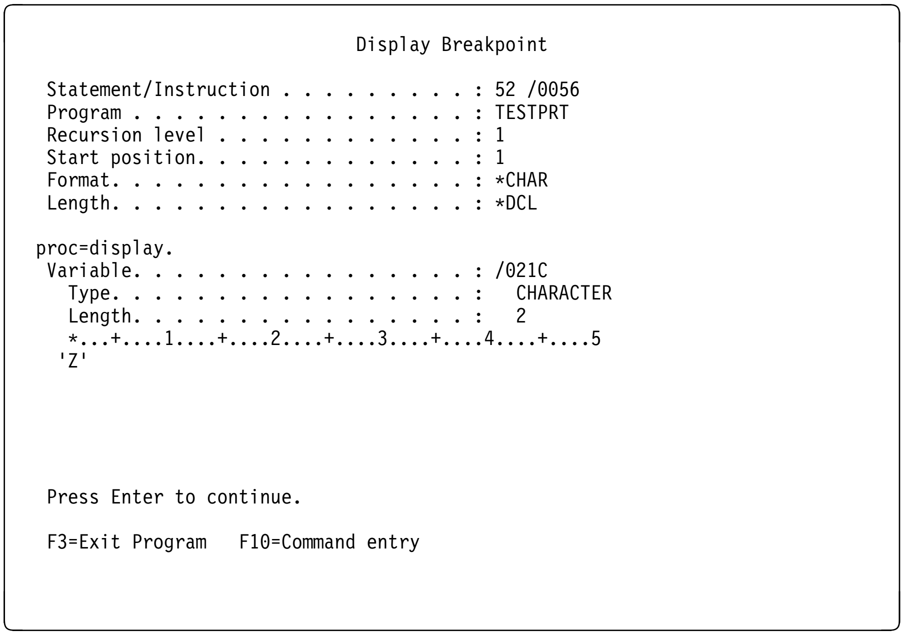
1 021C is the ODT number for NAME-FIELD

Now you can use ODT number 021C (for NAME-FIELD), with the following commands, to add a breakpoint to the program example at statement 52.

```
STRDBG      TESTPRT
ADDBKP      STMT(52)
            PGMVAR('/021C')
```

These commands are explained in the *CL Reference*.

The following is displayed when this breakpoint is reached:



```
                              Display Breakpoint

 Statement/Instruction . . . . . . . . . . : 52 /0056
 Program . . . . . . . . . . . . . . . . . : TESTPRT
 Recursion level . . . . . . . . . . . . . : 1
 Start position. . . . . . . . . . . . . . : 1
 Format. . . . . . . . . . . . . . . . . . : *CHAR
 Length. . . . . . . . . . . . . . . . . . : *DCL

proc=display.
 Variable. . . . . . . . . . . . . . . . . : /021C
   Type. . . . . . . . . . . . . . . . . . :   CHARACTER
   Length. . . . . . . . . . . . . . . . . :   2
   *...+....1....+....2....+....3....+....4....+....5
  'Z'




 Press Enter to continue.

 F3=Exit Program   F10=Command entry
```

Figure 21. Breakpoint at Statement 52

Changing Program Variables

Now you can change the value of program variables to alter your program's processing. You can use the Change Program Variable (CHGPGMVAR) command to change the value of a variable. This procedure is explained in more detail in the *CL Reference*.

You can use the DSPPGMVAR command to display pointer data items, but you cannot use CHGPGMVAR to change pointer data items. To change pointer data items, you use the CHGHLLPTR or CHGPTR commands. For more information on the CHGHLLPTR and CHGPTR commands, refer to the *CL Reference*.

Considerations for Using Breakpoints

You should know the following breakpoint characteristics before using breakpoints:

- If a breakpoint is bypassed by, for example the GO TO statement, that breakpoint isn't processed.
- When a breakpoint is set on a statement, the breakpoint occurs before that statement is processed.
- Breakpoint functions are specified through OS/400 commands.

  These functions include:

  – Adding breakpoints to programs

  – Removing breakpoints from programs

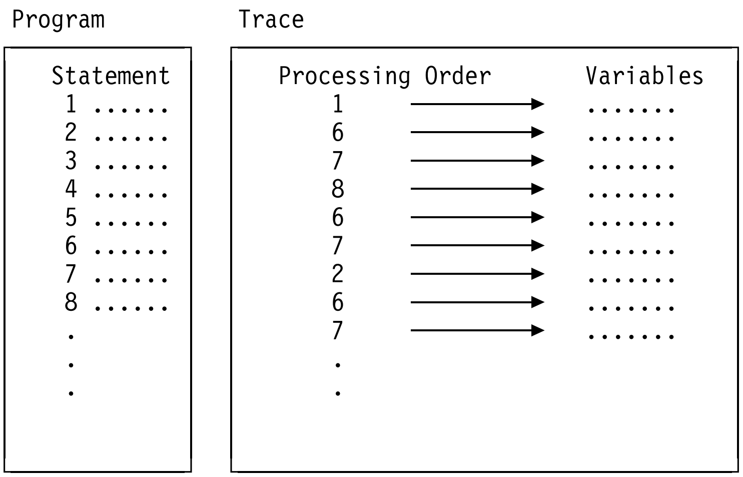
  – Displaying breakpoint information

  – Resuming the running of a program after a breakpoint has been reached (displayed).

See the *CL Programmer's Guide* for descriptions of these commands and for more details about breakpoints.

Using a Trace

A trace is a record of some or all of the statements run in a program. If requested, a trace also records the values of specific variables used in the program statements.



A trace differs from a breakpoint because the number of statements involved in the trace affects where the trace will end. The system records all the traced statements that were processed. You can request a display of the traced information, which shows the sequence in which the statements were processed and, if requested, the values of the variables used in the statements.

You specify which statements the system will trace. You can also specify that variables be displayed only when their value has changed since the last trace statement was run.

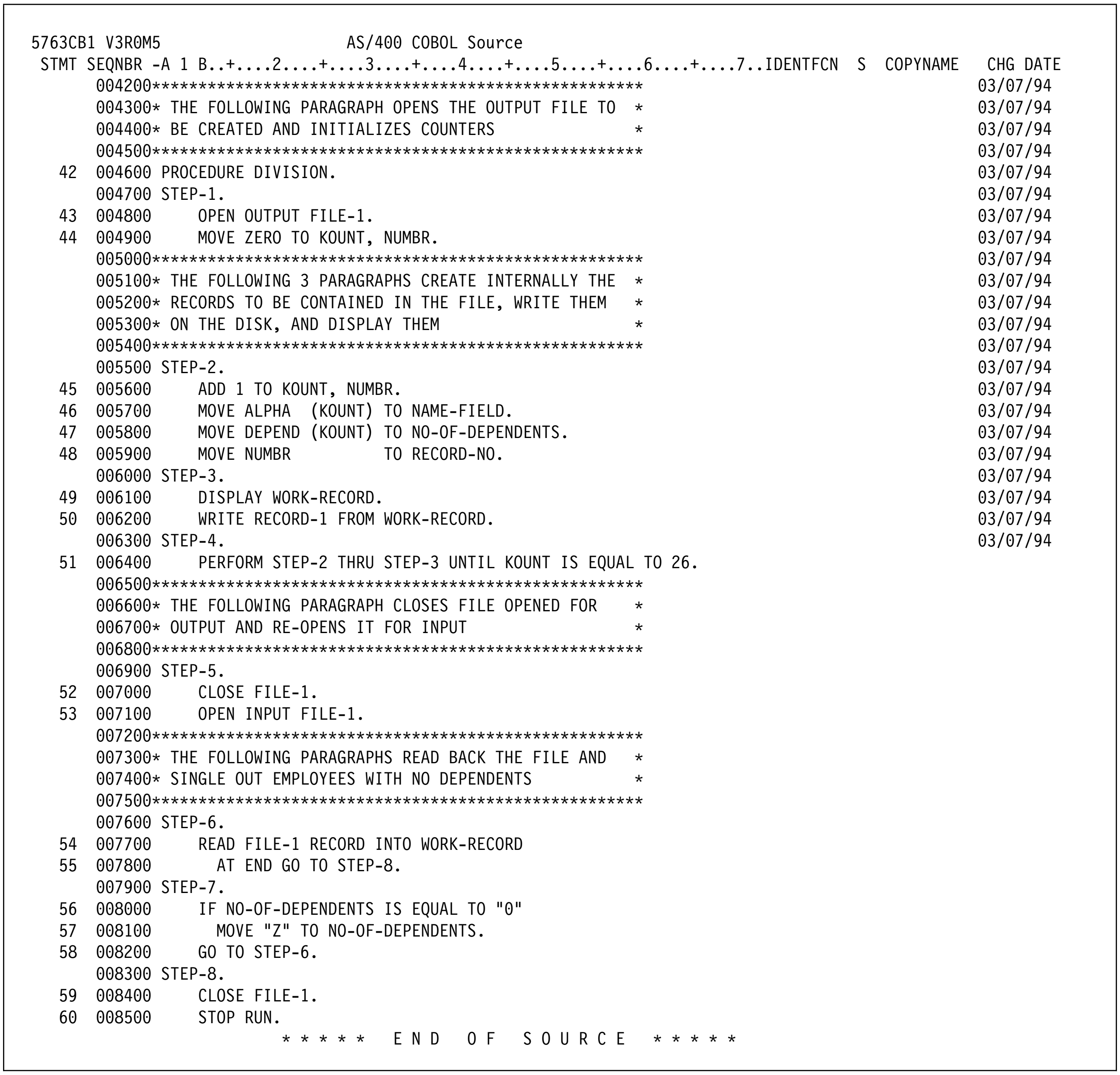
You can specify a trace of one statement in a program, a group of statements in a program, or all the statements in an entire program.

Example of Using a Trace

Figure 22 on page 65 shows a portion of a COBOL program example, TESTPRT. The following OS/400 command adds a trace of statements 54 through 58 in that program. The variable NO-OF-DEPENDENTS is to be recorded only if its value changes between statements 54 and 58:

```
ADDTRC      STMT((54 58))
            PGMVAR('NO-OF-DEPENDENTS')
            OUTVAR(*CHG)
```

Note: STRDBG must be entered before the ADDTRC statement.



```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
       004200*****************************************************                                    03/07/94
       004300* THE FOLLOWING PARAGRAPH OPENS THE OUTPUT FILE TO  *                                    03/07/94
       004400* BE CREATED AND INITIALIZES COUNTERS               *                                    03/07/94
       004500*****************************************************                                    03/07/94
   42  004600 PROCEDURE DIVISION.                                                                     03/07/94
       004700 STEP-1.                                                                                 03/07/94
   43  004800     OPEN OUTPUT FILE-1.                                                                 03/07/94
   44  004900     MOVE ZERO TO KOUNT, NUMBR.                                                          03/07/94
       005000*****************************************************                                    03/07/94
       005100* THE FOLLOWING 3 PARAGRAPHS CREATE INTERNALLY THE  *                                    03/07/94
       005200* RECORDS TO BE CONTAINED IN THE FILE, WRITE THEM   *                                    03/07/94
       005300* ON THE DISK, AND DISPLAY THEM                     *                                    03/07/94
       005400*****************************************************                                    03/07/94
       005500 STEP-2.                                                                                 03/07/94
   45  005600     ADD 1 TO KOUNT, NUMBR.                                                              03/07/94
   46  005700     MOVE ALPHA  (KOUNT) TO NAME-FIELD.                                                  03/07/94
   47  005800     MOVE DEPEND (KOUNT) TO NO-OF-DEPENDENTS.                                            03/07/94
   48  005900     MOVE NUMBR          TO RECORD-NO.                                                   03/07/94
       006000 STEP-3.                                                                                 03/07/94
   49  006100     DISPLAY WORK-RECORD.                                                                03/07/94
   50  006200     WRITE RECORD-1 FROM WORK-RECORD.                                                    03/07/94
       006300 STEP-4.                                                                                 03/07/94
   51  006400     PERFORM STEP-2 THRU STEP-3 UNTIL KOUNT IS EQUAL TO 26.
       006500*****************************************************
       006600* THE FOLLOWING PARAGRAPH CLOSES FILE OPENED FOR    *
       006700* OUTPUT AND RE-OPENS IT FOR INPUT                  *
       006800*****************************************************
       006900 STEP-5.
   52  007000     CLOSE FILE-1.
   53  007100     OPEN INPUT FILE-1.
       007200*****************************************************
       007300* THE FOLLOWING PARAGRAPHS READ BACK THE FILE AND   *
       007400* SINGLE OUT EMPLOYEES WITH NO DEPENDENTS           *
       007500*****************************************************
       007600 STEP-6.
   54  007700     READ FILE-1 RECORD INTO WORK-RECORD
   55  007800       AT END GO TO STEP-8.
       007900 STEP-7.
   56  008000     IF NO-OF-DEPENDENTS IS EQUAL TO "0"
   57  008100       MOVE "Z" TO NO-OF-DEPENDENTS.
   58  008200     GO TO STEP-6.
       008300 STEP-8.
   59  008400     CLOSE FILE-1.
   60  008500     STOP RUN.
                           * * * * *   E N D   O F   S O U R C E   * * * * *
```

Figure 22. Example of a COBOL Program Using a Trace

Figure 23 on page 66 is an example of a listing of the traced information. This information is produced by the Display Trace Data (DSPTRCDTA) command:

```
DSPTRCDTA OUTPUT(*PRINT) CLEAR(*YES)
```

This command is explained in the *CL Reference*.

```
5763SS1 V3R0M5                        Display Trace Data
Job  . . . :   DSP02        User . . . :   PGMRS        Number . . . . :   004122
                 Statement/
Program          Instruction           Recursion Level       Sequence Number
TESTPRT          54                           1                            1
 Start position  . . . . . . . . . . . . : 1
 Length  . . . . . . . . . . . . . . . . : *DCL
 Format  . . . . . . . . . . . . . . . . : *CHAR
 Variable  . . . . . . . . . . . . . . . : 05  NO-OF-DEPENDENTS
   Type  . . . . . . . . . . . . . . . . :   CHARACTER
   Length  . . . . . . . . . . . . . . . :   2
   *...+....1....+....2....+....3....+....4....+....5
  '0 '
                 Statement/
Program          Instruction           Recursion Level       Sequence Number
TESTPRT          56                           1                            2
TESTPRT          57                           1                            3
TESTPRT          58                           1                            4
 Start position  . . . . . . . . . . . . : 1
 Length  . . . . . . . . . . . . . . . . : *DCL
 Format  . . . . . . . . . . . . . . . . : *CHAR
*Variable  . . . . . . . . . . . . . . . : 05  NO-OF-DEPENDENTS
   Type  . . . . . . . . . . . . . . . . :   CHARACTER
   Length  . . . . . . . . . . . . . . . :   2
   *...+....1....+....2....+....3....+....4....+....5
  'Z '
                 Statement/
Program          Instruction           Recursion Level       Sequence Number
TESTPRT          54                           1                            5
TESTPRT          56                           1                            6
 Start position  . . . . . . . . . . . . : 1
 Length  . . . . . . . . . . . . . . . . : *DCL
 Format  . . . . . . . . . . . . . . . . : *CHAR
*Variable  . . . . . . . . . . . . . . . : 05  NO-OF-DEPENDENTS
   Type  . . . . . . . . . . . . . . . . :   CHARACTER
   Length  . . . . . . . . . . . . . . . :   2
   *...+....1....+....2....+....3....+....4....+....5
  '1 '
                 Statement/
Program          Instruction           Recursion Level       Sequence Number
TESTPRT          58                           1                            7
TESTPRT          54                           1                            8
TESTPRT          56                           1                            9
 Start position  . . . . . . . . . . . . : 1
 Length  . . . . . . . . . . . . . . . . : *DCL
 Format  . . . . . . . . . . . . . . . . : *CHAR
*Variable  . . . . . . . . . . . . . . . : 05  NO-OF-DEPENDENTS
   Type  . . . . . . . . . . . . . . . . :   CHARACTER
   Length  . . . . . . . . . . . . . . . :   2
   *...+....1....+....2....+....3....+....4....+....5
  '2 '
                 Statement/
Program          Instruction           Recursion Level       Sequence Number
TESTPRT          58                           1                           10
TESTPRT          54                           1                           11
TESTPRT          56                           1                           12
```

Figure 23. Trace Data Display Listing

Considerations for Using a Trace

You should understand the following trace characteristics before using them:

- Statements bypassed by, for example the GO TO statement, are not included in the trace.
- Trace functions are specified through OS/400 commands in the job containing the traced program. These functions include adding trace requests to a

program, removing trace requests from a program, removing data collected from previous traces, displaying trace information, and displaying the traces that have been specified for a program.

- In addition to statement numbers, names of COBOL-generated routines can appear on the trace output STMT field.

See the *CL Programmer's Guide* for more information on traces.

Using a Debug Run-Time Switch

A run-time switch is provided for the COBOL Debug facility. This switch activates the debugging code generated when WITH DEBUGGING MODE is specified. When the switch is set on, all compiled debugging sections are activated; when it is set off (the default), the USE FOR DEBUGGING Declarative procedures are deactivated. Refer to Appendix B, "Debugging Features" on page 313 for more information on COBOL debugging features and the use of the run-time switch.

Using a COBOL Formatted Dump

Some COBOL run-time messages allow you to obtain a COBOL formatted dump option by selecting either D or F. The formatted dump (choose D) includes current information about the files in your program, contents of fields, data structures, arrays, and tables for user-defined COBOL data variables.

If you choose the F option, the dump also includes a list of compiler-generated fields and their contents.

Both the D option and the F option will dump the first 256 characters of program variables. Any variable greater than 256 characters will be truncated.

If you do not want a dump, specify C (cancel with *no* dump). Reply C is also the default reply for all COBOL inquiry messages that allow a dump.

For more information about reply modes see "Replying to Run-Time Inquiry Messages" on page 52.

The output for the dump is sent to the IBM-supplied printer file QPPGMDMP.

To see an example of a formatted dump, refer to Appendix H, "Example of a COBOL Formatted Dump" on page 371.

Chapter 6. COBOL/400 Exception and Error Handling

This chapter describes COBOL/400 error handling and its use. It also explains the relationship between error handling and the processing of I/O verbs.

The COBOL/400 compiler provides two error-handling methods: standard and non-standard. Standard error handling is not available on compilers released earlier than Version 1 Release 3.

Standard Error Handling

Standard error handling gives you extra compatibility with other IBM COBOL compilers (such as VS COBOL II) as well as non-IBM COBOL compilers. It can help you during the processing of I/O statements by catching severe errors that might not otherwise be noticed.

An important characteristic of standard error handling is the issuing of a run-time message when an error occurs during the processing of an I/O statement if there is no AT END/INVALID KEY phrase in the I/O statement, USE procedure for the file, or FILE STATUS clause in the SELECT statement for the file.

Release Sensitivity!

Standard error handling was introduced in Version 1 Release 3 as a *default* option. To get the error handling that was used in earlier releases, specify *NOSTDERR as a generation option of the CRTCBLPGM command, or NOSTDERR in the PROCESS statement.

Error Handling Overview

When you run a COBOL program, several types of errors can occur. The COBOL statement active at the time of a given error causes certain COBOL clauses or phrases to run.

During arithmetic operations, typical errors are size (MCH1210) errors and decimal data (MCH1202) errors; the corresponding error-handling phrase is the SIZE ERROR phrase.

Most MCH errors are not directly detected by COBOL; they are detected by the operating system and result in system messages. COBOL then monitors for these messages, setting internal bits that determine whether to run a SIZE ERROR imperative statement or issue a run-time message (LBE7200) to end the program.

COBOL does detect errors that result from division by zero during an arithmetic operation. If detected by COBOL, these errors cause the SIZE ERROR imperative statement to run.

System message MCH1210 occurs when you move a numeric field to a receiver that is too small. This error is monitored by COBOL, and also results in the running of the SIZE ERROR imperative statement.

LBE7200 is a run-time message that is usually issued when an unmonitored severe error occurs in your COBOL program. Under *NOSTDERR, it can also be issued when an error occurs in the absence of an appropriate error handler.

System message MCH1202 is a typical example of an unmonitored severe error. This kind of error results in the COBOL run-time message LBE7200 (or LBE7204 if the error occurs in a program called by a COBOL program). System messages MCH3601 and MCH0601 are other examples of unmonitored severe errors.

For I/O operations, there are several important error handling phrases and clauses. These are the AT END/INVALID KEY and NO DATA phrases (coded at the COBOL statement level), the USE procedure, and the FILE STATUS clause (coded at the file level). During arithmetic and I/O operations, errors are detected by the system, which sends messages; the messages are then monitored by COBOL. Similar to the case of an error that results from division by zero, COBOL does detect some errors during an I/O operation. Regardless of how an error is detected during an I/O operation, the result will always be an internal file status in which the first character is not zero, run-time message, or both.

General-Use Programming Interface

Using Error-Handling Application Programming Interfaces (APIs)

You can use COBOL/400 APIs to control error handling for you within your programs. These APIs are Retrieve COBOL Error Handler (QLRRTVCE), and Set COBOL Error Handler (QLRSETCE).

The Retrieve COBOL Error Handler (QLRRTVCE) API allows you to retrieve the name of the current or pending COBOL error-handling program. You can call it from any programming language.

The Set COBOL Error Handler (QLRSETCE) API allows you to specify the identity of a COBOL error-handling program. You can call it from any programming language.

You can also use the Change COBOL Main Program (QLRCHGCM) API to create multiple run units, each with its own error handler.

For detailed information on all of these APIs, refer to the *System Programmer's Interface Reference*.

End of General-Use Programming Interface

Internal and External File Status

You must provide a FILE-CONTROL entry to specify the organization and access method for each file used by your COBOL program. You can also code a FILE STATUS clause in this entry.

The FILE STATUS clause designates one or two data items (coded in the WORKING-STORAGE section) to hold a copy of the result of an I/O operation. Your copy of the first of these items is called the external file status. If you use a TRANSACTION file, you have a further record of the result called the external return code, which consists of the external major and minor return codes.

COBOL keeps its own copies of these two data items, both of which are stored in the COBOL File Information Block (FIB). In this chapter, *file status* and (*major*/*minor*) *return code* refer to COBOL's copies unless otherwise specified.

During the processing of an I/O statement, the file status can be updated in one of three ways, as described below. The contents of the file status determine which error handling procedures to run.

Error handling procedures take control after an unsuccessful input or output operation, which is denoted by any file status in which the first character is not zero. Before any of these procedures run, the file status is copied into the external file status.

The file status is set in one of three ways:

- Method A (all files):

  COBOL checks the contents of variables in file control blocks. If the contents are not what is expected, a file status of other than zero is set. Most file statuses set in this way result from checking the COBOL File Information Block (FIB) and the system User File Control Block (UFCB).

- Method B (transaction files):

  COBOL checks the major and minor return codes from the system. If the major return code is not zero, the return code (consisting of major and minor return codes) is translated into a file status. If the major return code is zero, the file status may have been set by Method A or C.

  Note that for subfile READ, WRITE, and REWRITE operations, only Methods A and C apply.

  For a list of return codes and their corresponding file statuses, see "File Structure Support Summary and Status Key Values" in the *COBOL/400 Reference*.

- Method C (all files):

  A message is sent by the system when COBOL calls on data management to perform an I/O operation. COBOL then monitors for these messages and sets a file status accordingly.

  COBOL specifically monitors for a message by generating message monitors in the program object produced at compilation time. Message monitor generation is based on the types of files (organization type and access type are examples) that you specify in a program. Thus, a message that is specifically monitored for in one program may fall under the generic I/O handler in another. More information about message monitor generation will follow in this chapter.

  COBOL monitors for most messages sent by the system in response to an I/O operation. Typical I/O exceptions result in CPF messages that begin with "CPF4" or "CPF5," and COBOL does specific monitoring for these.

  For a list of messages for which COBOL does specific monitoring, see "File Structure Support Summary and Status Key Values" in the *COBOL/400 Reference*.

General Error Detection

How File Status is Set

001

Start of I/O operation

– Method A: Check contents of variables in file control blocks. (Check, for example, that the file has been opened properly and in the right mode.)

Has internal file status been changed from 00?

Yes No

002

Call on data management to perform I/O operation

– Method C: Monitor for messages sent by data management and set internal file status accordingly.

– Method A: Check system information blocks and set internal file status if not already set using Method C.

Is the file a transaction file?

Yes No

003

Set external file status

– Move internal file status to external file status (specified in file status clause). Based on internal file status, run error handling code.

004

Check major and minor return codes from system

– Method B: If data management has sent a message, translate major and minor return codes associated with system message into internal file status.

Continue at Step 003

005

Continue at Step 003

Message Monitor Generation

A message monitor provides a way for a program to handle messages sent by the system or by another program. A message monitor can handle one or more messages.

In some respects, a message monitor resembles a USE procedure. Similar to the way in which a USE procedure specifies actions to take in response to an I/O error, a message monitor specifies an action to take when an error occurs during the processing of a machine interface (MI) instruction. Note that an MI instructional error is signalled by a system message, and note that each COBOL statement is composed of one or more MI instructions.

Unlike a USE procedure (which may not be active during an entire program), a COBOL message monitor becomes active as soon as the program starts. Message monitors set file statuses and indicate SIZE ERROR, END-OF-PAGE, and OVERFLOW conditions.

Message monitors generated by COBOL are grouped into several sets, generated under certain conditions within a COBOL program. The following table provides general guidelines regarding the generation of message monitors:

Table 1 (Page 1 of 2). Generation of Message Monitors

Cause of Message Monitor	Sample Members of Monitored Message Set
You code a file status clause	• File not found, external file status 35 • Permanent error condition, external file status 30 • OPEN mode not valid, external file status 37 • No next record, system message CPF5183 (part of external file status 46) • Undefined or unauthorized access type, external file status 91 • Logic error, external file status 92 (except for system messages CPF4740 and CPF5070) • Record is locked, external file status 9D • OPEN with commitment control failed, external file status 9P • WRITE not valid, system messages CPF5018 and CPF5272 (part of external file status 24).
You code an AT END phrase	• End-of-file handler, system messages CPF5001 and CPF5025 • File not found, external file status 35.
You specify a subfile in your program	• Last record written to subfile, external file status 9M or 0M • Subfile record not found, system message CPF5020 (part of external file status 23) • Subfile boundary violation, system messages CPF5021 and CPF5043 (part of external file status 24). A **boundary violation** is an attempt to write beyond the externally defined boundaries of a sequential file.

Table 1 (Page 2 of 2). Generation of Message Monitors	
Cause of Message Monitor	**Sample Members of Monitored Message Set**
You code a subfile READ statement with the NEXT MODIFIED phrase	• No modified subfile record, external file status 12.
You use an indexed sequential file	• No specific monitor (Method A), set internal file statuses 21 and 22.
There is a keyed READ operation	• System messages CPF5006 and CPF5013 (part of external file status 23).
There is a sequential WRITE operation	• Boundary violation, system message CPF5116 (part of external file status 34).
There is an indexed sequential REWRITE operation	• No specific monitor (Method A), set internal file statuses 21, 43, 44, and 9S.
There is TRANSACTION I/O	• READ timeout, system message CPF4743, set internal file status 00 • No data during READ, system message CPF4742, set NO DATA bit • No acquired devices, system message CPF5070 (part of external file status 92) • No devices invited/acquired, system message CPF4740 (part of external file status 92 and external file status 10) • Cancel job, external file status 9A • WRITE failed, external file status 9I • Temporary error, external file status 9N.
You specify a format clause in an I/O statement	• Format name not valid/not found, internal file status 9K.
There is any I/O at all (including extended ACCEPT/DISPLAY operations) in your program.	• END-OF-PAGE exception handler (system message CPF5004) • Level check error, external file status 39 • Generic exception handler, external file status 90 • Indicator mismatch (run-time message LBE7421, system message CPF4238) • Ignore COMMIT or ROLLBACK (system message CPF8350). • Duplicate key, external file status 22. • READ DYNAMIC invalid change of direction, internal file status 9U, system message CPF5184.
Note: For a list of monitored messages that fall under a particular external file status, see “File Structure Support Summary and Status Key Values” in the *COBOL/400 Reference*.	

Ending of a COBOL Program

There are three things that can cause a COBOL program to end:

A COBOL statement (EXIT PROGRAM, STOP RUN, or GOBACK)

A reply to an inquiry message

An implicit STOP RUN or EXIT PROGRAM statement.

A STOP RUN statement is implied when a main COBOL program has no next executable statement (implicit EXIT PROGRAM for a COBOL subprogram), that is, when processing falls through the last statement of a program.

Inquiry messages can be issued in response to a COBOL statement (namely a STOP literal), but they are usually issued when a severe error occurs in a program, or when a COBOL operation does not complete successfully. (Examples are LBE7205, LBE7207, and LBE7208.)

There are four common replies to a COBOL inquiry message: C, D, F, and G (cancel, cancel and dump, cancel and full dump, continue). The first three cause (as their final steps) an implicit STOP RUN followed by escape message LBE9001. LBE9001 indicates that the program is ending because of a message.

An implicit or explicit STOP RUN statement, or a GOBACK statement that appears in a main program, ends the entire COBOL run unit. If an escape message (LBE9001) is issued as the final step of a run unit, the caller of the first COBOL program can monitor for it. (This is because the first COBOL program to be called becomes the main program.)

If a COBOL run unit consists of several COBOL and non-COBOL programs, it is the main COBOL program that can issue the escape message. Thus, any non-COBOL program that is called after the main program cannot monitor for the escape message.

Return Codes

When you specify a TRANSACTION file in your program, the FILE STATUS clause of your SELECT statement can contain two data names: the external file status, and the (major and minor) return code. As described under “Internal and External File Status” on page 70, a file status can be set in one of three ways; however, return codes are set by the system after any transaction I/O that calls data management. Consequently, most error conditions that result in a system message also have an associated return code.

Return codes are similar to file status values. That is, CPF messages sent by the system are grouped together under message monitors, and each message monitor sets one or more file statuses.

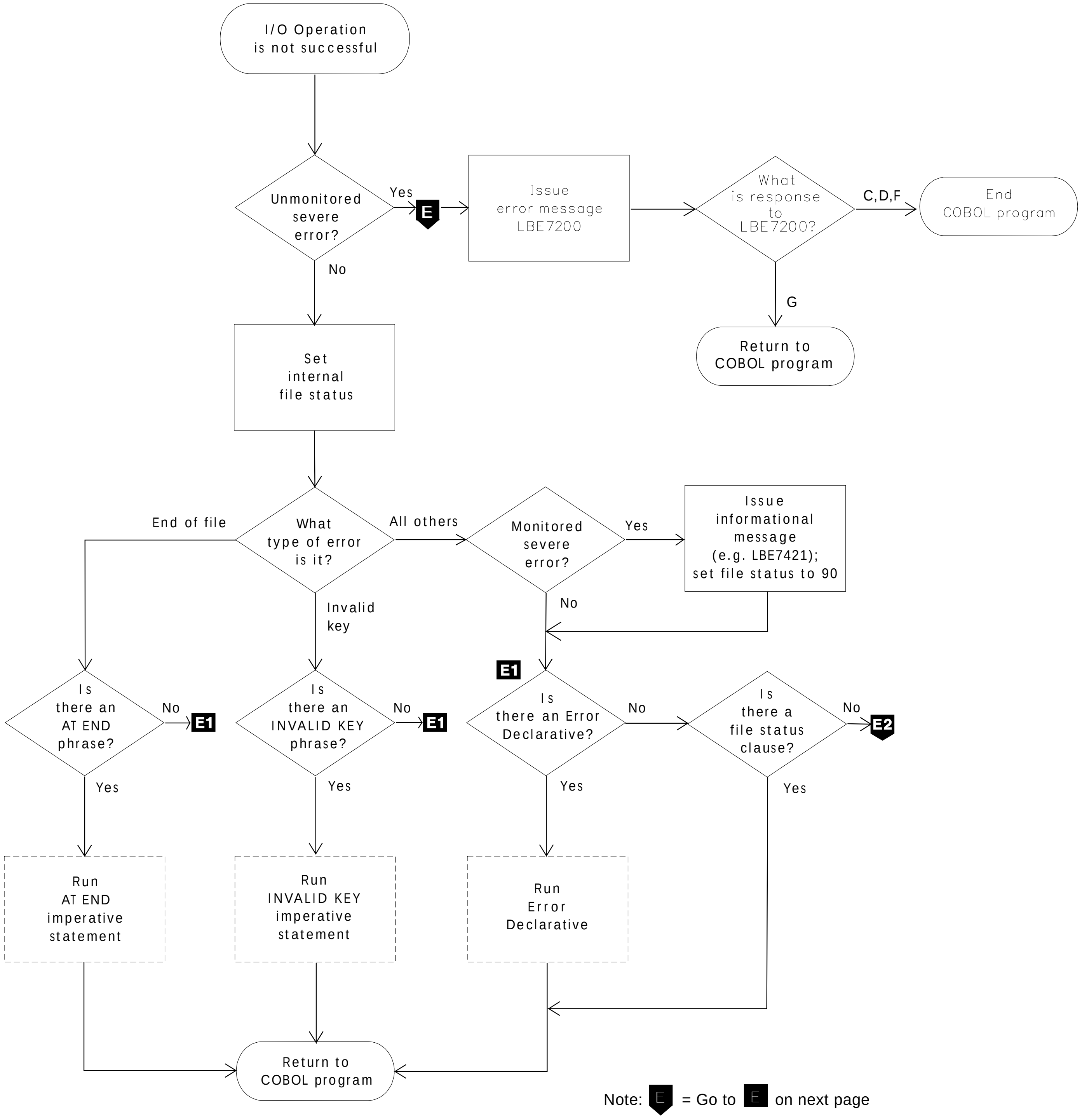
Similarly, CPF messages are grouped together, and each group of messages generates the same major return code. (The minor return code is not necessarily the same.)

The main difference between file statuses and return codes is that the grouping of CPF messages is different.

Although COBOL only sets return codes for TRANSACTION files, other types of files (such as printer files) also set return codes. You can access the return codes for these files through an ACCEPT from I-O-FEEDBACK operation.

Standard and Nonstandard Error Handling Models

Figures 24 and 25 show the two different error handling models.


I/O Operation is not successful
Unmonitored severe error?
Yes
E
Issue error message LBE7200
What is response to LBE7200?
C,D,F
End COBOL program
G
Return to COBOL program
No
Set internal file status
What type of error is it?
End of file
All others
Invalid key
Monitored severe error?
Yes
Issue informational message (e.g. LBE7421); set file status to 90
No
E1
Is there an AT END phrase?
No
E1
Yes
Is there an INVALID KEY phrase?
No
E1
Yes
Is there an Error Declarative?
No
Yes
Is there a file status clause?
No
E2
Yes
Run AT END imperative statement
Run INVALID KEY imperative statement
Run Error Declarative
Return to COBOL program

Note: E = Go to E on next page

Figure 24 (Part 1 of 2). Standard (default) Error Handling

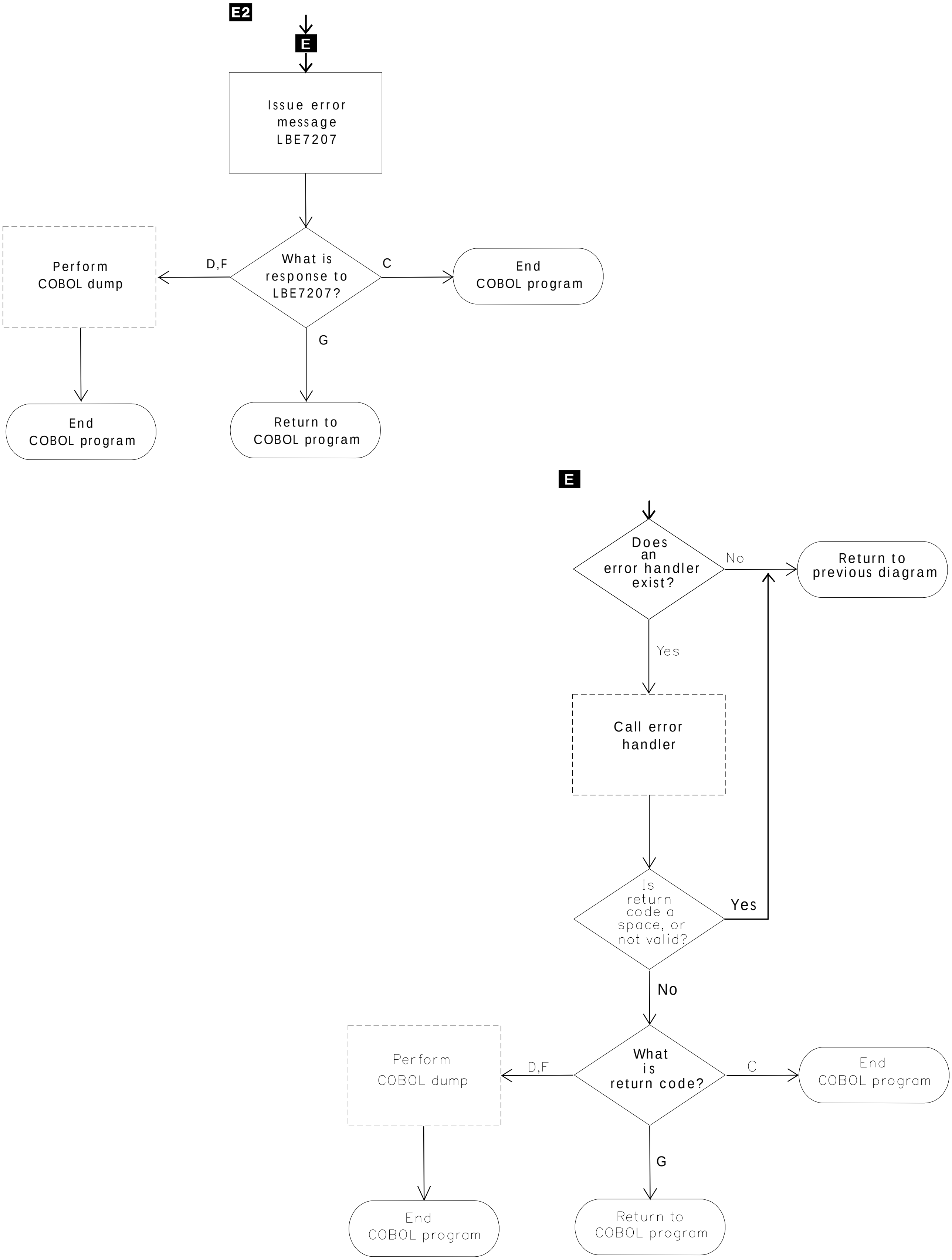
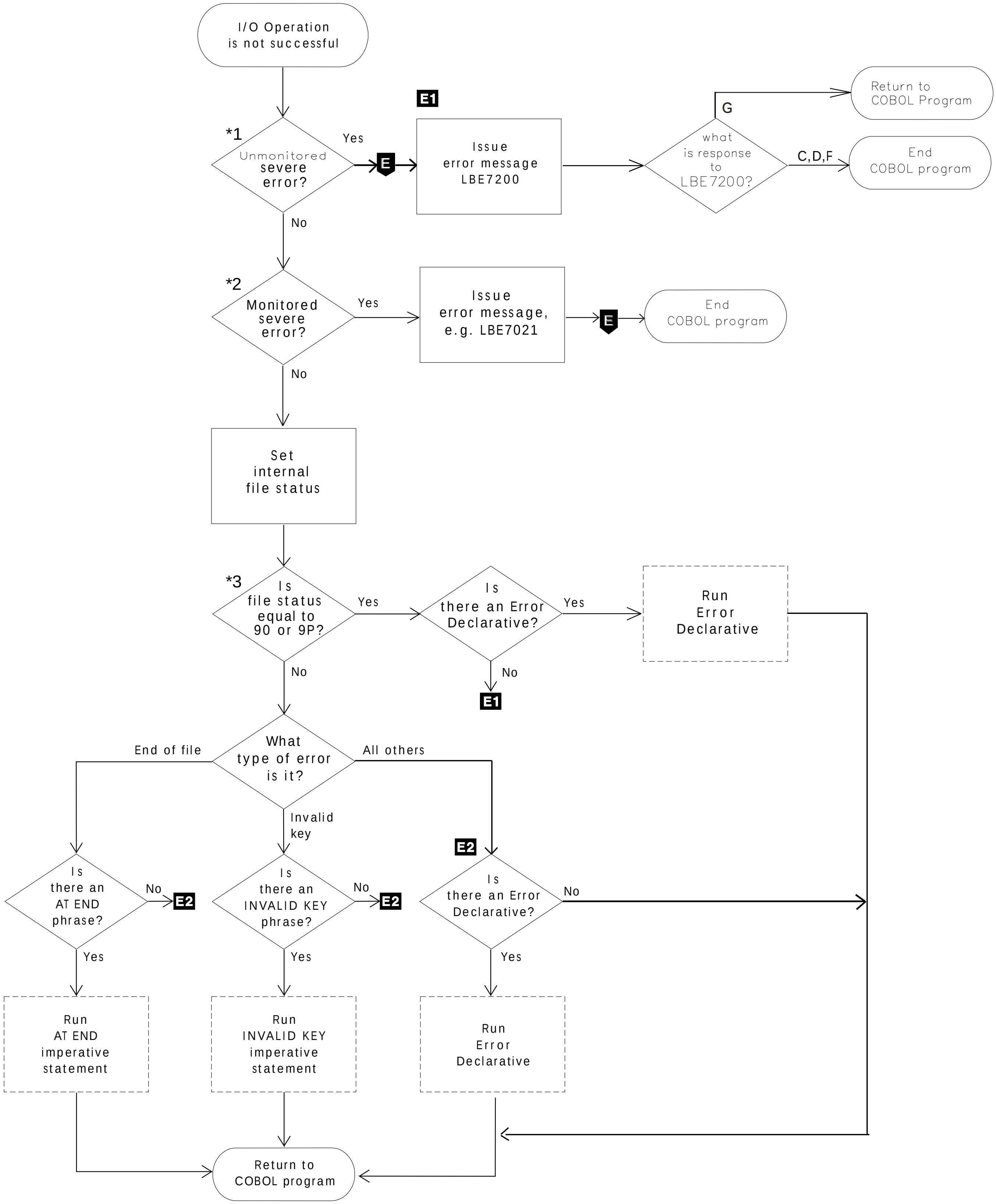


Figure 24 (Part 2 of 2). Standard (default) Error Handling



I/O Operation is not successful
*1
Unmonitored severe error?
Yes
E
E1
Issue error message LBE7200
what is response to LBE7200?
G
Return to COBOL Program
C,D,F
End COBOL program
No
*2
Monitored severe error?
Yes
Issue error message, e.g. LBE7021
E
End COBOL program
No
Set internal file status
*3
Is file status equal to 90 or 9P?
Yes
Is there an Error Declarative?
Yes
Run Error Declarative
No
E1
No
What type of error is it?
End of file
All others
Invalid key
E2
Is there an AT END phrase?
No
E2
Yes
Run AT END imperative statement
Is there an INVALID KEY phrase?
No
E2
Yes
Run INVALID KEY imperative statement
Is there an Error Declarative?
No
Yes
Run Error Declarative
Return to COBOL program

*Figure 25. Nonstandard Error Handling (available through *NOSTDERR option)*

Other I/O exceptions may occur that COBOL does not expect. These also result in CPF4xxx and CPF5xxx messages, but there is not specific monitoring for them. Instead, they are caught by a generic I/O error handler. This error handler monitors for certain ranges of CPF4xxx and CPF5xxx messages; it sets the file status to 90 and follows the *Yes* branch from position *3 in Figure 25 on page 78.

An I/O exception may occur that is being specifically monitored for and which, according to the nonstandard error handling model, is severe enough to stop the program. In this situation no file status is set.

These I/O exceptions result in specific COBOL escape messages followed by an ending of the program; they follow the *Yes* branch from position *2 in Figure 25.

> Example: CPF4238 - INDARA mismatch between program and file
>
> There is specific monitoring for this message, and the result is error message LBE7021 followed by an ending of the program.
>
> Other COBOL messages that fall into this category are LBE7020 and LBE7022.

During an I/O operation, a problem may occur that is not expected by the system. These problems generally result in messages (such as those starting with “MCH”) that fall outside the CPF4xxx and CPF5xxx range. Such errors, known as unmonitored severe errors, follow the *Yes* branch from position *1 in Figure 25. These errors are handled by an all-purpose message monitor and result in an ending of the COBOL program. No file status is set.

Effects of *STDERR and *NOSTDERR on File Status

- Effects of LBE742x and LBE702x messages:

  With *STDERR, file status 90 is set following the issue of LBE742x messages. The program then continues if there is a USE procedure or a FILE STATUS clause.

  With *NOSTDERR, LBE702x messages cause the program to end without setting a file status.

- Ending of a program because of file status 9P or 90:

  With *STDERR, a file status of 9P or 90 arising from an I/O error (signalled by CPF4xxx and CPF5xxx messages) does not cause the program to end as long as there is a USE procedure or a FILE STATUS clause. If neither exists, error message LBE7207 is issued.

  With *NOSTDERR, a file status of 9P or 90 in the absence of a USE procedure causes error message LBE7200 to be issued.

- Issuing of an error message for any file status in which the first character is not zero when there is no error handler or FILE STATUS clause:

  With *STDERR, any file status in which the first character is not zero when there is no AT END/INVALID KEY phrase, USE procedure, or FILE STATUS clause causes inquiry message LBE7207 (with response options C, D, F, and G) to be issued.

  With *NOSTDERR, any file status in which the first character is not zero when there is no AT END/INVALID KEY phrase or USE procedure allows the program to continue unless it has already ended.

Processing of I/O Verbs

The following diagram shows when the USE procedure and the (NOT) AT END, (NOT) INVALID KEY, and NO DATA imperative statements are run. This has been in place since Version 1 Release 3, and is *independent* of the error handling method you choose (*STDERR or *NOSTDERR).

Note that the file status shown here refers to the internal file status.

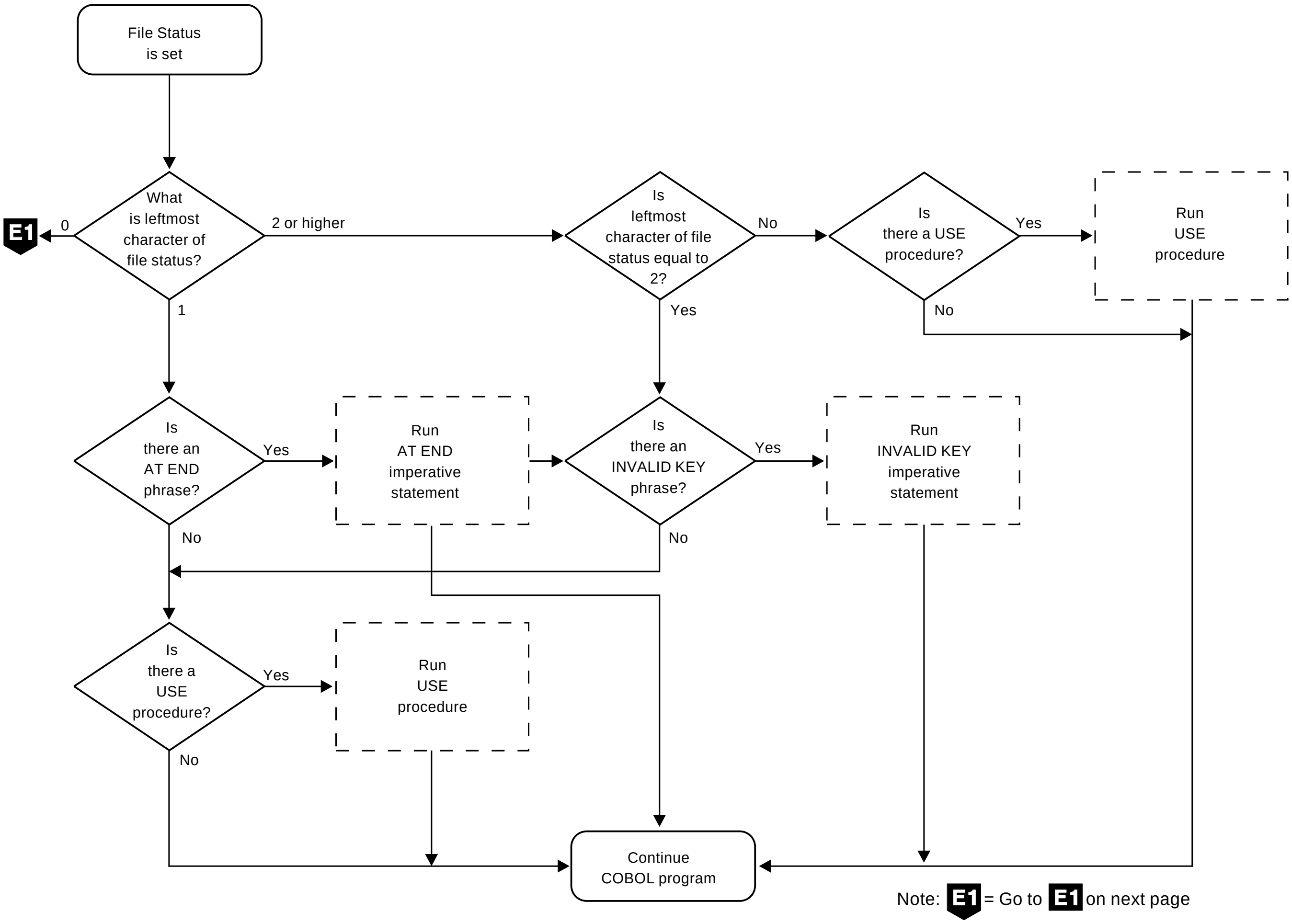

File Status is set
What is leftmost character of file status?
0
E1
2 or higher
1
Is leftmost character of file status equal to 2?
No
Yes
Is there a USE procedure?
Yes
No
Run USE procedure
Is there an AT END phrase?
Yes
No
Run AT END imperative statement
Is there an INVALID KEY phrase?
Yes
No
Run INVALID KEY imperative statement
Is there a USE procedure?
Yes
No
Run USE procedure
Continue COBOL program
Note: E1 = Go to E1 on next page

Figure 26 (Part 1 of 2). Processing of I/O Verbs

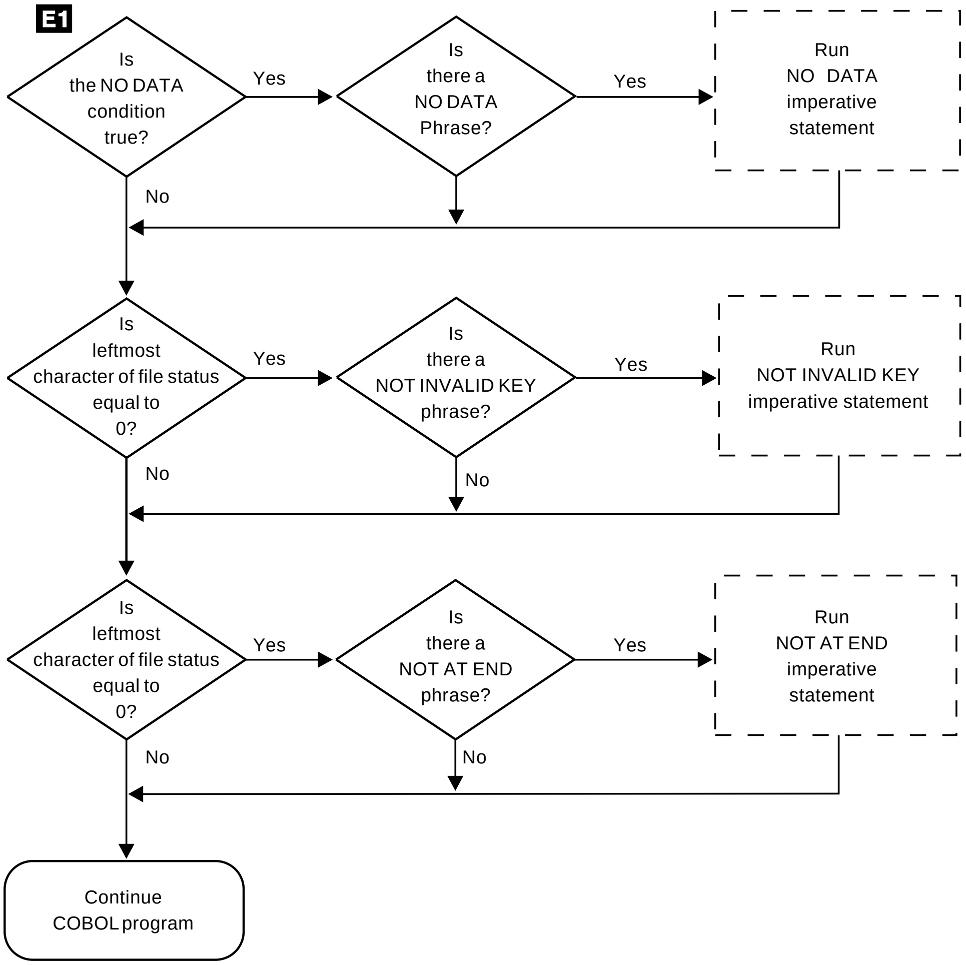

E1
Is the NO DATA condition true?
Yes
Is there a NO DATA Phrase?
Yes
Run NO DATA imperative statement
No
Is leftmost character of file status equal to 0?
Yes
Is there a NOT INVALID KEY phrase?
Yes
Run NOT INVALID KEY imperative statement
No
No
Is leftmost character of file status equal to 0?
Yes
Is there a NOT AT END phrase?
Yes
Run NOT AT END imperative statement
No
No
Continue COBOL program

Figure 26 (Part 2 of 2). Processing of I/O Verbs

Note: Follow the parts of the diagram that apply to your statements.

Common Exceptions and Some of Their Causes

MCH1202 Decimal data error:

- A numeric elementary item has been used as a source when no valid data has been previously stored in it. The item should have a VALUE clause, or a MOVE statement should be used to initialize its value.
- An attempt has been made to place nonnumeric data in a numeric item.
- Bad data was written to a subfile earlier in the program. The subfile data is not validated until it is written to the display, so the 1202 error can occur on the WRITE of a subfile control record, but the bad data was actually put to the subfile earlier.

MCH0601 Pointer exceptions:

- Part of a linkage section item extended beyond the space allocated.

  For example, if you set the address of a linkage section item, and one or more of its elementary data items extend beyond the space with a MOVE to the elementary data item, MCH0601 is issued.

For more information on using pointers, refer to “Using Pointers in a COBOL/400 Program” on page 282.

MCH0602 Pointer alignment:

- The pointer alignment in the Working-Storage Section of the calling program does not match the alignment in the Linkage Section of the called program. Alignment must be on a 16-byte boundary.

  For more information on using pointers, refer to “Using Pointers in a COBOL/400 Program” on page 282.

MCH3601 Pointer error:

- A reference is made to a record or a field within a record and the associated file has been closed or has never been opened.

  For example, the OPEN for the file was unsuccessful and the processing of any other I/O statement for that file is attempted. The file status should be checked before any other I/O is attempted.

CPF2415 End of requests:

- An attempt has been made to accept input from the job input stream while the system is running in batch mode and no input is available.

Recovery After a Failure

Recovery with Commitment Control

When the system is restarted after a failure, files under commitment control are automatically restored to their status at the last commitment boundary. For additional information about commitment control, see “Commitment Control Considerations” on page 94.

For a job failure (either because of user or system error), files under commitment control are restored as part of job termination to the files’ status at the previous commitment boundary.

Because files under commitment control are rolled back after system or process failure, this feature can be used to help in restarting. You can create a separate record to store data that may be useful should it become necessary to restart a job. This restart data can include items such as totals, counters, record key values, relative key values, and other relevant processing information from an application.

If you keep the restart data mentioned above in a file under commitment control, the restart data will also be permanently stored in the database when a COMMIT statement is issued. When a ROLLBACK occurs after job or process failure, you can retrieve a record of the extent of processing successfully processed before failure. Note that the above method is only a suggested programming technique and will not always be suitable, depending on the application.

TRANSACTION File Recovery

In some cases, you can recover from I/O errors on TRANSACTION files without intervention by the operator, or the varying off/varying on of work stations or communications devices.

For potentially recoverable I/O errors on TRANSACTION files, the system initiates action in addition to the steps that must be taken in the application program to attempt error recovery. For more information about action taken by the system, see the *Remote Work Station Guide*.

By examining the file status after an I/O operation, the application program can determine whether a recovery from an I/O error on the TRANSACTION file is possible. If the File Status Key has a value of 9N, the application program may be able to recover from the I/O error. A recovery procedure must be coded as part of the application program and varies depending on whether a single device was acquired by the TRANSACTION file or whether multiple devices were attached.

For a file with one acquired device:

1. Close the TRANSACTION file with the I/O error.
2. Reopen the file.
3. Process the steps necessary to retry the failing I/O operation. This may involve a number of steps, depending on the type of program device used. (For example, if the last I/O operation was a READ, you may have to repeat one or more WRITE statements, which were processed prior to the READ statement.) For more information on recovery procedures, see the *ICF Programmer's Guide*.

For a display file with multiple devices acquired:

1. DROP the program device that caused the I/O error on the TRANSACTION file.
2. ACQUIRE the same program device.
3. See Step 3 above.

For an ICF file with multiple devices acquired:

1. ACQUIRE the same program device.
2. See Step 3 above.

For a display file with multiple devices acquired:

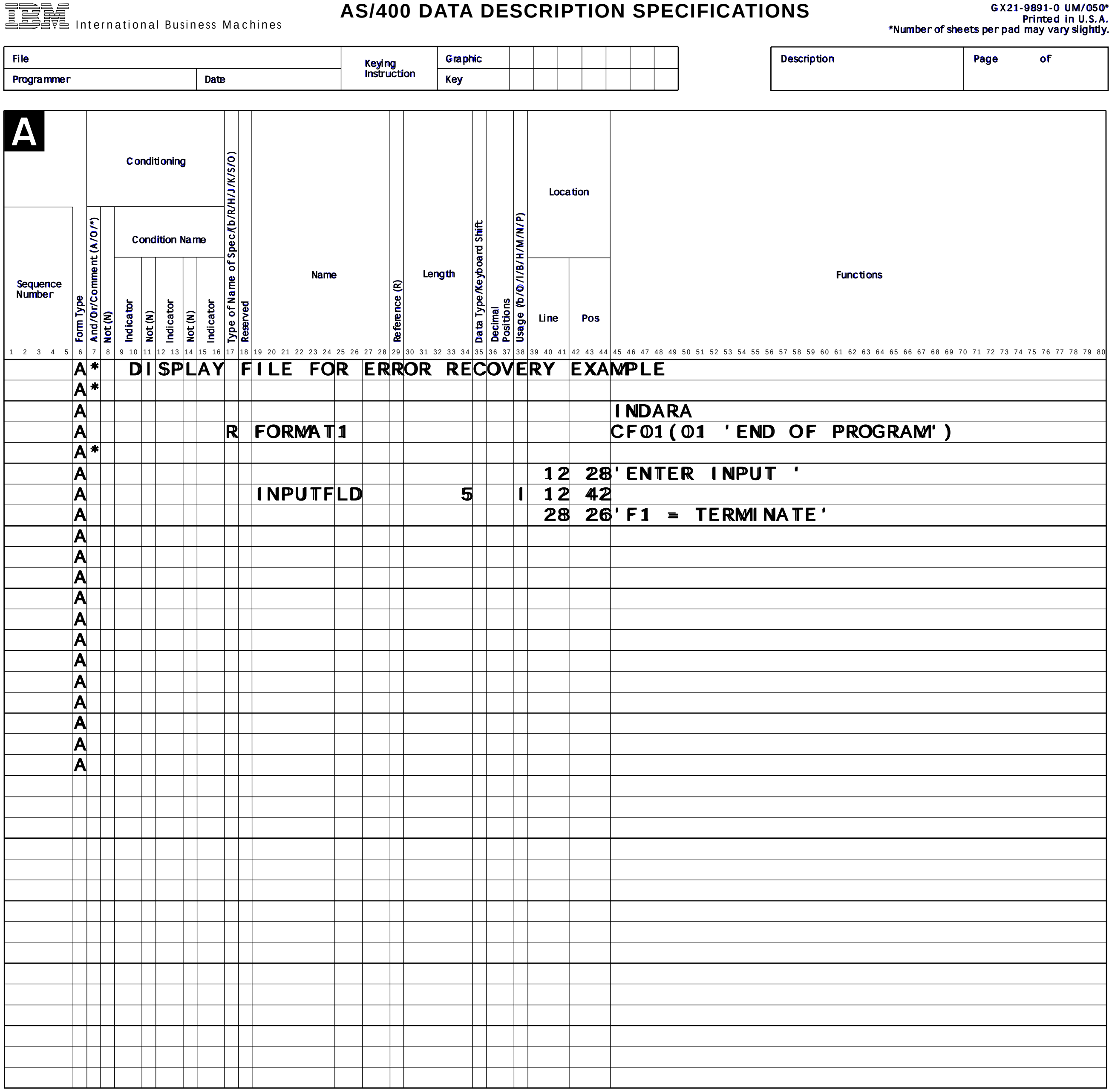
Application program recovery attempts should typically be tried only once.

If the recovery attempt fails:

- If the file has only one program device attached, terminate the program through processing of the STOP RUN, EXIT PROGRAM, or GOBACK statement, and attempt to locate the source of the error.
- If the file has multiple acquired program devices, you may want to do one of the following:
  - Continue processing without the program device that caused the I/O error on the TRANSACTION file, and reacquire the device later.
  - End the program.

For a description of major and minor return codes that may help in diagnosing I/O errors on the TRANSACTION file, see the *ICF Programmer's Guide* or the *Data Management Guide*.

Figure 27 gives an example of an error recovery procedure.



International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Description | Page of
Programmer | Date | Key

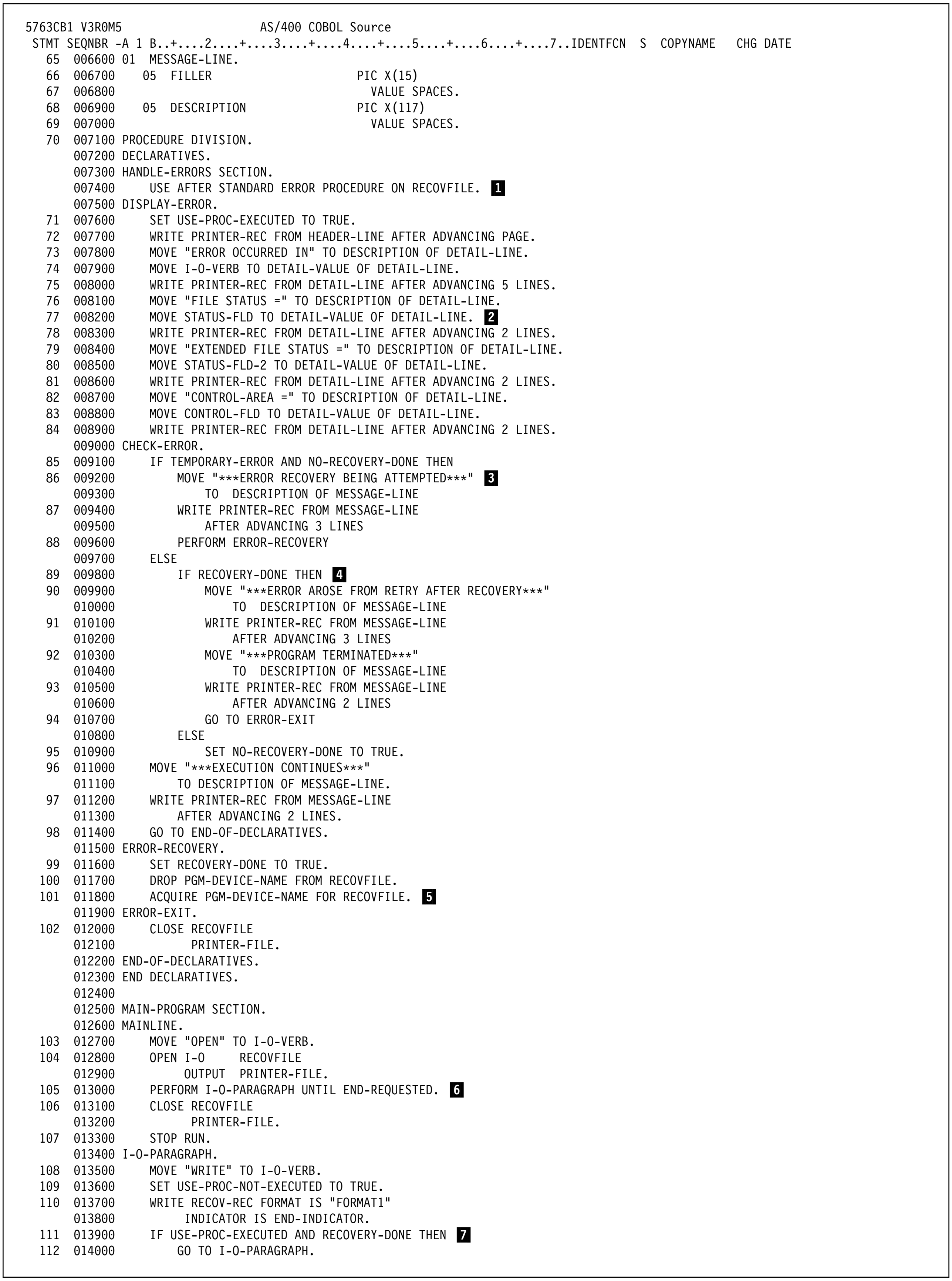
A

```
     A*  DISPLAY FILE FOR ERROR RECOVERY EXAMPLE
     A*
     A                                      INDARA
     A          R FORMAT1                   CF01(01 'END OF PROGRAM')
     A*
     A                                 12 28'ENTER INPUT '
     A            INPUTFLD       5     I 12 42
     A                                 28 26'F1 = TERMINATE'
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 27. Example of Error Recovery Procedure -- DDS

```
5763CB1 V3R0M5                   AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 IDENTIFICATION DIVISION.                                                                02/01/94
    2  000200 PROGRAM-ID.  RECOVERY.                                                                  02/05/94
    3  000300 ENVIRONMENT DIVISION.                                                                   02/01/94
    4  000400 CONFIGURATION SECTION.                                                                  02/01/94
    5  000500 SOURCE-COMPUTER. IBM-AS400.                                                             02/02/94
    6  000600 OBJECT-COMPUTER. IBM-AS400.                                                             02/02/94
    7  000700 INPUT-OUTPUT SECTION.                                                                   02/01/94
    8  000800 FILE-CONTROL.                                                                           02/01/94
    9  000900     SELECT RECOVFILE                                                                    02/05/94
   10  001000         ASSIGN TO WORKSTATION-RECVFILE-SI                                               03/22/94
   11  001100         ORGANIZATION IS TRANSACTION                                                     02/05/94
   12  001200         ACCESS MODE IS SEQUENTIAL                                                       02/01/94
   13  001300         FILE STATUS IS STATUS-FLD, STATUS-FLD-2                                         02/05/94
   14  001400         CONTROL-AREA IS CONTROL-FLD.                                                    02/05/94
   15  001500     SELECT PRINTER-FILE                                                                 02/05/94
   16  001600         ASSIGN TO PRINTER-QPRINT.                                                       02/05/94
       001700                                                                                         02/01/94
   17  001800 DATA DIVISION.                                                                          02/01/94
   18  001900 FILE SECTION.                                                                           02/01/94
   19  002000 FD  RECOVFILE                                                                           02/05/94
   20  002100     LABEL RECORDS ARE OMITTED                                                           02/05/94
   21  002200     DATA RECORD IS RECOV-REC.                                                           02/05/94
   22  002300 01  RECOV-REC.                                                                          02/05/94
   23  002400     COPY DDS-ALL-FORMATS OF RECVFILE.                                                   03/22/94
   24 +000001       05  RECVFILE-RECORD PIC X(5).                                          <-ALL-FMTS
      +000002*  INPUT FORMAT:FORMAT1    FROM FILE RECVFILE   OF LIBRARY COBNATEX           <-ALL-FMTS
      +000003*                                                                             <-ALL-FMTS
   25 +000004       05  FORMAT1-I     REDEFINES RECVFILE-RECORD.                           <-ALL-FMTS
   26 +000005           06 INPUTFLD          PIC X(5).                                     <-ALL-FMTS
      +000006* OUTPUT FORMAT:FORMAT1    FROM FILE RECVFILE   OF LIBRARY COBNATEX           <-ALL-FMTS
      +000007*                                                                             <-ALL-FMTS
      +000008*      05  FORMAT1-O     REDEFINES RECVFILE-RECORD.                           <-ALL-FMTS
       002500
   27  002600 FD  PRINTER-FILE.
   28  002700 01  PRINTER-REC.
   29  002800    05  PRINTER-RECORD             PIC X(132).
       002900
   30  003000 WORKING-STORAGE SECTION.
       003100
   31  003200 01  I-O-VERB                      PIC X(10).
   32  003300 01  STATUS-FLD                    PIC X(2).
   33  003400    88  NO-ERROR                     VALUE "00".
   34  003500    88  ACQUIRE-FAILED               VALUE "9H".
   35  003600    88  TEMPORARY-ERROR              VALUE "9N".
   36  003700 01  STATUS-FLD-2                  PIC X(4).
   37  003800 01  CONTROL-FLD.
   38  003900    05  FUNCTION-KEY               PIC X(2).
   39  004000    05  PGM-DEVICE-NAME            PIC X(10).
   40  004100    05  RECORD-FORMAT              PIC X(10).
   41  004200 01  END-INDICATOR                 PIC 1   INDICATOR 1
   42  004300                                     VALUE B"0".
   43  004400    88  END-NOT-REQUESTED            VALUE B"0".
   44  004500    88  END-REQUESTED                VALUE B"1".
   45  004600 01  USE-PROC-FLAG                 PIC 1
   46  004700                                     VALUE B"0".
   47  004800    88  USE-PROC-NOT-EXECUTED        VALUE B"0".
   48  004900    88  USE-PROC-EXECUTED            VALUE B"1".
   49  005000 01  RECOVERY-FLAG                 PIC 1
   50  005100                                     VALUE B"0".
   51  005200    88  NO-RECOVERY-DONE             VALUE B"0".
   52  005300    88  RECOVERY-DONE                VALUE B"1".
   53  005400 01  HEADER-LINE.
   54  005500    05  FILLER                     PIC X(60)
   55  005600                                     VALUE SPACES.
   56  005700    05  FILLER                     PIC X(72)
   57  005800                                     VALUE "ERROR REPORT".
   58  005900 01  DETAIL-LINE.
   59  006000    05  FILLER                     PIC X(15)
   60  006100                                     VALUE SPACES.
   61  006200    05  DESCRIPTION                PIC X(25)
   62  006300                                     VALUE SPACES.
   63  006400    05  DETAIL-VALUE               PIC X(92)
   64  006500                                     VALUE SPACES.
```

Figure 28 (Part 1 of 3). Example of Error Recovery Procedure



```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    65  006600 01  MESSAGE-LINE.
    66  006700    05  FILLER                    PIC X(15)
    67  006800                                    VALUE SPACES.
    68  006900    05  DESCRIPTION               PIC X(117)
    69  007000                                    VALUE SPACES.
    70  007100 PROCEDURE DIVISION.
        007200 DECLARATIVES.
        007300 HANDLE-ERRORS SECTION.
        007400     USE AFTER STANDARD ERROR PROCEDURE ON RECOVFILE.  1
        007500 DISPLAY-ERROR.
    71  007600     SET USE-PROC-EXECUTED TO TRUE.
    72  007700     WRITE PRINTER-REC FROM HEADER-LINE AFTER ADVANCING PAGE.
    73  007800     MOVE "ERROR OCCURRED IN" TO DESCRIPTION OF DETAIL-LINE.
    74  007900     MOVE I-O-VERB TO DETAIL-VALUE OF DETAIL-LINE.
    75  008000     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 5 LINES.
    76  008100     MOVE "FILE STATUS =" TO DESCRIPTION OF DETAIL-LINE.
    77  008200     MOVE STATUS-FLD TO DETAIL-VALUE OF DETAIL-LINE.  2
    78  008300     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
    79  008400     MOVE "EXTENDED FILE STATUS =" TO DESCRIPTION OF DETAIL-LINE.
    80  008500     MOVE STATUS-FLD-2 TO DETAIL-VALUE OF DETAIL-LINE.
    81  008600     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
    82  008700     MOVE "CONTROL-AREA =" TO DESCRIPTION OF DETAIL-LINE.
    83  008800     MOVE CONTROL-FLD TO DETAIL-VALUE OF DETAIL-LINE.
    84  008900     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
        009000 CHECK-ERROR.
    85  009100     IF TEMPORARY-ERROR AND NO-RECOVERY-DONE THEN
    86  009200         MOVE "***ERROR RECOVERY BEING ATTEMPTED***"  3
        009300             TO  DESCRIPTION OF MESSAGE-LINE
    87  009400         WRITE PRINTER-REC FROM MESSAGE-LINE
        009500             AFTER ADVANCING 3 LINES
    88  009600         PERFORM ERROR-RECOVERY
        009700     ELSE
    89  009800         IF RECOVERY-DONE THEN  4
    90  009900             MOVE "***ERROR AROSE FROM RETRY AFTER RECOVERY***"
        010000                 TO  DESCRIPTION OF MESSAGE-LINE
    91  010100             WRITE PRINTER-REC FROM MESSAGE-LINE
        010200                 AFTER ADVANCING 3 LINES
    92  010300             MOVE "***PROGRAM TERMINATED***"
        010400                 TO  DESCRIPTION OF MESSAGE-LINE
    93  010500             WRITE PRINTER-REC FROM MESSAGE-LINE
        010600                 AFTER ADVANCING 2 LINES
    94  010700             GO TO ERROR-EXIT
        010800         ELSE
    95  010900             SET NO-RECOVERY-DONE TO TRUE.
    96  011000     MOVE "***EXECUTION CONTINUES***"
        011100         TO DESCRIPTION OF MESSAGE-LINE.
    97  011200     WRITE PRINTER-REC FROM MESSAGE-LINE
        011300         AFTER ADVANCING 2 LINES.
    98  011400     GO TO END-OF-DECLARATIVES.
        011500 ERROR-RECOVERY.
    99  011600     SET RECOVERY-DONE TO TRUE.
   100  011700     DROP PGM-DEVICE-NAME FROM RECOVFILE.
   101  011800     ACQUIRE PGM-DEVICE-NAME FOR RECOVFILE.  5
        011900 ERROR-EXIT.
   102  012000     CLOSE RECOVFILE
        012100           PRINTER-FILE.
        012200 END-OF-DECLARATIVES.
        012300 END DECLARATIVES.
        012400
        012500 MAIN-PROGRAM SECTION.
        012600 MAINLINE.
   103  012700     MOVE "OPEN" TO I-O-VERB.
   104  012800     OPEN I-O     RECOVFILE
        012900          OUTPUT  PRINTER-FILE.
   105  013000     PERFORM I-O-PARAGRAPH UNTIL END-REQUESTED.  6
   106  013100     CLOSE RECOVFILE
        013200           PRINTER-FILE.
   107  013300     STOP RUN.
        013400 I-O-PARAGRAPH.
   108  013500     MOVE "WRITE" TO I-O-VERB.
   109  013600     SET USE-PROC-NOT-EXECUTED TO TRUE.
   110  013700     WRITE RECOV-REC FORMAT IS "FORMAT1"
        013800          INDICATOR IS END-INDICATOR.
   111  013900     IF USE-PROC-EXECUTED AND RECOVERY-DONE THEN  7
   112  014000         GO TO I-O-PARAGRAPH.
```

Figure 28 (Part 2 of 3). Example of Error Recovery Procedure

```
5763CB1 V3R0M5                   AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  113  014100     MOVE "READ" TO I-O-VERB.
  114  014200     SET USE-PROC-NOT-EXECUTED TO TRUE.
  115  014300     SET NO-RECOVERY-DONE TO TRUE.
  116  014400     READ RECOVFILE FORMAT IS "FORMAT1"
       014500         INDICATOR IS END-INDICATOR.  8
  117  014600     IF NO-ERROR THEN
  118  014700         PERFORM SOME-PROCESSING.
       014800 SOME-PROCESSING.
  119  014900     (INSERT SOME DATABASE PROCESSING, FOR EXAMPLE).
                           * * * * *  E N D   O F   S O U R C E   * * * * *
```

Figure 28 (Part 3 of 3). Example of Error Recovery Procedure

1 This defines processing that takes place when an I/O error occurs on RECOVFILE.

2 This prints out information to help in diagnosing the problem.

3 If the file-status equals 9N (temporary error), and no previous error recovery has been attempted for this I/O operation, error recovery is now attempted.

4 To avoid program looping, recovery is not attempted now if it was attempted previously.

5 Recovery consists of dropping, then reacquiring, the program device on which the I/O error occurred.

6 The mainline of the program consists of writing to and reading from a device until the user signals an end to the program by pressing F1.

7 If the WRITE operation failed but recovery was done, the WRITE is attempted again.

8 If the READ operation failed, processing will continue by writing to the device again, and then attempting the READ again.

Chapter 7. File and Data Management

This chapter contains general file and data management information you may need when creating COBOL/400 applications.

This chapter describes:

- The device-independent and device-dependent characteristics of COBOL/400 programs on the AS/400 system
- Input and output spooling functions
- System override considerations
- File and record locking considerations
- Commitment control
- Unblocking and blocking records
- File status and feedback areas
- General information about the use of program-described files and externally described files in a COBOL/400 program
- The Format 2 COPY statement (DD, DDR, DDS, or DDSR option).

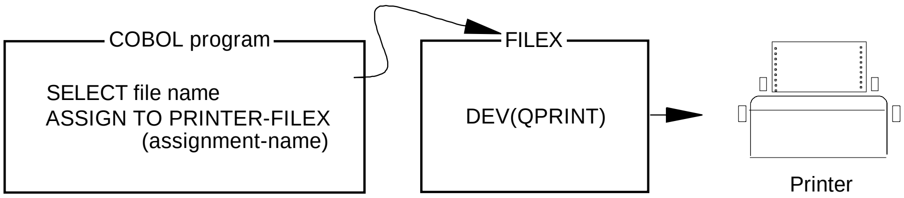
The maximum number of files that you can define and open within number of files used by a program a COBOL program is 99. If you use extended display options, the maximum number is 98. For information on specifying the extended display options, refer to page 23 .

Device Independence and Device Dependence

The key element for all I/O operations on the AS/400 system is the file. All files used are defined to the operating system. The operating system maintains a description of each file that is used by a program.

The files are kept online and serve as the connecting link between a program and the device used for I/O. The actual device association is made when the file is processed. In some instances, this type of I/O control allows the user to change the attribute of the file (and, in some cases, change the device) used in a program without changing the program.

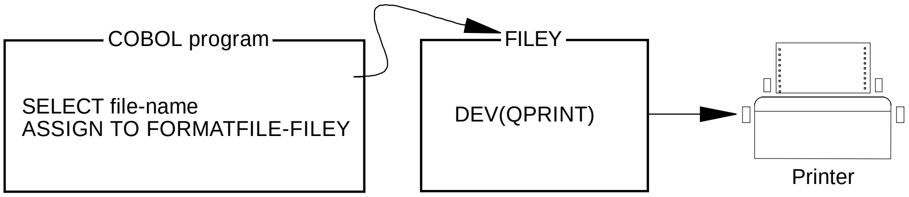
In the COBOL/400 language, the file name specified in the ASSIGNMENT-NAME entry of the ASSIGN clause of the file control entry is used to point to the file. This file name points to the system file description:



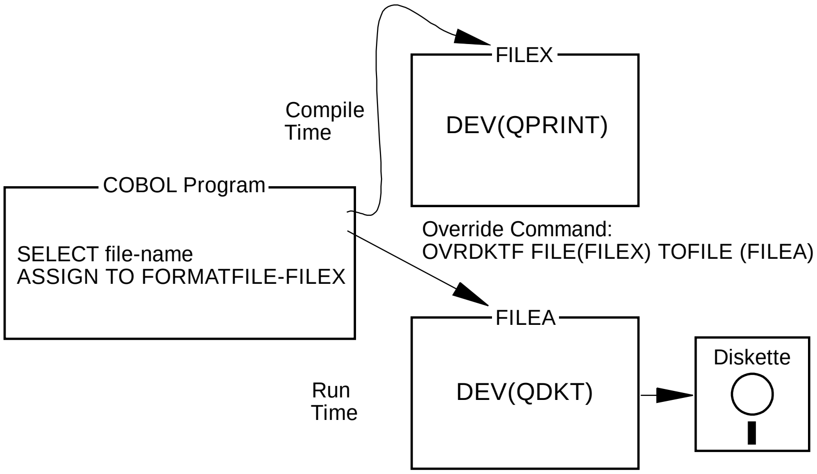
The COBOL device name in the ASSIGN clause defines the COBOL functions that can be processed on the selected file. At compilation time, certain COBOL functions are valid only for a specific COBOL device name; in this respect, COBOL is device dependent. The following are examples of device dependency:

- SUBFILE operations are valid only for a WORKSTATION device.
- Indicators are valid only for WORKSTATION or FORMATFILE devices.
- LINAGE is valid only for the PRINTER device.
- OPEN INPUT WITH NO REWIND is valid only for a TAPEFILE device.

For example, assume that the file name FILEY is associated in the COBOL program with the FORMATFILE device. The device FORMATFILE is an independent device type. Therefore, no line or page control specifications are valid in the COBOL program in the WRITE ADVANCING statement. When the program is run, the actual I/O device is specified in the description of FILEY. For example, the device might be a printer; only the default line and page control or those defined in the DDS would be used:



CL commands can be used to override a parameter in the specified file description or to redirect a file at compilation time or run time. File redirection allows the user to specify one file at compilation time and another file at run time:



In the preceding example, the Override to Diskette File command (OVRDKTF) allows the program to run with an entirely different device file than was specified at compilation time.

Not all file redirections or overrides are valid. At run time, checking occurs to ensure that the specifications within the COBOL program are valid for the file being processed. The OS/400 operating system allows some file redirections even if device specifics are contained in the program. For example, if the COBOL device name is PRINTER and the actual file the program uses is not a printer, the operating system ignores the COBOL print spacing and skipping specifications.

There are other file redirections that the operating system does not allow and that cause program termination. For example, if the COBOL device name is DATABASE or DISK and a keyed READ operation is specified in the program, the program is terminated if the actual file the program uses is not a disk or database file.

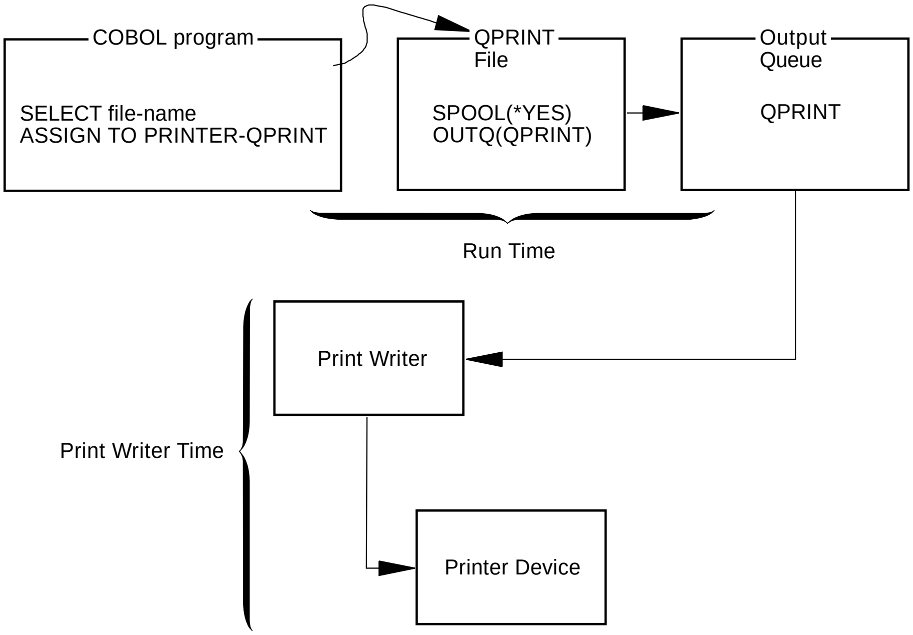
See “System Override Considerations” on page 92 for more detailed information on valid file redirections and file overrides.

Spooling

The AS/400 system provides for the use of input and output spooling functions. Each AS/400 file description contains a spool attribute that determines whether spooling is used for the file at run time. The COBOL program is not aware that spooling is being used. The actual physical device from which a file is read or to which a file is written is determined by the spool reader or the spool writer. See the *Data Management Guide* for more detailed information on spooling.

Output Spool

Output spooling is valid for batch and interactive jobs. The description of the file that is specified in COBOL by the system-name contains the specification for spooling as shown in the following example:

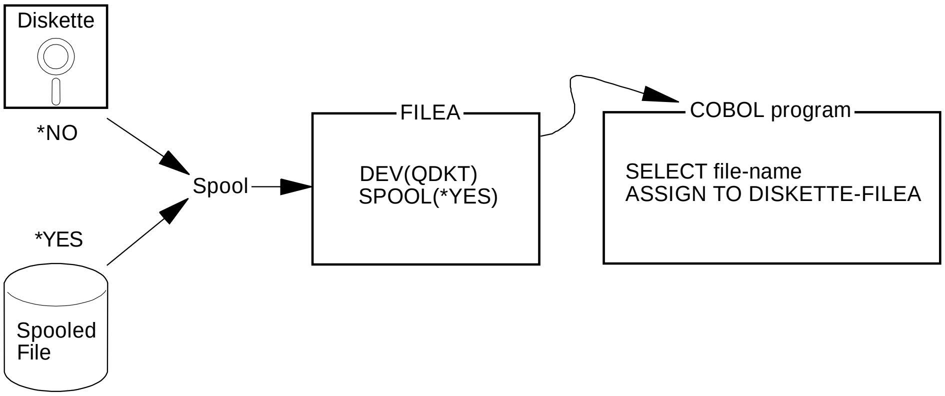


File override commands can be used at run time to override the spooling options that are specified in the file description, such as the number of copies to be printed. In addition, AS/400 spooling support allows you to redirect a file after the program has run. For example, you can direct the printer output to a different device, such as a diskette.

Input Spool

Input spooling is valid only for inline data files in batch jobs. If the input data read by COBOL comes from a spooled file, COBOL is not aware of which device the data was spooled in from.

The data is read from a spooled inline file:



See the *Data Management Guide* for more information on inline data files.

System Override Considerations

You must specify any overrides before the file is opened by the COBOL program. The system uses the file override command to determine the file to open and the attributes of the file.

The simplest form of overriding a file is to override some attributes of the file. For example, FILE(OUTPUT) with COPIES(2) is specified when a printer file is created. Then, before the COBOL program is run, the number of printed copies of output can be changed to 3. The override command is as follows:

```
OVRPRTF  FILE(OUTPUT)  COPIES(3)
```

Another form of file overriding is to redirect the COBOL program to access a different file. When the override redirects the program to a file of the *same* type (such as a printer file to another printer file), the file is processed in the same manner as the original file.

When the override redirects the program to a file of a *different* type, the overriding file is processed in the same manner as the original file would have been processed. Device-dependent specifications in the COBOL program are ignored, and the defaults are taken by the system.

Not all file redirections are valid. For example, an indexed file for a COBOL program can only be overridden to another indexed file with a keyed access path.

Multiple member processing can be accomplished for a database file by overriding a database file to process all members. Note the following exceptions:

- A database source file used for a COBOL program cannot be overridden to process all members. Specifying OVRDBF MBR(*ALL) will result in the termination of the compilation.

- A database file used for a COPY statement cannot be overridden to process all members. Specifying OVRDBF MBR(*ALL) will cause the COPY statement to be ignored.

The COBOL programmer must ensure that file overrides are applied properly. For more information on valid file redirections, the device dependent characteristics ignored, and the defaults assumed, see the *Data Management Guide*.

File and Record Locking by COBOL

The operating system allows a lock state (exclusive, exclusive allow read, shared-for-update, shared-no-update, or shared-for-read) to be placed on a file used during a job step. The file can be placed in a lock state with the Allocate Object (ALCOBJ) command.

By default, the operating system places the following lock states on database files when the files are opened by COBOL programs:

OPEN Type	Lock State
INPUT	Shared-for-read
I/O	Shared-for-update
EXTEND	Shared-for-update
OUTPUT	Shared-for-update

EXTEND mode is a method of adding records to the end of a sequential file when the file is opened.

The shared-for-read lock state allows another user to open the file with a lock state of shared-for-read, shared-for-update, shared-no-update, or exclusive-allow-read, but the user cannot specify the exclusive use of the file. The shared-for-update lock state allows another user to open the file with a shared-for-read or shared-for-update lock state.

The operating system places the shared-for-read lock on the device file and an exclusive-allow-read lock state on the device. Another user can open the file but cannot use the same device.

Note: When a COBOL program opens a physical file for OUTPUT, that file will be subject to an exclusive lock for the period of time necessary to clear the member.

For more information on allocating resources and the lock states, see the *Data Management Guide*.

Locking and Releasing Records

When a database record is read by COBOL and the file is opened for I/O, a lock is placed on that record so that another program cannot update it. That is, the record can be read by another program if it opens a file for input, but not if it opens the file for I/O.

For information about the duration of record lock with and without commitment control, refer to Table 2 on page 96.

To prevent the READ statement from locking records on files opened in I/O (update) mode, you can use the NO LOCK phrase. The READ WITH NO LOCK statement unlocks records locked by a previous READ statement. For more information about this phrase, refer to the section on the READ statement in the *COBOL/400 Reference*.

For a logical file based on one physical file, the lock is placed on the record in the physical file. If a logical file is based on more than one physical file, a lock is placed on one record in each physical file.

This lock applies not only to other programs, but also to the original program if it attempts to update the same underlying physical record through a second file.

Note: When a file with indexed or relative organization is opened for I/O, using random or dynamic access, a failed I/O operation on any of the I/O verbs except WRITE also unlocks the record. A WRITE operation is not considered an update operation; therefore, the record lock is not released.

For more information about releasing database records read for update, see the *Data Management Guide*.

Sharing an Open Data Path

If you have already opened a file through another program in your routing step, your COBOL program can use the same Open Data Path (ODP) to access the file.

Note: Routing steps are described in the *Programming: Work Management Guide*; a job usually contains only one routing step.

The following rules apply to shared ODPs:

1. You must specify SHARE(*YES) in the command that creates the file, in a change command, or in an override command for the file.
2. Once a file with a shared ODP has been opened for the first time by a program and remains open, subsequent OPEN operations within the same routing step run faster than standard OPEN operations. The speed of I/O operations other than opens is not affected.
3. Your use of the file within your different programs should be consistent. For example, if a non-COBOL program performs a READ PREVIOUS operation using blocked I/O, the COBOL READ statement might retrieve the record preceding the current file position rather than the record following the current file position.

Commitment Control Considerations

Commitment control is a function that allows:

- Synchronization of changes to database files within the same job
- Cancelation of changes that should not be permanently entered into the database
- Locking of records being changed until changes are complete
- Techniques for recovering from job or system failure.

In some applications, it is desirable to synchronize changes to database records. If the program determines the changes are valid, the changes are then permanently made to the database (a COMMIT statement is processed). If the changes are not valid, or if a problem occurs during processing, the changes can be canceled (a ROLLBACK statement is processed). (When a file is cleared after being opened for OUTPUT, processing of a ROLLBACK does not restore cleared records to the file.) Changes made to records in a file that is *not* under commitment control are always permanent. Such changes are never affected by subsequent COMMIT or ROLLBACK statements.

Each point where a COMMIT or ROLLBACK is successfully processed is a commitment boundary. (If no COMMIT or ROLLBACK has yet been issued in a program, a commitment boundary is created by the first open of any file under commitment control.) The committing or rolling back of changes only affects changes made since the previous commitment boundary.

The synchronizing of changes at commitment boundaries makes restart or recovery procedures after a failure easier. For more information, see "Recovery After a Failure" on page 82.

When commitment control is used for database files, records in those files are subject to either a high lock level LCKLVL (*ALL) or a low lock level LCKLVL(*CHG). With a low lock level (*CHG), all records that are changed (rewritten, deleted, or added) in files under commitment control are locked until a COMMIT or ROLLBACK statement is successfully processed. With a high lock level (*ALL), *all* records accessed, whether for input or output, are locked until a COMMIT or ROLLBACK is successfully processed. For both record locking levels, no other job can modify data in locked records until the COMMIT or ROLLBACK has been successfully completed. (A locked record can only be modified within the same job and through the same physical or logical file.)

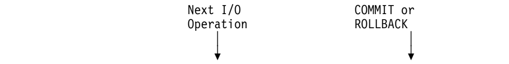
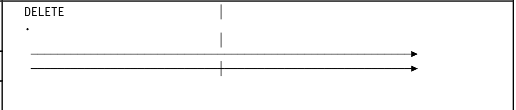
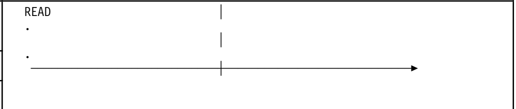
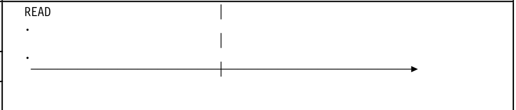
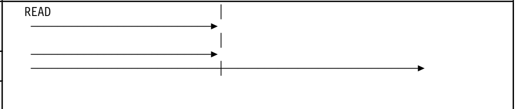
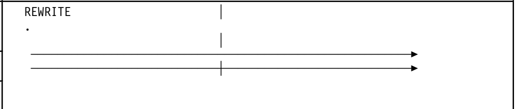
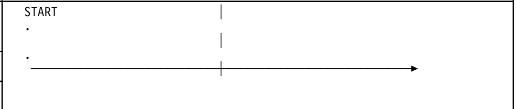
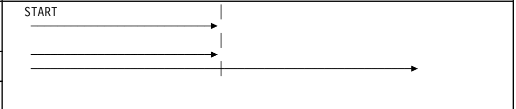
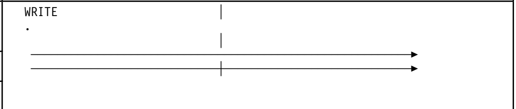
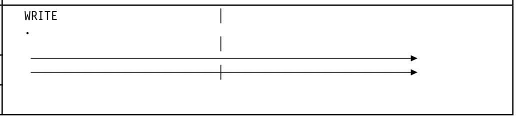
The lock level also governs whether locked records can be read. With a high lock level (*ALL), you cannot read locked records in a database file. With a low lock level (*CHG), you can read locked records in a database file, provided the file is opened as INPUT in your job, or opened as I/O and READ WITH NO LOCK is used.

A third lock level can be obtained by specifying LCKLVL(*CS), in which every record accessed from files under commitment control is locked. Records that are not updated or deleted are locked only until a different record is accessed. Records that are updated, added, or deleted are locked until the transaction is committed or rolled back.

Other jobs, where files are *not* under commitment control, can always read locked records, regardless of the lock level used, provided the files are opened as INPUT. Because it is possible in some cases for other jobs to read locked records, data can be accessed *before it is permanently committed to a database*. If a ROLLBACK statement is processed *after* another job has read locked records, the data accessed will not reflect the contents of the database.

Table 2 shows record locking considerations for files with and without commitment control.

Table 2. Record Locking Considerations with and without Commitment Control

VERB	OPEN MODE	LOCK LEVEL		DURATION OF RECORD LOCK
				
DELETE	I-O	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
READ	INPUT	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
READ WITH NO LOCK	I-O	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
READ	I-O	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
REWRITE	I-O	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
START	INPUT	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
START	I-O	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
WRITE	I-O	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	
WRITE	OUTPUT	Without Commitment Control		
		With Commitment Control	*CHG	
			*ALL	

A file under commitment control can be closed or opened without affecting the status of changes made since the last commitment boundary. A COMMIT must still be issued to make the changes permanent, or a ROLLBACK issued to cancel the changes. A COMMIT statement, when processed, leaves files in the same open or closed state as before processing.

All files under commitment control within the same job must be journaled to the same journal. For more information about journal management and its related functions, and for more information about commitment control, refer to the *Advanced Backup and Recovery Guide*.

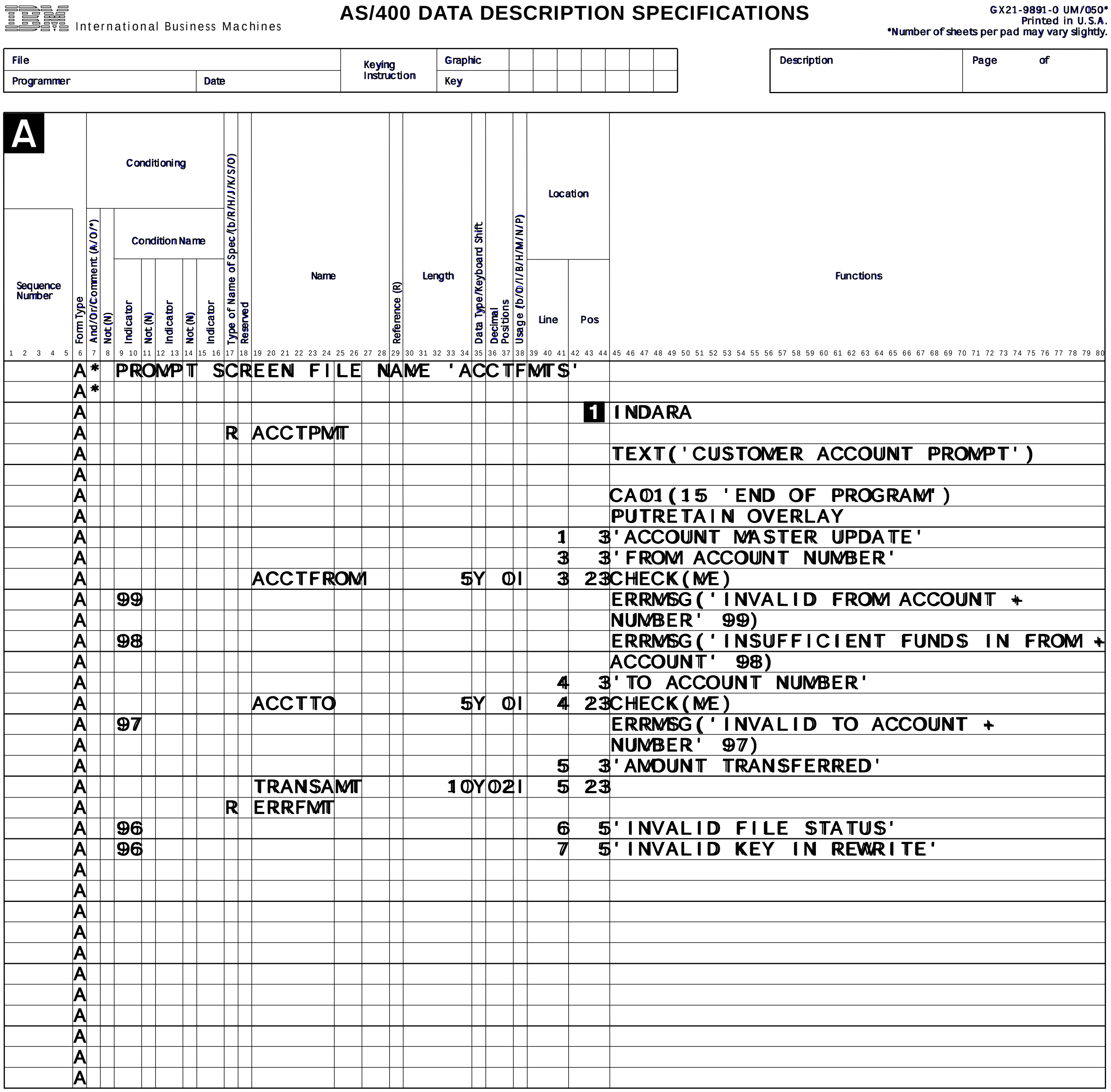
Commitment control must also be specified outside the COBOL language through the OS/400 control language (CL). The Start Commitment Control (STRCMTCTL) command establishes the capability for commitment control and sets the level of record locking at the high level (*ALL), or the low level (*CHG). The STRCMTCTL command does not automatically initiate commitment control for a file. That file must also be specified in the COMMITMENT CONTROL clause of the I-O-CONTROL paragraph within the COBOL program. The commitment control environment is normally ended by using the End Commitment Control

(ENDCMTCTL) command. This causes any uncommitted changes for database files under commitment control to be canceled. (An implicit ROLLBACK is processed.) Refer to the *CL Reference* for more information on the STRCMTCTL and ENDCMTCTL commands.

For more information about commitment control, see the *Advanced Backup and Recovery Guide*.

Note: The ability to prevent reading of uncommitted data that has been changed is a function of commitment control and is only available if you are running under commitment control. Normal (noncommitted) database support is not changed by the commitment control extension, and allows reading of locked records when a file that is opened only for input is read. Try to use files consistently. Typically, files should always be run under commitment control or never be run under commitment control.

Figure 29 on page 98 illustrates a possible usage of commitment control in a banking environment. The program processes transactions for transferring funds from one account to another. If no problems occur during the transaction, the changes are committed to the database file. If the transfer cannot take place because of improper account number or insufficient funds, a ROLLBACK is issued to cancel the changes.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Description | Page of
Programmer | Date | Key

A

```
     A* PROMPT SCREEN FILE NAME 'ACCTFMTS'
     A*
     A                                     1INDARA
     A          R ACCTPMT
     A                                      TEXT('CUSTOMER ACCOUNT PROMPT')
     A
     A                                      CA01(15 'END OF PROGRAM')
     A                                      PUTRETAIN OVERLAY
     A                                  1  3'ACCOUNT MASTER UPDATE'
     A                                  3  3'FROM ACCOUNT NUMBER'
     A            ACCTFROM       5Y 0I  3 23CHECK(ME)
     A  99                                  ERRMSG('INVALID FROM ACCOUNT +
     A                                      NUMBER' 99)
     A  98                                  ERRMSG('INSUFFICIENT FUNDS IN FROM +
     A                                      ACCOUNT' 98)
     A                                  4  3'TO ACCOUNT NUMBER'
     A            ACCTTO         5Y 0I  4 23CHECK(ME)
     A  97                                  ERRMSG('INVALID TO ACCOUNT +
     A                                      NUMBER' 97)
     A                                  5  3'AMOUNT TRANSFERRED'
     A            TRANSAMT      10Y02I  5 23
     A          R ERRFMT
     A  96                              6  5'INVALID FILE STATUS'
     A  96                              7  5'INVALID KEY IN REWRITE'
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 29. Example of Use of Commitment Control --DDS

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 IDENTIFICATION DIVISION.                                                                02/01/94
    2  000200 PROGRAM-ID.     ACCOUNT.                                                                02/04/94
    3  000300   AUTHOR.       PROGRAMMER NAME.                                                        01/27/94
    4  000400   INSTALLATION. COBOL DEVELOPMENT CENTRE.                                              01/27/94
    5  000500   DATE-WRITTEN. 02/02/88.                                                               02/04/94
    8  000080   DATE-COMPILED.  05/24/92 14:02:39   .                                                 03/01/94
    7  000700 ENVIRONMENT DIVISION.                                                                   01/27/94
    8  000800 CONFIGURATION SECTION.                                                                  01/27/94
    9  000900 SOURCE-COMPUTER. IBM-AS400.                                                             01/27/94
   10  001000 OBJECT-COMPUTER. IBM-AS400.                                                             01/27/94
   11  001100 INPUT-OUTPUT SECTION.                                                                   01/27/94
   12  001200 FILE-CONTROL.                                                                           01/27/94
   13  001300     SELECT ACCOUNT-FILE  ASSIGN TO DATABASE-ACCTMST                                     02/04/94
   14  001400         ORGANIZATION IS INDEXED                                                         02/04/94
   15  001500         ACCESS IS DYNAMIC                                                               02/04/94
   16  001600         RECORD IS EXTERNALLY-DESCRIBED-KEY                                              02/04/94
   17  001700         FILE STATUS IS ACCOUNT-FILE-STATUS.                                             02/04/94
   18  001800     SELECT DISPLAY-FILE ASSIGN TO WORKSTATION-ACCTFMTS-SI  1                            02/04/94
   19  001900         ORGANIZATION IS TRANSACTION.                                                    02/04/94
       002000**********************************************************************                   02/04/94
   20  002100 I-O-CONTROL.                                                                            02/04/94
   21  002200     COMMITMENT CONTROL FOR ACCOUNT-FILE.  2                                             02/04/94
       002300**********************************************************************                   02/04/94
   22  002400 DATA DIVISION.                                                                          02/04/94
   23  002500 FILE SECTION.                                                                           02/04/94
   24  002600 FD  ACCOUNT-FILE                                                                        02/04/94
   25  002700     LABEL RECORDS ARE STANDARD.                                                         02/04/94
   26  002800 01  ACCOUNT-RECORD.                                                                     02/04/94
   27  002900     COPY DDS-ALL-FORMATS OF ACCTMST.                                                    02/04/94
   28 +000001       05  ACCTMST-RECORD PIC X(82).                                          <-ALL-FMTS
      +000002*    I-O FORMAT:ACCNTREC   FROM FILE ACCTMST    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                                                                             <-ALL-FMTS
      +000004*THE KEY DEFINITIONS FOR RECORD FORMAT  ACCNTREC                              <-ALL-FMTS
      +000005*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ       <-ALL-FMTS
      +000006*   0001   ACCNTKEY                         ASCENDING   SIGNED     NO         <-ALL-FMTS
   29 +000007       05  ACCNTREC      REDEFINES ACCTMST-RECORD.                            <-ALL-FMTS
   30 +000008           06 ACCNTKEY          PIC S9(5).                                    <-ALL-FMTS
   31 +000009           06 NAME              PIC X(20).                                    <-ALL-FMTS
   32 +000010           06 ADDR              PIC X(20).                                    <-ALL-FMTS
   33 +000011           06 CITY              PIC X(20).                                    <-ALL-FMTS
   34 +000012           06 STATE             PIC X(2).                                     <-ALL-FMTS
   35 +000013           06 ZIP               PIC S9(5).                                    <-ALL-FMTS
   36 +000014           06 BALANCE           PIC S9(8)V9(2).                               <-ALL-FMTS
       003000
   37  003100 FD  DISPLAY-FILE
   38  003200     LABEL RECORDS ARE STANDARD.
   39  003300 01  DISPLAY-REC.
   40  003400     COPY DDS-ALL-FORMATS OF ACCTFMTS.
   41 +000001       05  ACCTFMTS-RECORD PIC X(20).                                         <-ALL-FMTS
      +000002*  INPUT FORMAT:ACCTPMT    FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                          CUSTOMER ACCOUNT PROMPT                            <-ALL-FMTS
   42 +000004       05  ACCTPMT-I     REDEFINES ACCTFMTS-RECORD.                           <-ALL-FMTS
   43 +000005           06 ACCTFROM          PIC S9(5).                                    <-ALL-FMTS
   44 +000006           06 ACCTTO            PIC S9(5).                                    <-ALL-FMTS
   45 +000007           06 TRANSAMT          PIC S9(8)V9(2).                               <-ALL-FMTS
      +000008* OUTPUT FORMAT:ACCTPMT    FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000009*                          CUSTOMER ACCOUNT PROMPT                            <-ALL-FMTS
      +000010*      05  ACCTPMT-O     REDEFINES ACCTFMTS-RECORD.                           <-ALL-FMTS
      +000011*  INPUT FORMAT:ERRFMT     FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000012*                                                                             <-ALL-FMTS
      +000013*      05  ERRFMT-I      REDEFINES ACCTFMTS-RECORD.                           <-ALL-FMTS
      +000014* OUTPUT FORMAT:ERRFMT     FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000015*                                                                             <-ALL-FMTS
      +000016*      05  ERRFMT-O      REDEFINES ACCTFMTS-RECORD.                           <-ALL-FMTS
   46  003500 WORKING-STORAGE SECTION.
   47  003600 77  ACCOUNT-FILE-STATUS           PIC X(2).
```

Figure 30 (Part 1 of 3). Example of Use of Commitment Control

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   48  003700 77  IND-ON                        PIC 1    VALUE B"1".
   49  003800 77  IND-OFF                       PIC 1    VALUE B"0".
   50  003900 01  DISPFILE-INDICS.
   51  004000     COPY DDS-ALL-FORMATS-INDIC OF ACCTFMTS. 3
   52 +000001       05  ACCTFMTS-RECORD.                                                   <-ALL-FMTS
      +000002*  INPUT FORMAT:ACCTPMT    FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                          CUSTOMER ACCOUNT PROMPT                            <-ALL-FMTS
   53 +000004           06 ACCTPMT-I-INDIC.                                                <-ALL-FMTS
   54 +000005                07 IN15         PIC 1  INDIC 15.                              <-ALL-FMTS
      +000006*                          END OF PROGRAM                                     <-ALL-FMTS
   55 +000007                07 IN97         PIC 1  INDIC 97.                              <-ALL-FMTS
      +000008*                          INVALID TO ACCOUNT NUMBER                          <-ALL-FMTS
   56 +000009                07 IN98         PIC 1  INDIC 98.                              <-ALL-FMTS
      +000010*                          INSUFFICIENT FUNDS IN FROM ACCOUNT                 <-ALL-FMTS
   57 +000011                07 IN99         PIC 1  INDIC 99.                              <-ALL-FMTS
      +000012*                          INVALID FROM ACCOUNT NUMBER                        <-ALL-FMTS
      +000013* OUTPUT FORMAT:ACCTPMT    FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000014*                          CUSTOMER ACCOUNT PROMPT                            <-ALL-FMTS
   58 +000015           06 ACCTPMT-O-INDIC.                                                <-ALL-FMTS
   59 +000016                07 IN97         PIC 1  INDIC 97.                              <-ALL-FMTS
      +000017*                          INVALID TO ACCOUNT NUMBER                          <-ALL-FMTS
   60 +000018                07 IN98         PIC 1  INDIC 98.                              <-ALL-FMTS
      +000019*                          INSUFFICIENT FUNDS IN FROM ACCOUNT                 <-ALL-FMTS
   61 +000020                07 IN99         PIC 1  INDIC 99.                              <-ALL-FMTS
      +000021*                          INVALID FROM ACCOUNT NUMBER                        <-ALL-FMTS
      +000022*  INPUT FORMAT:ERRFMT     FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000023*                                                                             <-ALL-FMTS
      +000024*          06 ERRFMT-I-INDIC.                                                 <-ALL-FMTS
      +000025* OUTPUT FORMAT:ERRFMT     FROM FILE ACCTFMTS   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000026*                                                                             <-ALL-FMTS
   62 +000027           06 ERRFMT-O-INDIC.                                                 <-ALL-FMTS
   63 +000028                07 IN95         PIC 1  INDIC 95.                              <-ALL-FMTS
   64 +000029                07 IN96         PIC 1  INDIC 96.                              <-ALL-FMTS
       004100
   65  004200 PROCEDURE DIVISION.
       004300 DECLARATIVES.
       004400 ERROR-SECTION SECTION.
       004500     USE AFTER STANDARD EXCEPTION PROCEDURE ON ACCOUNT-FILE.
       004600 ERROR-PARAGRAPH.
   66  004700     IF ACCOUNT-FILE-STATUS IS NOT EQUAL "23" THEN
   67  004800         MOVE IND-ON TO IN96 OF ERRFMT-O-INDIC    4
       004900     ELSE
   68  005000         MOVE IND-ON TO IN95 OF ERRFMT-O-INDIC. 5
   69  005100     WRITE DISPLAY-REC FORMAT IS "ERRFMT"
       005200          INDICATORS ARE ERRFMT-O-INDIC.
   70  005300     READ DISPLAY-FILE.
   71  005400     CLOSE DISPLAY-FILE
       005500           ACCOUNT-FILE.
   72  005600     STOP RUN.
       005700 END DECLARATIVES.
       005800 MAIN-PROGRAM SECTION.
       005900 MAINLINE.
   73  006000     OPEN I-O DISPLAY-FILE
       006100          I-O ACCOUNT-FILE.
   74  006200     MOVE ZEROS TO ACCTPMT-I-INDIC
       006300                   ACCTPMT-O-INDIC.
   75  006400     PERFORM WRITE-READ-DISPLAY.
   76  006500     PERFORM VERIFY-ACCOUNT-NO UNTIL IN15 EQUAL IND-ON.
   77  006600     CLOSE DISPLAY-FILE
       006700           ACCOUNT-FILE.
   78  006800     STOP RUN.
       006900 VERIFY-ACCOUNT-NO.
   79  007000     PERFORM VERIFY-TO-ACCOUNT.
   80  007100     IF IN97 OF ACCTPMT-O-INDIC EQUAL IND-OFF THEN
   81  007200         PERFORM VERIFY-FROM-ACCOUNT.
   82  007300     PERFORM WRITE-READ-DISPLAY.
       007400 VERIFY-FROM-ACCOUNT.
   83  007500     MOVE ACCTFROM TO ACCNTKEY.
   84  007600     READ ACCOUNT-FILE
   85  007700         INVALID KEY MOVE IND-ON TO IN99 OF ACCTPMT-O-INDIC.
   86  007800     IF IN99 OF ACCTPMT-O-INDIC EQUAL IND-ON THEN 6
       007900*                                               *
       008000         ROLLBACK
       008100*                                               *
   87  008200     ELSE
   88  008300         PERFORM UPDATE-FROM-ACCOUNT.
```

Figure 30 (Part 2 of 3). Example of Use of Commitment Control

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        008400 VERIFY-TO-ACCOUNT.
    89  008500     MOVE ACCTTO TO ACCNTKEY.
    90  008600     READ ACCOUNT-FILE
    91  008700         INVALID KEY MOVE IND-ON TO IN97 OF ACCTPMT-O-INDIC.  7
    92  008800     IF IN97 OF ACCTPMT-O-INDIC EQUAL IND-ON THEN
        008900*                                          *
        009000         ROLLBACK  8
        009100*                                          *
    93  009200     ELSE
    94  009300         PERFORM UPDATE-TO-ACCOUNT.
        009400 UPDATE-TO-ACCOUNT.
    95  009500     ADD TRANSAMT TO BALANCE.
    96  009600     REWRITE ACCOUNT-RECORD.
        009700 UPDATE-FROM-ACCOUNT.
    97  009800     SUBTRACT TRANSAMT FROM BALANCE.
    98  009900     REWRITE ACCOUNT-RECORD.
    99  010000     IF BALANCE IS LESS THAN 0 THEN
   100  010100         MOVE IND-ON TO IN98 OF ACCTPMT-O-INDIC
        010200*                                          *
        010300         ROLLBACK  9
        010400*                                          *
   101  010500     ELSE
        010600*                                          *
        010700         COMMIT.  10
        010800*                                          *
   102  010900 WRITE-READ-DISPLAY.
   103  011000     WRITE DISPLAY-REC FORMAT IS "ACCTPMT"
        011100         INDICATORS ARE ACCTPMT-O-INDIC.  11
   104  011200     MOVE ZEROS TO ACCTPMT-I-INDIC
        011300                   ACCTPMT-O-INDIC.
   105  011400     READ DISPLAY-FILE RECORD
        011500         INDICATORS ARE ACCTPMT-I-INDIC.
        011600
                            * * * * *   E N D   O F   S O U R C E   * * * * *
```

Figure 30 (Part 3 of 3). Example of Use of Commitment Control

1 A separate indicator area is provided for the program.

2 The COMMITMENT CONTROL clause specifies files to be placed under commitment control. Any files named in this clause are affected by the COMMIT and ROLLBACK verbs.

3 The Format 2 COPY statement with the indicator attribute INDIC, defines data description entries in WORKING-STORAGE for the indicators to be used in the program.

4 IN96 is set if there is an invalid file status.

5 IN95 is set if there is an INVALID KEY condition on the REWRITE operation.

6 IN99 is set if the entered account number is invalid for the account to which money is being transferred.

7 IN97 is set if the entered account number is invalid for the account to which money is being transferred.

8 If an INVALID KEY condition occurs on the READ, a ROLLBACK is used and the record lock placed on the record after the first READ is released.

9 If the transfer of funds is not allowed (an indicator has been set), the ROLLBACK statement is processed. All changes made to database files under commitment control are canceled.

10 If the transfer of funds was valid (no indicators have been set), the COMMIT statement is processed, and all changes made to database files under commitment control become permanent.

11 The INDICATORS phrase is required for options on the work station display that are controlled by indicators.

Unblocking Input Records and Blocking Output Records

A **block** contains more than one record. In the interest of improving the performance of input and output operations, the COBOL compiler generates code to unblock input records and block output records in either of the following conditions:

1. *NOBLK is specified (with or without a BLOCK CONTAINS clause) and **all** of the following conditions are met:

   a. ACCESS IS SEQUENTIAL is specified for the file.

   b. The file is opened only for INPUT or OUTPUT in that program.

   c. The file is assigned to DISK, DATABASE, DISKETTE, or TAPEFILE.

   d. No START statements are specified for the file.

   For RELATIVE organization, blocking is not performed for OPEN OUTPUT.

   If you specify BLOCK CONTAINS, it is ignored except for tape files. For tape files, the BLOCK CONTAINS clause controls the number of records to be blocked. If you do not specify BLOCK CONTAINS, the system determines the number of records to be blocked. In the case of DISKETTE files, the system always determines the number of records to be blocked.

2. *BLK is specified with BLOCK CONTAINS and **all** of the following conditions are met:

   a. ACCESS IS SEQUENTIAL or ACCESS IS DYNAMIC is specified for the file.

   b. The file is opened only for INPUT or OUTPUT in that program.

   c. The file is assigned to DISK, DATABASE, DISKETTE, or TAPEFILE.

   For RELATIVE organization, blocking is not performed for OPEN OUTPUT.

   The BLOCK CONTAINS clause controls the number of records to be blocked. In the case of DISKETTE files, the system always determines the number of records to be blocked.

Even when all of the above conditions are met, certain OS/400 restrictions can cause blocking and unblocking to not be processed. In these cases, performance improvements will not be realized.

If you are using dynamically accessed and indexed organization files, you can use READ PRIOR and READ NEXT to perform blocking. When using READ PRIOR and READ NEXT to perform blocking, you cannot change direction while there are records remaining in the block. To clear the records from a block, specify a random operation, such as a random READ or a random START, or use a sequential READ FIRST or READ LAST.

If an illegal change of direction takes place, file status 9U results. No further I/O is possible until the file is closed and reopened.

You can override blocking at run time by specifying `SEQONLY(*NO)` for the OVRDBF command.

For disk and database files, when you use BLOCK CONTAINS, and if the blocking factor of zero is specified or calculated, the system determines the blocking factor.

There are certain instances in which the blocking factor you specify may be changed. See the *Database Guide* for more information about these situations.

Where a block of records is written or read, the I/O feedback area contains the number of records in that block. The I/O-FEEDBACK area is not updated after each read or write for files where multiple records are blocked and unblocked by COBOL. It is updated when the next block is read or written. See “I/O FEEDBACK” in the *COBOL/400 Reference* for more information.

For database files, you may not see all changes as they occur, if the changes are made in different programs. For a description of the effect of blocking on changes to database files, see the discussion on sequential-only processing in the *Database Guide*.

File Status and Feedback Areas

To transfer data (OPEN-FEEDBACK or I-O-FEEDBACK areas) associated with an open file to an identifier use the following format:

ACCEPT Statement – Format 3 – Feedback

```
►►──ACCEPT──identifier──FROM──mnemonic-name──┬─────────────────┬──────────►◄
                                              └─FOR──file-name─┘
```

See the “ACCEPT Statement” section of the *COBOL/400 Reference* for more information on specifying this statement. See the “Attribute Data Formats” section of the *COBOL/400 Reference* for information on the OPEN-FEEDBACK and the I-O-FEEDBACK areas.

Refer to the *Data Management Guide* for information on OPEN-FEEDBACK and I-O-FEEDBACK and the layout and description of the data areas contained in the feedback areas.

When the FILE STATUS clause is specified, the system moves a value into the status key data item after each input/output request that explicitly or implicitly refers to this file. This 2-character value indicates the run status of the statement. When the compiler generates code to block output records or unblock input records, file status values that are caused by OS/400 exceptions are set only when a block is processed. For more information about blocking records, refer to “Unblocking Input Records and Blocking Output Records” on page 102.

The I-O-FEEDBACK area is not updated after each read or write for files in which multiple records are blocked and unblocked by COBOL.

For database files, you may not see all changes as they occur, if the changes are made in different programs. For a description of the effect of blocking on changes to database files, see the discussion on Sequential-Only Processing in the *Database Guide*.

File Descriptions

All files on the AS/400 system are defined to the OS/400 operating system. The extent to which files can be defined differs:

- A **program-described file** is described at the field level within the COBOL program in the Data Division. The description of the file to the operating system includes information about the type of file and the length of the records in the file.
- An **externally described file** is described at the field level to the operating system through IDDU, SQL/400* commands, or DDS. If you create a file (for instance, by using the CRTPF command) without specifying DDS for it, the file still has a field description. The single field has the same name as the file, and has the record length you specified in the create command.

  The description includes information about the type of file, such as database or a device, and a description of each field and its attributes. The file must be created before you compile the program.

Both externally described files and program-described files must be defined in the COBOL program within the INPUT-OUTPUT SECTION and the FILE SECTION. Record descriptions in the FILE SECTION for externally described files can be defined with the Format 2 COPY statement.

Device-dependent functions such as forms control are not extracted by the Format 2 COPY operation. Only field-level descriptions are extracted.

When EXTERNALLY-DESCRIBED-KEY is specified as RECORD KEY, the fields that make up RECORD KEY are also extracted from DDS.

For more information on the Format 2 COPY statement, see Figure 37 on page 112 and the accompanying text.

Note: Actual file processing within the Procedure Division is the same, if the file is externally described or program-described.

Program-Described Files

Records and fields for a program-described file are described by coding record descriptions in the File Section of the COBOL program instead of using the Format 2 COPY statement.

The file must exist on the system before the program can run, except when you use dynamic file creation, by specifying GENOPT(*CRTF) on the CRTCBLPGM command. For more information, refer to the description of the GENOPT parameter on page 22, or the OPEN statement in the *COBOL/400 Reference*. To create a file, use one of the Create File commands, which can be found in the *CL Reference*.

DDS can be used with the Create File commands. For a COBOL indexed file, a keyed access path must be created. Specify a key in DDS when the file is created. The record key in COBOL must match the key defined when the file was created.

Externally Described Files

Externally described files offer the following advantages over program-described files:

- Less coding in COBOL programs. If the same file is used by many programs, the fields can be defined once to the operating system, and then used by all the programs. This eliminates the need to code a separate record description for each program that uses the file.
- Less maintenance activity when the file's record format is changed. You can often update programs by changing the file's record format and then recompiling the programs that use the file without changing any coding in the program.
- Improved documentation. Programs using the same files use consistent record format and field names.
- Any editing to be processed on externally described output files can be specified in DDS.

The external description for a file includes:

- The record format specifications that contain a description of the fields in a record
- Access path specifications that describe how the records are to be retrieved.

These specifications come from the external file description and from the OS/400 command you use to create the file.

You can use an externally described file within a program by making it a program-described file (by coding the record description in the source). In this case, the compiler does not copy the external field-level description of the file at compilation time. You may find this useful during conversions, since an existing program can use a program-described file while a new program uses an externally described file to refer to the same file.

Figure 31 on page 106 shows how COBOL programs can relate to files on the AS/400 system, making use of external file descriptions from DDS.

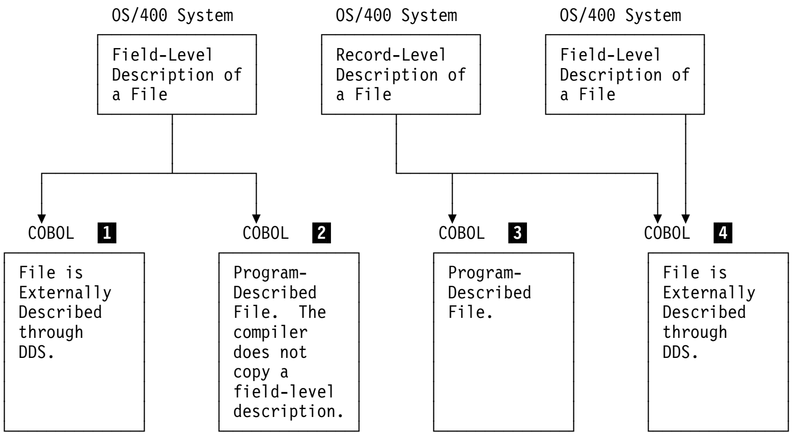

OS/400 System
Field-Level Description of a File
OS/400 System
Record-Level Description of a File
OS/400 System
Field-Level Description of a File
COBOL 1
File is Externally Described through DDS.
COBOL 2
Program-Described File. The compiler does not copy a field-level description.
COBOL 3
Program-Described File.
COBOL 4
File is Externally Described through DDS.

Figure 31. Example showing how COBOL can relate to AS/400 files

1 The COBOL program uses the field level description of a file that is defined to the operating system. The COBOL user coded a Format 2 COPY statement for the record description. At compilation time, the compiler copies in the external field-level description and translates it into a syntactically correct COBOL record description. The file must exist at compilation time.

2 An externally described file is used as a program-described file in the COBOL program. The entire record description for the file is coded in the COBOL program. This file does not have to exist at compilation time.

3 A file is described to the operating system as far as the record level only. The entire record description must be coded in the COBOL program. This file does not have to exist at compilation time.

4 A file name can be specified for compilation time, and a different file name can be specified for run time. A COBOL Format 2 COPY statement generates the record description for the file at compilation time. At run time, a different library list or a file override command can be used so that a different file is accessed by the program. The file description copied in at compilation time is used to describe the input records used at run time.

Note: For externally described files, the two file formats must be the same. Otherwise, a level check error will occur.

Data Description Specifications (DDS)

You can use Data Description Specifications (DDS) to describe files at the field level to the operating system. In DDS, each record format in an externally described file is identified by a unique record format name.

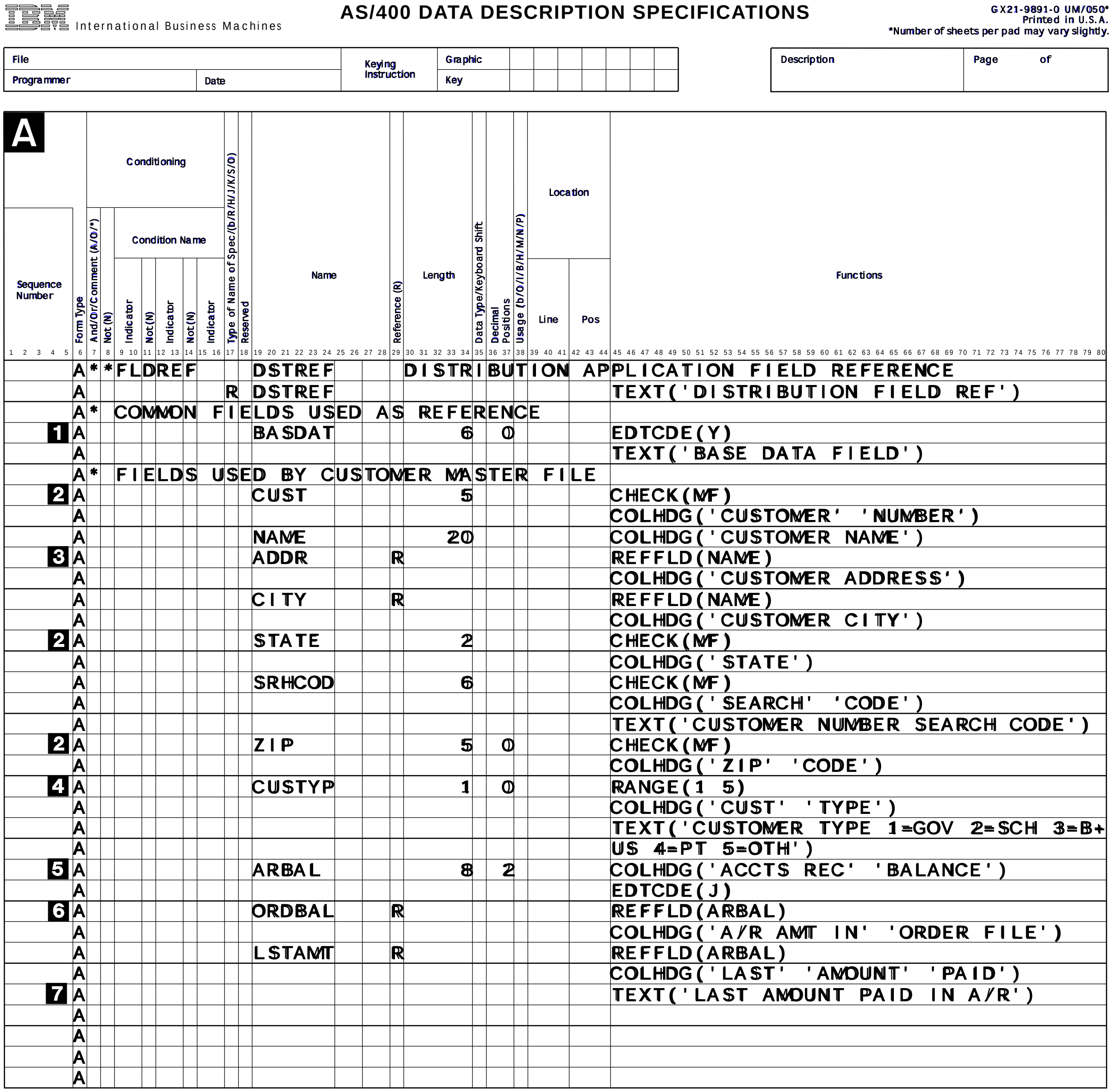
The record format specifications describe the fields in a record and the location of the fields in a record. The fields are located in the record in the order specified in DDS. The field description generally includes the field name, the field type (character, binary, external decimal, or internal decimal), and the field length (including the number of decimal positions in a numeric field). Instead of being specified in the record format for a physical or logical file, the field attributes can be defined in a field reference file. (See Figure 32 on page 107.)

The keys for a record format are specified in DDS. When you use a Format 2 COPY statement, a table of comments is generated in the source program listing showing how the keys for the format are defined in DDS.

In addition, DDS keywords can be used to:

- Specify edit codes for a field (EDTCDE)
- Specify edit words for a field (EDTWRD)
- Specify that duplicate key values are not allowed for the file (UNIQUE)
- Specify a text description for a record format or a field (TEXT).

See the *DDS Reference* for a complete list of the DDS keywords that are valid for a database file.



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Description | Page of
Programmer | Date | Key

A

Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Not (N), Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec/(b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
1 2 3 4 5 6 7 8 9 ...                                                          80
     A**FLDREF    DSTREF     DISTRIBUTION APPLICATION FIELD REFERENCE
     A          R DSTREF                    TEXT('DISTRIBUTION FIELD REF')
     A* COMMON FIELDS USED AS REFERENCE
    1A            BASDAT         6  0       EDTCDE(Y)
     A                                      TEXT('BASE DATA FIELD')
     A* FIELDS USED BY CUSTOMER MASTER FILE
    2A            CUST           5          CHECK(MF)
     A                                      COLHDG('CUSTOMER' 'NUMBER')
     A            NAME          20          COLHDG('CUSTOMER NAME')
    3A            ADDR      R               REFFLD(NAME)
     A                                      COLHDG('CUSTOMER ADDRESS')
     A            CITY      R               REFFLD(NAME)
     A                                      COLHDG('CUSTOMER CITY')
    2A            STATE          2          CHECK(MF)
     A                                      COLHDG('STATE')
     A            SRHCOD         6          CHECK(MF)
     A                                      COLHDG('SEARCH' 'CODE')
     A                                      TEXT('CUSTOMER NUMBER SEARCH CODE')
    2A            ZIP            5  0       CHECK(MF)
     A                                      COLHDG('ZIP' 'CODE')
    4A            CUSTYP         1  0       RANGE(1 5)
     A                                      COLHDG('CUST' 'TYPE')
     A                                      TEXT('CUSTOMER TYPE 1=GOV 2=SCH 3=B+
     A                                      US 4=PT 5=OTH')
    5A            ARBAL          8  2       COLHDG('ACCTS REC' 'BALANCE')
     A                                      EDTCDE(J)
    6A            ORDBAL    R               REFFLD(ARBAL)
     A                                      COLHDG('A/R AMT IN' 'ORDER FILE')
     A            LSTAMT    R               REFFLD(ARBAL)
     A                                      COLHDG('LAST' 'AMOUNT' 'PAID')
    7A                                      TEXT('LAST AMOUNT PAID IN A/R')
     A
     A
     A
     A
```

Figure 32. Example of a Field Reference File

This example of a field reference file shows the definitions of the fields that are used by the CUSMSTL (customer master logical) file, which is shown in Figure 33 on page 109. The field reference file normally contains the definitions of fields that are used by other files. The following text describes some of the entries for this field reference file.

1 The BASDAT field is edited by the Y edit code, as indicated by the keyword EDTCDE (Y). If this field is used in an externally described output file for a COBOL program, the COBOL-generated field is compatible with the data type specified in the DDS. The field is edited when the record is written. When the field is used in a program-described output file, compatibility with the DDS fields in the file is the user's responsibility. When DDS is not used to create the file, appropriate editing of the field in the COBOL program is also the user's responsibility.

2 The CHECK(MF) entry specifies that the field is a mandatory fill field when it is entered from a display work station. Mandatory fill means that all characters for the field must be entered from the display work station.

3 The ADDR and CITY fields share the same attributes that are specified for the NAME field, as indicated by the REFFLD keyword.

4 The RANGE keyword, which is specified for the CUSTYP field, ensures that the only valid numbers that can be entered into this field from a display work station are 1 through 5.

5 The COLHDG keyword provides a column head for the field if it is used by the Application Development Tools (Appl Dev Tools).

6 The ARBAL field is edited by the J edit code, as indicated by the keyword EDTCDE(J).

7 A text description (TEXT keyword) is provided for some fields. The TEXT keyword is used for documentation purposes and appears in various listings.

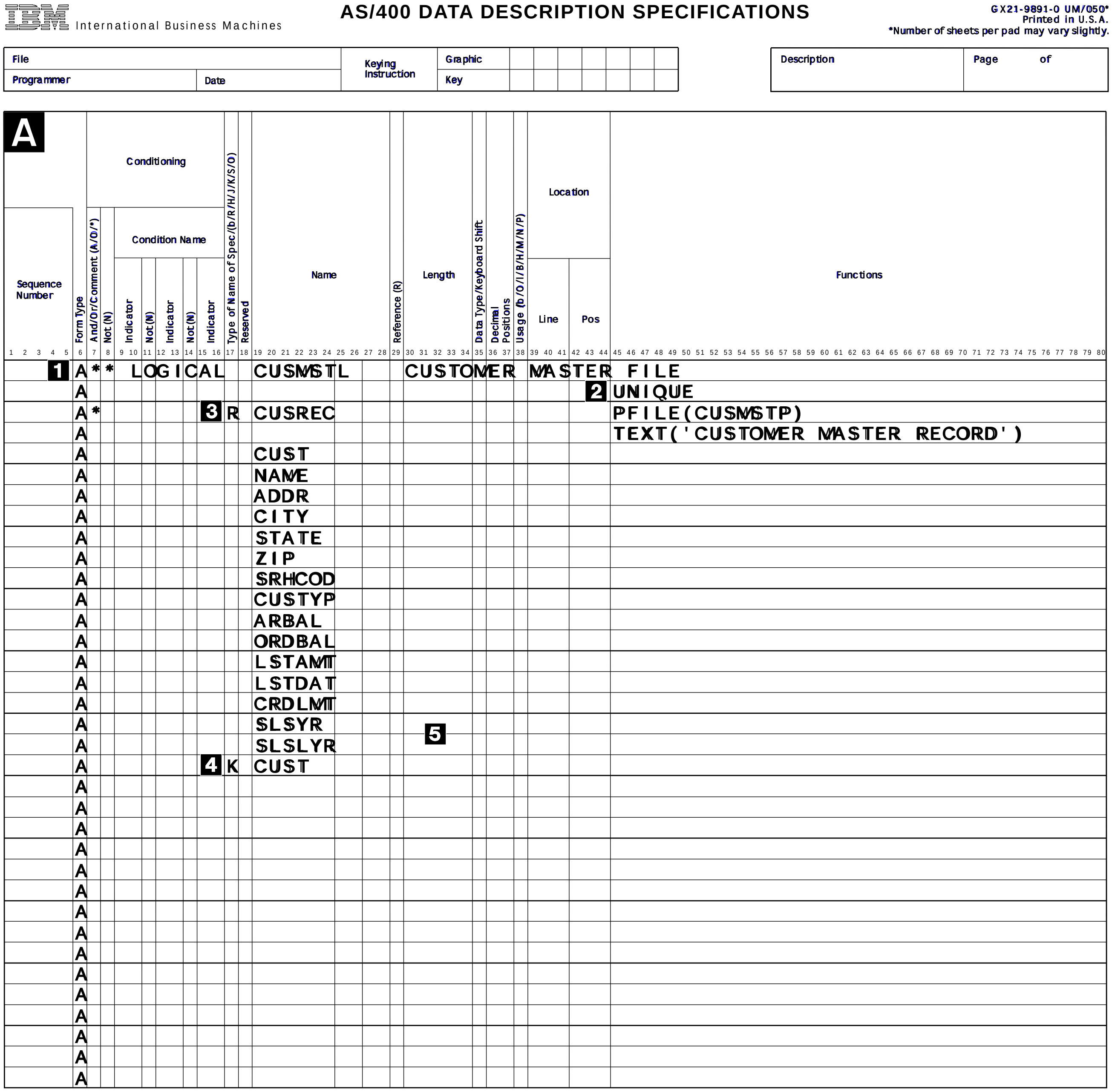
COBOL Specifications for Files Described Externally Using DDS

You can incorporate the file description in your program by coding a Format 2 COPY statement. The information from the external description is then retrieved by the COBOL compiler, and a COBOL data structure is generated.

The following pages provide examples of DDS usage and the COBOL code that would result from the use of a Format 2 COPY statement. (See “Format 2 COPY Statement (DD, DDR, DDS, or DDSR Option)” on page 112 for a detailed description of the Format 2 COPY statement.)

- Figure 33 on page 109 shows the DDS for a logical file and Figure 34 on page 110 shows the COBOL code generated.
- Figure 35 on page 111 describes the same file but includes the ALIAS keyword, and Figure 36 on page 112 shows the COBOL code generated.

Actual file processing within the Procedure Division is the same for both program-described and externally described files.



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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File		Keying Instruction	Graphic	Description	Page of
Programmer	Date		Key		

```
     A** LOGICAL  CUSMSTL    CUSTOMER MASTER FILE
     A                                      UNIQUE
     A*        R CUSREC                    PFILE(CUSMSTP)
     A                                      TEXT('CUSTOMER MASTER RECORD')
     A            CUST
     A            NAME
     A            ADDR
     A            CITY
     A            STATE
     A            ZIP
     A            SRHCOD
     A            CUSTYP
     A            ARBAL
     A            ORDBAL
     A            LSTAMT
     A            LSTDAT
     A            CRDLMT
     A            SLSYR
     A            SLSLYR
     A          K CUST
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 33. Example of Data Description Specifications for a Logical File

1 A logical file for processing the customer master physical file (CUSMSTP) is defined and named CUSMSTL.

2 The UNIQUE keyword indicates that duplicate key values for this file are not allowed.

3 One record format (CUSREC) is defined for the CUSMSTL file, which is to be based upon the physical file CUSMSTP.

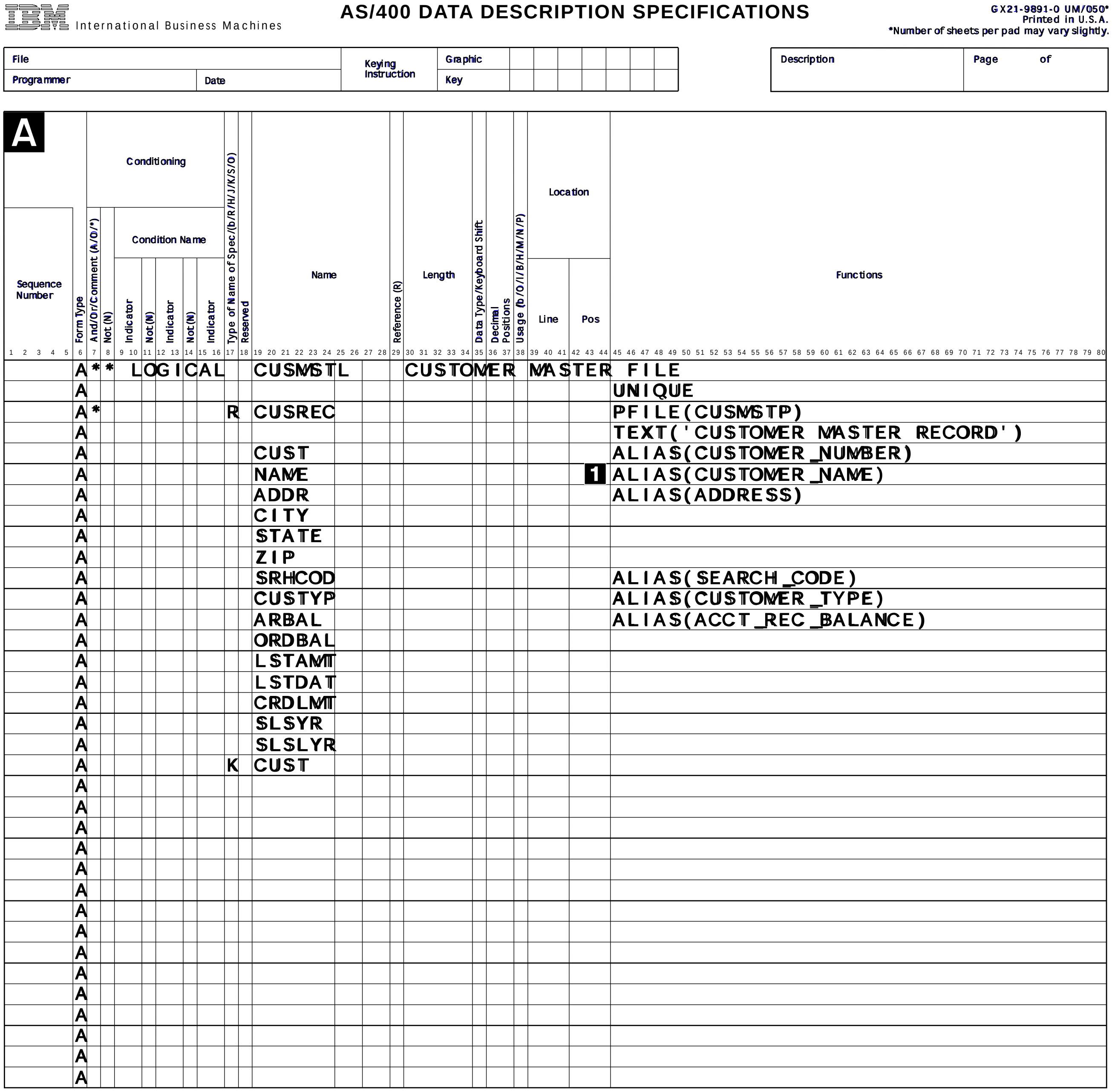
4 The CUST field is identified as the key field for this file.

5 If field attributes (such as length, data type, and decimal positions) are not specified in the DDS for a logical file, the attributes are obtained from the corresponding field in the physical file. Any field attributes specified in the DDS for the logical file override the attributes for the corresponding field in the physical file. The definition of the fields in the physical file could refer to a field reference file. A field reference file is a data description file consisting of field names and their definitions, such as size and type. When a field reference file is used, the same fields that are used in multiple record formats have to be defined only once in the field reference file. For more information on a field reference file, see the *Database Guide*.

Figure 32 on page 107 shows an example of a field reference file that defines the attributes of the fields used in the database file. See the *Database Guide* for more information regarding field reference files.

```
 01  CUS-MASTER.
     COPY DDS-CUSREC OF CUSLIB-CUSTMAST.
*I-O FORMAT: CUSREC FROM FILE CUSTMAST OF LIBRARY CUSLIB       CUSREC
*                   CUSTOMER MASTER RECORD                     CUSREC
*THE KEY DEFINITIONS FOR THE RECORD FORMAT CUSREC              CUSREC
*NUMBER   NAME    RETRIEVAL   TYPE    ALTSEQ                   CUSREC
*0001     CUST    ASCENDING   AN      NO                       CUSREC
    05   CUSREC.                                               CUSREC
        06 CUST     PIC X(5).                                  CUSREC
*                CUSTOMER NUMBER                               CUSREC
        06 NAME     PIC X(20).                                 CUSREC
*                CUSTOMER NAME                                 CUSREC
        06 ADDR     PIC X(20).                                 CUSREC
*                CUSTOMER ADDRESS                              CUSREC
        06 CITY     PIC X(20).                                 CUSREC
*                CUSTOMER CITY                                 CUSREC
        06 STATE    PIC X(2).                                  CUSREC
*                STATE ABBREVIATION                            CUSREC
        06 ZIP      PIC S9(5)     COMP-3.                      CUSREC
*                ZIP CODE                                      CUSREC
        06 SHRCOD   PIC X(6).                                  CUSREC
*                CUSTOMER NAME SEARCH CODE                     CUSREC
        06 CUSTYP   PIC 9(1).                                  CUSREC
*                CUSTOMER TYPE                                 CUSREC
        06 ARBAL    PIC S9(6)V9(2)     COMP-3.                 CUSREC
*                ACCT/REC BALANCE                              CUSREC
```

Figure 34. Example of the Results of the Format 2 COPY Statement (DDS)



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Key | Programmer | Date | Description | Page of

A

Sequence Number | Form Type | And/Or/Comment (A/O/*) | Not (N) | Conditioning: Condition Name: Indicator, Not(N), Indicator, Not(N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A** LOGICAL  CUSMSTL    CUSTOMER MASTER FILE
     A                                      UNIQUE
     A*         R CUSREC                    PFILE(CUSMSTP)
     A                                      TEXT('CUSTOMER MASTER RECORD')
     A            CUST                      ALIAS(CUSTOMER_NUMBER)
     A            NAME                      ALIAS(CUSTOMER_NAME)
     A            ADDR                      ALIAS(ADDRESS)
     A            CITY
     A            STATE
     A            ZIP
     A            SRHCOD                    ALIAS(SEARCH_CODE)
     A            CUSTYP                    ALIAS(CUSTOMER_TYPE)
     A            ARBAL                     ALIAS(ACCT_REC_BALANCE)
     A            ORDBAL
     A            LSTAMT
     A            LSTDAT
     A            CRDLMT
     A            SLSYR
     A            SLSLYR
     A          K CUST
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 35. Example of Data Description Specifications with ALIAS

1 This is the name associated with the ALIAS keyword, which will be included in the program. Available through the DDS ALIAS option, an alias is an alternative name that allows a data name of up to 30 characters to be included in a COBOL/400 program.

```
 01  CUS-MASTER.
     COPY DD-CUSREC OF CUSLIB-CUSTMAST.
*I-O FORMAT: CUSREC FROM FILE CUSTMAST OF LIBRARY CUSLIB       CUSREC
*                  CUSTOMER MASTER RECORD                      CUSREC
*THE KEY DEFINITIONS FOR THE RECORD FORMAT CUSREC              CUSREC
*NUMBER   NAME              RETRIEVAL  TYPE          ALTSEQ    CUSREC
*0001     CUSTOMER-NUMBER   ASCENDING  AN            NO        CUSREC
                                                               CUSREC
    05  CUSREC.                                                CUSREC
        06 CUSTOMER-NUMBER  PIC X(5).                          CUSREC
*               CUSTOMER NUMBER                                CUSREC
        06 CUSTOMER-NAME    PIC X(20).                         CUSREC
*               CUSTOMER NAME                                  CUSREC
        06 ADDRESS          PIC X(20).                         CUSREC
*               CUSTOMER ADDRESS                               CUSREC
        06 CITY             PIC X(20).                         CUSREC
*               CUSTOMER CITY                                  CUSREC
        06 STATE            PIC X(2).                          CUSREC
*               STATE ABBREVIATION                             CUSREC
        06 ZIP              PIC S9(5)    COMP-3.               CUSREC
*               ZIP CODE                                       CUSREC
        06 SEARCH-CODE      PIC X(6).                          CUSREC
*               CUSTOMER NAME SEARCH CODE                      CUSREC
        06 CUSTOMER-TYPE    PIC 9(1)                           CUSREC
*               CUSTOMER TYPE                                  CUSREC
        06 ACCT-REC-BALANCE PIC S9(6)V9(2)   COMP-3.           CUSREC
*               ACCT/REC BALANCE                               CUSREC
```

Figure 36. Example of the Results of the Format 2 COPY Statement (DD) with the ALIAS Keyword

IBM Extension

Format 2 COPY Statement (DD, DDR, DDS, or DDSR Option)

For general information about both formats of the COPY statement, see the *COBOL/400 Reference*.

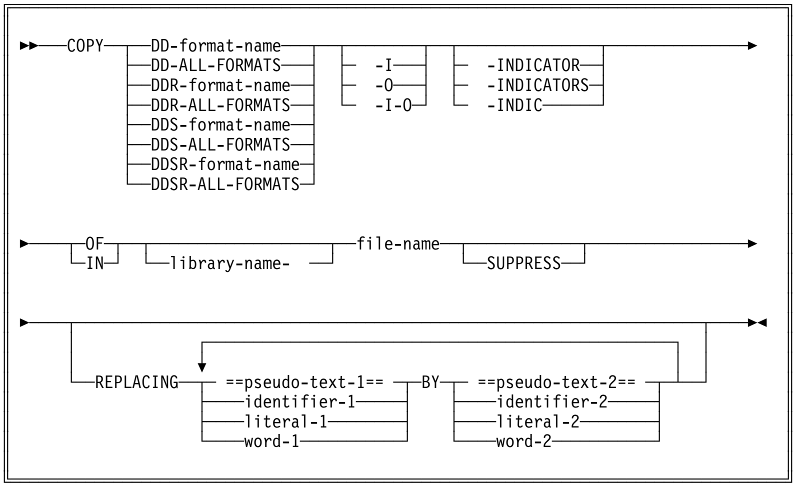


Figure 37. COPY Statement – Format 2 – DDS Translate

You can use the Format 2 COPY statement (DD, DDR, DDS, or DDSR option) to create COBOL Data Division statements to describe a file that exists on the system. These descriptions are based on the version of the file in existence at compilation time. They do not make use of any DDS source statements for the file. Refer to the “COPY Statement” section of the *COBOL/400 Reference* for more information about the COPY statement.

Note: The Format 2 COPY statement (DD, DDR, DDS, or DDSR option) will be denoted by the term *Format 2 COPY statement* throughout this manual.

The Format 2 COPY statement can be used only in the Data Division. You should ensure that a group level item that has a level-number less than 05 precedes the statement.

The DD option is used to reference ALIAS (alternative) names. The specification of an ALIAS name in DDS allows a data name of up to 30 characters to be included in the COBOL program.

When the DD option is used, any ALIAS names present replace the corresponding DDS field names. All underscores in the ALIAS names are translated into hyphens before any replacing occurs.

The DDR option does everything that the DD option does. It also copies the internal DDS format field names, replacing the invalid COBOL characters @, #, $, and _ with the valid COBOL characters A, N, D, and - accordingly. This option also removes any underscores from the ends of the field names.

The DDS option copies in the internal DDS format field names. For examples of keys and key names that can be generated when you use the DDS option of the Format 2 COPY statement, see pages 121 through 127.

The DDSR option does everything that the DDS option does. It also copies the internal DDS format field names, replacing the invalid COBOL characters @, #, $, and _ with the valid COBOL characters A, N, D, and - accordingly. This option also removes any underscores from the ends of the field names.

The following shows the effect of the DDR or DDSR option on invalid COBOL field names:

Original Field Name	**Modified Field Name**
FLD_A	FLD-A
NUMBER#1	NUMBERN1
POINT@7	POINTA7
BALANCE$	BALANCED

When the RECORD KEY clause specifies EXTERNALLY-DESCRIBED-KEY, a format can be copied only once under an FD. For example, if all of the formats of a file are copied under an FD, no other Format 2 COPY statement can be specified for the same file under that FD.

The format-name is the name of the DDS record format definition that is to be translated into COBOL data description entries. The format-name must follow the rules for formation of any COBOL/400 name.

If neither -I nor -O is specified, -I-O is assumed.

If format-name is specified without the Indicator attribute, and both -I and -O formats are to be generated, each record format is generated as a redefinition of an 05 elementary item defined as:

- The size of the largest record format that will be generated.

If ALL-FORMATS is specified (without the Indicator attribute) each record format is generated as a redefinition of an 05 elementary item defined as either:

- The size of the largest record format in the file, if the COPY statement appears in the File Section
- The size of the largest record format that will be generated, if the COPY statement appears outside of the File Section.

When the Indicator attribute is specified, no redefinition takes place. Instead, each of the formats generates a separate data structure.

More information can be found about the Indicator attribute in the section, “Indicator Attribute of the Format 2 COPY Statement” on page 118.

Library-name is optional. If it is not specified, the current job library list is used as the default value.

File-name is the name of an AS/400 system file. The generated DDS entries represent the record format defined in the file. The file must be created before the program is compiled.

If the file is a database file, a single I/O format is generated.

For all other file types, the description generated varies as follows:

- If -I is specified, the generated data description entries contain either:
  - The input and input/output fields for a nonsubfile format
  - The input, output, and input/output fields for a subfile format.
- If -O is specified, the generated data description entries contain either:
  - The output and input/output fields for a nonsubfile format
  - The input, output, and input/output fields for a subfile format.

Note: Subfile records with only output or input/output fields, and no field indicators specified, generate I/O formats.

If a separate storage area is needed in WORKING-STORAGE for each format, an individual COPY statement must be specified for each format.

For example, if you assume that the file CUSTMASTER contains two formats CUSADR and CUSTDETL, the following COPY statements could be specified:

```
   SELECT FILE-X
   ASSIGN TO DATABASE-CUSTMASTER.
⋮
FD   FILE-X
    LABEL RECORDS ARE STANDARD.
01   FILE-X-RECS.
    COPY DDS-ALL-FORMATS OF
       CUSTMASTER-QGPL.   (See Note 1.)
⋮
WORKING-STORAGE SECTION.
01   ADR-REC.
    COPY DDS-CUSTADR OF
       CUSTMASTER.     (See Note 2.)
01   DETAIL-REC.
    COPY DDS-CUSTDETL OF
       CUSTMASTER.     (See Note 2.)
```

Notes:

1. This COPY statement generates only one storage area for all formats.
2. These COPY statements generate separate storage areas.

Indicators

Indicators are Boolean data items that can have the values B"0" or B"1".

When you define a record format for a file using DDS, you can condition the options using indicators; indicators can also be used to reflect particular responses. These indicators are known as OPTION and RESPONSE, respectively. Option indicators provide options such as spacing, underlining, and allowing or requesting data transfer from a program to a printer or display device. Response indicators provide response information to a program from a device, such as function keys pressed by a work station user, and whether data has been entered.

Indicators can be used with TRANSACTION files and FORMATFILE files, but never with database files.

Data Structures Generated

Different DDS keywords influence the creation of various types of data structures.

Format (Record) Level Structures

At the beginning of each format, a table of comments is generated in the source program listing. These comments provide details of the files used during compilation of the program. If there are record keys for the file, comments are also generated to show how the keys are defined in DDS. The record key entries that may appear in the table and the table heading are listed below.

Heading	**Possible Entry**
NUMBER	key field number
NAME	key field name
RETRIEVAL	ASCENDING, DESCENDING
TYPE	ZONE, DIGIT, SIGNED, ABSVAL, AN (alphanumeric), N (numeric) J (DBCS item), DDS - L (date), DDS - T (time), DDS - Z (timestamp), DDS - G (fixed-length graphic), VARLEN (variable-length character or bracketed DBCS item), G VARLEN (variable-length DBCS-graphic)
ALTSEQ	NO, YES

If redefinition is required to allow for the generation of multiple formats, a group level name is generated as follows:

```
05 file-name-RECORD
    PIC X(size of largest record).
```

For each format, a group level name is assigned as follows:

- INPUT

  05 format-name-I

- OUTPUT

  05 format-name-O

- I/O Format

  05 format-name

Data Field Structures

Field names, PICTURE definitions, and numeric usage clauses are derived directly from the internal DDS format field names (or ALIAS names in the case of the DD or DDR option) and data type representations. Field names and PICTURE definitions are constructed as follows:

```
06  field-name PIC
```

Note: See Figure 38 on page 117 for the appropriate COBOL PICTURE definition.

Table 3. Data Field Structures

DDS		COBOL DATA DIVISION
		n=total field length (DDS pos. 30-34)
		m=number of decimals (DDS pos. 36 & 37)	

Data Type (pos. 35)	Formats	If DDS pos. 36 & 37 are blank	If DDS pos. 36 & 37 are not blank
PHYSICAL, LOGICAL, PRINTER, AND COMMUNICATIONS FILES			
ƀ(Blank)	Default	PIC X(n) [2]	PIC S9(n-m)V9(m)
P	Packed decimal	PIC S9(n) COMP-3	PIC S9(n-m)V9(m) COMP-3
S	Zoned decimal/signed numeric	PIC S9(n)	PIC S9(n-m)V9(m)
B	Binary	PIC S9(n) COMP-4	PIC S9(n-m)V9(m) COMP-4
F	Floating point [1]		
	single precision	PIC 9(5) COMP-4	PIC 9(5) COMP-4
	double precision	PIC 9(10) COMP-4	PIC 9(10) COMP-4
A	Character	PIC X(n) [2]	—
H	Hexadecimal data	PIC X(n)	—
L	Date [3]	PIC X(n)	—
T	Time [3]	PIC X(n)	—
Z	Timestamp [3]	PIC X(n)	—
J	DBCS-Only data	PIC X(n)	—
E	DBCS-Either data	PIC X(n)	—
O	DBCS-Open data	PIC X(n)	—
G	DBCS-Graphic data	PIC X(2n) [2]	—
DISPLAY FILES			
ƀ(Blank)	Default	PIC X(n)	PIC S9(n-m)V9(m)
X	Alphabetic Only	PIC X(n)	—
N	Numeric Shift	PIC X(n)	PIC S9(n-m)V9(m)
Y	Numeric Only	—	PIC S9(n-m)V9(m)
I	Inhibit Keyboard entry	PIC X(n)	PIC S9(n-m)V9(m)
W	Katakana	PIC X(n)	—
A	Alphanumeric Shift	PIC X(n)	—
D	Digits only	PIC X(n)	PIC S9(n)
F	Floating point [1]		
	single precision	PIC 9(5) COMP-4	PIC 9(5) COMP-4
	double precision	PIC 9(10) COMP-4	PIC 9(10) COMP-4
M	Numeric-only character	PIC X(n)	—
S	Signed-numeric shift	—	PIC S9(n-m)V9(m)
E	DBCS-either	PIC X(n)	—
J	DBCS-only	PIC X(n)	—
O	DBCS-open	PIC X(n)	—
G	DBCS-graphic	PIC X(2n)	—

[1] COBOL treats floating point fields as FILLER. See 'Floating Point Fields'.

[2] In DDS, if the field has an attribute of VARLEN, the result is two additional bytes at the beginning of the field.

[3] FILLER items by default. See 'Date, Time, and Timestamp Fields'.

Figure 38. Data Field Structures

Indicator Structures

If indicators are requested, and exist in the format, an additional group name (06 level) is generated at the beginning of the structure, followed by entries (07 level) for the relevant individual indicators.

```
06   format-name(-I or -O)-INDIC.
       07  INxx PIC 1 INDIC xx.
```

where xx is the indicator number.

For example:

```
 06   SAMPLE1-I-INDIC.
      07   IN01 PIC 1 INDIC 01.
      07   IN04 PIC 1 INDIC 04.
      07   IN05 PIC 1 INDIC 05.
      07   IN07 PIC 1 INDIC 07.
 06   FLD1 PIC  ...  .
 06   FLD2 PIC  ...  .
```

Indicator Attribute of the Format 2 COPY Statement

The Indicator attribute specifies if data description entries are generated for indicators.

If the Indicator attribute is specified, data description entries are generated for indicators, but not for data fields. A 05 group level entry is generated as follows:

- If the COPY is for a single structure (for example, COPY DDS-format-name-INDIC)

  05 format-name-I. (or -O as appropriate)

- If the COPY is for multiple structures (for example, COPY DDS-ALL-FORMATS-INDIC)

  05 file-name-RECORD.

The data description entries that are generated are determined by which one of the usage attributes (I, O, or I-O) is specified or assumed in the COPY statement.

- If ...I-INDICATOR... is specified, data description entries for input (response) indicators are generated for indicators used in the input record area.
- If ...O-INDICATOR... is specified, data description entries for output (option) indicators are generated for indicators used in the output record area.
- If ...I-O-INDICATOR... is specified or assumed, separate data description entries for both input and output (response and option) indicators are generated for indicators used in the input and output record areas.

If the Indicator attribute is not specified, generation of data description entries for indicators depends on if the file had the keyword INDARA specified in the DDS at the time it was created.

- If INDARA was not specified, data description entries are generated for both data fields and indicators.
- If INDARA was specified, data description entries are generated for data fields only, not for indicators.

Generation of I/O Formats

When all field descriptions are identical, and you have requested INPUT or OUTPUT fields implicitly or explicitly, only one set of field descriptions is generated. This type of description is annotated with a comment line reading, “I-O FORMAT: format-name”. Neither -I nor -O is appended to the record format name.

Note: This always happens for database files because all field descriptions within a database file are identical.

For example:

```
 01 RCUSREC.
    COPY DDS-CUSREC-I OF CUSFILE.
*   I-O FORMAT: CUSREC FROM FILE CUSFILE OF LIBRARY CUSLIB     CUSREC
* THE KEY DEFINITIONS FOR RECORD FORMAT CUSREC
*   NUMBER NAME RETRIEVAL TYPE ALTSEQ
*    0001 ARBAL ASCENDING SIGNED NO
*    0002 AREACD DESCENDING ABSVAL NO
       05   CUSREC.
       06   ARBAL          PIC S9(7)V9(2)      COMP-3          CUSREC
       06   AREACD         PIC S9(3)           COMP-3.         CUSREC
       06   BOSTAZ         PIC X(1).                           CUSREC
       06   CNTCT          PIC X(15).                          CUSREC
       06   CRCHKZ         PIC S9(2).                          CUSREC
       06   CSTAT          PIC X(1).                           CUSREC
       06   CUSTNZ         PIC S9(6).                          CUSREC
       06   DLORD          PIC S9(6).                          CUSREC
       06   DSCPCZ         PIC S9(2)V9(3)      COMP-3.         CUSREC
       06   INDUS          PIC S9(2).                          CUSREC
       06   NAME1          PIC X(25).                          CUSREC
       06   NAME2          PIC X(25).                          CUSREC
       06   NAME3          PIC X(25).                          CUSREC
       06   NAME4          PIC X(25).                          CUSREC
       06   PHONE          PIC S9(7)           COMP-3.         CUSREC
       06   PRICIZ         PIC S9(2).                          CUSREC
       06   SHPINZ         PIC X(25).                          CUSREC
       06   SLSMAZ         PIC X(3).                           CUSREC
       06   TAXCDZ         PIC S9(2).                          CUSREC
       06   TERMSZ         PIC S9(2).                          CUSREC
```

Figure 39. Example of Copy DDS Showing I/O Formats

Redefinition of Formats

Pay particular attention to the REDEFINES clause that may be generated for the ALL-FORMATS or -I-O phrases. Because all formats are redefined on the same area (generally a buffer area), several field names can describe the same area of storage, and unpredictable results can occur if the entire format area is not reinitialized prior to each output operation.

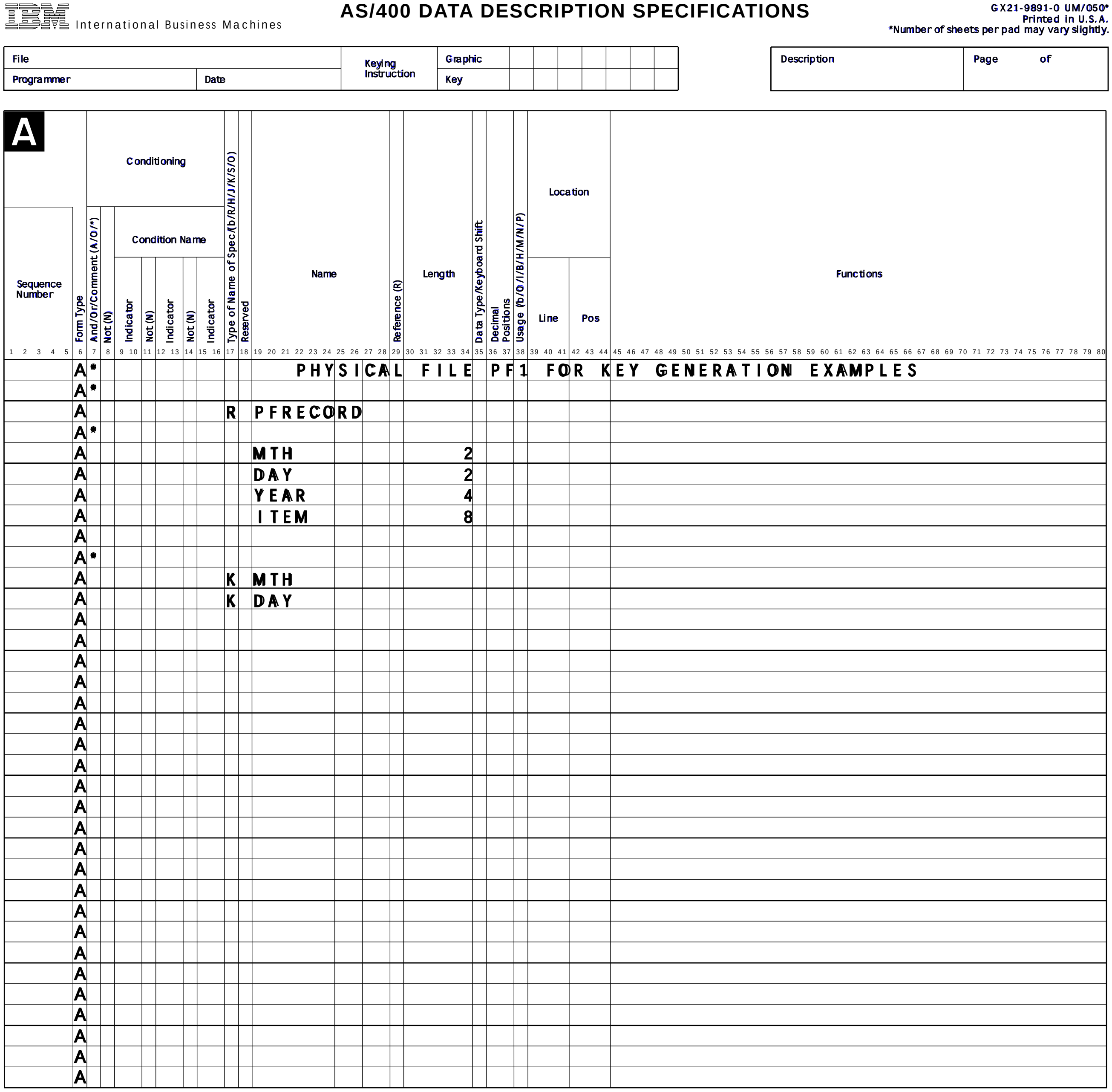
Data items that are subordinate to the data item specified in a MOVE CORRESPONDING statement do not correspond and are not moved when they contain a REDEFINES clause or are subordinate to a redefining item.

To avoid reinitialization, multiple Format 2 COPY statements using -I and -O suffixes can be used to create separate areas of storage in the Working-Storage section for each format or format type (input or output). READ INTO and WRITE FROM statements can be used with these record formats.

For example:

```
  FD ORDER-ENTRY-SCREEN ...
  01 ORDER-ENTRY-RECORD ...
⋮
  WORKING-STORAGE SECTION.
  01 ORDSFL-I-FORMAT.
     COPY DDS-ORDSFL-I OF DOESCR.
  01 ORDSFL-O-FORMAT.
     COPY DDS-ORDSFL-O OF DOESCR.
⋮
  PROCEDURE DIVISION.
⋮
  READ SUBFILE ORDER-ENTRY-SCREEN NEXT MODIFIED RECORD
     INTO ORDSFL-I-FORMAT FORMAT IS "ORDSFL"
     AT END SET NO-MODIFIED-SUBFILE-RCD TO TRUE.
⋮
  MOVE CORR ORDSFL-I TO ORDSFL-O.
  REWRITE SUBFILE ORDER-ENTRY-RECORD FROM ORDSFL-O-FORMAT
                             FORMAT IS "ORDSFL" ...
⋮
```

Key Generation Examples



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File

Programmer | Date

Keying Instruction | Graphic | Key

Description | Page of

A

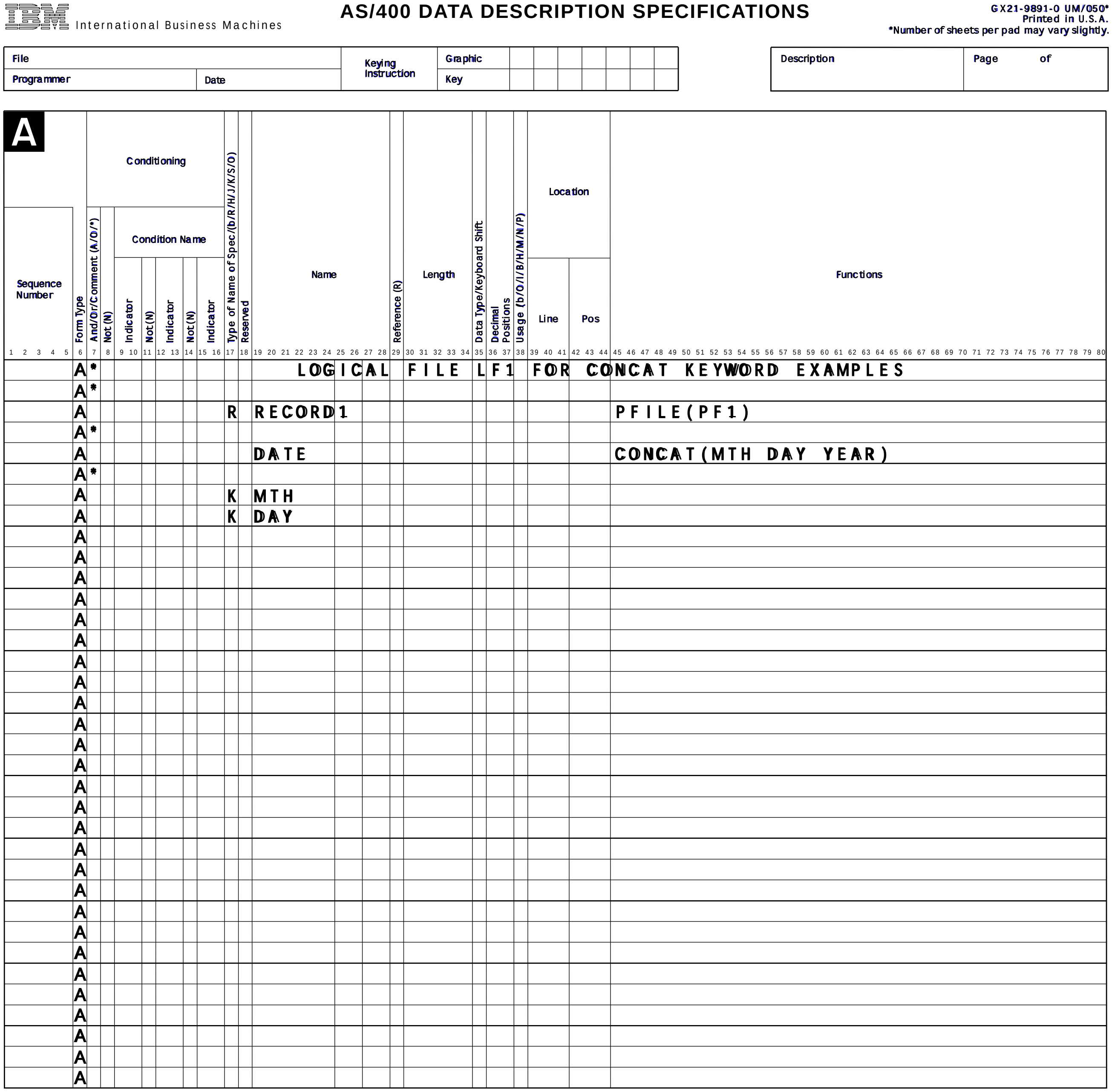
Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Condition Name: Not (N), Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A*              PHYSICAL FILE PF1 FOR KEY GENERATION EXAMPLES
     A*
     A          R PFRECORD
     A*
     A            MTH            2
     A            DAY            2
     A            YEAR           4
     A            ITEM           8
     A
     A*
     A          K MTH
     A          K DAY
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 40. Data Description Specifications for a Physical File

The physical file described by Figure 40 forms a basis for the examples that follow. Each example refers to a logical file (derived from the physical file) that specifies EXTERNALLY-DESCRIBED-KEY in its SELECT clause.

Example Using CONCAT Keyword



International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File
Programmer
Date
Keying Instruction
Graphic
Key
Description
Page of

```
     A*              LOGICAL FILE LF1 FOR CONCAT KEYWORD EXAMPLES
     A*
     A          R RECORD1                   PFILE(PF1)
     A*
     A            DATE                      CONCAT(MTH DAY YEAR)
     A*
     A          K MTH
     A          K DAY
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 41. Data Description Specifications Using the CONCAT Keyword

For the logical file described by Figure 41, COPY DDS generates keys and key names derived from the physical file:

```
 FD  LF1 LABEL RECORDS ARE STANDARD.
 01   LOG-RECORD.
              COPY DDS-ALL-FORMATS OF LF1.
       05  LF1-RECORD PIC X(8).
*    I-O FORMAT:RECORD1    FROM FILE LF1        OF LIBRARY COPYDDS
*
*THE KEY DEFINITIONS FOR RECORD FORMAT  RECORD1
*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ
*   0001   MTH-DDS                          ASCENDING      AN      NO
*          KEY NAME ORIGINATES FROM PHYSICAL FILE
*   0002   DAY-DDS-DDS                      ASCENDING      AN      NO
*          KEY NAME ORIGINATES FROM PHYSICAL FILE
       05  RECORD1       REDEFINES LF1-RECORD.
           06 DATE-DDS              PIC X(8).
           06 FILLER REDEFINES DATE-DDS.
              07 MTH-DDS            PIC X(2).
              07 DAY-DDS-DDS        PIC X(2).
              07 FILLER             PIC X(4).
```

Figure 42. Example Using the CONCAT Keyword

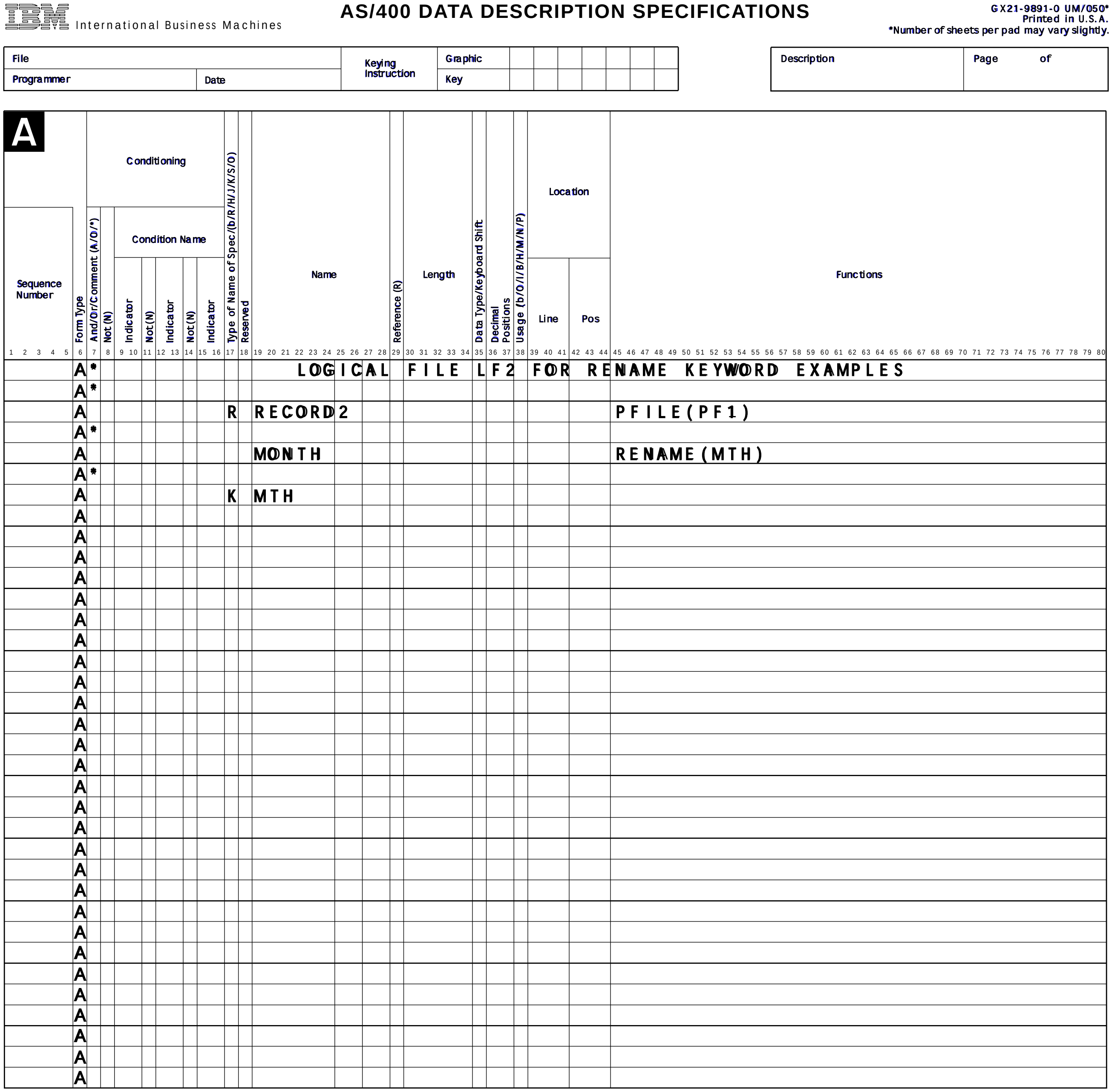
The COPY statement adds the suffix -DDS to the field names MTH and DATE because MTH is a key that originates from the physical file, and DATE is a COBOL reserved word. The COPY statement adds the suffix -DDS twice to the field name DAY because DAY is both a key that originates from the physical file and a COBOL reserved word.

Note that if you move your COPY statement from the File Section to the Working-Storage Section or to the Linkage Section, the fields subordinate to DATE-DDS are no longer available:

```
 WORKING-STORAGE SECTION.
 01   WRK-RECORD.
              COPY DDS-ALL-FORMATS OF LF1.
       05  LF1-RECORD PIC X(8).
*    I-O FORMAT:RECORD1    FROM FILE LF1        OF LIBRARY COPYDDS
*
       05  RECORD1       REDEFINES LF1-RECORD.
           06 DATE-DDS              PIC X(8).
```

Figure 43. Example Using the CONCAT Keyword-- Working-Storage Section

Example Using RENAME Keyword



International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Programmer | Date | Keying Instruction | Graphic | Key | Description | Page of

A
Sequence Number
Form Type
And/Or/Comment (A/O/*)
Not (N)
Conditioning
Condition Name
Indicator
Not (N)
Indicator
Not (N)
Indicator
Type of Name of Spec/(b/R/H/J/K/S/O)
Reserved
Name
Reference (R)
Length
Data Type/Keyboard Shift
Decimal Positions
Usage (b/O/I/B/H/M/N/P)
Location
Line
Pos
Functions

```
     A*              LOGICAL FILE LF2 FOR RENAME KEYWORD EXAMPLES
     A*
     A          R RECORD2                   PFILE(PF1)
     A*
     A            MONTH                     RENAME(MTH)
     A*
     A          K MTH
```

Figure 44. Data Description Specifications Using the RENAME Keyword

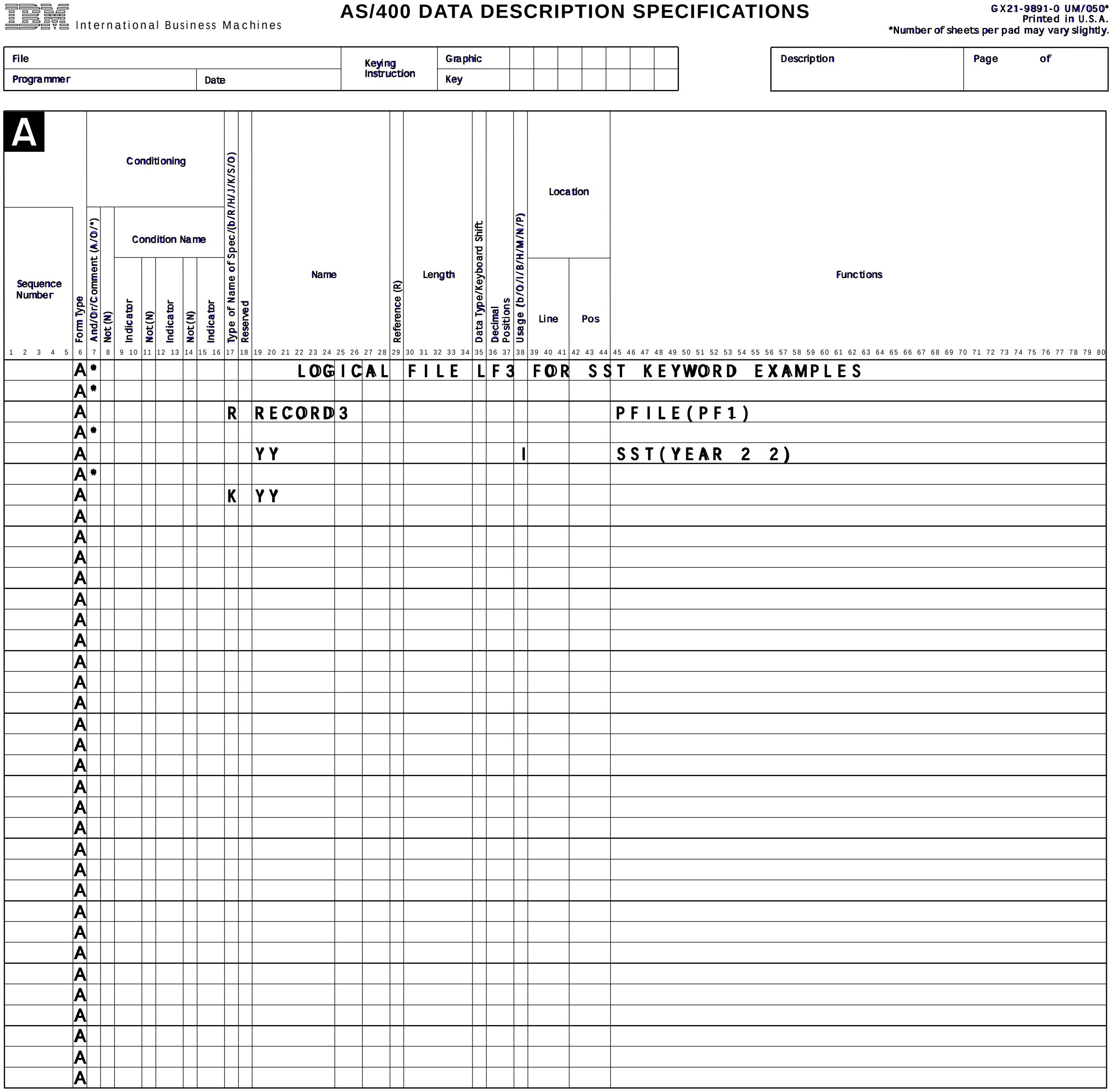
For the logical file described by Figure 44, COPY DDS generates a key and key name derived from the physical file:

```
 FD  LF2 LABEL RECORDS ARE STANDARD.
 01   LOG-RECORD.
              COPY DDS-ALL-FORMATS OF LF2.
       05  LF2-RECORD PIC X(2).
*    I-O FORMAT:RECORD2    FROM FILE LF2        OF LIBRARY COPYDDS
*
*THE KEY DEFINITIONS FOR RECORD FORMAT  RECORD2
*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ
*   0001   MTH-DDS                          ASCENDING      AN      NO
*          KEY NAME ORIGINATES FROM PHYSICAL FILE
       05  RECORD2       REDEFINES LF2-RECORD.
           06 MONTH                 PIC X(2).
           06 MTH-DDS REDEFINES MONTH PIC X(2).
```

Figure 45. Using the RENAME Keyword

The COPY statement adds the suffix -DDS to the field name MTH because MTH is a key that originates from the physical file.

Example Using SST Keyword



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Programmer | Date | Keying Instruction | Graphic | Key | Description | Page of

```
     A*               LOGICAL FILE LF3 FOR SST KEYWORD EXAMPLES
     A*
     A          R RECORD3                   PFILE(PF1)
     A*
     A            YY                 I      SST(YEAR 2 2)
     A*
     A          K YY
```

Figure 46. Data Description Specifications Using the SST Keyword

For the logical file described by Figure 46 on page 126, COPY DDS generates the following specifications:

```
 FD  LF3 LABEL RECORDS ARE STANDARD.
 01   LOG-RECORD.
              COPY DDS-ALL-FORMATS OF LF3.
       05  LF3-RECORD PIC X(2).
*    I-O FORMAT:RECORD3    FROM FILE LF3        OF LIBRARY COPYDDS
*
*THE KEY DEFINITIONS FOR RECORD FORMAT  RECORD3
*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ
*   0001   YY                               ASCENDING      AN      NO
       05  RECORD3       REDEFINES LF3-RECORD.
           06 YY                    PIC X(2).
```

Figure 47. Using the SST Keyword

The COPY statement does not add a suffix to the field name YY because YY is neither a key that originates from the physical file nor a COBOL reserved word.

Additional Notes on Field and Format Names

If the generated field name is a COBOL reserved word, the suffix -DDS is added to the field name.

The REPLACING phrase cannot be used to change the name of a key field when EXTERNALLY-DESCRIBED-KEY is used.

Floating-Point Fields

COBOL treats floating-point fields as FILLER. The fields can contain floating-point values set outside of COBOL. A COMP-4 definition is generated to maintain proper alignment in the record, but the data is *not* in binary format. No attempt must be made to use floating-point data for processing in the COBOL program.

Floating-point key fields are not allowed. In cases where some formats exist with a floating-point key field and other formats do not, use one or more Format 2 COPY statements with specific format names, rather than the ALL-FORMATS option.

Note: If you have not specified your own program collating sequence, you can create a record containing floating-point fields in your COBOL program by moving LOW-VALUES to the entire record before moving in the values of the non-floating-point fields. This will give the floating-point fields in the record a value of zero. Note that the above method is only recommended if valid floating-point fields with a value of zero are desirable for your particular application.

REPLACING Phrase in Format 2 COPY Statement

The REPLACING phrase can be used to replace any of the generated COBOL source, including the level numbers and the format-name. Note the following exception:

- When RECORD KEY IS EXTERNALLY-DESCRIBED-KEY is specified, the REPLACING phrase cannot change the name of a field that is a key.

For example:

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
       001500*                                                                                        03/25/94
       001600* COPY DDS W I T H O U T REPLACING OPTION                                                03/25/94
       001700*                                                                                        03/25/94
   14  001800 COPY DDS-CUSMST OF CUSMSTP.                                                             03/25/94
      +000001*    I-O FORMAT:CUSMST     FROM FILE CUSMSTP    OF LIBRARY COBNATEX           CUSMST
      +000002*                          CUSTOMER MASTER RECORD                             CUSMST
   15 +000003       05  CUSMST.                                                            CUSMST
   16 +000004           06 CUST              PIC X(5).                                     CUSMST
      +000005*                          CUSTOMER NUMBER                                    CUSMST
   17 +000006           06 NAME              PIC X(25).                                    CUSMST
      +000007*                          CUSTOMER NAME                                      CUSMST
   18 +000008           06 ADDR              PIC X(20).                                    CUSMST
      +000009*                          CUSTOMER ADDRESS                                   CUSMST
   19 +000010           06 CITY              PIC X(20).                                    CUSMST
      +000011*                          CUSTOMER CITY                                      CUSMST
   20 +000012           06 STATE             PIC X(2).                                     CUSMST
      +000013*                          STATE                                              CUSMST
   21 +000014           06 ZIP               PIC S9(5)        COMP-3.                      CUSMST
      +000015*                          ZIP CODE                                           CUSMST
```

Figure 48. COPY DDS without the REPLACING Option

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
       001900*                                                                                        03/25/94
       002000* COPY DDS W I T H REPLACING OPTION                                                      03/25/94
       002100*                                                                                        03/25/94
   31  002200 COPY DDS-CUSMST OF CUSMSTP                                                              03/25/94
   32  002300      REPLACING NAME BY ADDR-LINE-1                                                      03/25/94
   33  002400                ADDR BY ADDR-LINE-2                                                      03/25/94
   34  002500                CITY BY ADDR-LINE-3.                                                     03/25/94
      +000001*    I-O FORMAT:CUSMST     FROM FILE CUSMSTP    OF LIBRARY COBNATEX           CUSMST
      +000002*                          CUSTOMER MASTER RECORD                             CUSMST
   35 +000003       05  CUSMST.                                                            CUSMST
   36 +000004           06 CUST              PIC X(5).                                     CUSMST
      +000005*                          CUSTOMER NUMBER                                    CUSMST
   37 +000006           06 ADDR-LINE-1              PIC X(25).                             CUSMST
      +000007*                          CUSTOMER NAME                                      CUSMST
   38 +000008           06 ADDR-LINE-2              PIC X(20).                             CUSMST
      +000009*                          CUSTOMER ADDRESS                                   CUSMST
   39 +000010           06 ADDR-LINE-3              PIC X(20).                             CUSMST
      +000011*                          CUSTOMER CITY                                      CUSMST
   40 +000012           06 STATE             PIC X(2).                                     CUSMST
      +000013*                          STATE                                              CUSMST
   41 +000014           06 ZIP               PIC S9(5)        COMP-3.                      CUSMST
      +000015*                          ZIP CODE                                           CUSMST
```

Figure 49. COPY DDS with the REPLACING Option

End of IBM Extension

Access Path

The description of an externally described file contains the access path that describes how records are to be retrieved from the file. Records can be retrieved based on an arrival sequence (nonkeyed) access path or on a keyed sequence access path.

The arrival sequence access path is based on the order in which the records are stored in the file. Records are added only to the end of the file.

For the keyed sequence access path, the sequence in which records are retrieved from the file is based on the contents of the key fields defined in the DDS for the file. For example, in the DDS shown in Figure 33 on page 109, CUST is defined as the key field. The keyed sequence access path is updated whenever records are added, deleted, or when the contents of a key field change.

See the *Database Guide* for a complete description of the access paths for an externally described database file.

Record Keys and Common Keys

For a keyed sequence access path, one or more fields can be defined in the DDS to be used as the key fields for a record format. All record types in a file do not have to have the same key fields. For example, an order header record can have the ORDER field defined as the key field, and the order detail records can have the ORDER and LINE fields defined as the key fields.

The key for a file is determined by the valid keys for the record types in that file. The file’s key is determined in the following manner:

- If all record types in a file have the same number of key fields defined in DDS that are identical in attributes, the *key for the file* consists of all fields in the key for the record types. (The corresponding fields do not have to have the same name.) For example, if the file has three record types and the key for each record type consists of fields A, B, and C, the file’s key consists of fields A, B, and C. That is, the file’s key is the same as the records’ key.
- If all record types in the file do not have the same key fields, the key for the file consists of the key fields *common* to all record types. For example, a file has three record types and the key fields are defined as follows:
  - REC1 contains key field A.
  - REC2 contains key fields A and B.
  - REC3 contains key fields A, B, and C.

  Then the file’s key is field A, the key field common to all record types.
- If no key field is common to all record types, any keyed reference to the file will always return the first record in the file.

In COBOL, you must specify a RECORD KEY for an indexed file to identify the record you want to process. COBOL compares the key value with the key of the file or record, and processes the specified operation on the record whose key matches the RECORD KEY value.

When RECORD KEY IS EXTERNALLY-DESCRIBED-KEY is specified:

- If the FORMAT phrase is specified, the compiler builds the search argument from the key fields in the record area for the specified format
- If the FORMAT phrase is not specified, the compiler builds the search argument from the key fields in the record area for the first record format defined in the program for that file.

Note: For a file containing multiple key fields to be processed in COBOL, the key fields must be contiguous in the record format used by the COBOL program, except when RECORD KEY IS EXTERNALLY-DESCRIBED-KEY is specified.

Overriding or Adding COBOL Functions to the External Description

In addition to placing the external file description in the program through the use of the Format 2 COPY statement, you can also use standard record definition and redefinition to describe external files or to provide a group definition for a series of fields. It is the programmer's responsibility to ensure that program-described definitions are compatible with the external definitions of the file.

Level Checking

When a COBOL/400 program uses an externally described file, the operating system provides a level check function (LVLCHK). This function ensures that the format has not changed since compilation time.

The compiler always provides the information required by level checking when an externally described file is used (that is, when a record description was defined for the file by using the Format 2 COPY statement). Only those formats that were copied by the Format 2 COPY statement under the FD for a file are level checked. The level check function will be initiated at run time based on the selection made on the create, change, or override file commands. The default on the create file command is to request level checking. If level checking was requested, level checking occurs on a record format basis when the file is opened. If a level check error occurs, COBOL sets a file status of 39 at OPEN time.

When no level checking was requested, and the file is re-created using an existing format, existing COBOL programs that use that format may not work without recompilation, depending on the changes to the format. For instance,

- A change of keys will certainly cause a failure of the program on any I/O statement
- A change in the record length will cause any REWRITE to fail
- A change in the record layout can cause various errors in the processing of such a record.

You should use extreme caution when using COBOL programs without level checking or recompiling the programs.

Note: The compiler does not provide level checking for program-described files.

For more information on level checking, see the *Data Management Guide*.

Declaring Data Items Using CVTOPT Data Types

The COBOL/400 compiler allows you to convert variable-length fields from externally described files and SAA database data types to standard COBOL data items. The SAA data types you can convert are date, time, timestamp, and DBCS-graphic. COBOL/400 provides limited support for these data types.

Variable-length Fields

You can bring a variable-length field into your program if you specify *VARCHAR on the CVTOPT parameter of the CRTCBLPGM command, or the VARCHAR option of the PROCESS statement. When *VARCHAR is specified, your COBOL/400 program will convert a variable-length field from an externally described file into a COBOL/400 group item.

An example of such a group item is:

```
06  ITEM1.
    49  ITEM1-LENGTH     PIC S9(4) COMP-4.
    49  ITEM1-DATA       PIC X(n).
```

where n represents the maximum length of the variable-length field. Within the program, the `PIC S9(4) COMP-4` is treated like any other declaration of this type, and the `PIC X(n)` is treated as standard alphanumeric.

Since the maximum value that ITEM1-LENGTH can hold is 9 999, this is the length of the longest variable-length field you can write from a COBOL program.

When *VARCHAR is not specified, variable-length fields are ignored and declared as FILLER fields in COBOL/400 programs. If *NOVARCHAR is specified, the item is declared as follows:

```
06  FILLER     PIC x(n+2).
```

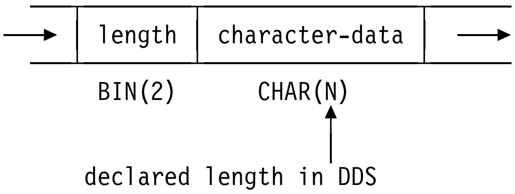
For syntax information, see the CVTOPT parameter on page 23.

Your program can perform any valid character operations on the generated data portion; however, because of the structure of the field, the length portion must be valid binary data. This data is not valid if it is negative, or greater than the maximum field length.

If the first two bytes of the field do not contain a valid binary number, an error will occur if you try to WRITE or REWRITE a record containing the field (or UPDATE or PUT the field in a database), and file status 90 is returned.

The following conditions apply when you specify variable-length fields:

- If a variable-length field is encountered when a field is extracted for an externally described file or an externally described data structure, it is declared in a COBOL/400 program as a fixed-length character field.
- For single-byte character fields, the length of the declared COBOL/400 field is the length of the DDS field plus 2 bytes.
- For DBCS-graphic data fields, the length of the declared COBOL/400 field is two times the length of the DDS field plus 2 bytes. For more information on graphic data types, see “DBCS-Graphic Fields” on page 133. The two extra bytes in the COBOL/400 field contain a binary number that represents the current length of the variable-length field. Figure 50 on page 132 shows the COBOL/400 field length of variable-length fields.



```
For single-byte character fields:  2  +  N  =  COBOL/400 field length

For DBCS-graphic data type fields:  2  + 2(N)  =  COBOL/400 field length
```

Figure 50. COBOL/400 Field Length of a Variable-Length Field

- Your COBOL/400 program can perform any valid character calculation operations on the declared fixed-length field. However, because of the structure of the field, the first two bytes of the field must contain valid binary data (invalid current field-length data is non-numeric, less than 0, or greater than the DDS field length.) An error occurs for an input or output operation if the first two bytes of the field contain invalid field-length data; file status 90 is returned.
- If you do not specify *VARCHAR, you can encounter problems performing WRITE operations on variable-length fields, because you cannot assign a value to FILLER. The two-byte field may have a value (for example `X'4040'`) which gives a length beyond the range allowed for the field. This causes an I/O error.

To see an example of a program using variable-length fields, refer to “Examples” on page 134.

Date, Time, and Timestamp Fields

Date, time, and timestamp fields are brought into your program only if you specify the *DATETIME option of the CRTCBLPGM CVTOPT parameter, or the DATETIME option of the PROCESS statement. For a description and the syntax of the CVTOPT parameter, see page 23. If *DATETIME is not specified, date, time, and timestamp fields are ignored and are declared as FILLER fields in your COBOL/400 program.

Date, time or timestamp fields are brought into a COBOL/400 program as fixed-length character fields. Your COBOL/400 program can perform any valid character operations on the fixed-length fields. These operations will follow the standard COBOL rules for alphanumeric data items.

The date, time, and timestamp data types each have their own format.

If a field containing date, time, or timestamp information is updated by your program, and the updated information is to be passed back to your database, the format of the field must be exactly the same as it was when the field was retrieved from the database. If you do not use the same format, an error will occur. For information on valid formats for each data type, see the *DDS Reference*.

If you try to WRITE a record before moving an appropriate value to a date, time, or timestamp field, the WRITE operation will fail, and file status 90 will be returned.

If you declare date, time or timestamp items in your program as FILLER, do not attempt to WRITE records containing these fields, since you will not be able to set them to values that will be accepted by the system.

Null-capable Fields

Although your program can process null-capable fields, null values are not supported. READ, SORT, and MERGE operations can be performed on null-capable fields, but if the fields actually contain null values, errors occur.

DBCS-Graphic Fields

The DBCS-graphic data type is a character string in which each character is represented by 2 bytes. The DBCS-graphic data type does not contain shift-out (SO) or shift-in (SI) characters. The difference between single-byte and DBCS-graphic data is shown in the following figure:

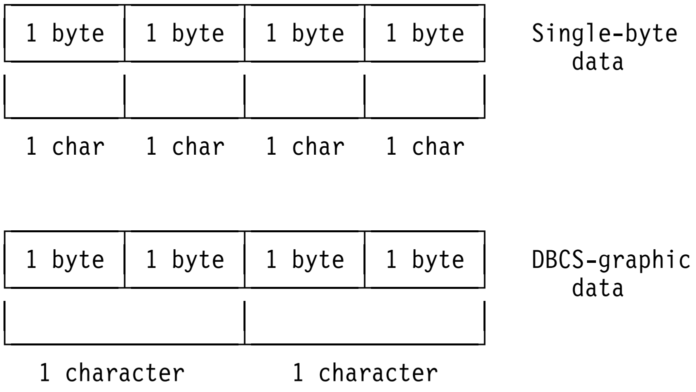


Figure 51. Comparing Single-byte and Graphic Data

DBCS-graphic data is brought into your COBOL/400 program only if you specify the *GRAPHIC value on the CVTOPT parameter of the CRTCBLPGM command, or the CVTGRAPHIC option of the PROCESS statement. If you do not specify DBCS-graphic data, graphic data is ignored and declared as FILLER fields in your COBOL/400 program. For a description and the syntax of the CVTOPT parameter, see page 23.

The following conditions apply when DBCS-graphic data is specified:

- DBCS-graphic data is copied into a COBOL/400 program as a fixed-length alphanumeric field.
- Every DBCS-graphic data *character* has a length of 2 bytes.
- Every fixed-length DBCS-graphic data *field* has a length of 2 bytes times the number of characters in the field. For a description of the field length of variable-length graphic data fields, see “Variable-length Fields” on page 131.
- Your COBOL/400 program can perform any valid character operations on the fixed-length fields.

Variable-length DBCS-Graphic Fields

You can use variable-length fields in combination with DBCS-graphic data types, to specify variable-length DBCS-graphic data. To specify variable-length DBCS-graphic data, specify *VARCHAR and *GRAPHIC for the CVTOPT parameter of the CRTCBLPGM command, or the VARCHAR and CVTGRAPHIC options for the PROCESS statement.

If you specify either of the following: CVTOPT(*NOVARCHAR *NOGRAPHIC) or CVTOPT(*NOVARCHAR *GRAPHIC) and the compiler encounters a variable-length DBCS-graphic data item, the resulting program contains the following:

```
               06 FILLER            PIC X(2n+2).
     *              (Variable-length field)
```

where n is the number of characters in the DDS field.

If you specify CVTOPT(*VARCHAR *NOGRAPHIC), and the compiler encounters a variable-length DBCS-graphic data item, the resulting program contains the following:

```
               06 NAME
     *              (Variable-length field)
                  49 NAME-LENGTH        PIC S9(4) COMP-4.
     *                         (Number of 2-byte characters)
                  49 FILLER             PIC X(2n).
     *                         (Graphic field)
```

where n is the number of characters in the DDS field.

If you specify CVTOPT(*VARCHAR *GRAPHIC), and the compiler encounters a variable-length DBCS-graphic data item, the resulting program contains the following:

```
               06 NAME
     *              (Variable-length field)
                  49 NAME-LENGTH        PIC S9(4) COMP-4.
     *                         (Number of 2-byte characters)
                  49 NAME-DATA          PIC X(2n).
     *                         (Graphic field)
```

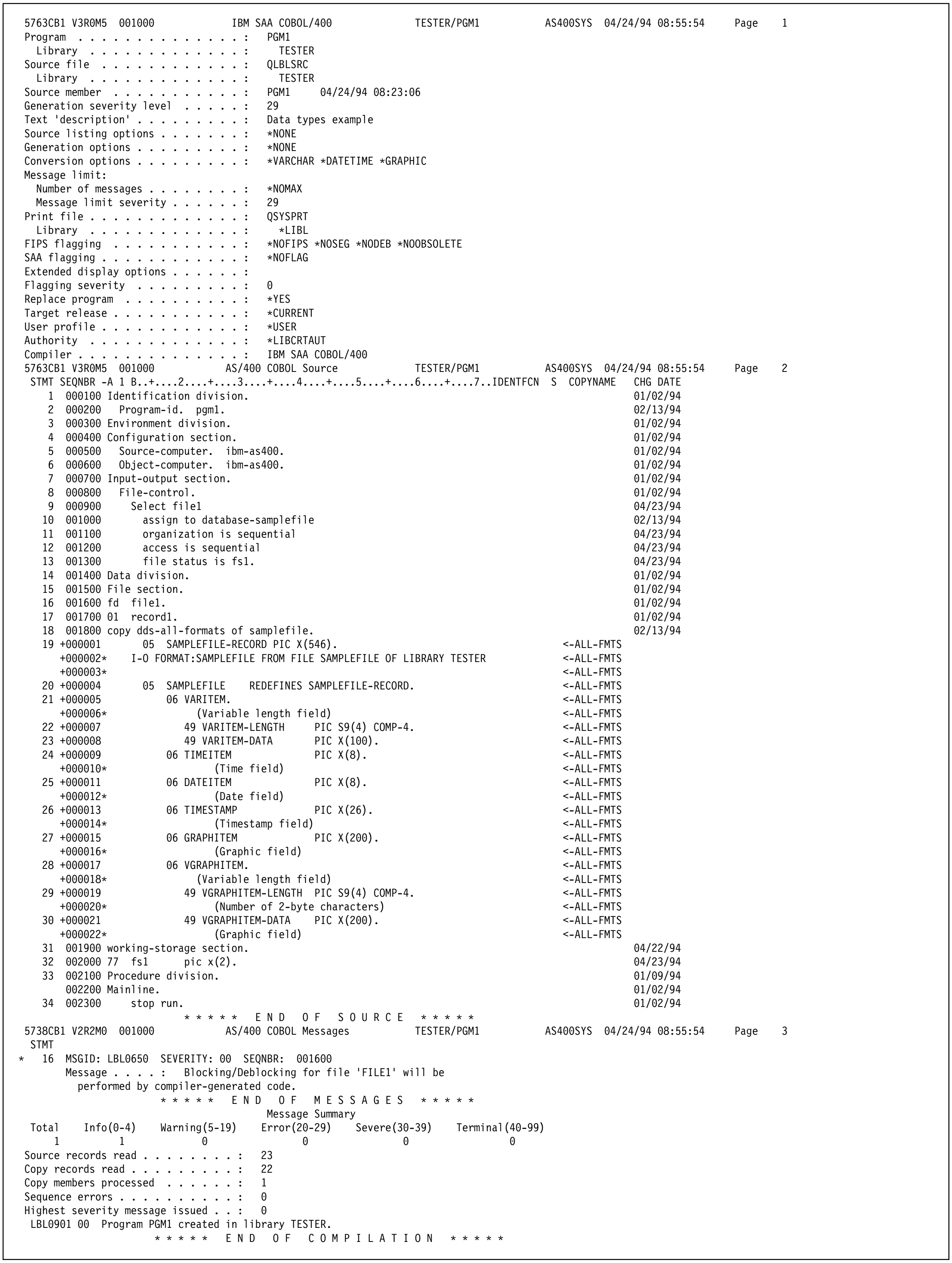
where n is the number of characters in the DDS field.

Examples

Figure 52 on page 135 shows an example of a DDS file that defines a variable-length DBCS-graphic data item. Figure 53 on page 136 shows the COBOL/400 program using a COPY DDS statement, and the resulting listing when the program is compiled.

```
A          R SAMPLEFILE
A*
A            VARITEM      100          VARLEN
A*
A            TIMEITEM        T         TIMFMT(*HMS)
A            DATEITEM        L         DATFMT(*YMD)
A            TIMESTAMP       Z
A*
A            GRAPHITEM    100G
A            VGRAPHITEM   100G         VARLEN
```

Figure 52. DDS File Defining a Variable-Length Graphic Data Field



```
5763CB1 V3R0M5  001000             IBM SAA COBOL/400              TESTER/PGM1           AS400SYS  04/24/94 08:55:54     Page    1
Program  . . . . . . . . . . . . . . :   PGM1
  Library  . . . . . . . . . . . . . :     TESTER
Source file  . . . . . . . . . . . . :   QLBLSRC
  Library  . . . . . . . . . . . . . :     TESTER
Source member  . . . . . . . . . . . :   PGM1     04/24/94 08:23:06
Generation severity level  . . . . . :   29
Text 'description' . . . . . . . . . :   Data types example
Source listing options . . . . . . . :   *NONE
Generation options . . . . . . . . . :   *NONE
Conversion options . . . . . . . . . :   *VARCHAR *DATETIME *GRAPHIC
Message limit:
  Number of messages . . . . . . . . :   *NOMAX
  Message limit severity . . . . . . :   29
Print file . . . . . . . . . . . . . :   QSYSPRT
  Library  . . . . . . . . . . . . . :    *LIBL
FIPS flagging  . . . . . . . . . . . :   *NOFIPS *NOSEG *NODEB *NOOBSOLETE
SAA flagging . . . . . . . . . . . . :   *NOFLAG
Extended display options . . . . . . :
Flagging severity  . . . . . . . . . :   0
Replace program  . . . . . . . . . . :   *YES
Target release . . . . . . . . . . . :   *CURRENT
User profile . . . . . . . . . . . . :   *USER
Authority  . . . . . . . . . . . . . :   *LIBCRTAUT
Compiler . . . . . . . . . . . . . . :   IBM SAA COBOL/400
5763CB1 V3R0M5  001000            AS/400 COBOL Source             TESTER/PGM1           AS400SYS  04/24/94 08:55:54     Page    2
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 Identification division.                                                                 01/02/94
    2  000200   Program-id.  pgm1.                                                                     02/13/94
    3  000300 Environment division.                                                                    01/02/94
    4  000400 Configuration section.                                                                   01/02/94
    5  000500   Source-computer.  ibm-as400.                                                           01/02/94
    6  000600   Object-computer.  ibm-as400.                                                           01/02/94
    7  000700 Input-output section.                                                                    01/02/94
    8  000800   File-control.                                                                          01/02/94
    9  000900     Select file1                                                                         04/23/94
   10  001000       assign to database-samplefile                                                      02/13/94
   11  001100       organization is sequential                                                         04/23/94
   12  001200       access is sequential                                                               04/23/94
   13  001300       file status is fs1.                                                                04/23/94
   14  001400 Data division.                                                                           01/02/94
   15  001500 File section.                                                                            01/02/94
   16  001600 fd  file1.                                                                               01/02/94
   17  001700 01  record1.                                                                             01/02/94
   18  001800 copy dds-all-formats of samplefile.                                                      02/13/94
   19 +000001       05  SAMPLEFILE-RECORD PIC X(546).                                      <-ALL-FMTS
      +000002*    I-O FORMAT:SAMPLEFILE FROM FILE SAMPLEFILE OF LIBRARY TESTER             <-ALL-FMTS
      +000003*                                                                             <-ALL-FMTS
   20 +000004       05  SAMPLEFILE    REDEFINES SAMPLEFILE-RECORD.                         <-ALL-FMTS
   21 +000005           06 VARITEM.                                                        <-ALL-FMTS
      +000006*               (Variable length field)                                       <-ALL-FMTS
   22 +000007              49 VARITEM-LENGTH     PIC S9(4) COMP-4.                         <-ALL-FMTS
   23 +000008              49 VARITEM-DATA       PIC X(100).                               <-ALL-FMTS
   24 +000009           06 TIMEITEM              PIC X(8).                                 <-ALL-FMTS
      +000010*                  (Time field)                                               <-ALL-FMTS
   25 +000011           06 DATEITEM              PIC X(8).                                 <-ALL-FMTS
      +000012*                  (Date field)                                               <-ALL-FMTS
   26 +000013           06 TIMESTAMP             PIC X(26).                                <-ALL-FMTS
      +000014*                  (Timestamp field)                                          <-ALL-FMTS
   27 +000015           06 GRAPHITEM             PIC X(200).                               <-ALL-FMTS
      +000016*                  (Graphic field)                                            <-ALL-FMTS
   28 +000017           06 VGRAPHITEM.                                                     <-ALL-FMTS
      +000018*               (Variable length field)                                       <-ALL-FMTS
   29 +000019              49 VGRAPHITEM-LENGTH  PIC S9(4) COMP-4.                         <-ALL-FMTS
      +000020*                  (Number of 2-byte characters)                              <-ALL-FMTS
   30 +000021              49 VGRAPHITEM-DATA    PIC X(200).                               <-ALL-FMTS
      +000022*                  (Graphic field)                                            <-ALL-FMTS
   31  001900 working-storage section.                                                                 04/22/94
   32  002000 77  fs1      pic x(2).                                                                   04/23/94
   33  002100 Procedure division.                                                                      01/09/94
       002200 Mainline.                                                                                01/02/94
   34  002300     stop run.                                                                            01/02/94
                           * * * * *  E N D  O F  S O U R C E  * * * * *
5738CB1 V2R2M0  001000            AS/400 COBOL Messages           TESTER/PGM1           AS400SYS  04/24/94 08:55:54     Page    3
 STMT
*  16  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  001600
       Message . . . . :   Blocking/Deblocking for file 'FILE1' will be
         performed by compiler-generated code.
                       * * * * *  E N D  O F  M E S S A G E S  * * * * *
                                         Message Summary
 Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
     1          1             0                0                0                 0
Source records read . . . . . . . . :   23
Copy records read . . . . . . . . . :   22
Copy members processed  . . . . . . :   1
Sequence errors . . . . . . . . . . :   0
Highest severity message issued . . :   0
 LBL0901 00  Program PGM1 created in library TESTER.
                      * * * * *  E N D  O F  C O M P I L A T I O N  * * * * *
```

Figure 53. COBOL/400 Program Using Variable-Length DBCS-Graphic Data Items

Cross-system Data Considerations

Coded character set identifiers (CCSIDs) can help you to maintain the integrity of character data across systems.

Character Data Representation Architecture (CDRA) defines CCSID values to identify the code points used to represent characters, and to convert these codes as needed to preserve their meanings.

As a consequence of CDRA conversion, you might have substitution characters (X'3F') in your data. If you write these characters to a display, the results will not be predictable.

For more information about CCSIDs and CDRA, see *System Operation*, SC41-3203 and the *Data Management Guide*.

Chapter 8. Transaction Files

IBM Extension

This chapter describes the COBOL/400 language extensions that support work stations and program-to-program communication.

The TRANSACTION file organization allows a COBOL program to communicate interactively with:

- One or more work station users
- One or more programs on a remote system
- One or more devices on a remote system.

The AS/400 system permits you to communicate with a program or device (such as Asynchronous communication types) on a remote system. For a detailed discussion of these devices, see the *ICF Programmer's Guide*.

Program-Described Transaction Files

COBOL TRANSACTION files are usually externally described. If these files are program-described, only simple display formatting can be performed. All field-level descriptions are defined in the COBOL program.

Do not send internal (packed) or binary data (COMP, COMP-3, or COMP-4) to a display station as output data. Such data can contain display station control characters that can cause unpredictable results.

See the *Data Management Guide* for more information about using program-described display files.

Externally Described Transaction Files

A COBOL TRANSACTION file uses an externally described file that contains file information and a description of the fields in the records. The records in this file can be described to the COBOL program by the Format 2 COPY statement.

The Format 2 COPY Statement

Format 2 COPY statements are used to generate COBOL Data Division statements within source programs to describe files that exist on the system.

Note: The term *Format 2 COPY statement* is used throughout this manual to describe the COPY statement (DD, DDR, DDS, or DDSR option).

For more information about the Format 2 COPY statement, see "Format 2 COPY Statement (DD, DDR, DDS, or DDSR Option)" on page 112.

Data Description Specifications

Data description specifications (DDS) are a description of the user's database or device files that are entered into the system in a fixed form. The description is then used to create files.

In addition to the field descriptions (such as field names and attributes), the data description specifications (DDS) for a display device file:

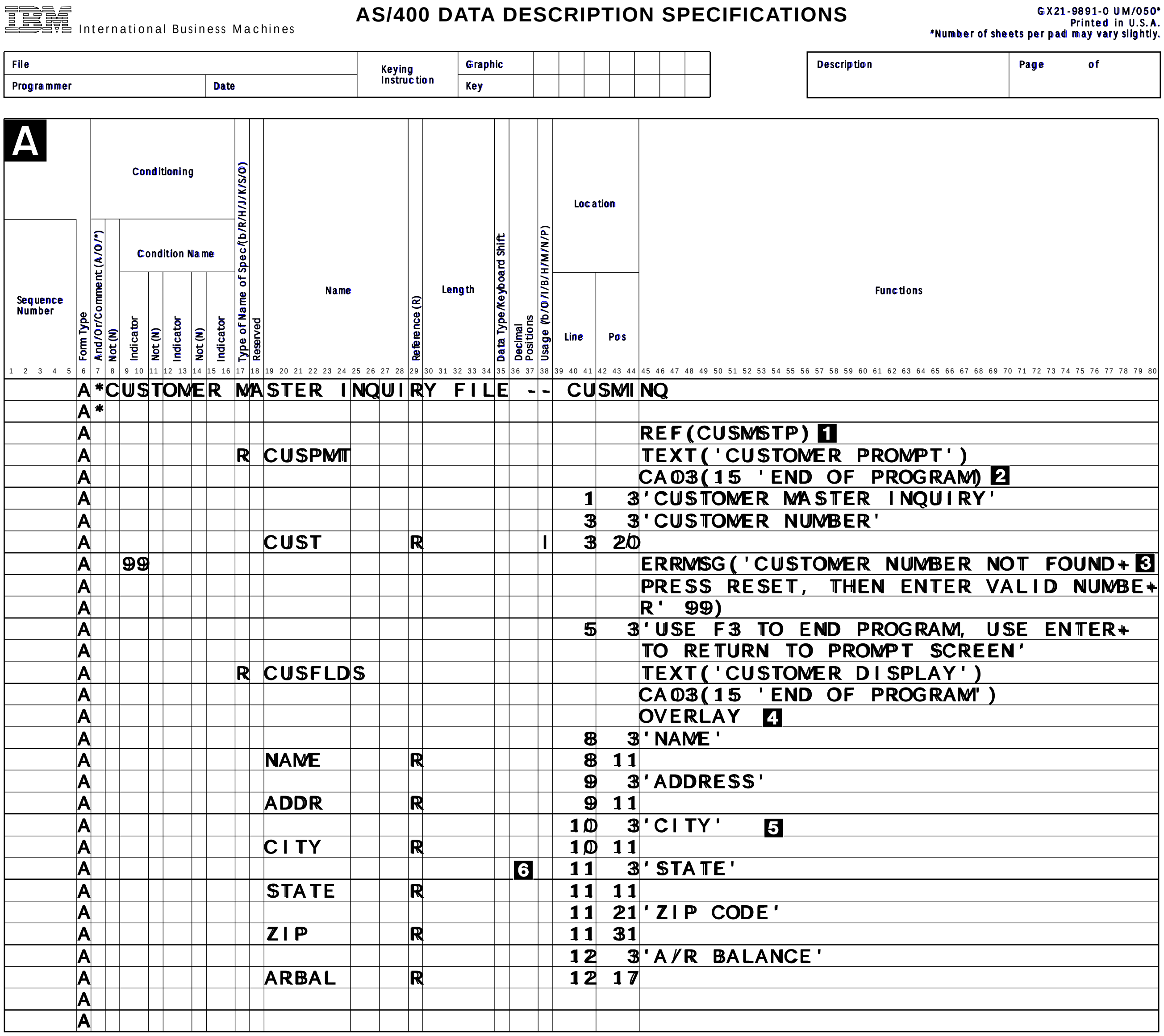
- Specify the line number and position number entries for each field and constant to format the placement of the record on the display.
- Specify attention functions such as underlining and highlighting fields, reverse image, or a blinking cursor.
- Specify validity checking for data entered at the display work station. Validity checking functions include:
  - Detecting fields where data is required
  - Detecting mandatory fill fields
  - Detecting incorrect data types
  - Detecting data for a specific range
  - Checking data for a valid entry
  - Performing modules 10 or 11 check digit verification.
- Control display management functions such as when fields are to be erased, overlaid, or retained when new data is displayed.
- Associate indicators 01 through 99 with function keys designated as type `CA` or `CF`. If a function key is designated as `CF`, both the modified data record and the response indicator are returned to the program. If a function key is designated as `CA`, the response indicator is returned to the program, but the data record usually contains default values for input-only fields and values written to the format for hidden output/input fields. For more information about type `CF` and `CA` function keys, see the *DDS Reference*.
- Assign an edit code (EDTCDE keyword) or edit word (EDTWRD keyword) to a field to specify how the field's values are to be displayed.
- Specify subfiles.

Display format data defines or describes a display. A display device record format contains three types of fields:

- *Input Fields:* Input fields pass from the device to the program when the program reads a record. Input fields can be initialized with a default value; if the default value is not changed, the default value passes to the program. Uninitialized input fields are displayed as blanks where the work station user can enter data.
- *Output Fields:* Output fields pass from the program to the device when the program writes a record to a display. The program or the record format in the device file can provide output fields.
- *Output/Input (both) Fields:* An output/input field is an output field that can be changed to become an input field. Output/input fields pass *from* the program when the program writes a record to a display and pass *to* the program when the program reads a record from the display. Output/input fields are used when the user is to change or update the data that is written to the display from the program.

For a detailed description of a data communications file, see the *ICF Programmer's Guide*. For more information on externally defined display files, see the *Data Management Guide*. For a list of the valid data description specifications (DDS) keywords, see the *DDS Reference*.

Figure 54 shows an example of the DDS for a display device file:



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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*Number of sheets per pad may vary slightly.

File | Programmer | Date | Keying Instruction | Graphic | Key | Description | Page of

A

Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Not (N), Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
A*CUSTOMER MASTER INQUIRY FILE -- CUSMINQ
A*
A                                      REF(CUSMSTP) 1
A          R CUSPMT                    TEXT('CUSTOMER PROMPT')
A                                      CA03(15 'END OF PROGRAM') 2
A                                  1  3'CUSTOMER MASTER INQUIRY'
A                                  3  3'CUSTOMER NUMBER'
A            CUST      R        I  3 20
A  99                                  ERRMSG('CUSTOMER NUMBER NOT FOUND+ 3
A                                      PRESS RESET, THEN ENTER VALID NUMBE+
A                                      R' 99)
A                                  5  3'USE F3 TO END PROGRAM, USE ENTER+
A                                      TO RETURN TO PROMPT SCREEN'
A          R CUSFLDS                   TEXT('CUSTOMER DISPLAY')
A                                      CA03(15 'END OF PROGRAM')
A                                      OVERLAY  4
A                                  8  3'NAME'
A            NAME      R           8 11
A                                  9  3'ADDRESS'
A            ADDR      R           9 11
A                                 10  3'CITY'     5
A            CITY      R          10 11
A                             6   11  3'STATE'
A            STATE     R          11 11
A                                 11 21'ZIP CODE'
A            ZIP       R          11 31
A                                 12  3'A/R BALANCE'
A            ARBAL     R          12 17
A
A
```

Figure 54. Example of the Data Description Specifications for a Display Device File

This display device file contains two record formats: CUSPMT and CUSFLDS.

1 The attributes for the fields in this file are defined in the CUSMSTP field reference file. For example, EDTCDE(J) is defined in CUSMSTP for the field ARBAL.

2 The F3 key is associated with indicator 15, with which the user ends the program.

3 The ERRMSG keyword identifies the error message that is displayed if indicator 99 is set on in the program that uses this record format.

4 The OVERLAY keyword is used for the record format CUSFLDS so that the CUSPMT record on the display will not be erased when the CUSFLDS record is written to the display.

5 The constants such as ‘Name’, ‘Address’, and ‘City’ describe the fields that are written out by the program.

6 The line and position entries identify where the fields or constants are written on the display.

Processing an Externally Described Transaction File

When an externally described TRANSACTION file is processed, the operating system transforms data from the program to the format specified for the file and displays the data. When data passes to the program, the data is transformed to the format used by the program.

The operating system provides device control information for performing input/output operations for the device. When an input record is requested from the device, the operating system issues the request, and then removes device control information from the data before passing the data to the program. In addition, the operating system can pass indicators to the program indicating which, if any, fields in the record have changed.

When the program requests an output operation, it passes the output record to the operating system. The operating system provides the necessary device control information to display the record. It also adds any constant information specified for the record format when the record is displayed.

When a record passes to a program, the fields are arranged in the order in which they are specified in the DDS. The order in which the fields are displayed is based on the display positions (line numbers and positions) assigned to the fields in the DDS. Therefore, the order in which the fields are specified in the DDS and the order in which they appear on the display need not be the same.

Using Indicators with Transaction Files

Indicators are Boolean data items that can have the values B"0" or B"1".

When you define a record format for a file using DDS, you can condition the options using indicators; indicators can also be used to reflect particular responses. These indicators are known as OPTION and RESPONSE, respectively.

Option indicators provide options such as spacing, underlining, and allowing or requesting data transfer from a program to a printer or display device. Response indicators provide response information to a program from a device, such as function keys pressed by a work station user, and whether data has been entered.

Indicators can be passed with data records in a record area, or outside the record area in a separate indicator area.

Indicators in a Separate Indicator Area

If you specify the file level keyword INDARA in the DDS, all indicators defined in the record format or formats for that file are passed to and from the program in a separate indicator area, not in the record area. For information on how to specify the INDARA keyword, see the *DDS Reference*.

The file control entry for a file that has INDARA specified in its DDS must have the separate indicator area attribute, SI, as part of the assignment-name.

The advantages of using a separate indicator area are as follows:

- The number and order of indicators used in an I/O statement for any record format in a file need not match the number and order of indicators specified in the DDS for that record format.
- The program associates the indicator number in a data description entry with the appropriate indicator.

Indicators in the Record Area

If the keyword INDARA is not used in the DDS of the file, indicators are created in the record area. When indicators are defined in a record format for a file, they are read, rewritten, and written with the data in the record area.

The number and order of indicators defined in the DDS for a record format for a file determines the number and order in which the data description entries for the indicators in the record format must be coded in the program.

The file control entry for a file that does not have the INDARA keyword specified in the DDS associated with it must *not* have the separate indicator area attribute, SI, as part of the assignment-name.

If a Format 2 COPY statement is used to copy indicators into a source program, the indicators are defined in the order in which they are specified in the DDS for the file.

ASSIGN Clause and the Separate Indicator Area Attribute

Format

```
►►──ASSIGN──┬────┬────WORKSTATION─── -file-name──┬──────┬──────────────►◄
            └─TO─┘                                └─ -SI─┘
```

The rules for the ASSIGN clause are as follows:

- Device must be WORKSTATION
- If -SI is coded, *file-name* must refer to a file that has the file level keyword INDARA specified in its DDS.

For more information about the ASSIGN clause, see “ASSIGN Clause” on page 172.

Data Description Entry–Boolean Data

When you use indicators in a COBOL program, you must describe them as Boolean data items using the data description entry for Boolean data.

Format 4 - Boolean Data

```
►►───level-number──┬───────────────┬──┬──────────────────────────┬──────────────────────►
                   ├──data-name-1──┤  ├─REDEFINES──data-name-2───┤
                   └──FILLER───────┘  └─LIKE───data-name-3───────┘

►─────┬───────────────────────────┬─────────────────────────────────────────────────────►
      └──┬─PICTURE─┬──┬──────┬─1──┘
         └─PIC─────┘  └─IS───┘

►─────┬──────────────────────────────┬──────────────────────────────────────────────────►
      └──┬──────────────────┬─DISPLAY─┘
         └─USAGE──┬──────┬──┘
                  └─IS───┘

►───┬───────────────────────────────────────────────────────────────────────────────────► 1
    └─OCCURS──┬─integer-1─TO─integer-2──┬───────┬─DEPENDING──┬────┬─data-name-4──┬──────► 2
              │                         └─TIMES─┘            └─ON─┘              │
              └─integer-2──┬───────┬─────────────────────────────────────────────┘
                           └─TIMES─┘

1 ►─────────────────────────────────────────────┬───────────────────────────────────────►
2 ►─────┬─────────────────────────────────────┬─┘
        │                  ┌───────────────┐  │
        │                  ▼               │  │
        └─INDEXED──┬────┬──index-name-1────┴──┘
                   └─BY─┘

►─────┬────────────────────────────┬────────────────────────────────────────────────────►
      └─┬─INDICATOR───┬─integer-3──┘
        ├─INDICATORS──┤
        └─INDIC───────┘

   ************************************************************************
►─────┬──────────────────────────────────────┬──┬─────────────────────────────┬─────────►
   *  └──┬─SYNCHRONIZED─┬──┬──────────┬──────┘  └─┬─JUSTIFIED─┬──┬───────┬───┘    *
   *     └─SYNC─────────┘  ├──LEFT────┤           └─JUST──────┘  └─RIGHT─┘        *
   *                       └──RIGHT───┘                                           *
   ************************************************************************

►─────┬────────────────────────────────────┬─.──────────────────────────────────────►◄
      └─VALUE──┬──────┬──Boolean-literal───┘
               └─IS───┘
```

Special Considerations

The special considerations for the clauses used with the Boolean data follow. All other rules for clauses are the same as those for other data as described in the "COBOL Program Structure" section of the *COBOL/400 Reference*.

PICTURE Clause: An elementary Boolean data name is defined by a PICTURE containing a single 1.

USAGE Clause: USAGE must be defined implicitly or explicitly as DISPLAY.

OCCURS Clause: When the OCCURS clause and the INDICATOR clause are both specified at an elementary level, a table of Boolean data items is defined with each element in the table corresponding to an external indicator. The first element in the table corresponds to the indicator number specified in the INDICATOR clause; the second element corresponds to the indicator that sequentially follows the indicator specified by the INDICATOR clause.

For example, if the following is coded, SWITCHES (1) corresponds to indicator 16, SWITCHES (2) corresponds to indicator 17,..., and SWITCHES (10) corresponds to indicator 25:

```
    07     SWITCHES       PIC 1
                          OCCURS 10 TIMES
                          INDICATOR 16.
```

INDICATOR Clause: If indicator fields are in a separate indicator area, the INDICATOR clause associates an indicator defined in DDS with a Boolean data item. If indicator fields are in the record area, the INDICATOR clause is syntax-checked, but is treated as a comment.

`Integer-3` must have a value of 1 through 99.

The INDICATOR clause must be specified at an elementary level only.

VALUE Clause: The VALUE clause specifies the initial content of a Boolean data item. The allowable values for Boolean literals are B"0", B"1", and ZERO.

LIKE Clause: You cannot use this clause to change the length of the data item.

INDICATORS Phrase

When the INDICATORS phrase is used in READ, REWRITE, and WRITE statements (see Figure 57 on page 150), it specifies which indicators are to be read, rewritten, and written.

The identifier specified in the INDICATORS phrase can be either of the following:

- An elementary Boolean data item
- A group item with elementary Boolean data items subordinate to it. (The Boolean data items can be anywhere in the group, but they are the only items you can read, write, or rewrite.)

  The identifier cannot be subordinate to an item that is subject to an OCCURS clause.

Indicators in a Separate Indicator Area

If INDARA is specified in the DDS for the file, the use of the indicators referenced in the INDICATORS phrase is based on indicator number.

- In a READ statement, only the response indicator numbers referenced by the INDICATORS phrase are updated. Indicators specified in the DDS for the format but not referenced by the INDICATORS phrase are ignored. Indicators referenced by the INDICATORS phrase but not specified in the DDS are not modified.

- In a WRITE or REWRITE statement, only the option indicators referenced by the INDICATORS phrase are used. Indicators specified in the DDS for the format but *not* referenced by the INDICATORS phrase are assumed to be **OFF**. Indicators referenced by the INDICATORS phrase but not used in the DDS for the format are ignored.

If the INDICATORS phrase is not specified, the following occurs:

- In the READ statement, indicators are not updated.
- In a WRITE or REWRITE statement, indicators are treated as though they are set to **OFF**.

Indicators in the Record Area

If INDARA is not specified in the DDS for the file, the size of the identifier in the INDICATORS phrase of an I/O statement (see Figure 57 on page 150) should be equal to the number of option or response indicators defined in the DDS for that format.

- In a READ statement, the identifier size should be equal to the number of response indicators.
- In a REWRITE or WRITE statement, the identifier size should be equal to the number of option indicators.

The contents of the identifier are not checked, but are copied to or from the beginning of the record, on a byte-by-byte basis; indicator numbers are ignored.

If the INDICATORS phrase is omitted, the data in the indicator fields in the record are still passed in the record area. The INDICATORS phrase is only used to copy indicators into the record area before a WRITE or REWRITE statement, or out of the record area after a READ statement.

Indicators Example Programs

This section contains examples of COBOL/400 programs that illustrate the use of indicators in either a record area or a separate indicator area.

All the programs do the following:

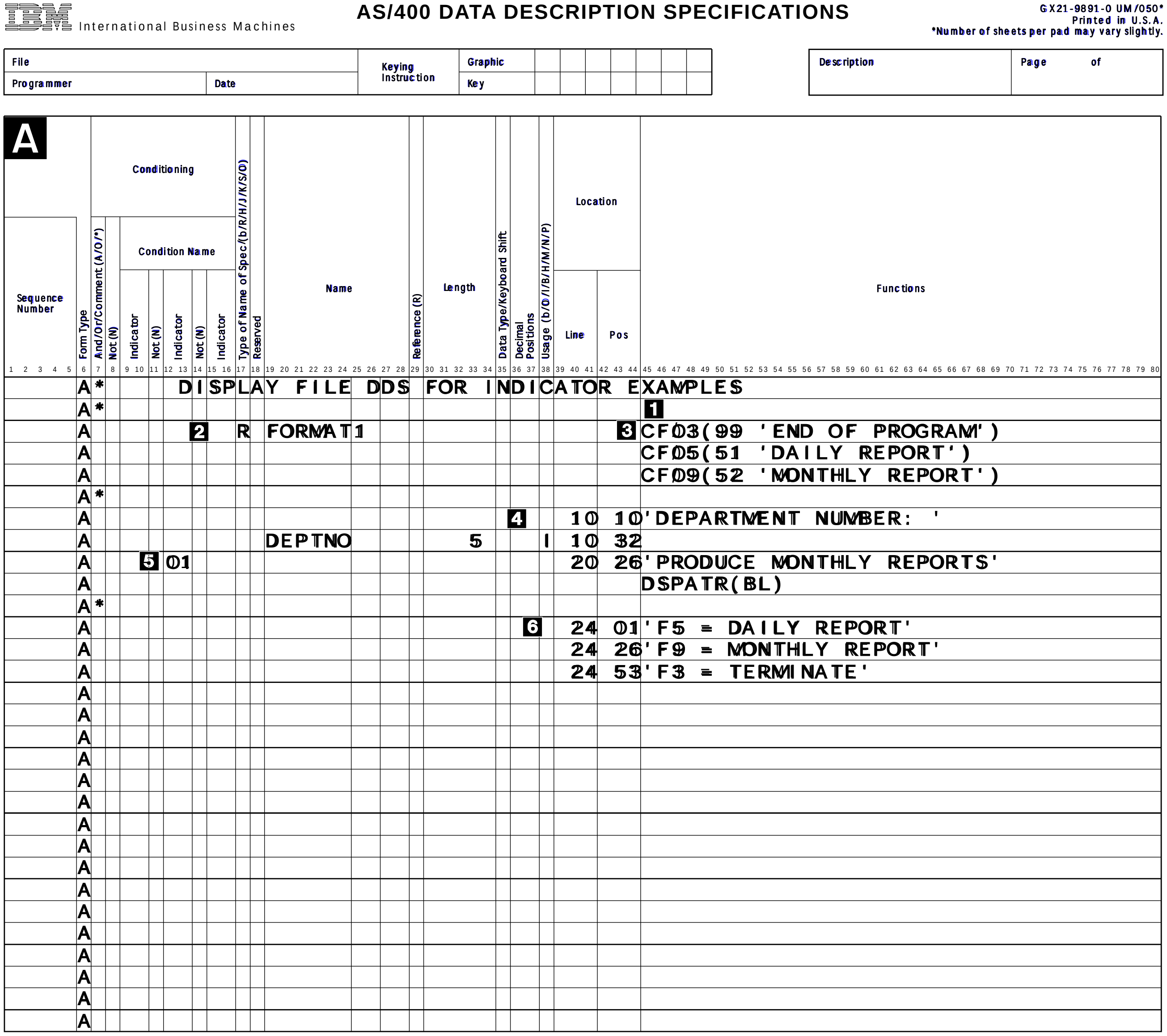
1. Determine the current date.
2. If it is the first day of the month, turn on an option indicator that causes an output field to appear and blink.
3. Allow you to press function keys to terminate the program, or turn on response indicators and call programs to write daily or monthly reports.

Figure 56 on page 148 shows a program that uses indicators in the record area but does not use the INDICATORS phrase in any I/O statement. Figure 55 on page 147 shows the associated DDS for the file.

Figure 57 on page 150 shows a program that uses indicators in the record area and the INDICATORS phrase in the I/O statements. The associated DDS for Figure 57 is Figure 55 on page 147.

Figure 59 on page 153 shows a program that uses indicators in a separate indicator area, defined in WORKING-STORAGE by using the Format 2 COPY statement. Figure 58 on page 152 shows the associated DDS for the file.

Figure 60 on page 155 shows a program that uses indicators in a separate indicator area, defined in a table in WORKING-STORAGE. The associated DDS for the file is the same as Figure 58 on page 152.



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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*Number of sheets per pad may vary slightly.

File | Programmer | Date | Keying Instruction | Graphic | Key | Description | Page of

```
     A*     DISPLAY FILE DDS FOR INDICATOR EXAMPLES
     A*                                     1
     A       2  R FORMAT1                  3CF03(99 'END OF PROGRAM')
     A                                      CF05(51 'DAILY REPORT')
     A                                      CF09(52 'MONTHLY REPORT')
     A*
     A                             4    10 10'DEPARTMENT NUMBER: '
     A            DEPTNO         5   I  10 32
     A   5 01                           20 26'PRODUCE MONTHLY REPORTS'
     A                                      DSPATR(BL)
     A*
     A                              6   24 01'F5 = DAILY REPORT'
     A                                  24 26'F9 = MONTHLY REPORT'
     A                                  24 53'F3 = TERMINATE'
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 55. Example of a Program Using Indicators in the Record Area without Using the INDICATORS Phrase in the I/O Statement–Data Description Specifications

1 The INDARA keyword is not used; indicators are stored in the record area with the data fields.

2 One record format, FORMAT1, is specified.

3 Three indicators are associated with three function keys. Indicator 99 will be set on when you press F3, and so on.

4 One field is defined for input.

5 Indicator 01 is defined to cause the associated constant field to blink if the indicator is on.

6 The function (F) key definitions are documented on the work station display.

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000100 IDENTIFICATION DIVISION.                                                                 03/09/94
     2  000200   PROGRAM-ID.     XMPLE71.                                                               03/22/94
        000300*    PROGRAM EXAMPLE WITH INDICATORS IN RECORD AREA.                                      03/09/94
     3  000400   AUTHOR.       PROGRAMMER NAME.                                                         03/09/94
     4  000500   INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                        03/09/94
     5  000600   DATE-WRITTEN. 12/08/88.                                                                03/09/94
     6  000070   DATE-COMPILED.  05/24/94 11:02:36   .
     7  000800 ENVIRONMENT DIVISION.                                                                    03/09/94
     8  000900   CONFIGURATION SECTION.                                                                 03/09/94
     9  001000   SOURCE-COMPUTER. IBM-AS400.                                                            03/25/94
    10  001100   OBJECT-COMPUTER. IBM-AS400.                                                            03/25/94
    11  001200   INPUT-OUTPUT SECTION.                                                                  03/09/94
    12  001300   FILE-CONTROL.                                                                          03/09/94
    13  001400     SELECT DISPFILE                                                                      03/09/94
    14  001500       ASSIGN TO WORKSTATION-DSPFILEX 1                                                   03/09/94
    15  001600       ORGANIZATION IS TRANSACTION                                                        03/09/94
    16  001700       ACCESS       IS SEQUENTIAL.                                                        03/09/94
    17  001800 DATA DIVISION.                                                                           03/09/94
    18  001900   FILE SECTION.                                                                          03/09/94
    19  002000   FD  DISPFILE                                                                           03/09/94
    20  002100     LABEL RECORDS ARE OMITTED                                                            03/09/94
    21  002200     DATA RECORD IS DISP-REC.                                                             03/09/94
    22  002300   01  DISP-REC.                                                                          03/09/94
    23  002400       COPY DDS-ALL-FORMATS OF DSPFILEX. 2                                                03/09/94
    24 +000001       05  DSPFILEX-RECORD PIC X(8).                                    <-ALL-FMTS
       +000002*  INPUT FORMAT:FORMAT1    FROM FILE DSPFILEX   OF LIBRARY XMPLIB       <-ALL-FMTS
       +000003*                                                                       <-ALL-FMTS
    25 +000004       05  FORMAT1-I     REDEFINES DSPFILEX-RECORD.                      <-ALL-FMTS
    26 +000005           06 FORMAT1-I-INDIC.                                           <-ALL-FMTS
    27 +000006                07 IN99         PIC 1  INDIC 99. 3                       <-ALL-FMTS
       +000007*                          END OF PROGRAM                               <-ALL-FMTS
    28 +000008                07 IN51         PIC 1  INDIC 51.                         <-ALL-FMTS
       +000009*                          DAILY REPORT                                 <-ALL-FMTS
    29 +000010                07 IN52         PIC 1  INDIC 52.                         <-ALL-FMTS
       +000011*                          MONTHLY REPORT                               <-ALL-FMTS
    30 +000012           06 DEPTNO            PIC X(5).                                <-ALL-FMTS
       +000013* OUTPUT FORMAT:FORMAT1    FROM FILE DSPFILEX   OF LIBRARY XMPLIB       <-ALL-FMTS
       +000014*                                                                       <-ALL-FMTS
    31 +000015       05  FORMAT1-O     REDEFINES DSPFILEX-RECORD.                      <-ALL-FMTS
    32 +000016           06 FORMAT1-O-INDIC.                                           <-ALL-FMTS
    33 +000017                07 IN01         PIC 1  INDIC 01.                         <-ALL-FMTS
        002500
    34  002600 WORKING-STORAGE SECTION.
    35  002700 01  CURRENT-DATE.
    36  002800    05  CURR-YEAR                PIC 9(2).
    37  002900    05  CURR-MONTH               PIC 9(2).
    38  003000    05  CURR-DAY                 PIC 9(2).
    39  003100 01  INDIC-AREA. 4
    40  003200    05  IN01                     PIC 1.
    41  003300       88  NEW-MONTH 5             VALUE B"1".
    42  003400    05  IN51                     PIC 1.
    43  003500       88  WANT-DAILY            VALUE B"1".
    44  003600    05  IN52                     PIC 1.
    45  003700       88  WANT-MONTHLY          VALUE B"1".
    46  003800    05  IN99                     PIC 1.
    47  003900       88  NOT-END-OF-JOB        VALUE B"0".
    48  004000       88  END-OF-JOB            VALUE B"1".
    49  004100 PROCEDURE DIVISION.
        004200 XAMPLE3-MAIN.
    50  004300     OPEN I-O DISPFILE.
    51  004400     ACCEPT CURRENT-DATE FROM DATE.
    52  004500     SET NOT-END-OF-JOB TO TRUE.
    53  004600     PERFORM DISPLAY-SCREEN THRU READ-AND-PROCESS-SCREEN
        004700             UNTIL END-OF-JOB.
    54  004800     CLOSE DISPFILE.
    55  004900     STOP RUN.
        005000 DISPLAY-SCREEN.
    56  005100     MOVE ZEROS TO INDIC-AREA. 6
    57  005200     IF CURR-DAY = 01 THEN
    58  005300        SET NEW-MONTH TO TRUE. 7
    59  005400     MOVE CORR INDIC-AREA TO FORMAT1-O-INDIC. 8
    60  005500     WRITE DISP-REC FORMAT IS "FORMAT1". 9
        005600 READ-AND-PROCESS-SCREEN.
    61  005700     MOVE ZEROS TO INDIC-AREA.
    62  005800     READ DISPFILE FORMAT IS "FORMAT1". 10
```

Figure 56 (Part 1 of 2). Example of a Program Using Indicators in the Record Area without Using the INDICATORS Phrase in the I/O Statement–COBOL Source Program

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    63  005900     MOVE CORR FORMAT1-I-INDIC TO INDIC-AREA. 11
    64  006000     IF WANT-DAILY THEN
    65  006100        CALL "DAILY" USING DEPTNO 12
        006200     ELSE
    66  006300        IF WANT-MONTHLY THEN
    67  006400           CALL "MONTHLY" USING DEPTNO.
                            * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                    AS/400 COBOL Messages
  STMT
                        * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                           Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      0         0           0                0                0                 0
 Source records read . . . . . . . . :   64
 Copy records read . . . . . . . . . :   17
 Copy members processed  . . . . . . :   1
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program XMPLE71 created in library XMPLIB.
                       * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 56 (Part 2 of 2). Example of a Program Using Indicators in the Record Area without Using the INDICATORS Phrase in the I/O Statement–COBOL Source Program

1 The separate indicator area attribute, SI, is not coded in the ASSIGN clause.

2 The Format 2 COPY statement defines data fields and indicators in the record area.

3 Because the file does not have a separate indicator area, response and option indicators are defined in the order in which they are used in the DDS, and the indicator numbers are treated as documentation.

4 All indicators used by the program are defined with meaningful names in data description entries in WORKING-STORAGE. Indicator numbers are omitted here because they have no effect.

5 For each indicator, a meaningful level-88 condition-name is associated with a value for that indicator.

6 Initialize group level to zeros.

7 IN01 in WORKING-STORAGE is set on if it is the first day of the month.

8 Indicators appropriate to the output of FORMAT1 are copied to the record area.

9 FORMAT1 is written to the work station display with both data and indicator values in the record area.

The INDICATORS phrase is not necessary because there is no separate indicator area and indicator values have been set in the record area through the previous MOVE CORRESPONDING statement.

10 FORMAT1, including both data and indicators, is read from the display.

11 The response indicators for FORMAT1 are copied from the record area to the data description entries in WORKING-STORAGE.

12 If F5 has been pressed, a program call is processed.

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 IDENTIFICATION DIVISION.                                                               03/07/94
    2  000200   PROGRAM-ID.     XMPLE713.                                                            03/22/94
       000300*    SAMPLE PROGRAM - FILE WITH INDICATORS IN RECORD AREA                               03/07/94
    3  000400   AUTHOR.       PROGRAMMER NAME.                                                       03/07/94
    4  000500   INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                      03/07/94
    5  000600   DATE-WRITTEN. 12/10/88.                                                              03/07/94
    6  000070   DATE-COMPILED.  05/24/94 11:04:34   .
    7  000800 ENVIRONMENT DIVISION.                                                                  03/07/94
    8  000900   CONFIGURATION SECTION.                                                               03/07/94
    9  001000   SOURCE-COMPUTER. IBM-AS400.                                                          03/07/94
   10  001100   OBJECT-COMPUTER. IBM-AS400.                                                          03/07/94
   11  001200   INPUT-OUTPUT SECTION.                                                                03/07/94
   12  001300   FILE-CONTROL.                                                                        03/07/94
   13  001400     SELECT DISPFILE                                                                    03/07/94
   14  001500       ASSIGN TO WORKSTATION-DSPFILEX 1                                                 03/22/94
   15  001600       ORGANIZATION IS TRANSACTION                                                      03/07/94
   16  001700       ACCESS       IS SEQUENTIAL.                                                      03/07/94
   17  001800 DATA DIVISION.                                                                         03/07/94
   18  001900   FILE SECTION.                                                                        03/07/94
   19  002000   FD  DISPFILE                                                                         03/07/94
   20  002100     LABEL RECORDS ARE OMITTED                                                          03/07/94
   21  002200     DATA RECORD IS DISP-REC.                                                           03/07/94
   22  002300   01  DISP-REC.                                                                        03/07/94
   23  002400       COPY DDS-ALL-FORMATS OF DSPFILEX. 2                                              03/22/94
   24 +000001       05  DSPFILEX-RECORD PIC X(8).                                           <-ALL-FMTS
      +000002*  INPUT FORMAT:FORMAT1    FROM FILE DSPFILEX   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                                                                          <-ALL-FMTS
   25 +000004       05  FORMAT1-I     REDEFINES DSPFILEX-RECORD.                            <-ALL-FMTS
   26 +000005           06 FORMAT1-I-INDIC.                                                 <-ALL-FMTS
   27 +000006                07 IN99         PIC 1  INDIC 99. 3                             <-ALL-FMTS
      +000007*                          END OF PROGRAM                                      <-ALL-FMTS
   28 +000008                07 IN51         PIC 1  INDIC 51.                               <-ALL-FMTS
      +000009*                          DAILY REPORT                                        <-ALL-FMTS
   29 +000010                07 IN52         PIC 1  INDIC 52.                               <-ALL-FMTS
      +000011*                          MONTHLY REPORT                                      <-ALL-FMTS
   30 +000012           06 DEPTNO           PIC X(5).                                       <-ALL-FMTS
      +000013* OUTPUT FORMAT:FORMAT1    FROM FILE DSPFILEX   OF LIBRARY XMPLIB              <-ALL-FMTS
      +000014*                                                                          <-ALL-FMTS
   31 +000015       05  FORMAT1-O     REDEFINES DSPFILEX-RECORD.                            <-ALL-FMTS
   32 +000016           06 FORMAT1-O-INDIC.                                                 <-ALL-FMTS
   33 +000017                07 IN01         PIC 1  INDIC 01.                               <-ALL-FMTS
       002500
   34  002600 WORKING-STORAGE SECTION.
   35  002700 01  CURRENT-DATE.
   36  002800     05  CURR-YEAR                PIC 9(2).
   37  002900     05  CURR-MONTH               PIC 9(2).
   38  003000     05  CURR-DAY                 PIC 9(2).
       003100
   39  003200 77  IND-OFF                      PIC 1      VALUE B"0".
   40  003300 77  IND-ON                       PIC 1      VALUE B"1".
       003400
   41  003500 01  RESPONSE-INDICS.
   42  003600     05  END-OF-PROGRAM           PIC 1. 4
   43  003700     05  DAILY-REPORT             PIC 1.
   44  003800     05  MONTHLY-REPORT           PIC 1.
   45  003900 01  OPTION-INDICS.
   46  004000     05  NEW-MONTH                PIC 1.
       004100
   47  004200 PROCEDURE DIVISION.
       004300 XMPLE3-MAIN.
   48  004400     OPEN I-O DISPFILE.
   49  004500     ACCEPT CURRENT-DATE FROM DATE.
   50  004600     MOVE IND-OFF TO END-OF-PROGRAM.
   51  004700     PERFORM DISPLAY-SCREEN THRU READ-AND-PROCESS-SCREEN
       004800             UNTIL END-OF-PROGRAM = IND-ON.
   52  004900     CLOSE DISPFILE.
   53  005000     STOP RUN.
       005100
       005200 DISPLAY-SCREEN.
   54  005300     MOVE ZEROS TO OPTION-INDICS.
   55  005400     IF CURR-DAY = 01 THEN 5
   56  005500        MOVE IND-ON TO NEW-MONTH.
   57  005600     WRITE DISP-REC FORMAT IS "FORMAT1" 6
       005700                    INDICATORS ARE OPTION-INDICS.
       005800
```

Figure 57 (Part 1 of 2). Example of a Program Using Indicators in the Record Area and the INDICATORS phrase in the I/O Statements–COBOL Source Program

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        005900 READ-AND-PROCESS-SCREEN.
    58  006000     MOVE ZEROS TO RESPONSE-INDICS.
    59  006100     READ DISPFILE FORMAT IS "FORMAT1" 7
        006200                   INDICATORS ARE RESPONSE-INDICS. 8
    60  006300     IF DAILY-REPORT = IND-ON THEN
    61  006400        CALL "DAILY" USING DEPTNO 9
        006500     ELSE
    62  006600        IF MONTHLY-REPORT = IND-ON THEN
    63  006700           CALL "MONTHLY" USING DEPTNO.
                             * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                    AS/400 COBOL Messages
  STMT
                         * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                          Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      0         0            0                0                0                0
 Source records read . . . . . . . . :   67
 Copy records read . . . . . . . . . :   17
 Copy members processed  . . . . . . :   1
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program XMPLE713 created in library XMPLIB.
                        * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 57 (Part 2 of 2). Example of a Program Using Indicators in the Record Area and the INDICATORS phrase in the I/O Statements–COBOL Source Program

1 The separate indicator area attribute, SI, is not coded in the ASSIGN clause.

2 The Format 2 COPY statement defines data fields and indicators in the record area.

3 Because the file does not have a separate indicator area, response and option indicators are defined in the order in which they are used in the DDS, and the indicator numbers are treated as documentation.

4 All indicators used by the program are defined with meaningful names in data description entries in WORKING-STORAGE. Indicator numbers are omitted here because they have no effect. Indicators should be defined in the order needed by the display file.

5 IN01 in WORKING-STORAGE is set on if it is the first day of the month.

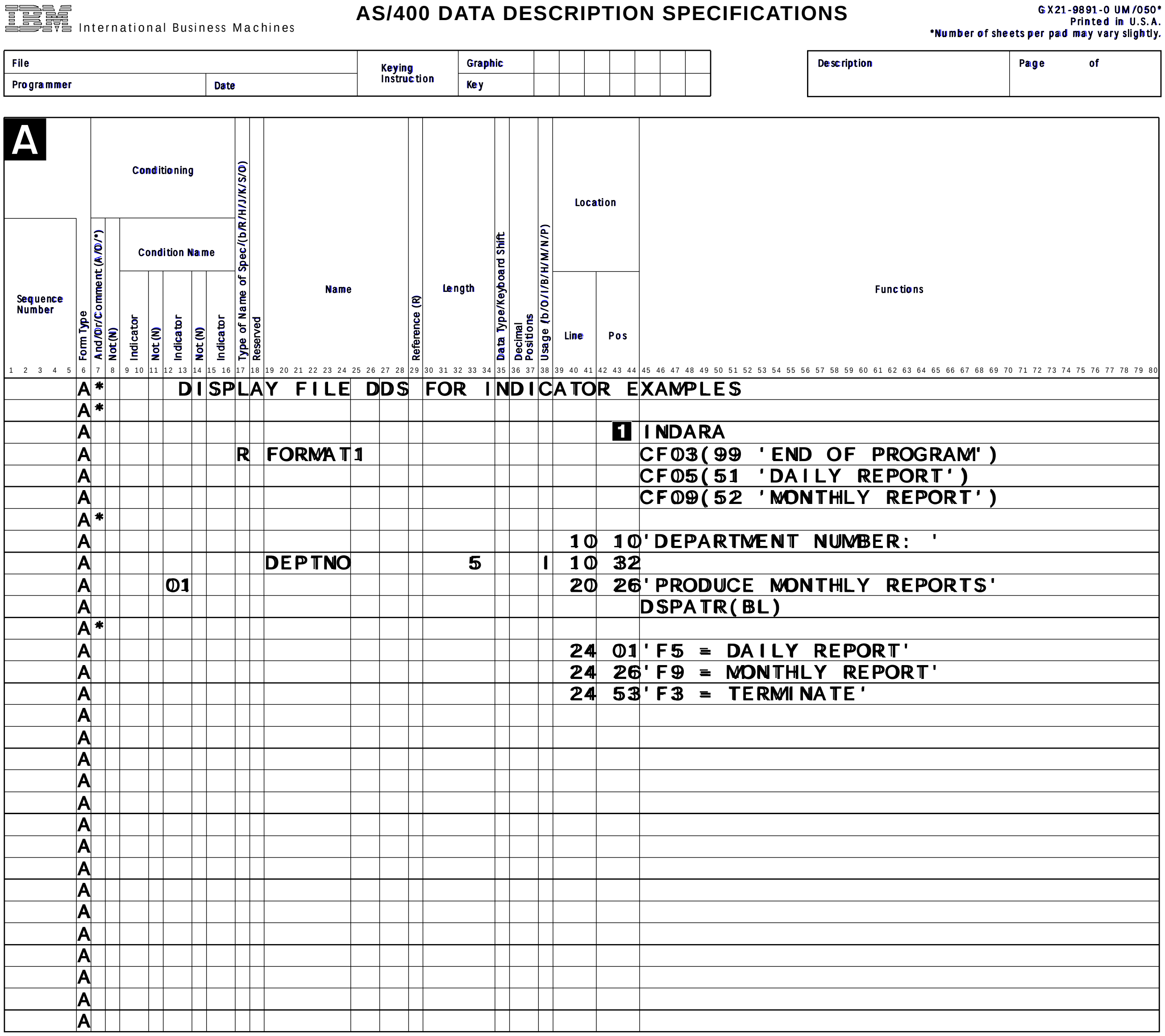
6 FORMAT1 is written to the work station display:

- The INDICATORS phrase causes the contents of the variable OPTION-INDICS to be copied to the beginning of the record area.
- Data and indicator values are written to the work station display.

7 FORMAT1, including both data and indicators, is read from the work station display.

8 The INDICATORS phrase causes bytes to be copied from the beginning of the record area to RESPONSE-INDICS.

9 If F5 has been pressed, a program call is processed.



International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Description | Page of
Programmer | Date | Key

A

Sequence Number | Form Type | And/Or/Comment (A/O/*) | Conditioning: Condition Name: Not (N) | Indicator | Not (N) | Indicator | Not (N) | Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line | Pos | Functions

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

```
     A*     DISPLAY FILE DDS FOR INDICATOR EXAMPLES
     A*
     A                                     1INDARA
     A          R FORMAT1
     A                                      CF03(99 'END OF PROGRAM')
     A                                      CF05(51 'DAILY REPORT')
     A                                      CF09(52 'MONTHLY REPORT')
     A*
     A                                 10 10'DEPARTMENT NUMBER: '
     A            DEPTNO         5   I 10 32
     A     01                          20 26'PRODUCE MONTHLY REPORTS'
     A                                      DSPATR(BL)
     A*
     A                                 24 01'F5 = DAILY REPORT'
     A                                 24 26'F9 = MONTHLY REPORT'
     A                                 24 53'F3 = TERMINATE'
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 58. Example of a Program Using Indicators in a Separate Indicator Area, Defined in WORKING-STORAGE by Using the COPY Statement, DDS Format

1 The INDARA keyword is specified; indicators are stored in a separate indicator area, not in the record area. Except for this specification, the DDS for this file is the same as that shown in Figure 55 on page 147.

```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000100 IDENTIFICATION DIVISION.                                                                03/09/94
     2  000200 PROGRAM-ID.     XMPLE717.                                                               03/22/94
        000300*    SAMPLE PROGRAM - FILE WITH SEPARATE INDICATORS AREA                                 03/09/94
     3  000400 AUTHOR.       PROGRAMMER NAME.                                                          03/09/94
     4  000500 INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                          03/09/94
     5  000600 DATE-WRITTEN. 12/08/88.                                                                 03/09/94
     6  000070 DATE-COMPILED.  05/24/94 12:53:17   .
     7  000800 ENVIRONMENT DIVISION.                                                                   03/09/94
     8  000900 CONFIGURATION SECTION.                                                                  03/09/94
     9  001000 SOURCE-COMPUTER. IBM-AS400.                                                             03/09/94
    10  001100 OBJECT-COMPUTER. IBM-AS400.                                                             03/09/94
    11  001200 INPUT-OUTPUT SECTION.                                                                   03/09/94
    12  001300 FILE-CONTROL.                                                                           03/09/94
    13  001400     SELECT DISPFILE                                                                     03/09/94
    14  001500         ASSIGN TO WORKSTATION-DSPFILE-SI  1                                             03/22/94
    15  001600         ORGANIZATION IS TRANSACTION                                                     03/09/94
    16  001700         ACCESS IS SEQUENTIAL.                                                           03/09/94
        001800                                                                                         03/09/94
    17  001900 DATA DIVISION.                                                                          03/09/94
    18  002000 FILE SECTION.                                                                           03/09/94
    19  002100 FD  DISPFILE                                                                            03/09/94
    20  002200     LABEL RECORDS ARE OMITTED                                                           03/09/94
    21  002300     DATA RECORD IS DISP-REC.                                                            03/09/94
    22  002400 01  DISP-REC.                                                                           03/09/94
    23  002500     COPY DDS-ALL-FORMATS OF DSPFILE.  2                                                 03/22/94
    24 +000001       05  DSPFILE-RECORD PIC X(5).                                        <-ALL-FMTS
       +000002*  INPUT FORMAT:FORMAT1    FROM FILE DSPFILE    OF LIBRARY XMPLIB            <-ALL-FMTS
       +000003*                                                                          <-ALL-FMTS
    25 +000004       05  FORMAT1-I     REDEFINES DSPFILE-RECORD.                         <-ALL-FMTS
    26 +000005           06 DEPTNO           PIC X(5).                                   <-ALL-FMTS
       +000006* OUTPUT FORMAT:FORMAT1    FROM FILE DSPFILE    OF LIBRARY XMPLIB            <-ALL-FMTS
       +000007*                                                                          <-ALL-FMTS
       +000008*      05  FORMAT1-O     REDEFINES DSPFILE-RECORD.                         <-ALL-FMTS
        002600
    27  002700 WORKING-STORAGE SECTION.
    28  002800 01  CURRENT-DATE.
    29  002900    05  CURR-YEAR                 PIC 9(2).
    30  003000    05  CURR-MONTH                PIC 9(2).
    31  003100    05  CURR-DAY                  PIC 9(2).
        003200
    32  003300    77 IND-OFF                    PIC 1 VALUE B"0".
    33  003400    77 IND-ON                     PIC 1 VALUE B"1".
    34  003500 01  DISPFILE-INDICS.
    35  003600     COPY DDS-ALL-FORMATS-INDIC OF DSPFILE.  3
    36 +000001       05  DSPFILE-RECORD.                                                 <-ALL-FMTS
       +000002*  INPUT FORMAT:FORMAT1    FROM FILE DSPFILE    OF LIBRARY XMPLIB            <-ALL-FMTS
       +000003*                                                                          <-ALL-FMTS
    37 +000004           06 FORMAT1-I-INDIC.                                             <-ALL-FMTS
    38 +000005                07 IN51         PIC 1  INDIC 51.  4                        <-ALL-FMTS
       +000006*                          DAILY REPORT                                    <-ALL-FMTS
    39 +000007                07 IN52         PIC 1  INDIC 52.                           <-ALL-FMTS
       +000008*                          MONTHLY REPORT                                  <-ALL-FMTS
    40 +000009                07 IN99         PIC 1  INDIC 99.                           <-ALL-FMTS
       +000010*                          END OF PROGRAM                                  <-ALL-FMTS
       +000011* OUTPUT FORMAT:FORMAT1    FROM FILE DSPFILE    OF LIBRARY XMPLIB            <-ALL-FMTS
       +000012*
    41 +000013           06 FORMAT1-O-INDIC.
    42 +000014                07 IN01         PIC 1  INDIC 01.
        003700
    43  003800 PROCEDURE DIVISION.
        003900
        004000 MAIN-PROCESS.
        004100
    44  004200     OPEN I-O DISPFILE.
    45  004300     ACCEPT CURRENT-DATE FROM DATE.
    46  004400     MOVE IND-OFF TO IN99 IN FORMAT1-I-INDIC.
    47  004500     PERFORM DISPLAY-SCREEN THRU READ-AND-PROCESS-SCREEN
        004600         UNTIL IN99 IN FORMAT1-I-INDIC = IND-ON.
    48  004700     CLOSE DISPFILE.
    49  004800     STOP RUN.
        004900
        005000 DISPLAY-SCREEN.
        005100
    50  005200     MOVE ZEROS TO FORMAT1-O-INDIC.
    51  005300     IF CURR-DAY = 01 THEN
    52  005400        MOVE IND-ON TO IN01 IN FORMAT1-O-INDIC.  5
```

Figure 59 (Part 1 of 2). COBOL Listing Using Indicators in a Separate Indicator Area

```
 5763CB1 V3R0M5                  AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    53  005500     WRITE DISP-REC FORMAT IS "FORMAT1"
        005600                    INDICATORS ARE FORMAT1-O-INDIC.  6
        005700
        005800 READ-AND-PROCESS-SCREEN.
        005900
    54  006000     MOVE ZEROS TO FORMAT1-I-INDIC.
    55  006100     READ DISPFILE FORMAT IS "FORMAT1"
        006200                   INDICATORS ARE FORMAT1-I-INDIC.  7
    56  006300     IF IN51 IN FORMAT1-I-INDIC = IND-ON THEN
    57  006400         CALL "DAILY" USING DEPTNO  8
        006500     ELSE
    58  006600         IF IN52 IN FORMAT1-I-INDIC = IND-ON THEN
    59  006700             CALL "MONTHLY" USING DEPTNO.
                            * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                  AS/400 COBOL Messages
  STMT
*   23  MSGID: LBL0600  SEVERITY: 10  SEQNBR:  000250
        Message . . . . :   No OUTPUT fields found for format FORMAT1.
                        * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                   Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1         0            1              0               0                0
 Source records read . . . . . . . . :   67
 Copy records read . . . . . . . . . :   22
 Copy members processed  . . . . . . :   2
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   10
  LBL0901 00  Program XMPLE717 created in library XMPLIB.
                       * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 59 (Part 2 of 2). COBOL Listing Using Indicators in a Separate Indicator Area

1 The separate indicator area attribute, SI, is specified in the ASSIGN clause.

2 The Format 2 COPY statement generates data descriptions in the record area for data fields only. The data description entries for the indicators are not generated because a separate indicator area has been specified for the file.

3 The Format 2 COPY statement, with the INDICATOR attribute, INDIC, defines data description entries in WORKING-STORAGE for all indicators used in the DDS for the record format for the file.

4 Because the file has a separate indicator area, the indicator numbers used in the data description entries are not treated as documentation.

5 IN01 in the separate indicator area for FORMAT1 is set on if it is the first day of the month.

6 The INDICATORS phrase is required to send indicator values to the work station display.

7 The INDICATORS phrase is required to receive indicator values from the work station display. If you have pressed F5, IN51 is set on.

8 If IN51 has been set on, a program call is processed.

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000100 IDENTIFICATION DIVISION.                                                                   01/22/94
     2  000200 PROGRAM-ID.     XMPLE720.                                                                  03/22/94
        000300*    PROGRAM EXAMPLE                                                                        01/22/94
        000400*    FILE WITH SEPARATE INDICATORS AREA IN WORKING STORAGE                                  01/22/94
     3  000500 AUTHOR.       PROGRAMMER NAME.                                                             01/22/94
     4  000600 INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                            01/22/94
     5  000700 DATE-WRITTEN. 12/08/88.                                                                    01/22/94
     6  000080 DATE-COMPILED.  05/24/94 12:46:00   .
     7  000900 ENVIRONMENT DIVISION.                                                                      01/22/94
     8  001000 CONFIGURATION SECTION.                                                                     01/22/94
     9  001100 SOURCE-COMPUTER. IBM-AS400.                                                                01/22/94
    10  001200 OBJECT-COMPUTER. IBM-AS400.                                                                01/22/94
    11  001300 INPUT-OUTPUT SECTION.                                                                      01/22/94
    12  001400 FILE-CONTROL.                                                                              01/22/94
    13  001500     SELECT DISPFILE                                                                        01/22/94
    14  001600         ASSIGN TO WORKSTATION-DSPFILE-SI 1                                                 03/22/94
    15  001700         ORGANIZATION IS TRANSACTION                                                        01/22/94
    16  001800         ACCESS IS SEQUENTIAL.                                                              01/22/94
        001900                                                                                            01/22/94
    17  002000 DATA DIVISION.                                                                             01/22/94
    18  002100 FILE SECTION.                                                                              01/22/94
    19  002200 FD  DISPFILE                                                                               01/22/94
    20  002300     LABEL RECORDS ARE OMITTED                                                              01/22/94
    21  002400     DATA RECORD IS DISP-REC.                                                               01/22/94
    22  002500 01  DISP-REC.                                                                              01/22/94
    23  002600     COPY DDS-ALL-FORMATS OF DSPFILE. 2                                                     03/22/94
    24 +000001       05  DSPFILE-RECORD PIC X(5).                                       <-ALL-FMTS
       +000002*  INPUT FORMAT:FORMAT1    FROM FILE DSPFILE    OF LIBRARY XMPLIB            <-ALL-FMTS
       +000003*                                                                         <-ALL-FMTS
    25 +000004       05  FORMAT1-I     REDEFINES DSPFILE-RECORD.                        <-ALL-FMTS
    26 +000005           06 DEPTNO            PIC X(5).                                 <-ALL-FMTS
       +000006* OUTPUT FORMAT:FORMAT1    FROM FILE DSPFILE    OF LIBRARY XMPLIB            <-ALL-FMTS
       +000007*                                                                         <-ALL-FMTS
       +000008*      05  FORMAT1-O     REDEFINES DSPFILE-RECORD.                        <-ALL-FMTS
        002700
    27  002800 WORKING-STORAGE SECTION.
    28  002900 01  CURRENT-DATE.
    29  003000    05  CURR-YEAR                 PIC 9(2).
    30  003100    05  CURR-MONTH                PIC 9(2).
    31  003200    05  CURR-DAY                  PIC 9(2).
        003300
    32  003400 01  INDIC-AREA.
    33  003500    05 INDIC-TABLE  OCCURS 99     PIC 1    INDICATOR 1. 3
    34  003600      88  IND-OFF                          VALUE B"0".
    35  003700      88  IND-ON                           VALUE B"1".
        003800
    36  003900 01  DISPFILE-INDIC-USAGE.
    37  004000    05  IND-NEW-MONTH             PIC 9(2) VALUE 01.
    38  004100    05  IND-DAILY                 PIC 9(2) VALUE 51. 4
    39  004200    05  IND-MONTHLY               PIC 9(2) VALUE 52.
    40  004300    05  IND-EOJ                   PIC 9(2) VALUE 99.
        004400
    41  004500 PROCEDURE DIVISION.
        004600
        004700 XMPLE-MAIN.
    42  004800     OPEN I-O DISPFILE.
    43  004900     ACCEPT CURRENT-DATE FROM DATE.
    44  005000     SET IND-OFF (IND-EOJ) TO TRUE.
    45  005100     PERFORM DISPLAY-SCREEN THRU READ-AND-PROCESS-SCREEN
        005200         UNTIL IND-ON (IND-EOJ).
    46  005300     CLOSE DISPFILE.
    47  005400     STOP RUN.
        005500
        005600 DISPLAY-SCREEN.
        005700
    48  005800     MOVE ZEROS TO INDIC-AREA.
    49  005900     IF CURR-DAY = 01 THEN
    50  006000        SET IND-ON (IND-NEW-MONTH) TO TRUE. 5
    51  006100     WRITE DISP-REC FORMAT IS "FORMAT1"
        006200                   INDICATORS ARE INDIC-TABLE. 6
        006300
        006400 READ-AND-PROCESS-SCREEN.
        006500
    52  006600     READ DISPFILE FORMAT IS "FORMAT1"
        006700                  INDICATORS ARE INDIC-TABLE. 7
```

Figure 60 (Part 1 of 2). Example of a Program Using Indicators in a Separate Indicator Area, Defined in a Table in WORKING-STORAGE

```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    53  006800     IF IND-ON (IND-DAILY) THEN 8
    54  006900         CALL "DAILY" USING DEPTNO
        007000     ELSE
    55  007100         IF IND-ON (IND-MONTHLY) THEN
    56  007200             CALL "MONTHLY" USING DEPTNO.
                            * * * * *  E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                   AS/400 COBOL Messages
  STMT
*   23  MSGID: LBL0600  SEVERITY: 10  SEQNBR:  000260
        Message . . . . :   No OUTPUT fields found for format FORMAT1.
                        * * * * *  E N D   O F   M E S S A G E S   * * * * *
                                         Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1         0             1               0               0                 0
 Source records read . . . . . . . . :   72
 Copy records read . . . . . . . . . :   8
 Copy members processed  . . . . . . :   1
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   10
  LBL0901 00  Program XMPLE720 created in library XMPLIB.
                       * * * * *  E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 60 (Part 2 of 2). Example of a Program Using Indicators in a Separate Indicator Area, Defined in a Table in WORKING-STORAGE

1 The separate indicator area attribute, SI, is specified in the ASSIGN clause.

2 The Format 2 COPY statement generates fields in the record area for data fields only.

3 A table of 99 Boolean data items is defined in WORKING-STORAGE. The INDICATOR clause for this data description entry causes these data items to be associated with indicators 1 through 99 respectively. The use of such a table may result in improved performance as compared to the use of a group item with multiple subordinate entries for individual indicators.

4 A series of data items is defined in WORKING-STORAGE to provide meaningful subscript names with which to refer to the table of indicators. The use of such data items is not required.

5 INDIC-TABLE (01) in the separate indicator area for FORMAT1 is set on if it is the first day of the month.

6 The INDICATOR phrase is required to send indicator values to the work station display.

7 The INDICATOR phrase is required to receive indicator values from the work station display. If F5 has been pressed, INDIC-TABLE (51) will be set on.

8 If INDIC-TABLE (51) has been set on, program DAILY is called.

Subfiles

Subfiles can be specified in the DDS for a display file to allow you to handle multiple records of the same type on a display. See Figure 61 on page 157 for an example of a subfile display. A **subfile** is a group of records that are read from or written to a display device. The program processes one record at a time, but the operating system and the work station send and receive blocks of records. If more records are transmitted than can be shown on the display at one time, the work station operator can page through the block of records without returning control to the program.

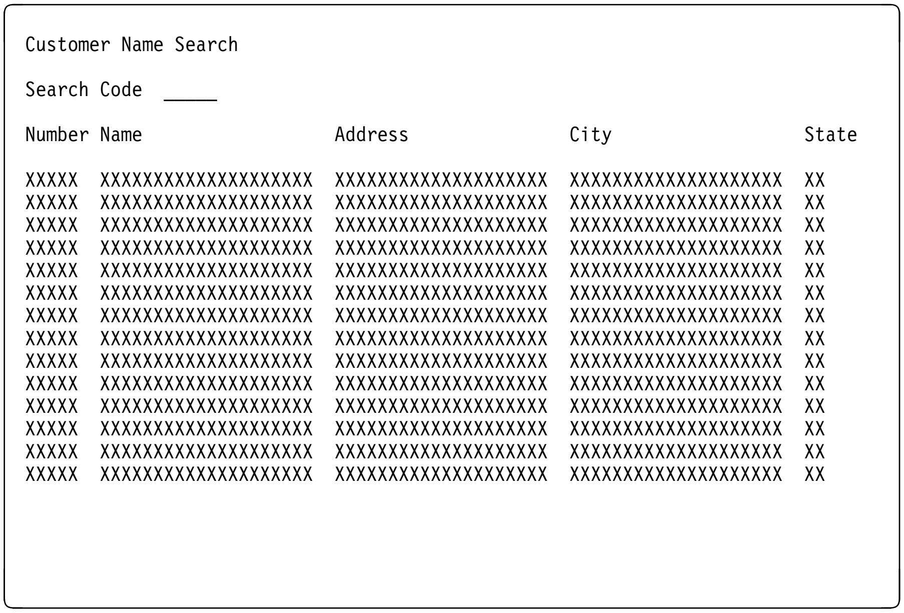
Records to be included in a subfile are specified in the DDS for the file. The number of records that can be contained in a subfile must also be specified in the DDS. One file can contain more than one subfile; however, only twelve subfiles can be active concurrently for a device. Twelve subfiles can be displayed on a device at the same time.

The DDS for a subfile consists of two record formats: a subfile record format and a subfile control record format.

The subfile record format contains the field descriptions for the records in the subfile. Specifications of the subfile record format on a READ, WRITE, or REWRITE causes the specified subfile record to be processed, but does not directly affect the displayed data.

Specification of the subfile control record format on the READ or WRITE statement causes the physical read, write, or setup operations of a subfile to take place. Figure 62 on page 159 shows an example of the DDS for a subfile record format, and Figure 63 on page 161 shows an example of the DDS for a subfile control record format.

For a description of how the records in a subfile can be displayed and for a description of the keywords that can be specified for a subfile, see the *Data Management Guide* and also the *DDS Reference*.



```
Customer Name Search

Search Code  _____

Number Name                 Address              City                 State

XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
XXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XXXXXXXXXXXXXXXXXXXX  XX
```

Figure 61. Subfile Display

To use a subfile for a display file in a COBOL program, you must specify the SUBFILE phrase with the input/output operation. Valid subfile operations are:

- READ SUBFILE file-name RECORD
- WRITE SUBFILE record-name
- REWRITE SUBFILE record-name.

Subfiles can be processed sequentially with the READ SUBFILE NEXT MODIFIED statement, or processed randomly by specifying a relative key value. A relative key is an unsigned number that can be used directly by the system to locate a record in a file.

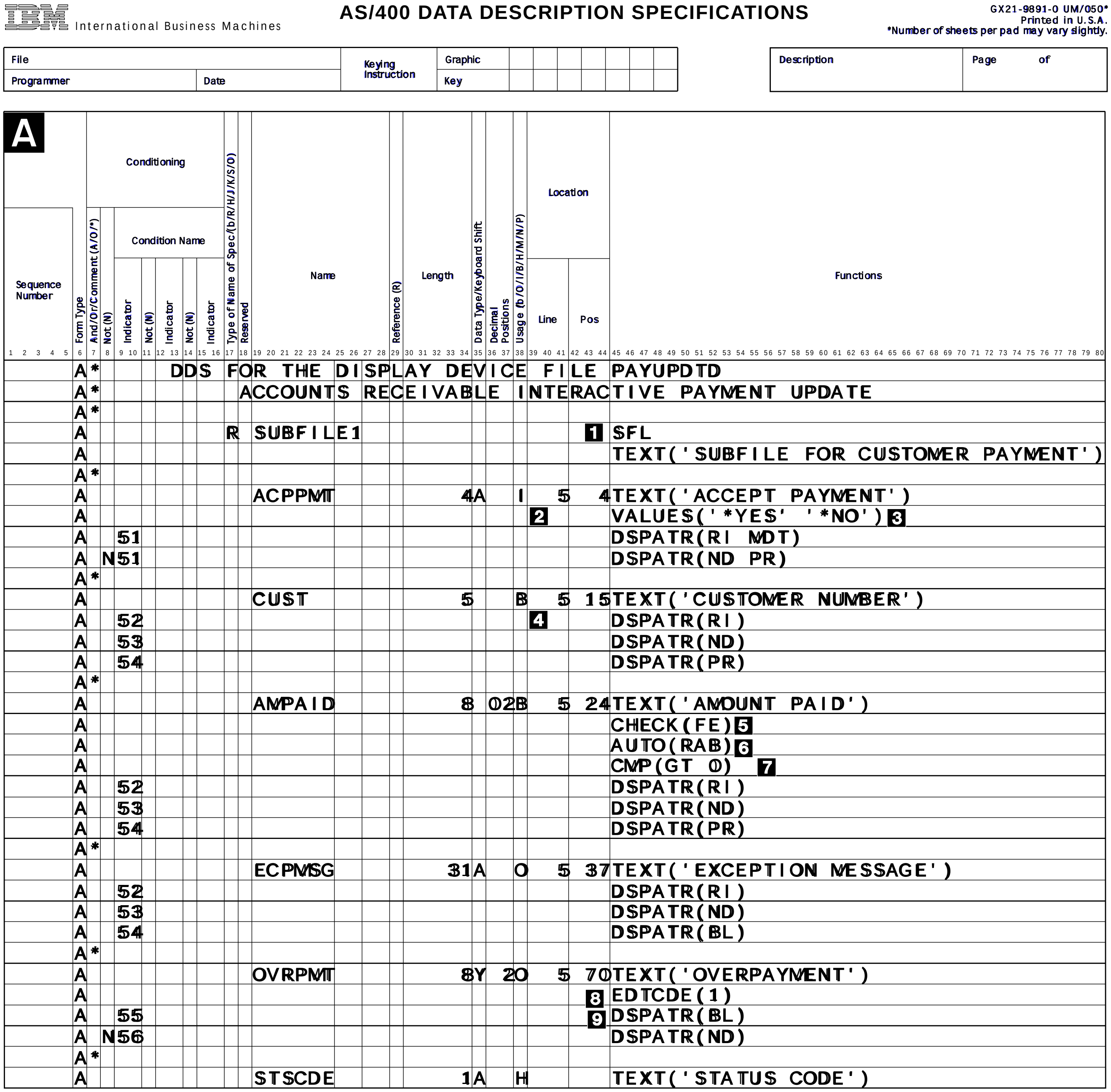
The TRANSACTION file must be an externally defined file. In COBOL, all access to the subfile is done with a relative record number. If the SUBFILE phrases are used with a TRANSACTION file, the SELECT statement in the Environment Division must state that ACCESS MODE IS DYNAMIC and must specify the RELATIVE KEY to be used.

If more than one display device is acquired by a display file, there is a separate subfile for each individual display device. If a subfile has been created for a particular display device acquired by a TRANSACTION file, all input operations that refer to a record format for the subfile are performed against the subfile belonging to that device. See the discussion on the TERMINAL phrase on page 182 of this chapter for information about how to determine which device is used. Any operations that reference a record format name that is not designated as a subfile are processed as an input/output operation directly to the display device.

Use of Subfiles

Some typical uses of subfiles include:

Use	Meaning
Display Only	The work station user reviews the display.
Display With Selection	The user requests more information about one of the items on display.
Modification	The user modifies one or more of the records.
Input Only (with no validity checking)	A subfile is used for a data-entry function.
Input Only (with validity checking)	A subfile is used for a data-entry function, and the records are checked as well.
Combination of Tasks	A subfile can be used as a display with modification.



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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*Number of sheets per pad may vary slightly.

File		Keying Instruction	Graphic
Programmer	Date		Key

Description	Page of

A

Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Condition Name: Not (N), Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name or Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A*     DDS FOR THE DISPLAY DEVICE FILE PAYUPDTD
     A*          ACCOUNTS RECEIVABLE INTERACTIVE PAYMENT UPDATE
     A*
     A          R SUBFILE1               1SFL
     A                                      TEXT('SUBFILE FOR CUSTOMER PAYMENT')
     A*
     A            ACPPMT         4A  I  5  4TEXT('ACCEPT PAYMENT')
     A                                2     VALUES('*YES' '*NO')3
     A  51                                  DSPATR(RI MDT)
     A N51                                  DSPATR(ND PR)
     A*
     A            CUST           5   B  5 15TEXT('CUSTOMER NUMBER')
     A  52                            4     DSPATR(RI)
     A  53                                  DSPATR(ND)
     A  54                                  DSPATR(PR)
     A*
     A            AMPAID         8 02B  5 24TEXT('AMOUNT PAID')
     A                                      CHECK(FE)5
     A                                      AUTO(RAB)6
     A                                      CMP(GT 0)  7
     A  52                                  DSPATR(RI)
     A  53                                  DSPATR(ND)
     A  54                                  DSPATR(PR)
     A*
     A            ECPMSG        31A  O  5 37TEXT('EXCEPTION MESSAGE')
     A  52                                  DSPATR(RI)
     A  53                                  DSPATR(ND)
     A  54                                  DSPATR(BL)
     A*
     A            OVRPMT         8Y 2O  5 70TEXT('OVERPAYMENT')
     A                                     8EDTCDE(1)
     A  55                                 9DSPATR(BL)
     A N56                                  DSPATR(ND)
     A*
     A            STSCDE         1A  H      TEXT('STATUS CODE')
```

Figure 62. Data Description Specifications for a Subfile Record Format

The data description specifications (DDS) for a subfile record format describe the records in the subfile:

1 The SFL keyword identifies the record format as a subfile.

2 The line and position entries define the location of the fields on the display.

3 The VALUES keyword specifies that the user can only specify *YES or *NO as values for the ACPPMT field.

4 The usage entries define whether the named field is to be an output (O), input (I), output/input (B), or hidden (H) field.

5 The entry CHECK(FE) specifies that the user cannot skip to the next input field without pressing one of the field exit keys.

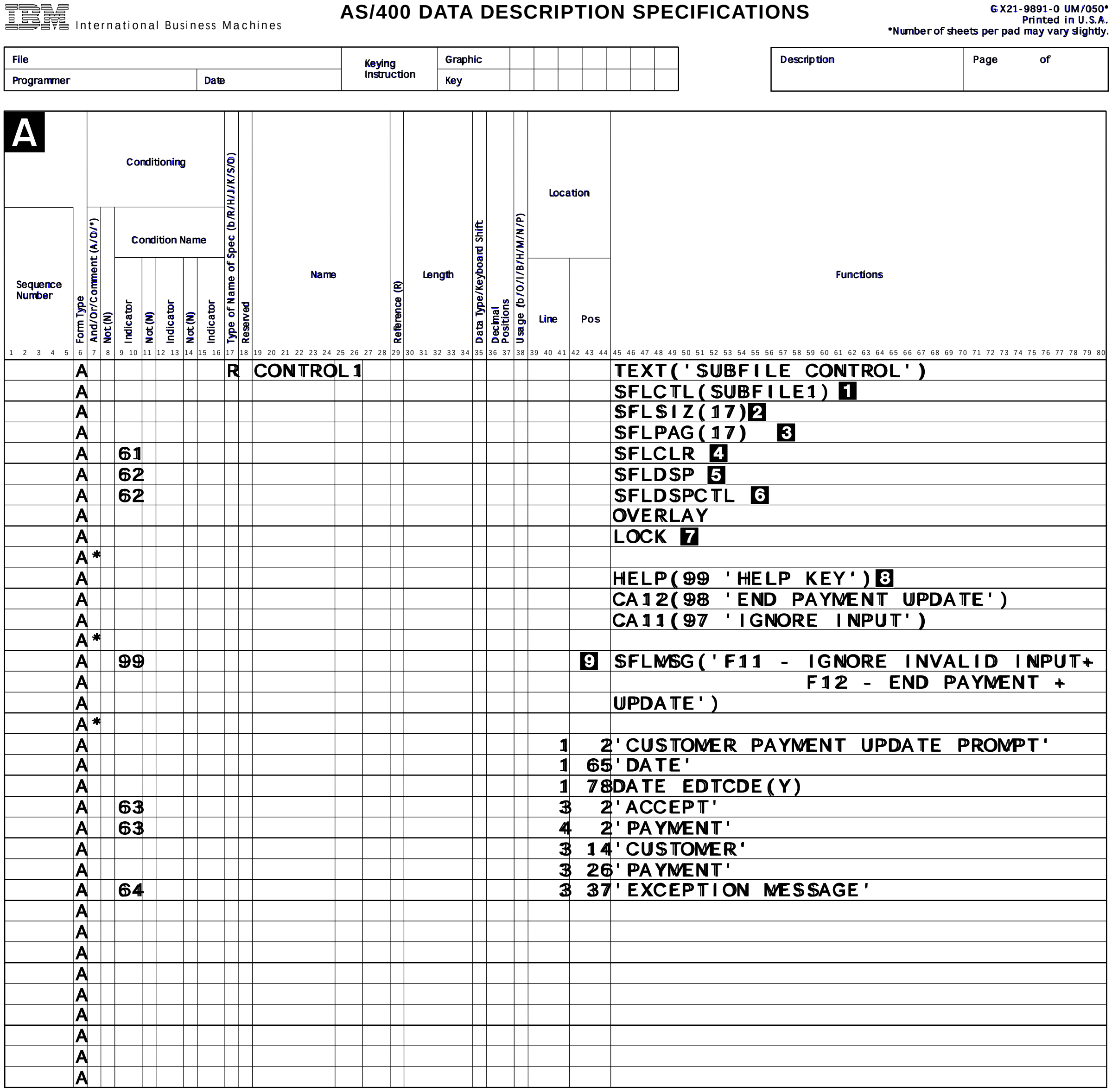
6 The entry AUTO(RAB) specifies that data entered into the field AMPAID is to be automatically right-justified, and the leading characters are to be filled with blanks.

7 The entry CMP(GT 0) specifies that the data entered for the field AMPAID is to be compared to zero to ensure that the value is greater than zero.

8 The EDTCDE keyword specifies the desired editing for output field OVRPMT. EDTCDE(1) indicates that the field OVRPMT is to be printed with commas, decimal point, and no sign. Also, a zero balance will be printed, and leading zeros will be suppressed.

9 The DSPATR keyword is used to specify the display attributes for the named field when the corresponding indicator status is true. The attributes specified are:

- BL (blink)
- RI (reverse image)
- PR (protect)
- MDT (set modified data tag)
- ND (nondisplay).



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AS/400 DATA DESCRIPTION SPECIFICATIONS

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*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Key | Programmer | Date | Description | Page of

A

```
     A          R CONTROL1                  TEXT('SUBFILE CONTROL')
     A                                      SFLCTL(SUBFILE1) 1
     A                                      SFLSIZ(17)2
     A                                      SFLPAG(17)   3
     A  61                                  SFLCLR 4
     A  62                                  SFLDSP 5
     A  62                                  SFLDSPCTL 6
     A                                      OVERLAY
     A                                      LOCK 7
     A*
     A                                      HELP(99 'HELP KEY')8
     A                                      CA12(98 'END PAYMENT UPDATE')
     A                                      CA11(97 'IGNORE INPUT')
     A*
     A  99                                 9SFLMSG('F11 - IGNORE INVALID INPUT+
     A                                                    F12 - END PAYMENT +
     A                                      UPDATE')
     A*
     A                                    1  2'CUSTOMER PAYMENT UPDATE PROMPT'
     A                                    1 65'DATE'
     A                                    1 78DATE EDTCDE(Y)
     A  63                                3  2'ACCEPT'
     A  63                                4  2'PAYMENT'
     A                                    3 14'CUSTOMER'
     A                                    3 26'PAYMENT'
     A  64                                3 37'EXCEPTION MESSAGE'
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 63. Data Description Specifications for a Subfile Control Record Format

The subfile control record format defines the attributes of the subfile, the search input field, constants, and command keys. The keywords used indicate the following:

1 SFLCTL identifies this record as a subfile control record and names the associated subfile record (SUBFILE1).

2 SFLSIZ indicates the total number of records to be included in the subfile (17).

3 SFLPAG indicates the total number of records in a page (17).

4 SFLCLR indicates when the subfile should be cleared (when indicator 61 is on).

5 SFLDSP indicates when to display the subfile (when indicator 62 is on).

6 SFLDSPCTL indicates when to display the subfile control record (when indicator 62 is on).

7 The LOCK keyword prevents the work station user from using the keyboard when the CONTROL1 record format is initially displayed.

8 HELP allows the user to press the Help key and sets indicator 99 on.

9 SFLMSG identifies the constant as a message that is displayed if indicator 99 is on.

In addition to the control information, the subfile control record format defines the constants to be used as column headings for the subfile record format. Refer to Figure 63 on page 161 for an example of the subfile control record format.

Multiple Device Files and Single Device Files

A **multiple device file** is either a display file or an intersystem communications function (ICF) file. A multiple device file can acquire more than one program device. For an example of the use of multiple device files, see Figure 64 on page 163.

A **single device file** is a device file created with only one program device defined for it. Printer files, diskette files and tape files are single device files. Display files and intersystem communication function (ICF) files created with a maximum number of one program device are also single device files.

A display file can have multiple program devices when the MAXDEV parameter of the CRTDSPF command is greater than 1. If you specify *NONE for the DEV parameter of this command, you must supply the name of a display device *before* you use any fields that are related to the file.

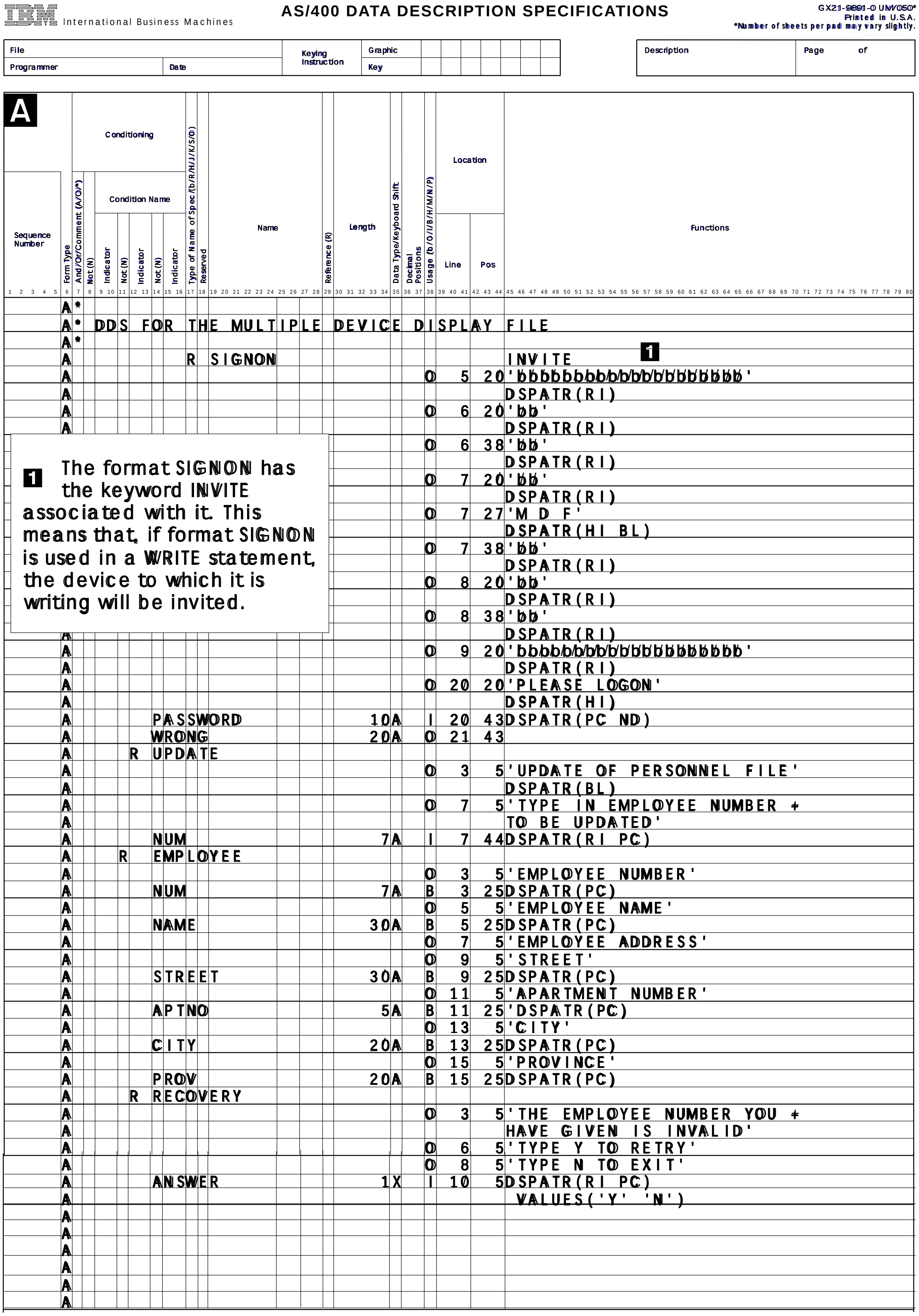
For more information about how to create and use a display file, see the *Data Management Guide*.

ICF files can have multiple program devices when the MAXPGMDEV parameter of the CRTICFF command is greater than 1. For more information about how to create and use ICF files, see the *ICF Programmer's Guide*.

COBOL determines at run time whether a file is a single device file or a multiple device file, based on whether the file is *capable* of having multiple devices. The actual number of devices acquired does not affect whether a file is considered a single or multiple device file. Whether a file is a single or a multiple device file is *not* determined at compilation time; this determination is based on the current description of the display or ICF file.

For multiple device files, if a particular program device is to be used in an I/O statement, that device is specified by the TERMINAL phrase. The TERMINAL phrase can also be specified for a single device file.

The following pages contain an example illustrating the use of multiple device files. The program uses a display file, and is intended to be run in batch mode. The program acquires terminals and invites those terminals using a sign-on display. After the terminals are invited, they are polled. If nobody signs on before the wait time expires, the program ends. If you enter a valid password, you are allowed to update an employee file by calling another COBOL program. Once the update is complete, the device is invited again and the terminals are polled again.



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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File
Programmer
Date
Keying Instruction
Graphic
Key
Description
Page of

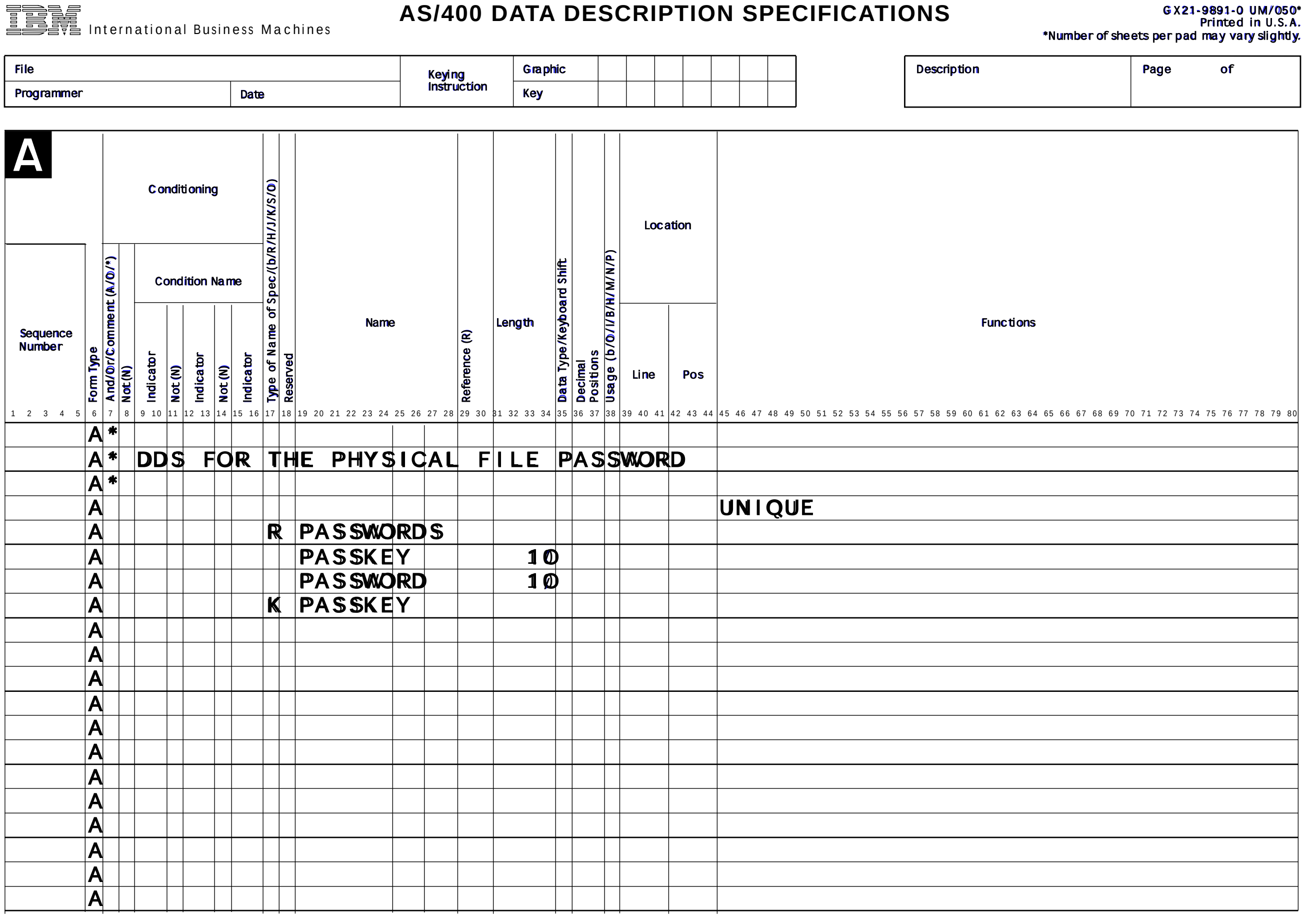
A

Sequence Number | Form Type | And/Or/Comment (A/O/*) | Conditioning: Not (N), Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A*
     A*  DDS FOR THE MULTIPLE DEVICE DISPLAY FILE
     A*
     A          R SIGNON                    INVITE
     A                               O  5 20'ƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀ'
     A                                      DSPATR(RI)
     A                               O  6 20'ƀƀ'
     A                                      DSPATR(RI)
                                     O  6 38'ƀƀ'
                                            DSPATR(RI)
                                     O  7 20'ƀƀ'
                                            DSPATR(RI)
                                     O  7 27'M D F'
                                            DSPATR(HI BL)
                                     O  7 38'ƀƀ'
                                            DSPATR(RI)
                                     O  8 20'ƀƀ'
                                            DSPATR(RI)
                                     O  8 38'ƀƀ'
     A                                      DSPATR(RI)
     A                               O  9 20'ƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀ'
     A                                      DSPATR(RI)
     A                               O 20 20'PLEASE LOGON'
     A                                      DSPATR(HI)
     A       PASSWORD           10A  I 20 43DSPATR(PC ND)
     A       WRONG              20A  O 21 43
     A     R UPDATE
     A                               O  3  5'UPDATE OF PERSONNEL FILE'
     A                                      DSPATR(BL)
     A                               O  7  5'TYPE IN EMPLOYEE NUMBER +
     A                                      TO BE UPDATED'
     A       NUM                 7A  I  7 44DSPATR(RI PC)
     A    R  EMPLOYEE
     A                               O  3  5'EMPLOYEE NUMBER'
     A       NUM                 7A  B  3 25DSPATR(PC)
     A                               O  5  5'EMPLOYEE NAME'
     A       NAME               30A  B  5 25DSPATR(PC)
     A                               O  7  5'EMPLOYEE ADDRESS'
     A                               O  9  5'STREET'
     A       STREET             30A  B  9 25DSPATR(PC)
     A                               O 11  5'APARTMENT NUMBER'
     A       APTNO               5A  B 11 25'DSPATR(PC)
     A                               O 13  5'CITY'
     A       CITY               20A  B 13 25DSPATR(PC)
     A                               O 15  5'PROVINCE'
     A       PROV               20A  B 15 25DSPATR(PC)
     A     R RECOVERY
     A                               O  3  5'THE EMPLOYEE NUMBER YOU +
     A                                      HAVE GIVEN IS INVALID'
     A                               O  6  5'TYPE Y TO RETRY'
     A                               O  8  5'TYPE N TO EXIT'
     A       ANSWER              1X  I 10  5DSPATR(RI PC)
     A                                       VALUES('Y' 'N')
     A
     A
     A
     A
     A
     A
```

1 The format SIGNON has the keyword INVITE associated with it. This means that, if format SIGNON is used in a WRITE statement, the device to which it is writing will be invited.

Figure 64 (Part 1 of 3). Example of the Use of Multiple Device Files



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
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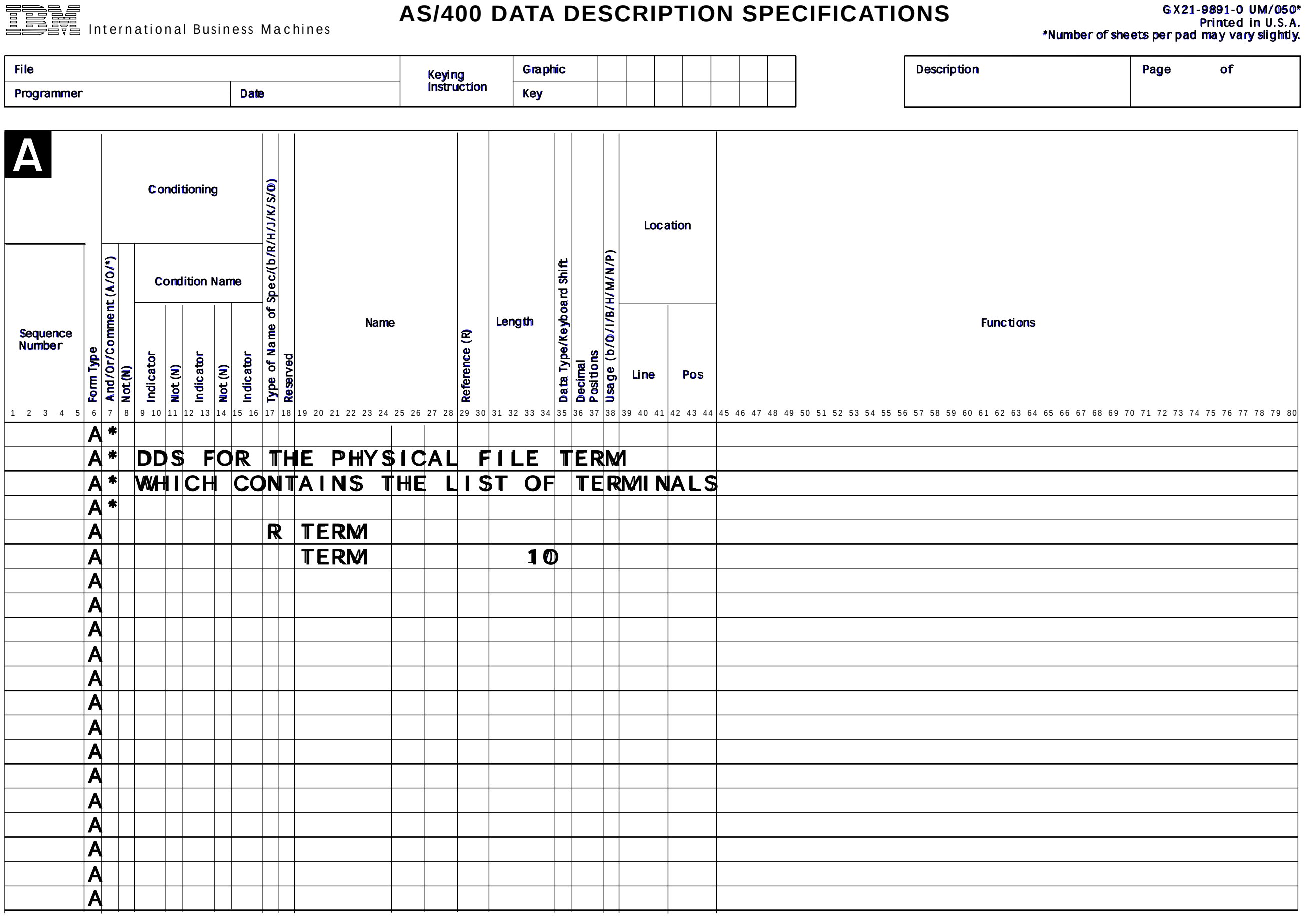
*Number of sheets per pad may vary slightly.

File | Keying Instruction | Graphic | Description | Page of
Programmer | Date | Key

```
     A*
     A*  DDS FOR THE PHYSICAL FILE PASSWORD
     A*
     A                                      UNIQUE
     A          R PASSWORDS
     A            PASSKEY       10
     A            PASSWORD      10
     A          K PASSKEY
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

A
Sequence Number
Form Type
Conditioning
And/Or/Comment (A/O/*)
Not (N)
Condition Name
Indicator
Not (N)
Indicator
Not (N)
Indicator
Type of Name of Spec/(b/R/H/J/K/S/O)
Reserved
Name
Reference (R)
Length
Data Type/Keyboard Shift
Decimal Positions
Usage (b/O/I/B/H/M/N/P)
Location
Line
Pos
Functions
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Figure 64 (Part 2 of 3). Example of the Use of Multiple Device Files



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AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

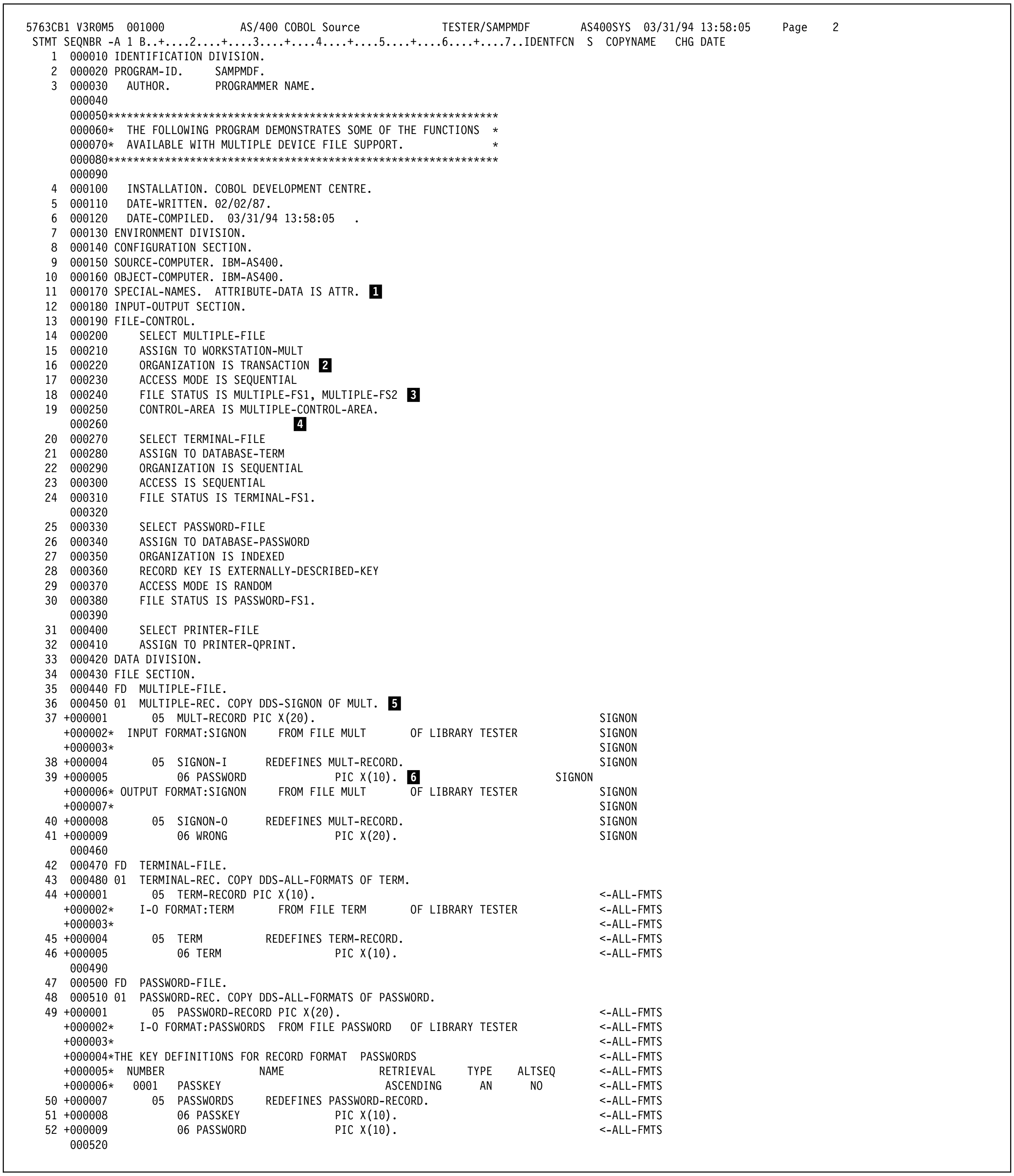
File
Programmer
Date
Keying Instruction
Graphic
Key
Description
Page of

A

Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Not (N), Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

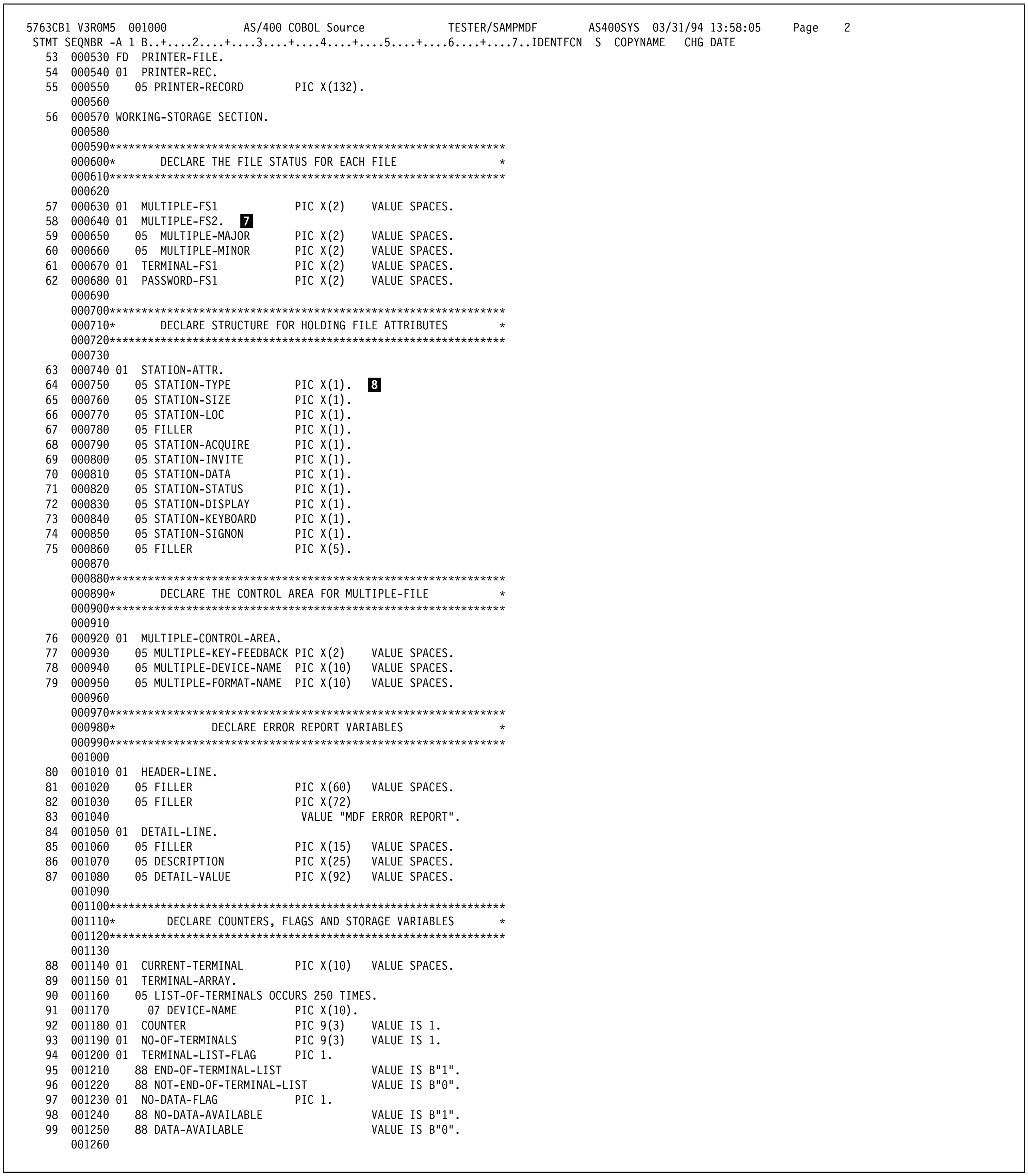
```
     A*
     A* DDS FOR THE PHYSICAL FILE TERM
     A* WHICH CONTAINS THE LIST OF TERMINALS
     A*
     A          R TERM
     A            TERM          10
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 64 (Part 3 of 3). Example of the Use of Multiple Device Files



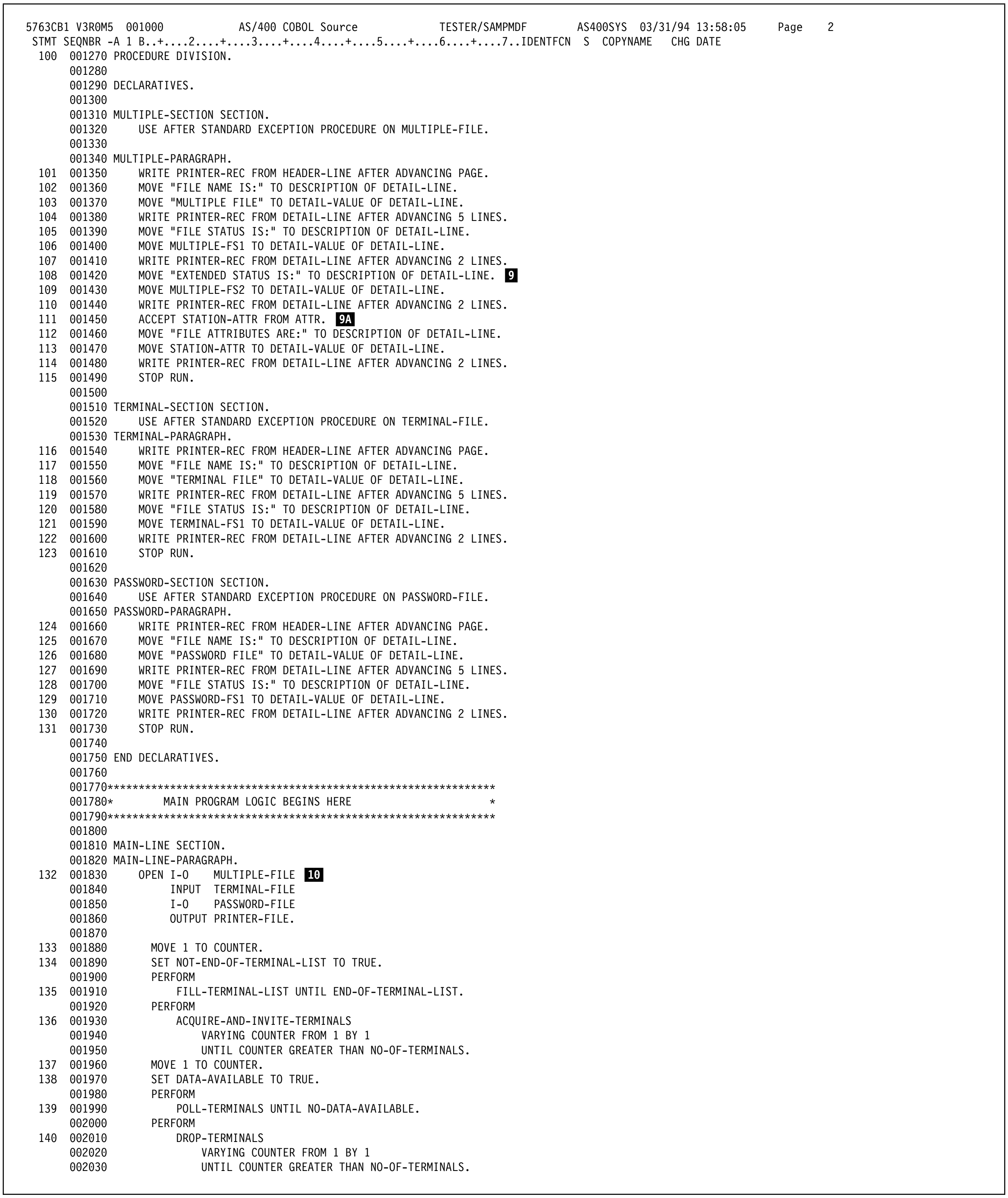
```
  5763CB1 V3R0M5  001000            AS/400 COBOL Source            TESTER/SAMPMDF        AS400SYS  03/31/94 13:58:05     Page    2
   STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
      1  000010 IDENTIFICATION DIVISION.
      2  000020 PROGRAM-ID.     SAMPMDF.
      3  000030   AUTHOR.       PROGRAMMER NAME.
         000040
         000050**************************************************************
         000060*  THE FOLLOWING PROGRAM DEMONSTRATES SOME OF THE FUNCTIONS  *
         000070*  AVAILABLE WITH MULTIPLE DEVICE FILE SUPPORT.              *
         000080**************************************************************
         000090
      4  000100   INSTALLATION. COBOL DEVELOPMENT CENTRE.
      5  000110   DATE-WRITTEN. 02/02/87.
      6  000120   DATE-COMPILED.  03/31/94 13:58:05   .
      7  000130 ENVIRONMENT DIVISION.
      8  000140 CONFIGURATION SECTION.
      9  000150 SOURCE-COMPUTER. IBM-AS400.
     10  000160 OBJECT-COMPUTER. IBM-AS400.
     11  000170 SPECIAL-NAMES.  ATTRIBUTE-DATA IS ATTR.  1
     12  000180 INPUT-OUTPUT SECTION.
     13  000190 FILE-CONTROL.
     14  000200     SELECT MULTIPLE-FILE
     15  000210     ASSIGN TO WORKSTATION-MULT
     16  000220     ORGANIZATION IS TRANSACTION  2
     17  000230     ACCESS MODE IS SEQUENTIAL
     18  000240     FILE STATUS IS MULTIPLE-FS1, MULTIPLE-FS2  3
     19  000250     CONTROL-AREA IS MULTIPLE-CONTROL-AREA.
         000260                              4
     20  000270     SELECT TERMINAL-FILE
     21  000280     ASSIGN TO DATABASE-TERM
     22  000290     ORGANIZATION IS SEQUENTIAL
     23  000300     ACCESS IS SEQUENTIAL
     24  000310     FILE STATUS IS TERMINAL-FS1.
         000320
     25  000330     SELECT PASSWORD-FILE
     26  000340     ASSIGN TO DATABASE-PASSWORD
     27  000350     ORGANIZATION IS INDEXED
     28  000360     RECORD KEY IS EXTERNALLY-DESCRIBED-KEY
     29  000370     ACCESS MODE IS RANDOM
     30  000380     FILE STATUS IS PASSWORD-FS1.
         000390
     31  000400     SELECT PRINTER-FILE
     32  000410     ASSIGN TO PRINTER-QPRINT.
     33  000420 DATA DIVISION.
     34  000430 FILE SECTION.
     35  000440 FD  MULTIPLE-FILE.
     36  000450 01  MULTIPLE-REC. COPY DDS-SIGNON OF MULT.  5
     37 +000001       05  MULT-RECORD PIC X(20).                                    SIGNON
        +000002*  INPUT FORMAT:SIGNON     FROM FILE MULT       OF LIBRARY TESTER             SIGNON
        +000003*                                                                     SIGNON
     38 +000004       05  SIGNON-I      REDEFINES MULT-RECORD.                       SIGNON
     39 +000005           06 PASSWORD             PIC X(10).  6                  SIGNON
        +000006* OUTPUT FORMAT:SIGNON     FROM FILE MULT       OF LIBRARY TESTER             SIGNON
        +000007*                                                                     SIGNON
     40 +000008       05  SIGNON-O      REDEFINES MULT-RECORD.                       SIGNON
     41 +000009           06 WRONG                PIC X(20).                         SIGNON
         000460
     42  000470 FD  TERMINAL-FILE.
     43  000480 01  TERMINAL-REC. COPY DDS-ALL-FORMATS OF TERM.
     44 +000001       05  TERM-RECORD PIC X(10).                                    <-ALL-FMTS
        +000002*    I-O FORMAT:TERM       FROM FILE TERM       OF LIBRARY TESTER             <-ALL-FMTS
        +000003*                                                                     <-ALL-FMTS
     45 +000004       05  TERM          REDEFINES TERM-RECORD.                       <-ALL-FMTS
     46 +000005           06 TERM                 PIC X(10).                         <-ALL-FMTS
         000490
     47  000500 FD  PASSWORD-FILE.
     48  000510 01  PASSWORD-REC. COPY DDS-ALL-FORMATS OF PASSWORD.
     49 +000001       05  PASSWORD-RECORD PIC X(20).                                <-ALL-FMTS
        +000002*    I-O FORMAT:PASSWORDS  FROM FILE PASSWORD   OF LIBRARY TESTER             <-ALL-FMTS
        +000003*                                                                     <-ALL-FMTS
        +000004*THE KEY DEFINITIONS FOR RECORD FORMAT  PASSWORDS                     <-ALL-FMTS
        +000005*  NUMBER              NAME              RETRIEVAL     TYPE    ALTSEQ       <-ALL-FMTS
        +000006*   0001   PASSKEY                        ASCENDING      AN      NO         <-ALL-FMTS
     50 +000007       05  PASSWORDS     REDEFINES PASSWORD-RECORD.                   <-ALL-FMTS
     51 +000008           06 PASSKEY              PIC X(10).                         <-ALL-FMTS
     52 +000009           06 PASSWORD             PIC X(10).                         <-ALL-FMTS
         000520
```

Figure 65 (Part 1 of 4). COBOL Source Listing for Multiple Device File Support



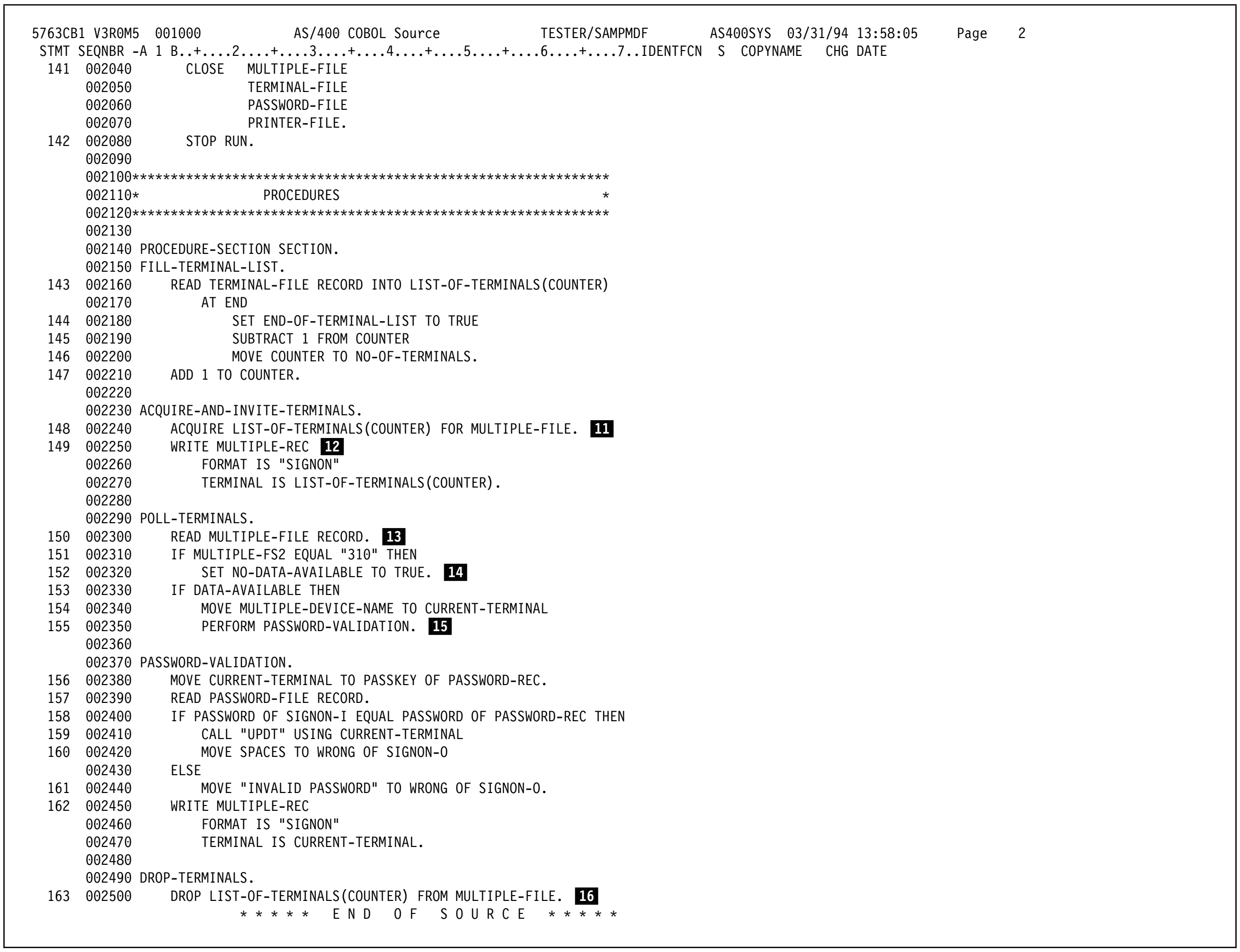
```
 5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/SAMPMDF        AS400SYS  03/31/94 13:58:05     Page    2
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    53  000530 FD  PRINTER-FILE.
    54  000540 01  PRINTER-REC.
    55  000550    05 PRINTER-RECORD        PIC X(132).
        000560
    56  000570 WORKING-STORAGE SECTION.
        000580
        000590**************************************************************
        000600*       DECLARE THE FILE STATUS FOR EACH FILE                *
        000610**************************************************************
        000620
    57  000630 01  MULTIPLE-FS1            PIC X(2)    VALUE SPACES.
    58  000640 01  MULTIPLE-FS2.  7
    59  000650    05  MULTIPLE-MAJOR       PIC X(2)    VALUE SPACES.
    60  000660    05  MULTIPLE-MINOR       PIC X(2)    VALUE SPACES.
    61  000670 01  TERMINAL-FS1            PIC X(2)    VALUE SPACES.
    62  000680 01  PASSWORD-FS1            PIC X(2)    VALUE SPACES.
        000690
        000700**************************************************************
        000710*       DECLARE STRUCTURE FOR HOLDING FILE ATTRIBUTES        *
        000720**************************************************************
        000730
    63  000740 01  STATION-ATTR.
    64  000750    05 STATION-TYPE          PIC X(1).   8
    65  000760    05 STATION-SIZE          PIC X(1).
    66  000770    05 STATION-LOC           PIC X(1).
    67  000780    05 FILLER                PIC X(1).
    68  000790    05 STATION-ACQUIRE       PIC X(1).
    69  000800    05 STATION-INVITE        PIC X(1).
    70  000810    05 STATION-DATA          PIC X(1).
    71  000820    05 STATION-STATUS        PIC X(1).
    72  000830    05 STATION-DISPLAY       PIC X(1).
    73  000840    05 STATION-KEYBOARD      PIC X(1).
    74  000850    05 STATION-SIGNON        PIC X(1).
    75  000860    05 FILLER                PIC X(5).
        000870
        000880**************************************************************
        000890*       DECLARE THE CONTROL AREA FOR MULTIPLE-FILE           *
        000900**************************************************************
        000910
    76  000920 01  MULTIPLE-CONTROL-AREA.
    77  000930    05 MULTIPLE-KEY-FEEDBACK PIC X(2)    VALUE SPACES.
    78  000940    05 MULTIPLE-DEVICE-NAME  PIC X(10)   VALUE SPACES.
    79  000950    05 MULTIPLE-FORMAT-NAME  PIC X(10)   VALUE SPACES.
        000960
        000970**************************************************************
        000980*               DECLARE ERROR REPORT VARIABLES               *
        000990**************************************************************
        001000
    80  001010 01  HEADER-LINE.
    81  001020    05 FILLER                PIC X(60)   VALUE SPACES.
    82  001030    05 FILLER                PIC X(72)
    83  001040                              VALUE "MDF ERROR REPORT".
    84  001050 01  DETAIL-LINE.
    85  001060    05 FILLER                PIC X(15)   VALUE SPACES.
    86  001070    05 DESCRIPTION           PIC X(25)   VALUE SPACES.
    87  001080    05 DETAIL-VALUE          PIC X(92)   VALUE SPACES.
        001090
        001100**************************************************************
        001110*        DECLARE COUNTERS, FLAGS AND STORAGE VARIABLES       *
        001120**************************************************************
        001130
    88  001140 01  CURRENT-TERMINAL        PIC X(10)   VALUE SPACES.
    89  001150 01  TERMINAL-ARRAY.
    90  001160    05 LIST-OF-TERMINALS OCCURS 250 TIMES.
    91  001170      07 DEVICE-NAME         PIC X(10).
    92  001180 01  COUNTER                 PIC 9(3)    VALUE IS 1.
    93  001190 01  NO-OF-TERMINALS         PIC 9(3)    VALUE IS 1.
    94  001200 01  TERMINAL-LIST-FLAG      PIC 1.
    95  001210    88 END-OF-TERMINAL-LIST              VALUE IS B"1".
    96  001220    88 NOT-END-OF-TERMINAL-LIST          VALUE IS B"0".
    97  001230 01  NO-DATA-FLAG            PIC 1.
    98  001240    88 NO-DATA-AVAILABLE                 VALUE IS B"1".
    99  001250    88 DATA-AVAILABLE                    VALUE IS B"0".
        001260
```

Figure 65 (Part 2 of 4). COBOL Source Listing for Multiple Device File Support



```
 5763CB1 V3R0M5  001000            AS/400 COBOL Source            TESTER/SAMPMDF        AS400SYS  03/31/94 13:58:05     Page    2
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   100  001270 PROCEDURE DIVISION.
        001280
        001290 DECLARATIVES.
        001300
        001310 MULTIPLE-SECTION SECTION.
        001320     USE AFTER STANDARD EXCEPTION PROCEDURE ON MULTIPLE-FILE.
        001330
        001340 MULTIPLE-PARAGRAPH.
   101  001350     WRITE PRINTER-REC FROM HEADER-LINE AFTER ADVANCING PAGE.
   102  001360     MOVE "FILE NAME IS:" TO DESCRIPTION OF DETAIL-LINE.
   103  001370     MOVE "MULTIPLE FILE" TO DETAIL-VALUE OF DETAIL-LINE.
   104  001380     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 5 LINES.
   105  001390     MOVE "FILE STATUS IS:" TO DESCRIPTION OF DETAIL-LINE.
   106  001400     MOVE MULTIPLE-FS1 TO DETAIL-VALUE OF DETAIL-LINE.
   107  001410     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
   108  001420     MOVE "EXTENDED STATUS IS:" TO DESCRIPTION OF DETAIL-LINE.  9
   109  001430     MOVE MULTIPLE-FS2 TO DETAIL-VALUE OF DETAIL-LINE.
   110  001440     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
   111  001450     ACCEPT STATION-ATTR FROM ATTR.  9A
   112  001460     MOVE "FILE ATTRIBUTES ARE:" TO DESCRIPTION OF DETAIL-LINE.
   113  001470     MOVE STATION-ATTR TO DETAIL-VALUE OF DETAIL-LINE.
   114  001480     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
   115  001490     STOP RUN.
        001500
        001510 TERMINAL-SECTION SECTION.
        001520     USE AFTER STANDARD EXCEPTION PROCEDURE ON TERMINAL-FILE.
        001530 TERMINAL-PARAGRAPH.
   116  001540     WRITE PRINTER-REC FROM HEADER-LINE AFTER ADVANCING PAGE.
   117  001550     MOVE "FILE NAME IS:" TO DESCRIPTION OF DETAIL-LINE.
   118  001560     MOVE "TERMINAL FILE" TO DETAIL-VALUE OF DETAIL-LINE.
   119  001570     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 5 LINES.
   120  001580     MOVE "FILE STATUS IS:" TO DESCRIPTION OF DETAIL-LINE.
   121  001590     MOVE TERMINAL-FS1 TO DETAIL-VALUE OF DETAIL-LINE.
   122  001600     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
   123  001610     STOP RUN.
        001620
        001630 PASSWORD-SECTION SECTION.
        001640     USE AFTER STANDARD EXCEPTION PROCEDURE ON PASSWORD-FILE.
        001650 PASSWORD-PARAGRAPH.
   124  001660     WRITE PRINTER-REC FROM HEADER-LINE AFTER ADVANCING PAGE.
   125  001670     MOVE "FILE NAME IS:" TO DESCRIPTION OF DETAIL-LINE.
   126  001680     MOVE "PASSWORD FILE" TO DETAIL-VALUE OF DETAIL-LINE.
   127  001690     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 5 LINES.
   128  001700     MOVE "FILE STATUS IS:" TO DESCRIPTION OF DETAIL-LINE.
   129  001710     MOVE PASSWORD-FS1 TO DETAIL-VALUE OF DETAIL-LINE.
   130  001720     WRITE PRINTER-REC FROM DETAIL-LINE AFTER ADVANCING 2 LINES.
   131  001730     STOP RUN.
        001740
        001750 END DECLARATIVES.
        001760
        001770*************************************************************
        001780*        MAIN PROGRAM LOGIC BEGINS HERE                     *
        001790*************************************************************
        001800
        001810 MAIN-LINE SECTION.
        001820 MAIN-LINE-PARAGRAPH.
   132  001830     OPEN I-O    MULTIPLE-FILE  10
        001840          INPUT  TERMINAL-FILE
        001850          I-O    PASSWORD-FILE
        001860          OUTPUT PRINTER-FILE.
        001870
   133  001880       MOVE 1 TO COUNTER.
   134  001890       SET NOT-END-OF-TERMINAL-LIST TO TRUE.
        001900       PERFORM
   135  001910           FILL-TERMINAL-LIST UNTIL END-OF-TERMINAL-LIST.
        001920       PERFORM
   136  001930           ACQUIRE-AND-INVITE-TERMINALS
        001940               VARYING COUNTER FROM 1 BY 1
        001950               UNTIL COUNTER GREATER THAN NO-OF-TERMINALS.
   137  001960       MOVE 1 TO COUNTER.
   138  001970       SET DATA-AVAILABLE TO TRUE.
        001980       PERFORM
   139  001990           POLL-TERMINALS UNTIL NO-DATA-AVAILABLE.
        002000       PERFORM
   140  002010           DROP-TERMINALS
        002020               VARYING COUNTER FROM 1 BY 1
        002030               UNTIL COUNTER GREATER THAN NO-OF-TERMINALS.
```

Figure 65 (Part 3 of 4). COBOL Source Listing for Multiple Device File Support



```
 5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/SAMPMDF       AS400SYS  03/31/94 13:58:05     Page    2
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   141  002040       CLOSE   MULTIPLE-FILE
        002050               TERMINAL-FILE
        002060               PASSWORD-FILE
        002070               PRINTER-FILE.
   142  002080       STOP RUN.
        002090
        002100**************************************************************
        002110*                PROCEDURES                                  *
        002120**************************************************************
        002130
        002140 PROCEDURE-SECTION SECTION.
        002150 FILL-TERMINAL-LIST.
   143  002160     READ TERMINAL-FILE RECORD INTO LIST-OF-TERMINALS(COUNTER)
        002170         AT END
   144  002180             SET END-OF-TERMINAL-LIST TO TRUE
   145  002190             SUBTRACT 1 FROM COUNTER
   146  002200             MOVE COUNTER TO NO-OF-TERMINALS.
   147  002210     ADD 1 TO COUNTER.
        002220
        002230 ACQUIRE-AND-INVITE-TERMINALS.
   148  002240     ACQUIRE LIST-OF-TERMINALS(COUNTER) FOR MULTIPLE-FILE.  11
   149  002250     WRITE MULTIPLE-REC  12
        002260         FORMAT IS "SIGNON"
        002270         TERMINAL IS LIST-OF-TERMINALS(COUNTER).
        002280
        002290 POLL-TERMINALS.
   150  002300     READ MULTIPLE-FILE RECORD.  13
   151  002310     IF MULTIPLE-FS2 EQUAL "310" THEN
   152  002320         SET NO-DATA-AVAILABLE TO TRUE.  14
   153  002330     IF DATA-AVAILABLE THEN
   154  002340         MOVE MULTIPLE-DEVICE-NAME TO CURRENT-TERMINAL
   155  002350         PERFORM PASSWORD-VALIDATION.  15
        002360
        002370 PASSWORD-VALIDATION.
   156  002380     MOVE CURRENT-TERMINAL TO PASSKEY OF PASSWORD-REC.
   157  002390     READ PASSWORD-FILE RECORD.
   158  002400     IF PASSWORD OF SIGNON-I EQUAL PASSWORD OF PASSWORD-REC THEN
   159  002410         CALL "UPDT" USING CURRENT-TERMINAL
   160  002420         MOVE SPACES TO WRONG OF SIGNON-O
        002430     ELSE
   161  002440         MOVE "INVALID PASSWORD" TO WRONG OF SIGNON-O.
   162  002450     WRITE MULTIPLE-REC
        002460         FORMAT IS "SIGNON"
        002470         TERMINAL IS CURRENT-TERMINAL.
        002480
        002490 DROP-TERMINALS.
   163  002500     DROP LIST-OF-TERMINALS(COUNTER) FROM MULTIPLE-FILE.  16
                            * * * * *   E N D   O F   S O U R C E   * * * * *
```

Figure 65 (Part 4 of 4). COBOL Source Listing for Multiple Device File Support

Device File Attributes

1 ATTR is the mnemonic-name associated with the function-name ATTRIBUTE-DATA. ATTR is used in the ACCEPT statement to obtain attribute data for the TRANSACTION file MULTIPLE-FILE. See item **9A**.

2 File MULT must have been created using the CRTDSPF command, where the DEV parameter has a value of *NONE and the MAXDEV parameter has a value greater than 1. The WAITRCD parameter specifies the wait time for READ operations on the file. The WAITRCD parameter must have a value greater than 0.

3 MULTIPLE-FS2 is the extended file status for the TRANSACTION file MULTIPLE-FILE. This variable has been declared in the WORKING-STORAGE section of the program. See item **7**.

4 MULTIPLE-CONTROL-AREA is the control area for the TRANSACTION file MULTIPLE-FILE. This variable is used to determine which program device was used to sign on. See item **15**.

5 The data description for MULTIPLE-REC has been defined using the COPY DDS statement.

Note: Only the fields that are copied are named fields. Refer to the DDS of this example for comments regarding the DDS used.

6 Format SIGNON is the format with the INVITE keyword. This is the format that will be used to invite devices via the WRITE statement.

7 This is the declaration for the extended file-status MULTIPLE-FS2. It is a 4-byte field that is subdivided into a major return code (first 2 bytes) and a minor return code (last 2 bytes).

8 STATION-ATTR is where the ACCEPT statement contains the attribute data for the TRANSACTION file MULTIPLE-FILE. See item **9A** .

9 In this statement, the extended file status MULTIPLE-FS2 is being written.

9A This is an example of accepting attribute-data for the TRANSACTION file MULTIPLE-FILE. Because there is no interest in a specific program device, but rather the last program device used, the FOR phrases are not used with the ACCEPT.

10 This statement opens the TRANSACTION file MULTIPLE-FILE. Because the ACQPGMDEV parameter of the CRTDSPF command has the value *NONE, no program devices are implicitly acquired when this file is opened.

11 This statement acquires the program device contained in the variable LIST-OF-TERMINALS (COUNTER), for the TRANSACTION file MULTIPLE-FILE.

12 This WRITE statement is inviting the program device specified in the TERMINAL phrase. The format SIGNON has the DDS keyword INVITE associated with it. Refer to item **13** .

13 This READ statement will read from any invited program device. See item **12** . If the wait time expires before anyone inputs to the invited devices, the extended file status will be set to “0310” and processing will continue. See item **14** .

14 In this statement, the extended file status for MULTIPLE-FILE is being checked to see if the wait time expired.

15 The program device name stored in the control area is used to determine which program device was used to sign on. See item **4** .

16 This DROP statement detaches the program device contained in the variable LIST-OF-TERMINALS from the TRANSACTION file MULTIPLE-FILE.

Environment Division

File-Control Entry

The TRANSACTION file must be named by a file-control entry in the FILE-CONTROL paragraph. This entry also specifies other information related to the file.

Format

```
                                          *************************
                                          *  ┌──────────────────┐ *
                                          *  │                  │ *
                                          **▼*******************│**
►►──SELECT──file-name───ASSIGN──┬────┬─────┬─assignment-name-1─┬──────────────────►
                                └─TO─┘     └─literal-1─────────┘


►──┬──────────────────────────┬─TRANSACTION──────────────────────────────────────►
   └─ORGANIZATION─┬────┬──────┘
                  └─IS─┘

►──┬─────────────────────────────────────────────────────────────────────────┬──►
   └─ACCESS─┬──────┬──┬────┬──┬─SEQUENTIAL───────────────────────────────────┤
            └─MODE─┘  └─IS─┘  └─DYNAMIC───RELATIVE─┬─────┬──┬────┬─data-name-3─┘
                                                   └─KEY─┘  └─IS─┘

►──┬──────────────────────────────────────────────────────────────┬──────────────►
   └─┬──────┬─STATUS─┬────┬─data-name-1─┬───────────────────┬─────┘
     └─FILE─┘        └─IS─┘             └─────data-name-5───┘

►──┬────────────────────────────────────────┬─────.──────────────────────────►◄
   └─CONTROL-AREA─┬────┬─data-name-6─────────┘
                  └─IS─┘
```

ASSIGN Clause

The ASSIGN clause associates the TRANSACTION file with a display file or ICF file through the use of assignment-name-1.

Assignment-name-1 has the following structure:

Format

```
►►──ASSIGN──┬────┬──WORKSTATION─── -file-name──┬───────┬──────────────►◄
            └─TO─┘                              └─  ─SI─┘
```

Device specifies the type of device associated with the file. The value must be WORKSTATION.

The AS/400 file name is a one-to-ten character external name of the display file or ICF file specified on the create device file commands, CRTDSPF or CRTICFF.

The attribute -SI is used to specify the file level option for a separate indicator area. See “Using Indicators with Transaction Files” on page 142 for further details.

The second and subsequent assignment-names are syntax-checked, but are treated as documentation.

ORGANIZATION Clause

The ORGANIZATION clause specifies the logical structure of a file. TRANSACTION organization signifies interaction between the program and either a work station user or another system.

TRANSACTION Organization: TRANSACTION processing is defined as the random arrival of a record from one of multiple possible sources followed by appropriate processing, and finally, by the output of results or feedback information of some type to the source of the record.

In some cases, all records are homogeneous; that is, a logical transaction is completed with one exchange of records. In other situations, a series of records is passed back and forth in a logical progression with various record types either being selected by the initiator or as part of the processing based on input data values.

Each transaction can be processed by a different program, or multiple transactions can be processed by the same program, depending on the system environment.

The initiation of a transaction can cause a program to be scheduled to process the transaction.

A transaction can consist of a series of alternating requests and responses (a dialogue). Each request and response can consist of multiple logical records.

ACCESS MODE Clause

For files with TRANSACTION organization, the access mode can be SEQUENTIAL or DYNAMIC.

Note: **Dynamic processing** is a method of reading from or writing to a file in a nonsequential order and reading from a file in a sequential order with the same OPEN statement.

When ACCESS IS SEQUENTIAL is specified or implied, the format name contained in the format name field of the control area specifies which record was accessed. When ACCESS IS SEQUENTIAL is specified for a TRANSACTION file, do not specify the RELATIVE KEY data item.

When ACCESS IS DYNAMIC is specified, records in the file can be accessed sequentially or randomly, depending on the form of the specific input/output request. Random accessing of a TRANSACTION file is only valid if subfile processing is being performed. For subfile processing, you *must* specify ACCESS IS DYNAMIC.

RELATIVE KEY Clause

The RELATIVE KEY clause specifies the relative record number for a specific record in a subfile. The RELATIVE KEY data item, data-name-3, must be defined as an unsigned integer and cannot be scaled. Also, the data item must not be defined in a record description entry associated with the TRANSACTION file.

FILE STATUS Clause

Data-name-5 identifies the extended-file-status data item, which contains major and minor return codes. These major and minor return codes can, in some cases, indicate I/O errors when the file status code does not. After an I/O operation is performed on an unopened file, the extended file status will have a value of zeros.

For more information about the FILE STATUS clause, refer to “File Status and Feedback Areas” on page 103. General considerations about the FILE STATUS clause and data-name-1 are described in Part 2 of the *COBOL/400 Reference* in the section, “FILE STATUS Clause.”

For information about the role of file status in error handling, refer to Chapter 6, “COBOL/400 Exception and Error Handling” on page 69.

Data-name-5 must be defined in the Data Division as a 4-byte alphanumeric data item, and must *not* be defined in the File Section. The first 2 bytes of the extended-file-status data item contain the major return code, and the second 2 bytes contain the minor return code. Return codes are moved into data-name-5 after any input or output operation (except the ACCEPT or CLOSE statement) on the TRANSACTION file. The values placed in data-name-5 can also be accessed by the ACCEPT statement using the I-O-FEEDBACK function-name. For more information about the major and minor return codes, see the *Data Management Guide* and the *ICF Programmer’s Guide*.

CONTROL-AREA Clause

The CONTROL-AREA clause specifies device-dependent and system-dependent information that is used to control input/output operations for TRANSACTION files.

Data-name-6 is a CONTROL-AREA data item that must be defined in the LINKAGE SECTION or WORKING-STORAGE SECTION. Data-name-6 is assumed to have the following format:

```
01   data-name-6.
     02   function-key PIC X(2).
               (Function key feedback field)
     02   device-name PIC X(10).
               (Program device name)
     02   record-format PIC X(10).
               (Record format)
```

Data-name-6 must be 2, 12, or 22 characters long. Based upon the length of data-name-6, the compiler assumes the availability of key feedback bytes, the program device name, and record format.

Programming Note: For an ICF file, the actual name of a device may be different from the program device name (data-name-11).

Information is moved into data-name-6 for each READ operation from a file that has been assigned to a WORKSTATION device type. The information is valid only if the READ operation is successfully completed (provided the wait time has not expired). The information is in the fixed format as shown in the following example:

```
 FILE-CONTROL.
 SELECT SCREEN-FILE
     ASSIGN TO WORKSTATION-MYFMTS
     ORGANIZATION IS TRANSACTION
     CONTROL-AREA IS
      TRANSACTION-CONTROL-AREA.
⋮
 WORKING-STORAGE SECTION.
 01  TRANSACTION-CONTROL-AREA.
*    FEEDBACK ITEM
     02  FUNCTION-KEY  PIC XX.
     02  TERMINAL-ID   PIC X(10).
     02  FORMAT-NAME   PIC X(10).
```

Each field in the TRANSACTION-CONTROL-AREA data item in the example is described as follows:

- FUNCTION-KEY: A two-digit number inserted in the field by the work station interface that identifies the function key the operator pressed to initiate the transaction. The codes are as follows:

00	Enter key
01-24	Function keys 1 through 24
90	Roll Up/Page Down key
91	Roll Down/Page Up key
92	Print key
93	Help key
94	Clear key
95	Home key
99	Undefined

  Any function keys for which feedback information is desired must be defined for the display file using DDS.
- TERMINAL-ID: The *program device name.*
- FORMAT-NAME: The DDS record format name that was referenced by the last I/O statement run.

Data Division

File Description Entry

A file description entry consists of a level indicator (FD), a file name, and a series of independent clauses. For a TRANSACTION file, the independent clauses allowed are the RECORD CONTAINS clause, the LABEL RECORDS clause, and the DATA RECORDS clause.

Format

```
►►──FD──file-name────────────────────────────────────────────────────────►

►──┬─────────────────────────────────────────────────────────────────┬──►
   └─RECORD─┬──────────┬─┬─────────────────┬─integer-4─┬────────────┬┘
            └─CONTAINS─┘ └─integer-3 TO────┘           └─CHARACTERS─┘

►──┬────────────────────────────────────────────────┬────────────────────►
   │ ********************************************** │
   └───LABEL──┬─RECORD──┬──────┬──┬─┬─STANDARD─┬────┘
     *        │         └─IS─┘    │ └─OMITTED──┘  *
     *        └─RECORDS─┬───────┬─┘                *
     *                  └─ARE─┘                    *
     **********************************************

►──┬───────────────────────────────────────────────────┬─.──────────────►◄
   │                                ┌─────────────────┐ │
   │                                ▼                 │ │
   └─DATA──┬─RECORD──┬──────┬──┬──────data-name-2────┴─┘
           │         └─IS─┘    │
           └─RECORDS─┬──────┬──┘
                     └─ARE─┘
```

The LABEL RECORDS clause specifies whether or not labels are present. This clause is required in every file description entry. This clause is syntax-checked, but is treated as documentation.

Boolean Data Items

The use of Boolean data and the use of indicators are described under “Data Description Entry–Boolean Data” on page 144.

Procedure Division

Procedure Division Concepts

The COBOL/400 language provides a number of extensions to PROCEDURE DIVISION statements to support TRANSACTION processing. The sections that follow describe the statements involved and their usage.

ACCEPT Statement

The ACCEPT statement retrieves information (attribute data) about a particular program device associated with a TRANSACTION file.

ACCEPT Statement – Format 6 – Attribute Data

```
►►──ACCEPT───identifier-1───FROM───mnemonic-name──────────────────────────►

►──┬────────────────────────────────────────────────────────┬──────────────►◄
   └─FOR──┬─identifier-2─┬──┬─────────────────────────┬──┘
          └─literal-1────┘  └─FOR──file-name-1────────┘
```

This format of the ACCEPT statement can only be used for files with an organization of TRANSACTION. Mnemonic-name must be associated with the function-name ATTRIBUTE-DATA in the SPECIAL-NAMES paragraph.

If file-name is not specified, the default file for the ACCEPT statement is the first TRANSACTION file specified in a SELECT clause of the FILE-CONTROL paragraph.

Literal-1 or the contents of identifier-2, if specified, indicates the program device name for which attribute data is made available. This device must be defined by a CRTDSPF, ADDICFDEVE, or OVRICFDEVE CL command. The device does not actually have to be acquired. Literal-1, if specified, must be nonnumeric and 10 characters or fewer in length. The contents of identifier-2, if specified, must be an alphanumeric data item 10 characters or fewer in length. If an incorrect program device name is specified, or if the file is not open at the time the ACCEPT statement is processed, message LBE7205

```
ACCEPT ATTRIBUTE-DATA statement has failed (C D F).
```

is issued and processing terminates.

If both FOR phrases are omitted (indicating the default TRANSACTION file is being used), the ACCEPT statement uses the program device from which a READ, WRITE, REWRITE, or ACCEPT (Attribute Data) operation on the default file was most recently performed. If the only prior operation on the file was an OPEN, the ACCEPT statement uses the program device implicitly acquired by the file when the file was opened. When both FOR phrases are omitted, a program device must have been acquired to use this particular format of the ACCEPT statement.

Program device attributes are moved into identifier-1 from the appropriate attribute data format, according to the rules for a group MOVE without the CORRESPONDING phrase.

You can make use of multiple display files along with ordinary files in a program that includes an Extended ACCEPT or Extended DISPLAY statement. (See the *COBOL/400 Reference* for more information.)

Attribute Data Formats

The attribute data retrieved by the ACCEPT statement has two different formats, depending if the data is for a work station or for a communications device.

The ATTRIBUTE-DATA mnemonic name can be used *only* to obtain information about a program device for a TRANSACTION file. Attribute data does *not* provide information about the status of a completed or attempted I/O operation. To obtain information about I/O operations, use the Format 3 ACCEPT statement with the I-O-FEEDBACK or OPEN-FEEDBACK mnemonic names. For more information about these mnemonic names, see the “SPECIAL NAMES Paragraph” section of the *COBOL/400 Reference*.

ACQUIRE Statement

The ACQUIRE statement acquires a program device for a TRANSACTION file.

ACQUIRE Statement – TRANSACTION File

```
►►──ACQUIRE──┬─identifier─┬──FOR──file-name──────────────────────────────►◄
             └─literal────┘
```

Literal or the contents of identifier indicates the program device name to be acquired by the specified file. Literal, if specified, must be nonnumeric and 10 characters or fewer in length. Identifier, if specified, must refer to an alphanumeric data item 10 characters or fewer in length.

File-name must be the name of a file with an organization of TRANSACTION, and the file must be open when the ACQUIRE statement is run. A compilation error message is issued if the organization is not TRANSACTION.

For a description of conditions that must be met before a communications device can be acquired, see the *ICF Programmer’s Guide*. For more information about the requirements for displays, see the *Data Management Guide*.

Successful completion of the ACQUIRE operation makes the program device available for input and output operations.

If the ACQUIRE operation is unsuccessful, the file status value is set to 9H and the USE AFTER EXCEPTION/ERROR procedure is called (if specified). For more information, refer to Chapter 6, “COBOL/400 Exception and Error Handling.”

Only one program device can be implicitly acquired when a file is opened. If a file is an ICF file, the single implicitly acquired program device is determined by the ACQPGMDEV parameter of the CRTICFF command. If the file is a display file, the single implicitly acquired program device is determined by the first entry in the DEV parameter of the CRTDSPF command. Additional program devices *must* be explicitly acquired.

A program device is explicitly acquired by using the ACQUIRE statement. For an ICF file, that device must have been defined to the file with the ADDICFDEVE or OVRICFDEVE CL command before the file was opened. For display files there is no such requirement. That is, the device named in the ACQUIRE statement does not have to be specified in the DEV parameter of the CRTDSPF command, the CHGDSPF command, or the OVRDSPF command. For a display file, the program device name must match the display device.

The ACQUIRE statement can also be used as an aid in recovering from I/O errors. For more information, see the “ACQUIRE Statement” section of the *COBOL/400 Reference*.

For more information about these commands, see the *CL Reference*.

CLOSE Statement

The CLOSE statement terminates the processing of volumes and files, with optional lock where applicable.

CLOSE Statement – Format 3 – TRANSACTION File

```
            ┌───────────────────────────────┐
            ↓                               │
►►──CLOSE──file-name-1──┬───────────────────┼──────────────────────────────►◄
                        └──┬──────┬──LOCK───┘
                           └─WITH─┘
```

For a detailed discussion of the CLOSE statement, see the “CLOSE Statement” section of the *COBOL/400 Reference*.

DROP Statement

The DROP statement releases a program device that has been acquired by a TRANSACTION file.

DROP Statement

```
►►──DROP──┬─identifier─┬──FROM──file-name──────────────────────────────►◄
          └─literal────┘
```

Literal or the contents of identifier indicates the program device name of the device to be dropped. Literal, if specified, must be nonnumeric and 10 characters or fewer in length. Identifier, if specified, must refer to an alphanumeric data item, 10 characters or fewer in length.

File-name must refer to a file with an organization of TRANSACTION, and the file must be open to be used in the DROP statement. If no DROP statement is issued, program devices attached to a TRANSACTION file are implicitly released when that file is finally closed.

Program devices specified in a DROP statement must have been acquired by the TRANSACTION file, either through an explicit ACQUIRE or through an implicit ACQUIRE at OPEN time.

After successful running of the DROP statement, the program device is no longer available for input or output operations through the TRANSACTION file. The device can be reacquired if necessary. The contents of the record area associated with a released program device are no longer available, even if the device is reacquired.

If the DROP operation is unsuccessful, the USE AFTER EXCEPTION/ERROR procedure is processed (if specified). For more information, refer to Chapter 6, “COBOL/400 Exception and Error Handling.”

The DROP statement can also be used as an aid in recovering from I/O errors. For more information, see the “DROP Statement” section of the *COBOL/400 Reference*.

OPEN Statement

The OPEN statement initiates the processing of files.

OPEN Statement – Format 3 – TRANSACTION Files

```
              ┌───────────┐
              ▼           │
►►───OPEN I-O──file-name──┴────────────────────────────────────►◄
```

A TRANSACTION file must be opened in the I/O mode. For a further discussion of the OPEN statement, see the *COBOL/400 Reference*.

The OPEN statement can cause a program device to be implicitly acquired for a TRANSACTION file. For a further discussion about the acquiring of program devices, see the “ACQUIRE Statement” on page 178.

Common Processing Facilities

The following discussion on FORMAT, INDICATORS, SUBFILE, and TERMINAL phrases relates to the READ, REWRITE, and WRITE statements.

FORMAT Phrase

The literal or identifier specified must be a character string of 10 characters or fewer in length.

Multiple data records, each with a different format, can be concurrently active for a TRANSACTION file. If the FORMAT phrase is specified, it must specify a valid format name that is defined to the system, and the I/O operation must be performed on a data record of the same format. If the format is an invalid name or if it does not exist, the FILE STATUS data item, if specified, is set to a value of 9K and the contents of the record area are undefined.

DB-FORMAT-NAME Special Register: After the running of an input/output statement for a TRANSACTION file, the DB-FORMAT-NAME special register is modified according to the following rules:

- If the input/output operation is successful, the record format name is implicitly moved to the special register after completion of the input/output operation.
- If the input/output operation is unsuccessful, DB-FORMAT-NAME contains the record format name used in the last successful input/output operation.

When the FORMAT phrase is not specified, DB-FORMAT-NAME can be used if the file contains a default record format name. The default value is always moved to the DB-FORMAT-NAME special register.

DB-FORMAT-NAME is implicitly defined as PICTURE X(10).

INDICATORS Phrase

The identifier specified in the INDICATORS phrase must be either an elementary Boolean data item specified without the OCCURS clause or a group item that has elementary Boolean data items subordinate to it.

When a data record is written or rewritten, indicators can be written or rewritten with it. The indicators can control how the record is displayed and the various data management functions.

When a data record is read, indicators can be read with it. The indicators can be used to pass information about the data record and how it was entered into your program.

By defining a format using DDS, you determine what functions are to be controlled by indicators, and which indicators control a particular function.

For detailed information on the INDICATORS phrase, refer to “Using Indicators with Transaction Files” on page 142.

SUBFILE Phrase

When the SUBFILE phrase is specified, it indicates that all formats referenced by the statement are subfiles. When SUBFILE is not specified in a TRANSACTION I/O statement, it indicates that none of the formats referenced by the statement are subfiles. This information is not verified at compilation time. If it is specified incorrectly, the subfile is processed as a series of input/output operations directly to the display device. When the specified format name exists as a display file format, the READ/WRITE operations complete successfully.

When SUBFILE is not specified, the RELATIVE KEY data item associated with the file, if specified, is not referenced or changed by the I/O operation.

When SUBFILE is specified, a RELATIVE KEY data item must be defined for the file. Its value is referenced, and sometimes changed, by the I/O operation. See each of the statements associated with SUBFILE operations for a detailed description of when and how the RELATIVE KEY data item is changed.

The SUBFILE phrase can be specified only for display files.

TERMINAL Phrase

When the TERMINAL phrase is specified, it indicates a specific program device is to be used for a READ, WRITE, or REWRITE operation on a TRANSACTION file.

The TERMINAL phrase can be omitted for I/O operations on single device files, because that device is always used.

If the TERMINAL phrase is omitted for an I/O operation on a TRANSACTION file that has acquired multiple program devices, the program device that last attempted a READ, WRITE, REWRITE, ACQUIRE, DROP, or ACCEPT (Attribute Data) operation on the file is used. If the only prior operation on the file was an OPEN, the default program device used is the program device implicitly acquired by the TRANSACTION file when the file was opened. A run-time error message occurs if no program device has been acquired when the file is opened.

For a READ statement with both the TERMINAL phrase and the NO DATA phrase specified, the imperative-statement in the NO DATA phrase is run only if data is not immediately available from the program device specified by the TERMINAL phrase.

If the TERMINAL phrase is specified and the data-item or literal has a value of blanks, the phrase is treated at run time as if it were not specified.

READ Statement

The READ statement makes available a record from a device, using a named format. If the format is a subfile, the READ statement makes available a specified record from that subfile.

READ Statement – Format 4 – TRANSACTION File (Nonsubfile)

```
►►──READ──file-name──┬────────┬───────────────────────────────────────►
                     └─RECORD─┘

►──┬─────────────────────┬────────────────────────────────────────────►
   └──INTO──identifier-1─┘

►──┬────────────────────────────────────┬─────────────────────────────►
   └──FORMAT──┬────┬──┬─identifier-2─┬──┘
              └─IS─┘  └─literal-1────┘

►──┬──────────────────────────────────────┬───────────────────────────►
   └──TERMINAL──┬────┬──┬─identifier-3─┬──┘
                └─IS─┘  └─literal-2────┘

►──┬────────────────────────────────────────┬─────────────────────────►
   └──┬─INDICATOR──┬──┬─────┬──identifier-4─┘
      ├─INDICATORS─┤  ├─IS──┤
      └─INDIC──────┘  └─ARE─┘

►──┬───────────────────────────────────┬──────────────────────────────►
   └──NO DATA──imperative-statement-1──┘

►──┬──────────────────────────────────────┬───────────────────────────►
   └──┬────┬──END──imperative-statement-2─┘
      └─AT─┘

►──┬────────────────────────────────────────────┬──┬──────────┬──────►◄
   └──NOT──┬────┬──END──imperative-statement-3──┘  └─END-READ─┘
           └─AT─┘
```

Format 4 is used only to read a format that is not a subfile. The RELATIVE KEY data item, if specified in the FILE-CONTROL entry, is not used. The Format 4 READ statement is not valid for a subfile record. However, a Format 4 READ statement for the subfile control record format must be used to place those subfile records that were updated on a display into the subfile.

If the requested data is available, it is returned in the record area. The names of the record format and the program device are returned in the I-O-FEEDBACK area in the CONTROL-AREA.

The READ statement is valid only when there are acquired devices for the file. If a READ is processed and there are no acquired devices, the file status is set to 92 (logic error).

The manner in which the Format 4 READ statement functions depends on:

- If the READ is for a single device file or a multiple device file
- If a specific program device has been requested through the TERMINAL phrase
- If a specific record format has been requested through the FORMAT phrase
- If the NO DATA phrase has been specified.

In the following sections, references to *data available* or *returned* include the situation where only the response indicators are set. This also applies even when a separate indicator area is used and the indicators are not returned in the record area for the file.

The following chart shows the possible combinations of phrases and the function performed for a single device file or a multiple device file. For example, if TERMINAL is N, FORMAT is N, and NO DATA is N, the single device is D and multiple device is A.

Function	**Phrase**	**Y=Yes N=No**
Checked at Compilation	TERMINAL[2]	N N N N Y Y Y Y
	FORMAT[2]	N N Y Y N N Y Y
	NO DATA	N Y N Y N Y N Y
Determined at Run Time	Single Device	D C D B D C D B
	Multiple Device	A A D B D C D B

Codes A through D are explained below:

Code A–Read From Invited Program Device (Multiple Device Files only)

This type of READ receives data from the first invited program device that has data available. Invited program devices are work stations or other communication devices that are invited to send input. The inviting is done by writing to the program device with a format specifying the DDS keyword INVITE. Once an invited program device is actually read from, it is no longer invited. That program device will not be used for input by another READ statement unless reinvited, or unless a READ is directed to it specifying the TERMINAL phrase or FORMAT phrase.

The record format returned from the program device is determined by the system. See the chapter on display device support in the *Data Management Guide* for information on how record format is determined for work stations. See the *ICF Programmer's Guide* for information on the FMTSLT parameter on the ADDICFDEVE and OVRICFDEVE commands.

This READ can be completed without returning any data in the following cases:

- If there are no invited devices.
- If a controlled cancelation of the job occurs. This results in a file status value of 9A and a major/minor return code value of 0309.

[2] If the phrase is specified and the data item or literal is blank, the phrase is treated at run time as if it were not specified.

- If the NO DATA phrase is omitted, and the specified wait time expires. This results in a file status value of 00 and a major/minor return code value of 0310.
- If the specified wait time is the value entered on the WAITRCD parameter for the file.
- If the NO DATA phrase is specified, and no data is immediately available when the READ is processed.

If data is available, it is returned in the record area. The record format is returned in the I-O-FEEDBACK area and in the CONTROL-AREA. For more information about “Reading from Invited Program Devices,” see the *ICF Programmer’s Guide*.

Code B–Read From One Program Device (Combination not Allowed)

A compilation-time message is issued, and the NO DATA phrase is ignored. See the table entry for the same combination of phrases with the NO DATA phrase omitted.

Code C–Read From One Program Device (with NO DATA phrase)

This function of the READ statement never causes program processing to stop and wait until data is available. Either the data is immediately available or the NO DATA imperative-statement is processed.

This READ function can be used to periodically check if data is available from a particular program device (either the default program device or one specified by the TERMINAL phrase). This checking for data is done in the following manner:

1. The program device is determined as follows:
   a. If the TERMINAL phrase was omitted or contains blanks, the default program device is used. The default program device is the one used by the last attempted READ, WRITE, REWRITE, ACQUIRE, or DROP statement. If none of the above I/O operations were previously issued, the default program device is the first program device acquired.
   b. If the TERMINAL phrase was specified, the indicated program device is used.
2. A check is done to determine if data is available and if the program device is invited.
3. If data is available, that data is returned in the record area and the program device is no longer invited. If no data is immediately available, the NO DATA imperative-statement is run and the program device remains invited.
4. If the program device is not invited, the AT END condition exists and the file status is set to 10.

Code D–Read From One Program Device (without NO DATA Phrase)

This READ always waits for data to be made available. Even if the job receives a controlled cancellation, or a WAITRCD time is specified for the file, the program will never regain control from the READ statement. This READ operation is performed in the following manner:

1. The program device is determined as follows:
   a. If the TERMINAL phrase is omitted or contains a blank value, the default program device is used. The default program device is the program device used by the last attempted READ, WRITE, REWRITE, ACQUIRE, DROP or ACCEPT (Attribute Data) statement. If none of these operations has been done, the program device implicitly acquired when the file was opened is used. If there are no acquired devices, the AT END condition exists.
   b. If the TERMINAL phrase is specified, the indicated program device is used.
2. The record format is determined as follows:
   a. If the FORMAT phrase is omitted or contains blanks, the record format returned is determined by the system. For information on how the record format is calculated for work station devices, refer to the *Data Management Guide*. For information about how the record format is determined for communications, see the section on the FMTSLT parameter on the ADDICFDEVE and OVRICFDEVE commands in the *ICF Programmer's Guide*.
   b. If the FORMAT phrase is specified, the indicated record format is returned. If the data available does not match the requested record format, a file status of 9G is set.
3. Program processing stops until data becomes available. The data is returned in the record area after the READ statement is run. If the program device was previously invited, it will no longer be invited after this READ statement.

INTO Phrase

The INTO phrase can be specified if:

- Only one record description is subordinate to the file description entry,

OR

- All record names associated with file-name and the data item referenced by identifier-1 describe a group item or an elementary alphanumeric item.

FORMAT Phrase

Literal-1 or identifier-2 specifies the name of the record format to be read. Literal-1, if specified, must be nonnumeric and 10 characters or fewer in length. Identifier-2, if specified, must refer to an alphanumeric data item, 10 characters or fewer in length. If identifier-2 contains blanks, the READ statement is run as if the FORMAT phrase were omitted.

NO DATA Phrase

When the NO DATA phrase is specified, the READ statement determines if data is immediately available. If data is available, the data is returned in the record area. If no data is immediately available, imperative-statement-1 is processed. The NO DATA phrase prevents the READ statement from waiting for data to become available.

TERMINAL Phrase

Literal-2 or identifier-3 specifies the program device name. Literal-2, if specified, must be nonnumeric and 10 characters or fewer in length. Identifier-3, if specified, must refer to an alphanumeric data item, 10 characters or fewer in length. The program device must have been acquired before the READ statement is processed. If identifier-3 contains blanks, the READ statement is processed as if the TERMINAL phrase were omitted. For a single device file, the TERMINAL phrase can be omitted. The program device is assumed to be that single device.

If the TERMINAL phrase is omitted for a READ of a TRANSACTION file that has acquired multiple program devices, the default program device is used. See the discussion of the TERMINAL phrase on page 182, to see how the default program device is determined.

AT END Phrase

Imperative-statement-2 is performed when the AT END condition is detected.

Note: An AT END condition occurs at the following times:

- During a READ statement for a sequentially accessed file when no next logical record exists in the file, or when the number of significant digits in the relative record number is larger than the size of the relative key data item, or when an optional input file is not present.
- During a RETURN statement when no logical record exists for the associated sort or merge file.
- During a SEARCH statement when the search operation ends without satisfying the condition specified in any of the associated WHEN phrases.

NOT AT END Phrase

This phrase allows you to specify procedures to be performed when the READ operation is successful.

END-READ Phrase

The END-READ phrase serves to explicitly delimit the scope of the statement.

READ Statement – Format 5 – TRANSACTION File (Subfile)

```
►►──READ SUBFILE──file-name──────────────────────────────────────────────►

►──┬──────────────────────┬──┬──────────┬─────────────────────────────────►
   └─┬──────┬─MODIFIED──┘  └─RECORD─┘
     └─NEXT─┘

►──┬──────────────────────┬───────────────────────────────────────────────►
   └──INTO──identifier-1──┘

►──┬──────────────────────────────────────┬───────────────────────────────►
   └──FORMAT──┬──────┬──┬─identifier-2─┬──┘
              └─IS─┘  └─literal-1────┘

►────TERMINAL──┬──────┬──┬─identifier-3─┬─────────────────────────────────►
               └─IS─┘  └─literal-2────┘

►──┬─────────────────────────────────────────────┬────────────────────────►
   └─┬─INDICATOR──┬──┬───────┬──identifier-4─┘
     ├─INDICATORS─┤  ├─IS──┤
     └─INDIC──────┘  └─ARE─┘

►──┬───────────────────────────────────────────────┬──────────────────────►
   └──INVALID──┬───────┬──imperative-statement-1──┘
               └─KEY─┘

►──┬───────────────────────────────────────────────────┬──────────────────►
   └──NOT INVALID──┬───────┬──imperative-statement-2──┘
                   └─KEY─┘

►──┬─────────────────────────────────────────┬────────────────────────────►
   └─┬──────┬─END──imperative-statement-3─┘
     └─AT─┘

►──┬──────────────────────────────────────────────┬──┬────────────┬──────►◄
   └──NOT──┬──────┬─END──imperative-statement-4──┘  └─END-READ─┘
           └─AT─┘
```

Format 5 is used only to read a format that is a subfile record. The AT END phrase can only be used when the NEXT MODIFIED phrase is specified. The INVALID KEY phrase must not be used when the NEXT MODIFIED phrase is specified.

Format 5 cannot be used for communications devices. If the subfile format of the READ statement is used for a communications device, the READ fails and a file status of 90 is set.

Random Access of Subfile Records: The NEXT MODIFIED phrase must not be used to randomly access records in a subfile. The INVALID KEY phrase can only be used for random access of subfile records.

Sequential Access of Subfile Records: The NEXT MODIFIED phrase must be specified to access subfile records sequentially. The AT END phrase can only be specified with the NEXT MODIFIED phrase.

NEXT MODIFIED Phrase

When NEXT MODIFIED is not specified, the data record made available is the record in the subfile with a relative record number that corresponds to the value of the RELATIVE KEY data item.

When the NEXT MODIFIED phrase is not specified, and if the RELATIVE KEY data item contains a value other than the relative record number of a record in the subfile, the INVALID KEY condition exists and the running of the READ statement is unsuccessful.

When the NEXT MODIFIED phrase is specified, the record made available is the next modified record following the current pointer position in the file. For information about turning on the Modified Data Tag, see the *Data Management Guide*.

The search for the next modified record begins:

- At the beginning of the subfile if:
  - An I/O operation has been performed for the subfile control record.
  - The I/O operation cleared, initialized, or displayed the subfile.
- For all other cases, with the record following the record that was read by a previous read operation.

The value of the RELATIVE KEY data item is updated to reflect the relative record number of the record made available to the program.

If NEXT MODIFIED is specified and there are no further user-modified records in the subfile, the AT END condition exists. Imperative-statement-2, or an applicable USE AFTER ERROR/EXCEPTION procedure, if any, is then run.

FORMAT Phrase

When a format-name is not specified, the format used is the last record format written to the display device that contains input fields, input/output fields, or hidden fields. If no such format exists for the display file, the format used is the record format of the last WRITE operation to the display device.

Note: An **input field** is a field specified in a display file or database file that is reserved for information supplied by a user.

If the FORMAT phrase is specified, literal-1 or the contents of identifier-2 must specify a format, which is active for the appropriate program device. The READ statement reads a data record of the specified format.

To ensure correct results, always specify the FORMAT phrase for multiple format files. For more information on the FORMAT phrase, see the Procedure Division, “Common Processing Facilities” on page 181.

TERMINAL Phrase

See Format 4 of the READ Statement for general considerations concerning the TERMINAL phrase.

For a Format 5 READ, if the TERMINAL phrase is omitted for a file that has multiple devices acquired for it, a record is read from the subfile associated with the default program device. See the discussion of the TERMINAL phrase on page 182, to see how the default program device is determined.

INVALID KEY Phrase

If the RELATIVE KEY data item at the time of running the statement contains a value that does not correspond to a relative record number for the subfile, the INVALID KEY condition exists and the running of the statement is unsuccessful. To see what happens next, refer to the diagrams on pages 76 through 78.

| For a Format 5 READ, you should specify the INVALID KEY phrase if the NEXT MODIFIED phrase is not specified and there is no applicable USE procedure specified for the file name.

NOT INVALID KEY Phrase

This phrase allows you to specify procedures to be performed when the READ operation is successful.

AT END Phrase

If the NEXT MODIFIED phrase is specified and there is no user-modified record in the subfile, the AT END condition exists, and the READ operation is unsuccessful.

Specify the AT END phrase when the NEXT MODIFIED phrase is used, and no applicable USE procedure is specified for the file name. If the AT END phrase and a USE procedure are both specified for a file, and the AT END condition arises, control transfers to the AT END imperative statement and the USE procedure is not run.

NOT AT END Phrase

This phrase allows you to specify procedures to be performed when the READ operation is successful.

END-READ Phrase

The END-READ phrase serves to explicitly delimit the scope of the statement.

REWRITE Statement

The REWRITE statement is used to replace a subfile record that already exists in the subfile.

REWRITE Statement – Format 2 – TRANSACTION File (Subfile)

```
►►──REWRITE SUBFILE──record-name-1──┬──────────────────────┬──────────────►
                                    └──FROM──identifier-1──┘

►──FORMAT──┬────┬──┬─identifier-2─┬────────────────────────────────────────►
           └─IS─┘  └─literal-1────┘

►──┬───────────────────────────────────────────────┬───────────────────────►
   └──TERMINAL──┬────┬──┬─identifier-3─┬───────────┘
                └─IS─┘  └─literal-2────┘

►──┬─────────────────────────────────────────────────┬─────────────────────►
   └─┬─INDICATOR──┬──┬─────┬──identifier-4───────────┘
     ├─INDICATORS─┤  ├─IS──┤
     └─INDIC──────┘  └─ARE─┘

►──┬────────────────────────────────────────────────┬──────────────────────►
   └──INVALID──┬─────┬──imperative-statement-1──────┘
               └─KEY─┘

►──┬───────────────────────────────────────────────────┬──┬───────────────┬──►◄
   └──NOT INVALID──┬─────┬──imperative-statement-2─────┘  └─END-REWRITE───┘
                   └─KEY─┘
```

The number of character positions in the record referenced by record-name must be equal to the number of character positions in the record being replaced. A successful READ operation on the record must be done prior to the REWRITE operation. The record replaced in the subfile is the record in the subfile accessed by the previous READ operation.

FORMAT Phrase

The record format specified in the FORMAT phrase must be the record format accessed on the previous READ operation. Literal-1 or the contents of identifier-2 must be the name of the subfile format accessed on the previous READ. For more information on the FORMAT phrase, see “Common Processing Facilities” on page 181.

TERMINAL Phrase

The TERMINAL phrase indicates which program device's subfile is to have a record rewritten. If the TERMINAL phrase is specified, literal-2 or identifier-3 must refer to a work station that has been acquired by the TRANSACTION file. If literal-2 or identifier-3 contains blanks, the TERMINAL phrase has no effect. The program device specified by the TERMINAL phrase must have been acquired, either explicitly or implicitly, and must have a subfile associated with the device.

Literal-2 or identifier-3 must be a valid program device name. Literal-2, if specified, must be nonnumeric and 10 characters or fewer. Identifier-3, if specified, must refer to an alphanumeric data item, 10 characters or fewer.

If the TERMINAL phrase is omitted from a TRANSACTION file that has acquired multiple program devices, the subfile used is the subfile associated with the last program device from which a READ of the TRANSACTION file was attempted.

The REWRITE statement cannot be used for communications devices. If the REWRITE statement is used for a communications device, the operation fails and a file status of 90 is set.

INVALID KEY Phrase

If the RELATIVE KEY data item at the time of running the statement contains a value that does not correspond to a relative record number for the subfile, the INVALID KEY condition exists and the running of the statement is unsuccessful. To see what happens next, refer to the diagrams on pages 76 through 78.

NOT INVALID KEY Phrase

This phrase allows you to specify procedures to be performed when the REWRITE operation is successful.

END-REWRITE Phrase

The END-REWRITE phrase serves to explicitly delimit the scope of the statement.

WRITE Statement

The WRITE statement releases a logical record to the file.

WRITE Statement – Format 4 – TRANSACTION File (Nonsubfile)

```
►►──WRITE──record-name-1──┬──────────────────────┬─────────────────────►
                          └─FROM──identifier-1──┘

►───FORMAT──┬──────┬──┬─identifier-2─┬─────────────────────────────────►
            └─IS──┘  └─literal-1────┘

►────┬──────────────────────────────────────────────┬──────────────────►
     └──TERMINAL──┬──────┬──┬─identifier-3─┬────────┘
                  └─IS──┘  └─literal-2────┘

►────┬─────────────────────────────────────────────────────────┬───────►
     └──STARTING──┬──────┬──┬────────┬──┬─identifier-4─┬──────┘
                  └─AT──┘  └─LINE──┘  └─literal-3────┘

►────┬─────────────────────────────────────────────────────────────────► 1
     └──┬─BEFORE─┬──ROLLING──┬─────────┬──┬─identifier-5─┬─────────────► 2
        └─AFTER──┘           ├─LINES──┤  └─literal-4────┘
                             └─LINE───┘

1 ►──────────────────────────────────────────────────────────────────┬──►
2 ►────┬───────────┬──┬─identifier-6─┬──┬─UP───┬──┬─identifier-7─┬──┬─────────┬──┘
       ├─THROUGH──┤  └─literal-5────┘  └─DOWN─┘  └─literal-6────┘  ├─LINES──┤
       └─THRU─────┘                                                 └─LINE───┘

►────┬─────────────────────────────────────────────┬──┬─────────────┬──►◄
     └──┬─INDICATOR───┬──┬───────┬──identifier-8──┘  └─END-WRITE──┘
        ├─INDICATORS──┤  ├─IS───┤
        └─INDIC───────┘  └─ARE──┘
```

TERMINAL Phrase

The TERMINAL phrase specifies the program devices to which the output record is to be sent.

The contents of literal-2 or identifier-3 must be the name of a program device previously acquired, either implicitly or explicitly, by the file. Literal-2, if specified, must be nonnumeric and 10 characters or fewer in length. Identifier-3, if specified, must refer to an alphanumeric data item, 10 characters or fewer in length. A value of blanks is treated as if the TERMINAL phrase were omitted.

If only a single program device was acquired by the TRANSACTION file, the

TERMINAL phrase can be omitted. That program device is always used for the WRITE.

If the TERMINAL phrase is omitted for a WRITE operation to a TRANSACTION file that has acquired multiple program devices, the default program device is used. See the discussion of the TERMINAL phrase on page 182 to see how the default program device is determined.

STARTING Phrase

The STARTING phrase specifies the starting line number for the record formats that use the variable start line keyword. This phrase is only valid for display devices.

The actual line number on which a field begins can be determined from the following equation:

$$\text{Actual-line} = \text{Start-line} + \text{DDS Start-line} - 1$$

Figure 66. Line Number Equation for the STARTING Phrase

Where:

Actual-line is the actual line number
Start-line is the starting line number specified in the program
DDS Start-line is the line number specified in positions 39 through 41 of the Data Description Specifications form.

The WRITE operation is successful if:

- The result of the above equation is positive and less than or equal to the number of lines on the display.
- The value specified for the STARTING phrase is 0. In this case, a value of 1 is assumed.

The WRITE operation is unsuccessful, and the program ends, if:

- The result of the above equation is greater than the number of lines on the display.
- The value specified for the STARTING phrase is negative.

If the value specified for the STARTING phrase is within the screen area, any fields outside of the screen area are ignored.

Literal-3 of the STARTING phrase must be a numeric literal. Identifier-4 must be an elementary numeric item.

To use the STARTING phrase, the DDS record level keyword SLNO(*VAR) must be specified for the format being written. If the record format does not specify this keyword, the STARTING phrase is ignored at run time.

The DDS keyword CLRL also affects the STARTING phrase. CLRL controls how much of the display is cleared when the WRITE statement is processed.

See the *DDS Reference* for further information on SLNO(*VAR) and CLRL keywords.

ROLLING Phrase

The ROLLING phrase allows you to move lines displayed on the work station screen. All or some of the lines on the screen can be rolled up or down. The lines vacated by the rolled lines are cleared, and can have another screen format written into them. This phrase is only valid for display devices.

ROLLING is specified in the WRITE statement that is writing a new format to the display You must specify whether the write is before or after the roll, the range of lines you want to roll, how many lines you want to roll these lines, and whether the roll operation is up or down.

After lines are rolled, the fields on these lines retain their DDS display attributes, for example, underlining, but lose their DDS usage attributes, for example, input-capability. Fields on lines that are written and then rolled (BEFORE ROLLING phrase) also lose their usage attributes.

If any part of a format is rolled, the entire format loses its usage attributes. If more than one format exists, only the rolled formats lose their usage attributes.

When you specify the ROLLING phrase, the following general rules apply.

- The DDS record level keyword ALWROL must be specified for every record format written in a WRITE statement containing the ROLLING phrase.
- Other DDS keywords mutually exclusive with the ALWROL keyword must not be used.
- Either of the DDS keywords, CLRL or OVERLAY, must be specified for a record format that is to be written and rolled to prevent the display from being cleared when that record format is written. See the *DDS Reference* manual for more information on DDS keywords.
- All the identifiers and literals must represent positive integer values.
- The roll starting line number (identifier-5 or literal-4) must not exceed the ending line number (identifier-6 or literal-5).
- The contents of lines that are rolled outside of the window specified by the starting and ending line numbers disappear.

Figure 67 on page 197 shows an example of a rolling operation. An initial screen format, FMT1, is written on the display. The program processes this screen format and is now ready to write the next screen format, FMT2, to the work station screen. Part of FMT1 is rolled down two lines before FMT2 is written to the display.

Processing of the following WRITE statement causes part of FMT1 to be rolled down two lines, and FMT2 to be written to the display:

```
WRITE SCREENREC FORMAT "FMT2"
 AFTER ROLLING LINES 14 THROUGH 20
 DOWN 2 LINES
```

When this WRITE statement is run, the following steps occur:

1. The contents of lines 14 through 20 are rolled down two lines.

   a. The contents of lines 14 through 18 now appear on lines 16 through 20.

   b. The contents of lines 14 and 15 are vacated and cleared.

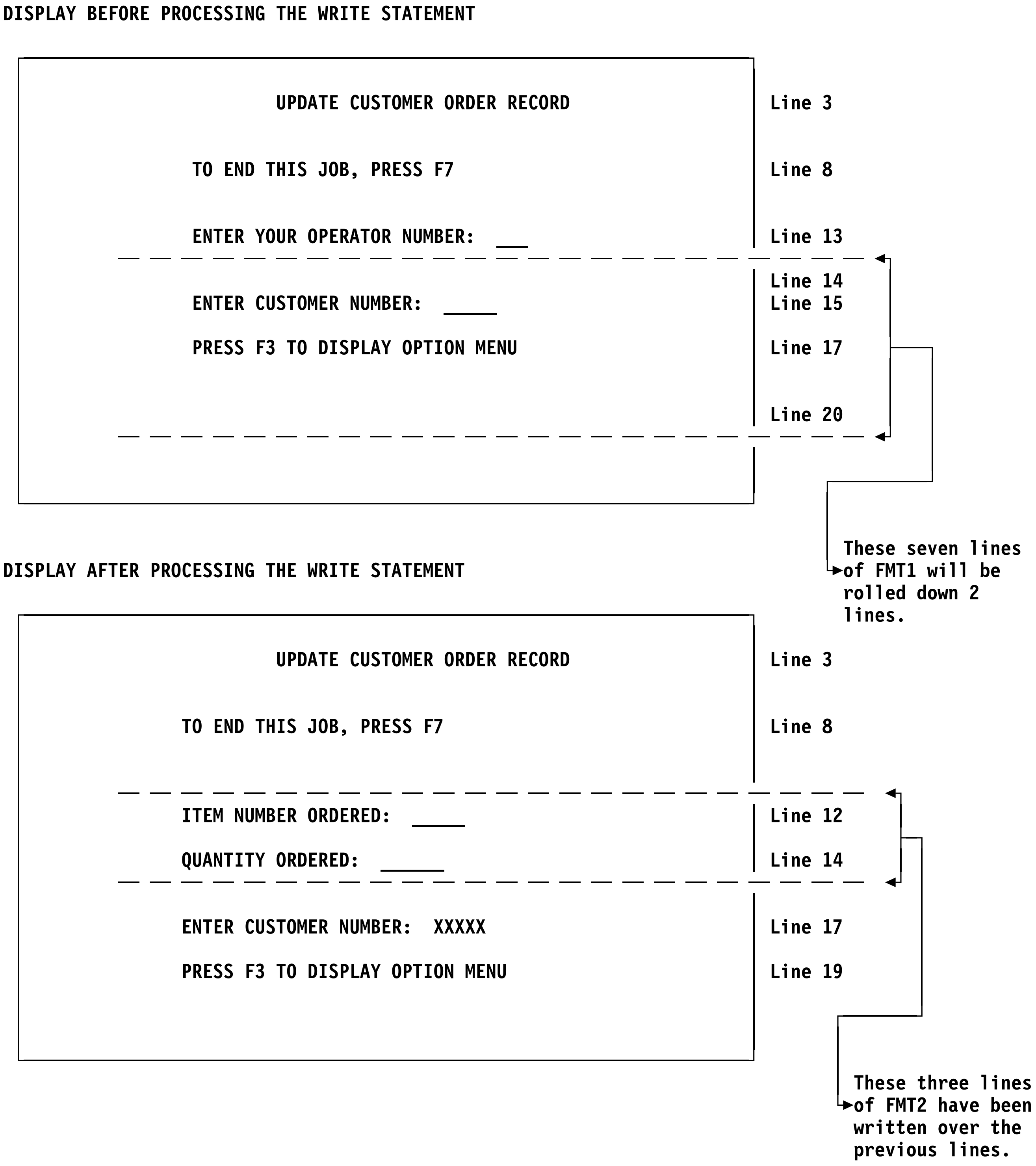
   c. The contents of lines 19 and 20 are rolled outside the window and disappear.

2. After the rolling operation takes place, FMT2 is written to the display.

   a. Part of FMT2 is written to the area vacated by the roll operation.

   b. Part of FMT2 is written over the data left from FMT1.

3. When the contents of the display are returned to the program by a READ statement, only the input capable fields of FMT2 are returned.



DISPLAY BEFORE PROCESSING THE WRITE STATEMENT

```
             UPDATE CUSTOMER ORDER RECORD              Line 3

     TO END THIS JOB, PRESS F7                         Line 8

     ENTER YOUR OPERATOR NUMBER:  ___                  Line 13
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                                                       Line 14
     ENTER CUSTOMER NUMBER:  _____                     Line 15

     PRESS F3 TO DISPLAY OPTION MENU                   Line 17

                                                       Line 20
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

These seven lines of FMT1 will be rolled down 2 lines.

DISPLAY AFTER PROCESSING THE WRITE STATEMENT

```
             UPDATE CUSTOMER ORDER RECORD              Line 3

     TO END THIS JOB, PRESS F7                         Line 8

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
     ITEM NUMBER ORDERED:  _____                       Line 12

     QUANTITY ORDERED:  ______                         Line 14
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     ENTER CUSTOMER NUMBER:  XXXXX                     Line 17

     PRESS F3 TO DISPLAY OPTION MENU                   Line 19
```

These three lines of FMT2 have been written over the previous lines.

Figure 67. Example of ROLLING Operation

WRITE Statement – Format 5 – TRANSACTION File (Subfile)

```
►►──WRITE SUBFILE──record-name-1──┬─────────────────────────┬──────────►
                                  └──FROM──identifier-1─────┘

►────FORMAT──┬──────┬──┬─identifier-2─┬─────────────────────────────────►
             └─IS───┘  └─literal-1────┘

►────┬────────────────────────────────────────────┬─────────────────────►
     └──TERMINAL──┬──────┬──┬─identifier-3─┬──────┘
                  └─IS───┘  └─literal-2────┘

►────┬──────────────────────────────────────────────────┬───────────────►
     └──┬─INDICATOR───┬──┬───────┬──identifier-4─────────┘
        ├─INDICATORS──┤  ├─IS────┤
        └─INDIC───────┘  └─ARE───┘

►────┬─────────────────────────────────────────────────┬────────────────►
     └──INVALID──┬───────┬──imperative-statement-1─────┘
                 └─KEY───┘

►────┬──────────────────────────────────────────────────┬──┬─────────────┬──►◄
     └──NOT INVALID──┬───────┬──imperative-statement-2──┘  └─END-WRITE───┘
                     └─KEY───┘
```

Format 5 can only be used for display devices. If the subfile form of the WRITE statement is used for any other type of device, the WRITE operation fails and a file status of 90 is set.

If the format is a subfile record, and SUBFILE is specified, the RELATIVE KEY clause must have been specified on the SELECT clause for the file being written. The record written to the subfile is the record in the subfile identified by the format name that has a relative record number equal to the value of the RELATIVE KEY data item. See the *Data Management Guide* for more information on subfiles.

TERMINAL Phrase

See the explanation following Format 4 for general considerations concerning the TERMINAL phrase.

The TERMINAL phrase specifies which program device's subfile is to have a record written to it. If the TERMINAL phrase is specified, literal-2 or identifier-3 must refer to a work station associated with the TRANSACTION file. If literal-2 or identifier-3 contains a value of blanks, the TERMINAL phrase is treated as if it were not specified. The work station specified by the TERMINAL phrase must have been acquired, either explicitly or implicitly.

If the TERMINAL phrase is omitted, the subfile used is the subfile associated with the default program device. See the discussion of the TERMINAL phrase on page 182 to see how the default program device is determined.

INVALID KEY Phrase

The INVALID KEY condition exists if a record is already in the subfile with that record number, or if the relative record number specified is greater than the maximum allowable subfile record number. The INVALID KEY phrase should be specified in the WRITE SUBFILE statement for all files for which an appropriate USE procedure is not specified.

For information about what happens when the INVALID KEY condition arises, refer to the diagrams on pages 76 through 78.

NOT INVALID KEY Phrase

This phrase allows you to specify procedures to be performed when the WRITE operation is successful.

END-WRITE Phrase

The END-WRITE phrase serves to explicitly delimit the scope of the statement.

For a further discussion of the WRITE statement, the FROM phrase, and the INVALID KEY phrase, see the *COBOL/400 Reference*. For information on the FORMAT phrase, see the Procedure Division, “Common Processing Facilities” on page 181.

USE Statement

The USE statement specifies procedures for input/output error handling that are in addition to the standard procedures provided by the input/output control system.

Format

```
►►──USE AFTER──┬──────────┬──┬─EXCEPTION─┬──────────────────────────────────►
               └─STANDARD─┘  └─ERROR─────┘

                                ┌────────────┐
                                ▼            │
►──PROCEDURE──┬────┬──────┬─file-name-1─┴──┬───────────────────────────►◄
              └─ON─┘      └─I-O─────────────┘
```

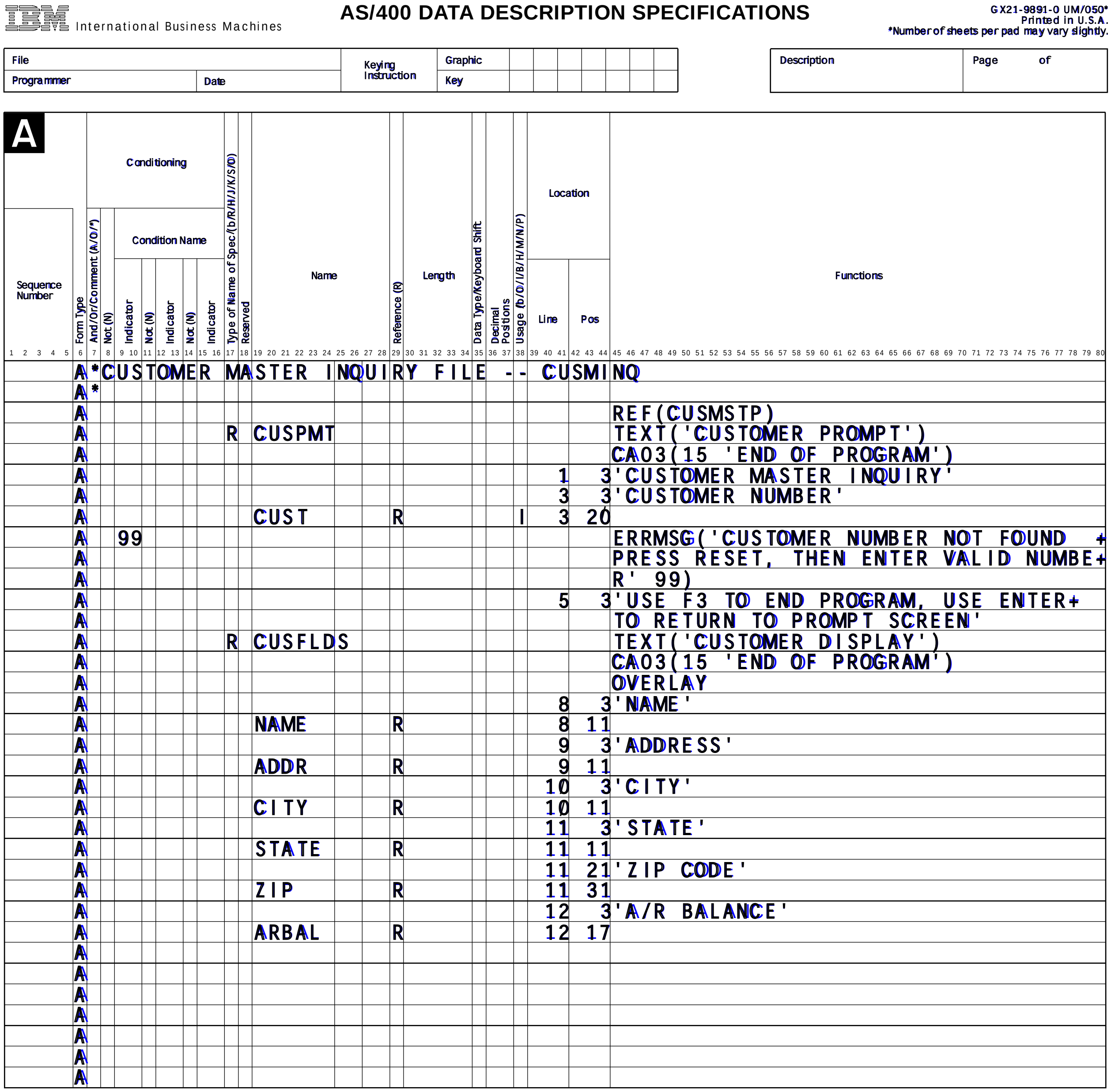
See the “USE Statement” section of the *COBOL/400 Reference* for a further discussion of the USE statement.

Examples of Work Station Programs

This section contains examples of COBOL programs that illustrate work station applications on the AS/400 system.

Basic Inquiry Program

Figure 68 shows the associated DDS for a basic inquiry program that uses the COBOL TRANSACTION file.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

```
     A*CUSTOMER MASTER INQUIRY FILE -- CUSMINQ
     A*
     A                                      REF(CUSMSTP)
     A          R CUSPMT                    TEXT('CUSTOMER PROMPT')
     A                                      CA03(15 'END OF PROGRAM')
     A                                  1  3'CUSTOMER MASTER INQUIRY'
     A                                  3  3'CUSTOMER NUMBER'
     A            CUST      R        I  3 20
     A  99                                  ERRMSG('CUSTOMER NUMBER NOT FOUND  +
     A                                      PRESS RESET, THEN ENTER VALID NUMBE+
     A                                      R' 99)
     A                                  5  3'USE F3 TO END PROGRAM, USE ENTER+
     A                                       TO RETURN TO PROMPT SCREEN'
     A          R CUSFLDS                   TEXT('CUSTOMER DISPLAY')
     A                                      CA03(15 'END OF PROGRAM')
     A                                      OVERLAY
     A                                  8  3'NAME'
     A            NAME      R           8 11
     A                                  9  3'ADDRESS'
     A            ADDR      R           9 11
     A                                 10  3'CITY'
     A            CITY      R          10 11
     A                                 11  3'STATE'
     A            STATE     R          11 11
     A                                 11 21'ZIP CODE'
     A            ZIP       R          11 31
     A                                 12  3'A/R BALANCE'
     A            ARBAL     R          12 17
     A
     A
     A
     A
     A
     A
     A
```

Figure 68. Example of a TRANSACTION Inquiry Program Using a Single Display Device

The data description specifications (DDS) for the display device file (CUSMINQ) to be used by this program describe two record formats: CUSPMT and CUSFLDS.

The CUSPMT record format contains the constant ‘Customer Master Inquiry’, which identifies the display. It also contains the prompt ‘Customer Number’ and the input field (CUST) where you enter the customer number. Five underscores appear under the input field CUST on the display where you are to enter the customer number. The error message:

```
Customer number not found
```

is also included in this record format. This message is displayed if indicator 99 is set to **ON** by the program. In addition, this record format defines a function key that you can press to end the program. When you press function key F3, indicator 15 is set to **ON** in the COBOL program. This indicator is then used to end the program.

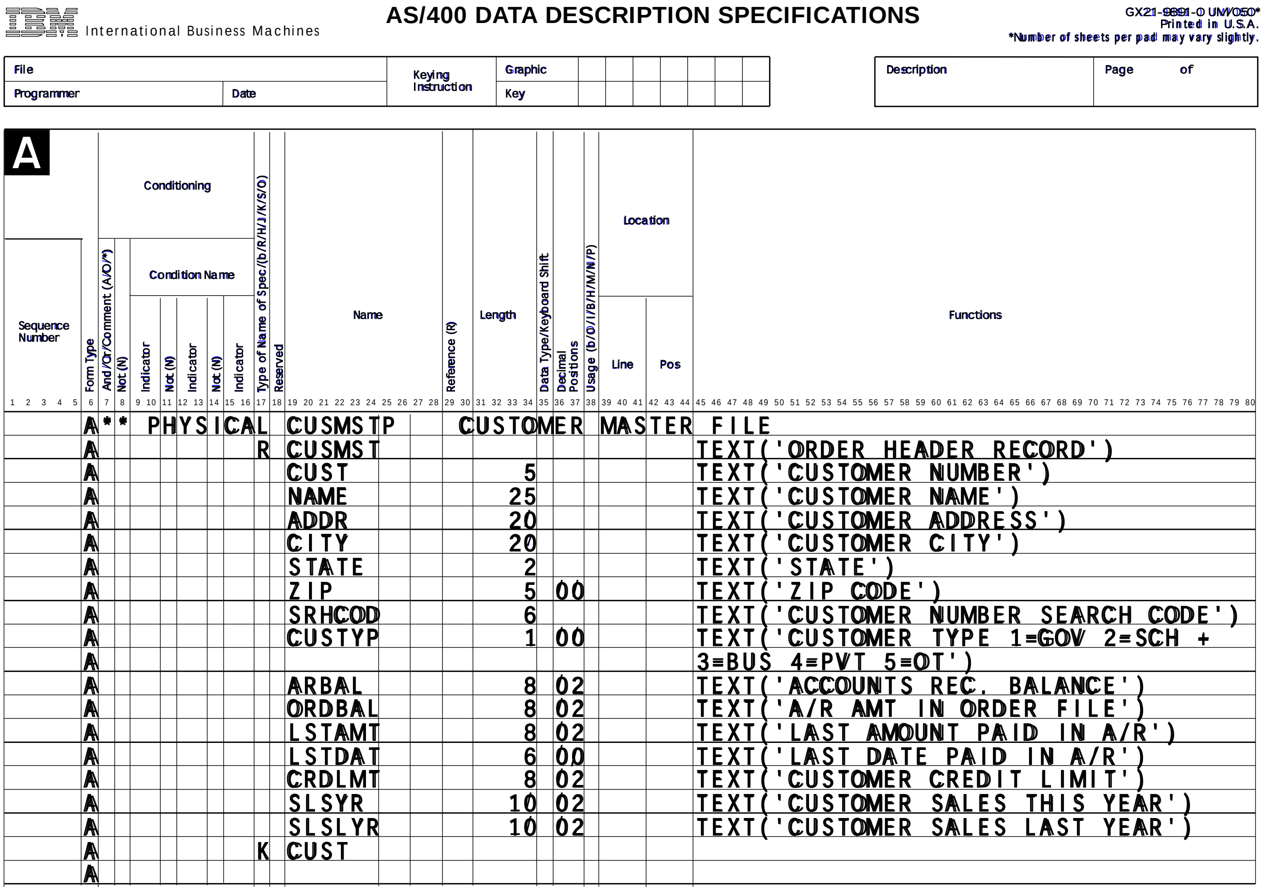
The CUSFLDS record format contains the following constants:

- Name
- Address
- City
- State
- Zip Code
- A/R Balance.

These constants identify the fields to be written out from the program. This record format also describes the fields that correspond to these constants. All of these fields are described as output fields (blank in position 38) because they are filled in by the program; you do not enter any data into these fields. To enter another customer number, press Enter in response to this record. Notice that the CUSFLDS record overlays the CUSPMT record. Therefore, when the CUSFLDS record is written to the display, the CUSPMT record remains on the display.

In addition to describing the constants, fields, and attributes for the display, the record formats also define the line numbers and horizontal positions where the constants and fields are to be displayed.

Note: The field attributes are defined in a physical file (CUSMSTP) used for field reference purposes, instead of in the DDS for the display file. For example, EDTCDE(J) is defined in CUSMSTP for the field ARBAL.



International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File		Keying Instruction	Graphic	Description
Programmer	Date		Key	Page of

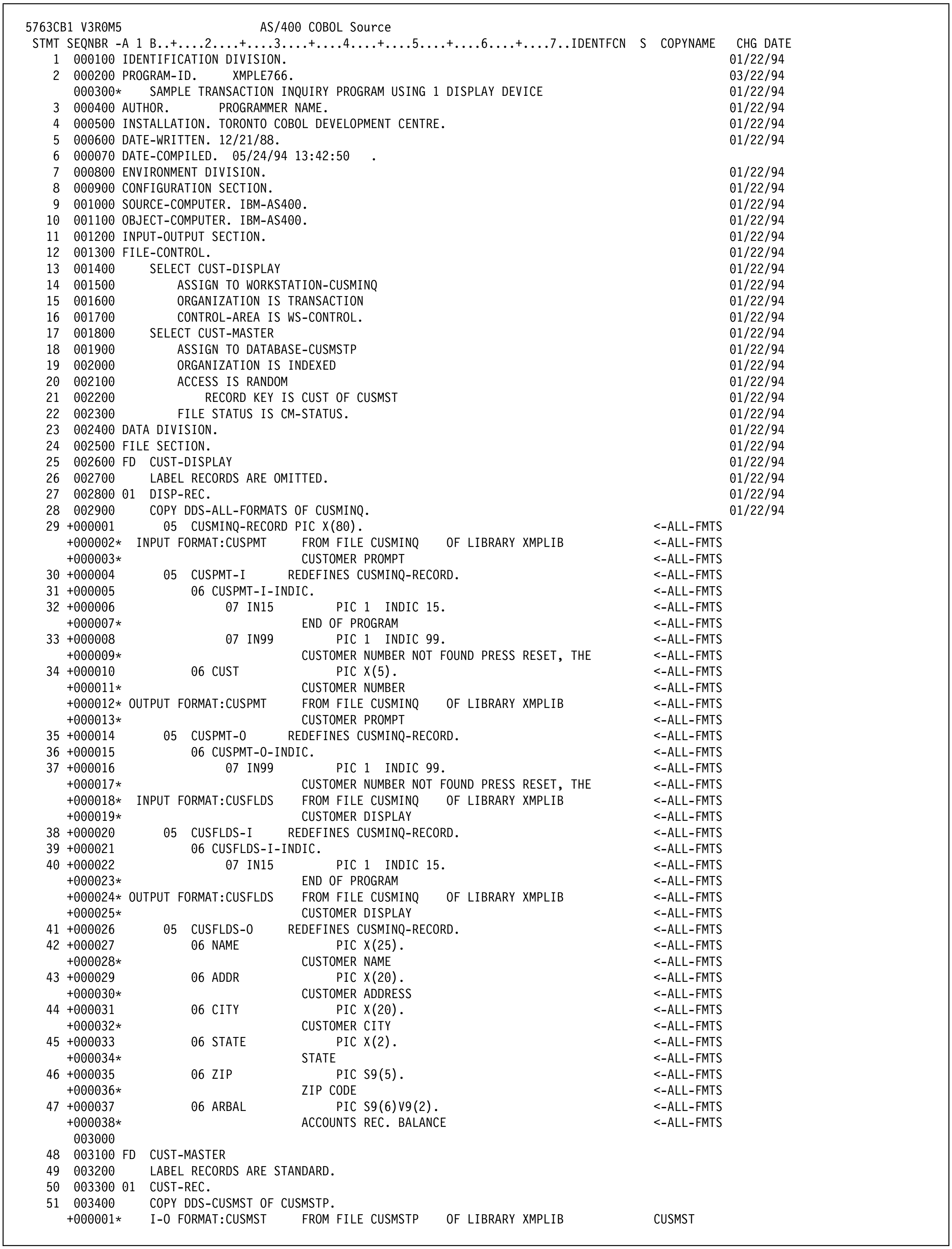
A

Sequence Number · Form Type · And/Or/Comment (A/O/*) · Conditioning: Not (N), Indicator, Not (N), Indicator, Not (N), Indicator (Condition Name) · Type of Name of Spec (b/R/H/J/K/S/O) · Reserved · Name · Reference (R) · Length · Data Type/Keyboard Shift · Decimal Positions · Usage (b/O/I/B/H/M/N/P) · Location: Line, Pos · Functions

```
     A** PHYSICAL CUSMSTP    CUSTOMER MASTER FILE
     A          R CUSMST                    TEXT('ORDER HEADER RECORD')
     A            CUST           5          TEXT('CUSTOMER NUMBER')
     A            NAME          25          TEXT('CUSTOMER NAME')
     A            ADDR          20          TEXT('CUSTOMER ADDRESS')
     A            CITY          20          TEXT('CUSTOMER CITY')
     A            STATE          2          TEXT('STATE')
     A            ZIP            5 00       TEXT('ZIP CODE')
     A            SRHCOD         6          TEXT('CUSTOMER NUMBER SEARCH CODE')
     A            CUSTYP         1 00       TEXT('CUSTOMER TYPE 1=GOV 2=SCH +
     A                                      3=BUS 4=PVT 5=OT')
     A            ARBAL          8 02       TEXT('ACCOUNTS REC. BALANCE')
     A            ORDBAL         8 02       TEXT('A/R AMT IN ORDER FILE')
     A            LSTAMT         8 02       TEXT('LAST AMOUNT PAID IN A/R')
     A            LSTDAT         6 00       TEXT('LAST DATE PAID IN A/R')
     A            CRDLMT         8 02       TEXT('CUSTOMER CREDIT LIMIT')
     A            SLSYR         10 02       TEXT('CUSTOMER SALES THIS YEAR')
     A            SLSLYR        10 02       TEXT('CUSTOMER SALES LAST YEAR')
     A          K CUST
     A
```

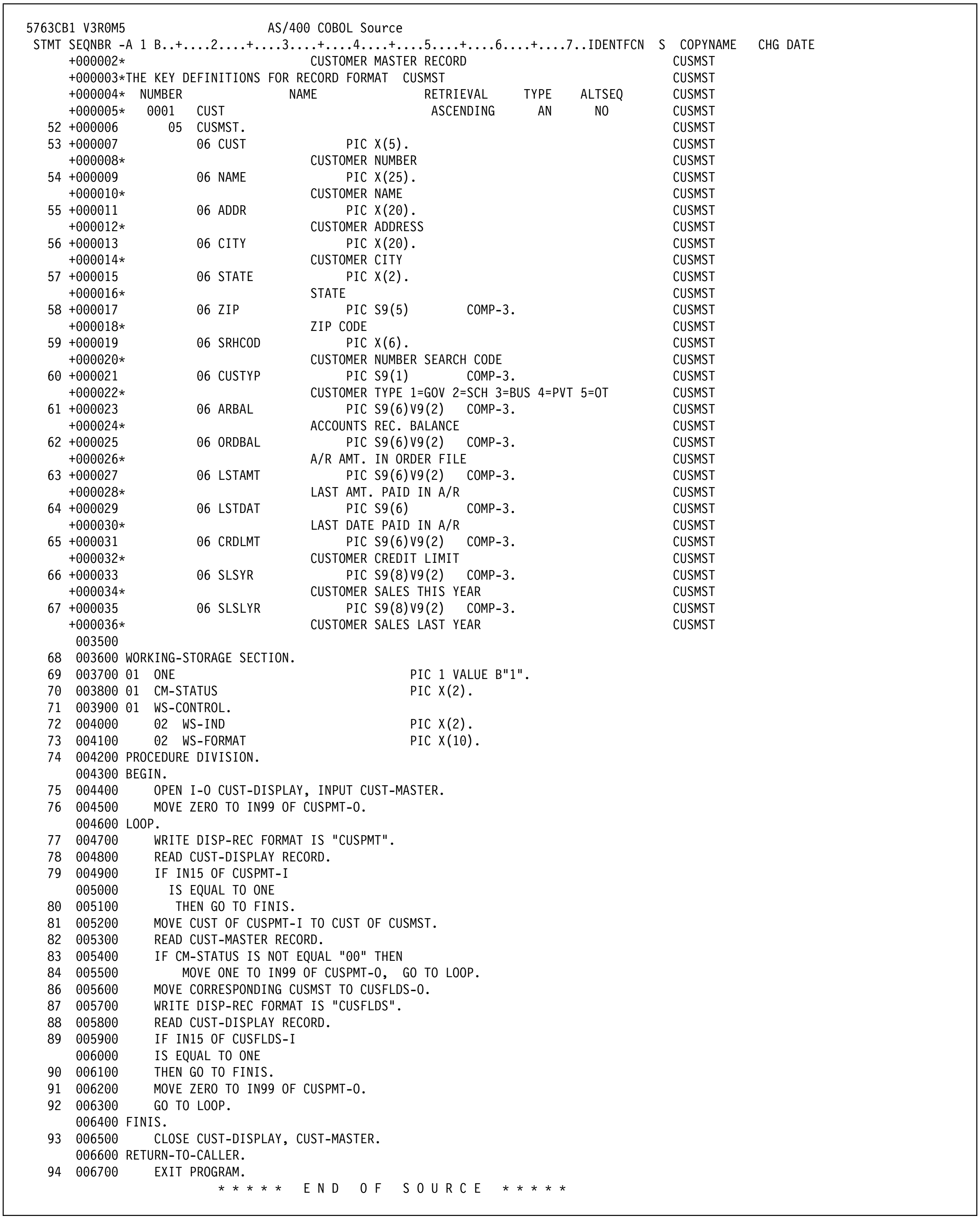
Figure 69. Data Description Specification for the Record Format CUSMST.

The data description specifications (DDS) for the database file that is used by this program describe one record format: CUSMST. Each field in the record format is described, and the CUST field is identified as the key field for the record format.



```
 5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 IDENTIFICATION DIVISION.                                                                01/22/94
    2  000200 PROGRAM-ID.     XMPLE766.                                                               03/22/94
       000300*    SAMPLE TRANSACTION INQUIRY PROGRAM USING 1 DISPLAY DEVICE                           01/22/94
    3  000400 AUTHOR.       PROGRAMMER NAME.                                                          01/22/94
    4  000500 INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                         01/22/94
    5  000600 DATE-WRITTEN. 12/21/88.                                                                 01/22/94
    6  000070 DATE-COMPILED.  05/24/94 13:42:50   .
    7  000800 ENVIRONMENT DIVISION.                                                                   01/22/94
    8  000900 CONFIGURATION SECTION.                                                                  01/22/94
    9  001000 SOURCE-COMPUTER. IBM-AS400.                                                             01/22/94
   10  001100 OBJECT-COMPUTER. IBM-AS400.                                                             01/22/94
   11  001200 INPUT-OUTPUT SECTION.                                                                   01/22/94
   12  001300 FILE-CONTROL.                                                                           01/22/94
   13  001400     SELECT CUST-DISPLAY                                                                 01/22/94
   14  001500         ASSIGN TO WORKSTATION-CUSMINQ                                                   01/22/94
   15  001600         ORGANIZATION IS TRANSACTION                                                     01/22/94
   16  001700         CONTROL-AREA IS WS-CONTROL.                                                     01/22/94
   17  001800     SELECT CUST-MASTER                                                                  01/22/94
   18  001900         ASSIGN TO DATABASE-CUSMSTP                                                      01/22/94
   19  002000         ORGANIZATION IS INDEXED                                                         01/22/94
   20  002100         ACCESS IS RANDOM                                                                01/22/94
   21  002200             RECORD KEY IS CUST OF CUSMST                                                01/22/94
   22  002300         FILE STATUS IS CM-STATUS.                                                       01/22/94
   23  002400 DATA DIVISION.                                                                          01/22/94
   24  002500 FILE SECTION.                                                                           01/22/94
   25  002600 FD  CUST-DISPLAY                                                                        01/22/94
   26  002700     LABEL RECORDS ARE OMITTED.                                                          01/22/94
   27  002800 01  DISP-REC.                                                                           01/22/94
   28  002900     COPY DDS-ALL-FORMATS OF CUSMINQ.                                                    01/22/94
   29 +000001       05  CUSMINQ-RECORD PIC X(80).                                         <-ALL-FMTS
      +000002*  INPUT FORMAT:CUSPMT     FROM FILE CUSMINQ    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                          CUSTOMER PROMPT                                    <-ALL-FMTS
   30 +000004       05  CUSPMT-I      REDEFINES CUSMINQ-RECORD.                            <-ALL-FMTS
   31 +000005           06 CUSPMT-I-INDIC.                                                 <-ALL-FMTS
   32 +000006                07 IN15         PIC 1  INDIC 15.                              <-ALL-FMTS
      +000007*                          END OF PROGRAM                                     <-ALL-FMTS
   33 +000008                07 IN99         PIC 1  INDIC 99.                              <-ALL-FMTS
      +000009*                          CUSTOMER NUMBER NOT FOUND PRESS RESET, THE         <-ALL-FMTS
   34 +000010           06 CUST             PIC X(5).                                      <-ALL-FMTS
      +000011*                          CUSTOMER NUMBER                                    <-ALL-FMTS
      +000012* OUTPUT FORMAT:CUSPMT     FROM FILE CUSMINQ    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000013*                          CUSTOMER PROMPT                                    <-ALL-FMTS
   35 +000014       05  CUSPMT-O      REDEFINES CUSMINQ-RECORD.                            <-ALL-FMTS
   36 +000015           06 CUSPMT-O-INDIC.                                                 <-ALL-FMTS
   37 +000016                07 IN99         PIC 1  INDIC 99.                              <-ALL-FMTS
      +000017*                          CUSTOMER NUMBER NOT FOUND PRESS RESET, THE         <-ALL-FMTS
      +000018*  INPUT FORMAT:CUSFLDS    FROM FILE CUSMINQ    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000019*                          CUSTOMER DISPLAY                                   <-ALL-FMTS
   38 +000020       05  CUSFLDS-I     REDEFINES CUSMINQ-RECORD.                            <-ALL-FMTS
   39 +000021           06 CUSFLDS-I-INDIC.                                                <-ALL-FMTS
   40 +000022                07 IN15         PIC 1  INDIC 15.                              <-ALL-FMTS
      +000023*                          END OF PROGRAM                                     <-ALL-FMTS
      +000024* OUTPUT FORMAT:CUSFLDS    FROM FILE CUSMINQ    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000025*                          CUSTOMER DISPLAY                                   <-ALL-FMTS
   41 +000026       05  CUSFLDS-O     REDEFINES CUSMINQ-RECORD.                            <-ALL-FMTS
   42 +000027           06 NAME             PIC X(25).                                     <-ALL-FMTS
      +000028*                          CUSTOMER NAME                                      <-ALL-FMTS
   43 +000029           06 ADDR             PIC X(20).                                     <-ALL-FMTS
      +000030*                          CUSTOMER ADDRESS                                   <-ALL-FMTS
   44 +000031           06 CITY             PIC X(20).                                     <-ALL-FMTS
      +000032*                          CUSTOMER CITY                                      <-ALL-FMTS
   45 +000033           06 STATE            PIC X(2).                                      <-ALL-FMTS
      +000034*                          STATE                                              <-ALL-FMTS
   46 +000035           06 ZIP              PIC S9(5).                                     <-ALL-FMTS
      +000036*                          ZIP CODE                                           <-ALL-FMTS
   47 +000037           06 ARBAL            PIC S9(6)V9(2).                                <-ALL-FMTS
      +000038*                          ACCOUNTS REC. BALANCE                              <-ALL-FMTS
       003000
   48  003100 FD  CUST-MASTER
   49  003200     LABEL RECORDS ARE STANDARD.
   50  003300 01  CUST-REC.
   51  003400     COPY DDS-CUSMST OF CUSMSTP.
      +000001*    I-O FORMAT:CUSMST     FROM FILE CUSMSTP    OF LIBRARY XMPLIB             CUSMST
```

Figure 70 (Part 1 of 2). Source Listing of a TRANSACTION Inquiry Program Using a Single Display Device.



```
 5763CB1 V3R0M5                  AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
       +000002*                       CUSTOMER MASTER RECORD                             CUSMST
       +000003*THE KEY DEFINITIONS FOR RECORD FORMAT  CUSMST                             CUSMST
       +000004*  NUMBER              NAME              RETRIEVAL     TYPE    ALTSEQ      CUSMST
       +000005*   0001   CUST                           ASCENDING      AN      NO        CUSMST
    52 +000006       05  CUSMST.                                                         CUSMST
    53 +000007           06 CUST             PIC X(5).                                   CUSMST
       +000008*                       CUSTOMER NUMBER                                    CUSMST
    54 +000009           06 NAME             PIC X(25).                                  CUSMST
       +000010*                       CUSTOMER NAME                                      CUSMST
    55 +000011           06 ADDR             PIC X(20).                                  CUSMST
       +000012*                       CUSTOMER ADDRESS                                   CUSMST
    56 +000013           06 CITY             PIC X(20).                                  CUSMST
       +000014*                       CUSTOMER CITY                                      CUSMST
    57 +000015           06 STATE            PIC X(2).                                   CUSMST
       +000016*                       STATE                                              CUSMST
    58 +000017           06 ZIP              PIC S9(5)        COMP-3.                    CUSMST
       +000018*                       ZIP CODE                                           CUSMST
    59 +000019           06 SRHCOD           PIC X(6).                                   CUSMST
       +000020*                       CUSTOMER NUMBER SEARCH CODE                        CUSMST
    60 +000021           06 CUSTYP           PIC S9(1)        COMP-3.                    CUSMST
       +000022*                       CUSTOMER TYPE 1=GOV 2=SCH 3=BUS 4=PVT 5=OT         CUSMST
    61 +000023           06 ARBAL            PIC S9(6)V9(2)   COMP-3.                    CUSMST
       +000024*                       ACCOUNTS REC. BALANCE                              CUSMST
    62 +000025           06 ORDBAL           PIC S9(6)V9(2)   COMP-3.                    CUSMST
       +000026*                       A/R AMT. IN ORDER FILE                             CUSMST
    63 +000027           06 LSTAMT           PIC S9(6)V9(2)   COMP-3.                    CUSMST
       +000028*                       LAST AMT. PAID IN A/R                              CUSMST
    64 +000029           06 LSTDAT           PIC S9(6)        COMP-3.                    CUSMST
       +000030*                       LAST DATE PAID IN A/R                              CUSMST
    65 +000031           06 CRDLMT           PIC S9(6)V9(2)   COMP-3.                    CUSMST
       +000032*                       CUSTOMER CREDIT LIMIT                              CUSMST
    66 +000033           06 SLSYR            PIC S9(8)V9(2)   COMP-3.                    CUSMST
       +000034*                       CUSTOMER SALES THIS YEAR                           CUSMST
    67 +000035           06 SLSLYR           PIC S9(8)V9(2)   COMP-3.                    CUSMST
       +000036*                       CUSTOMER SALES LAST YEAR                           CUSMST
        003500
    68  003600 WORKING-STORAGE SECTION.
    69  003700 01  ONE                              PIC 1 VALUE B"1".
    70  003800 01  CM-STATUS                        PIC X(2).
    71  003900 01  WS-CONTROL.
    72  004000     02  WS-IND                       PIC X(2).
    73  004100     02  WS-FORMAT                    PIC X(10).
    74  004200 PROCEDURE DIVISION.
        004300 BEGIN.
    75  004400     OPEN I-O CUST-DISPLAY, INPUT CUST-MASTER.
    76  004500     MOVE ZERO TO IN99 OF CUSPMT-O.
        004600 LOOP.
    77  004700     WRITE DISP-REC FORMAT IS "CUSPMT".
    78  004800     READ CUST-DISPLAY RECORD.
    79  004900     IF IN15 OF CUSPMT-I
        005000       IS EQUAL TO ONE
    80  005100        THEN GO TO FINIS.
    81  005200     MOVE CUST OF CUSPMT-I TO CUST OF CUSMST.
    82  005300     READ CUST-MASTER RECORD.
    83  005400     IF CM-STATUS IS NOT EQUAL "00" THEN
    84  005500         MOVE ONE TO IN99 OF CUSPMT-O,  GO TO LOOP.
    86  005600     MOVE CORRESPONDING CUSMST TO CUSFLDS-O.
    87  005700     WRITE DISP-REC FORMAT IS "CUSFLDS".
    88  005800     READ CUST-DISPLAY RECORD.
    89  005900     IF IN15 OF CUSFLDS-I
        006000     IS EQUAL TO ONE
    90  006100     THEN GO TO FINIS.
    91  006200     MOVE ZERO TO IN99 OF CUSPMT-O.
    92  006300     GO TO LOOP.
        006400 FINIS.
    93  006500     CLOSE CUST-DISPLAY, CUST-MASTER.
        006600 RETURN-TO-CALLER.
    94  006700     EXIT PROGRAM.
                        * * * * *   E N D   O F   S O U R C E   * * * * *
```

Figure 70 (Part 2 of 2). Source Listing of a TRANSACTION Inquiry Program Using a Single Display Device.

The complete source listing for this program example is shown here. In particular, note the FILE-CONTROL and FD entries and the data structures generated by the Format 2 COPY statements.

The WRITE operation in statement 77 writes the CUSPMT format to the display. This record prompts you to enter a customer number. If you enter a customer number and press Enter, the next READ operation then reads the record back into the program.

The READ operation in statement 82 uses the customer number (CUST) field to retrieve the corresponding CUSMST record from the CUSMSTP file. If no record is found in the CUSMSTP file, indicator 99 is set on. The GO TO operation in statement 84, which is run when indicator 99 is set on, causes the program to branch back to the beginning. The message:

```
Customer number not found
```

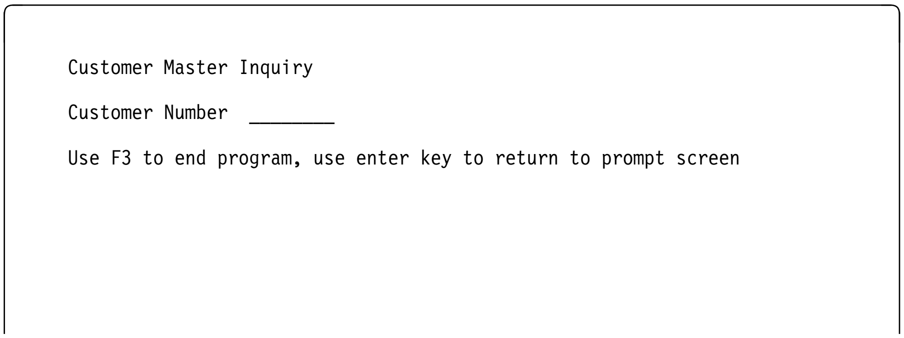
is displayed when the format is written, because it is conditioned by indicator 99 in the DDS for the file. When you receive this message, the keyboard locks. You must press the Reset key in response to this message to unlock the keyboard. You can then enter another customer number.

If the READ operation retrieves a record from the CUSMSTP file, the WRITE operation writes the CUSFLDS record to the display work station. This record contains the customer's name, address, and accounts receivable balance.

You then press Enter, and the program branches back to the beginning. You can enter another customer number or end the program. To end the program, press F3, which sets on indicator 15 in the program.

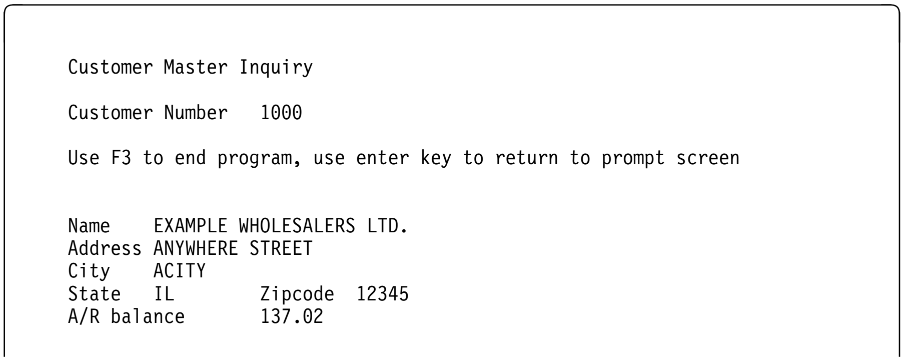
When indicator 15 is on, the program closes all files and processes the EXIT PROGRAM statement. The program then returns control to the individual who called the COBOL program.

This is the initial display written by the WRITE operation in statement 77:



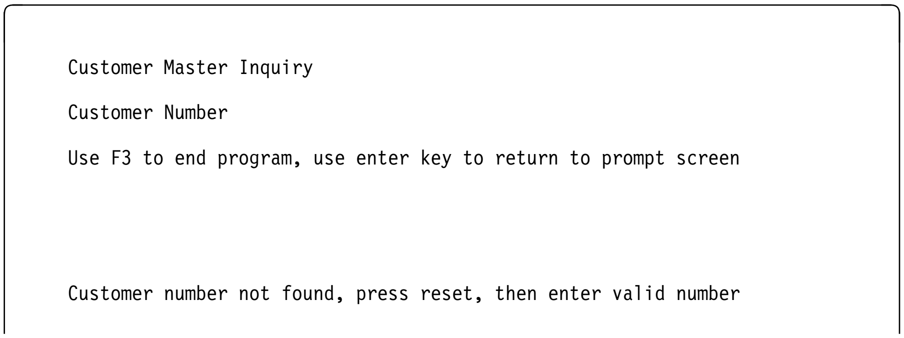
```
Customer Master Inquiry

Customer Number  ________

Use F3 to end program, use enter key to return to prompt screen
```

This display appears if a record is found in the CUSMSTP file for the customer number entered in response to the first display:



```
Customer Master Inquiry

Customer Number   1000

Use F3 to end program, use enter key to return to prompt screen


Name    EXAMPLE WHOLESALERS LTD.
Address ANYWHERE STREET
City    ACITY
State   IL        Zipcode  12345
A/R balance       137.02
```

This display appears if the CUSMSTP file does not contain a record for the customer number entered in response to the first display:

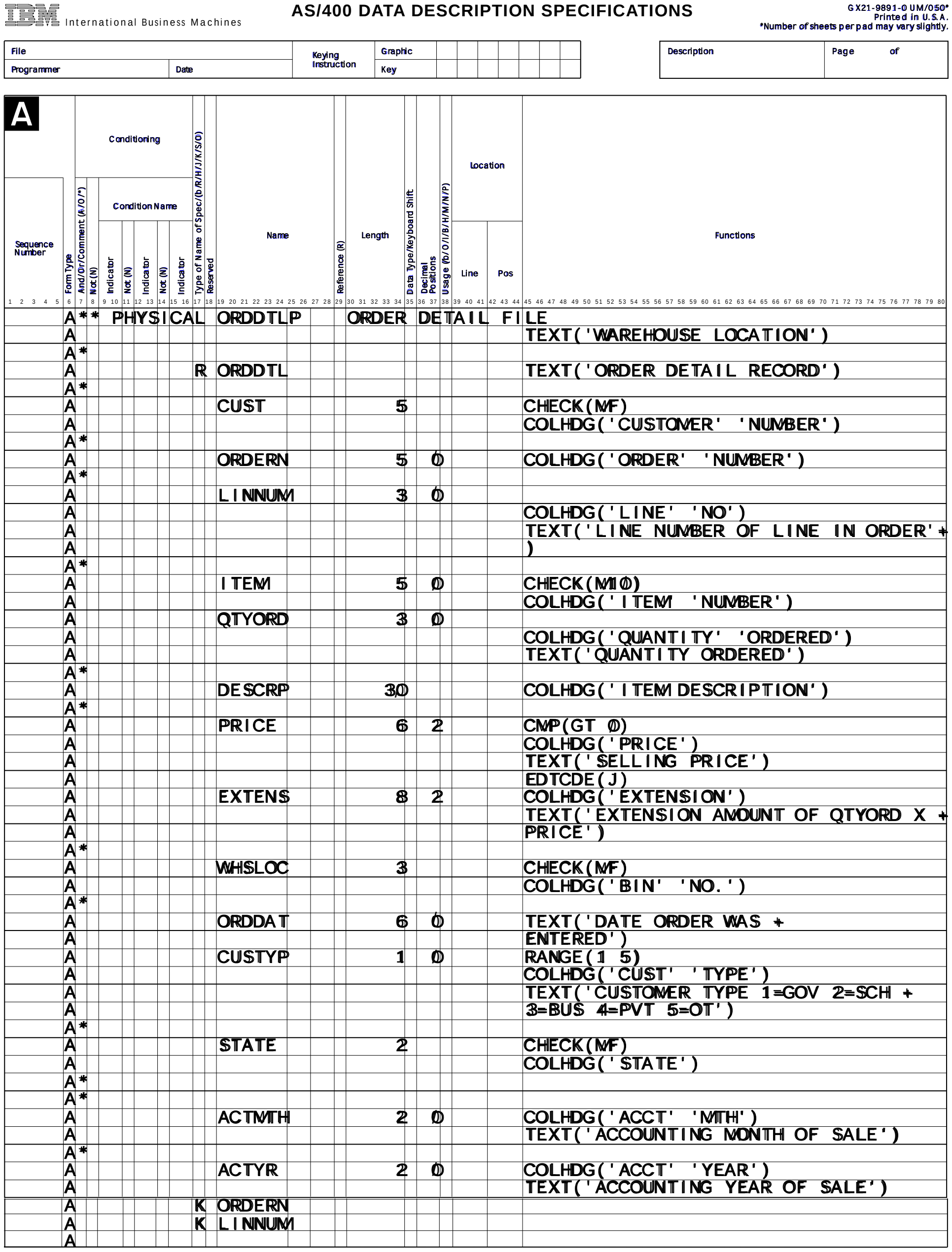


```
Customer Master Inquiry

Customer Number

Use F3 to end program, use enter key to return to prompt screen





Customer number not found, press reset, then enter valid number
```

Order Inquiry Programs Using Subfiles

Figure 72 on page 210 shows an example of an order inquiry program, XMPLE773, that uses subfiles. The associated DDS is also shown, except for the DDS for the customer master file, CUSMSTP. Refer to Figure 69 on page 202 for the DDS for CUSMSTP.

XMPLE773 displays all the detail order records for the requested order number. The program prompts you to enter the order number that is to be reviewed. The order number is checked against the order header file, ORDHDRP. If the order number exists, the customer number accessed from the order header file is checked against the customer master file, CUSMSTP. All order detail records in ORDDTLP for the requested order are read and written to the subfile. A write for the subfile control record format is processed, and the detail order records in the subfile are displayed for you to review. You end the program by pressing F12.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

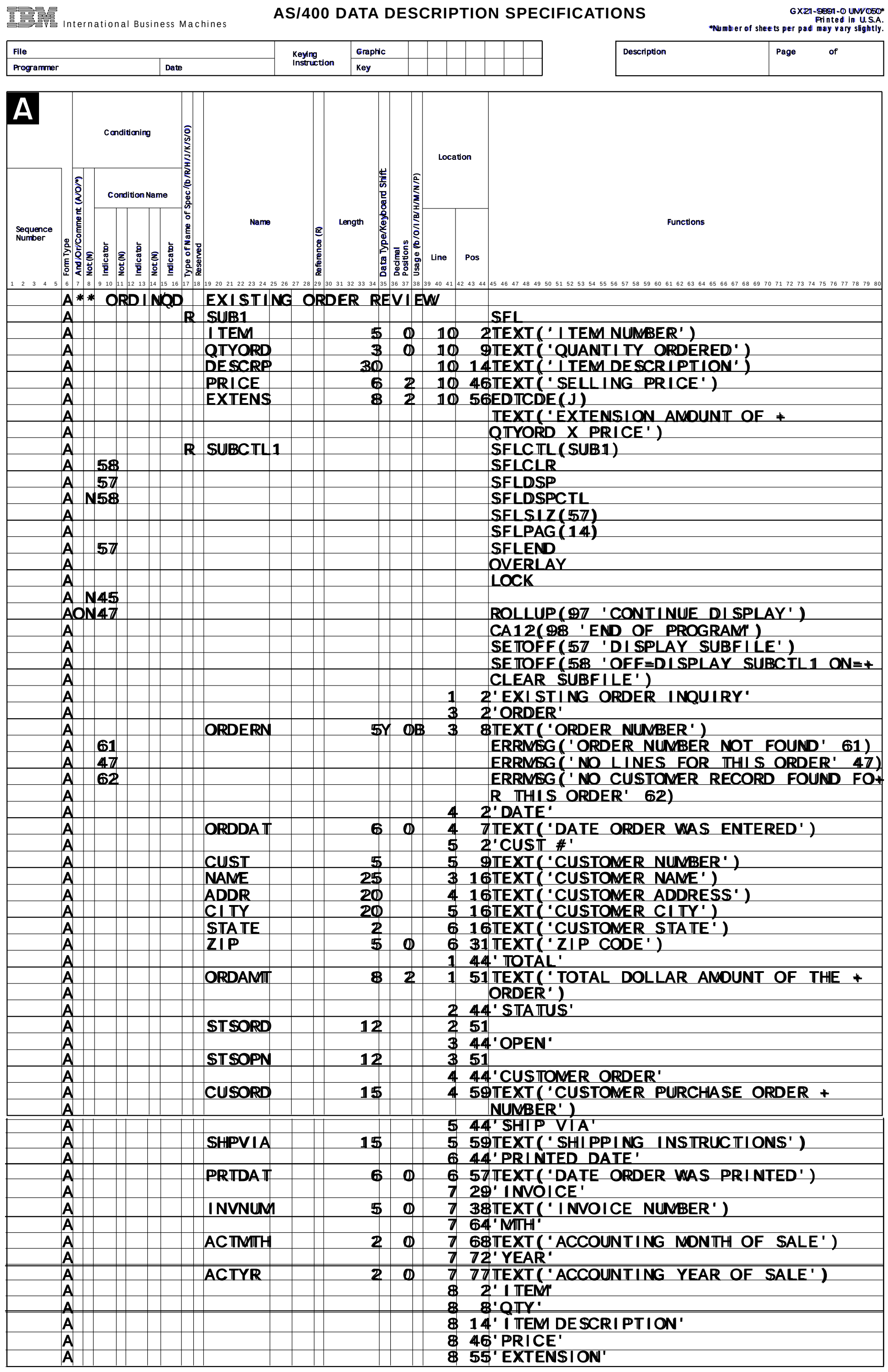
GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Programmer | Date | Keying Instruction | Graphic | Key | Description | Page of

A

```
     A** PHYSICAL ORDDTLP    ORDER DETAIL FILE
     A                                      TEXT('WAREHOUSE LOCATION')
     A*
     A          R ORDDTL                    TEXT('ORDER DETAIL RECORD')
     A*
     A            CUST           5          CHECK(MF)
     A                                      COLHDG('CUSTOMER' 'NUMBER')
     A*
     A            ORDERN         5  0       COLHDG('ORDER' 'NUMBER')
     A*
     A            LINNUM         3  0
     A                                      COLHDG('LINE' 'NO')
     A                                      TEXT('LINE NUMBER OF LINE IN ORDER'+
     A                                      )
     A*
     A            ITEM           5  0       CHECK(M10)
     A                                      COLHDG('ITEM' 'NUMBER')
     A            QTYORD         3  0
     A                                      COLHDG('QUANTITY' 'ORDERED')
     A                                      TEXT('QUANTITY ORDERED')
     A*
     A            DESCRP        30          COLHDG('ITEM DESCRIPTION')
     A*
     A            PRICE          6  2       CMP(GT 0)
     A                                      COLHDG('PRICE')
     A                                      TEXT('SELLING PRICE')
     A                                      EDTCDE(J)
     A            EXTENS         8  2       COLHDG('EXTENSION')
     A                                      TEXT('EXTENSION AMOUNT OF QTYORD X +
     A                                      PRICE')
     A*
     A            WHSLOC         3          CHECK(MF)
     A                                      COLHDG('BIN' 'NO.')
     A*
     A            ORDDAT         6  0       TEXT('DATE ORDER WAS +
     A                                      ENTERED')
     A            CUSTYP         1  0       RANGE(1 5)
     A                                      COLHDG('CUST' 'TYPE')
     A                                      TEXT('CUSTOMER TYPE 1=GOV 2=SCH +
     A                                      3=BUS 4=PVT 5=OT')
     A*
     A            STATE          2          CHECK(MF)
     A                                      COLHDG('STATE')
     A*
     A*
     A            ACTMTH         2  0       COLHDG('ACCT' 'MTH')
     A                                      TEXT('ACCOUNTING MONTH OF SALE')
     A*
     A            ACTYR          2  0       COLHDG('ACCT' 'YEAR')
     A                                      TEXT('ACCOUNTING YEAR OF SALE')
     A          K ORDERN
     A          K LINNUM
     A
```

Figure 71 (Part 1 of 3). Data Description Specifications for an Order Inquiry Program



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File		Keying Instruction	Graphic	Description	Page of
Programmer	Date		Key		

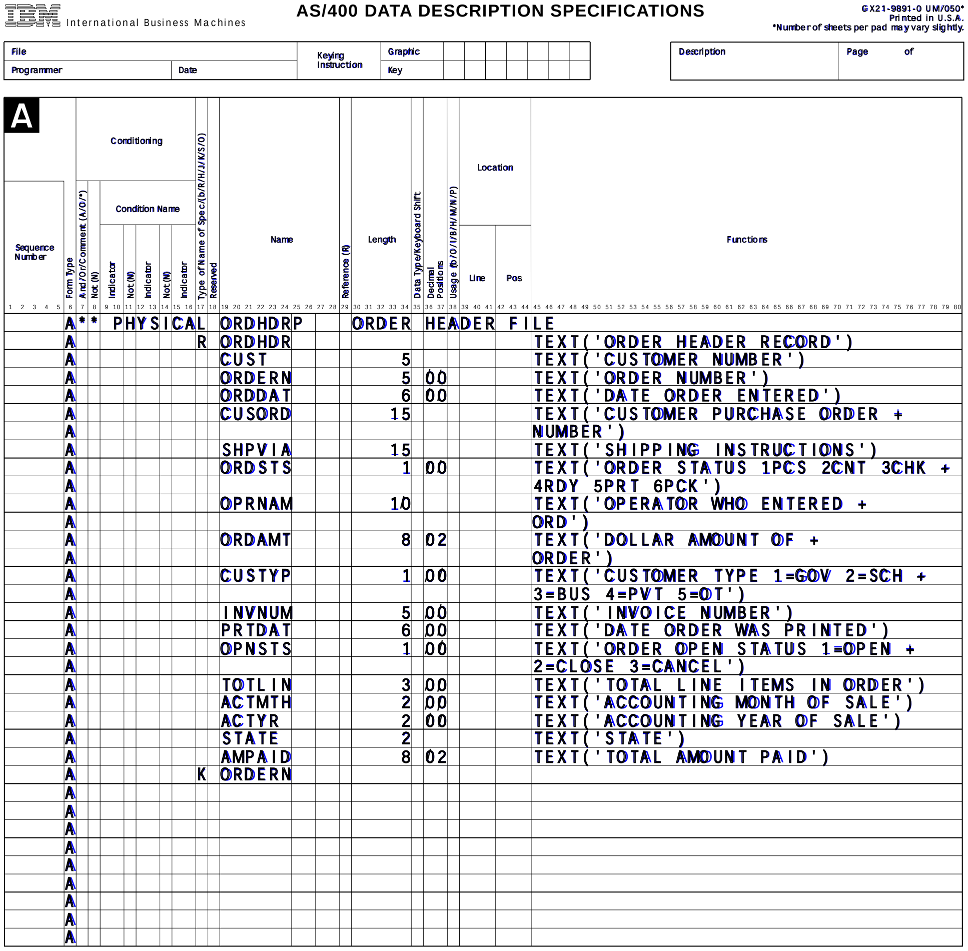
A

Sequence Number	Form Type	And/Or/Comment (A/O/*)	Not (N)	Indicator	Not (N)	Indicator	Not (N)	Indicator	Type of Name of Spec (b/R/H/J/K/S/O)	Reserved	Name	Reference (R)	Length	Data Type/Keyboard Shift	Decimal Positions	Usage (b/O/I/B/H/M/N/P)	Line	Pos	Functions
1 2 3 4 5	6	7	8	9 10	11	12 13	14	15 16	17	18	19 20 21 22 23 24 25 26 27 28	29	30 31 32 33 34	35	36 37	38	39 40 41	42 43 44	45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

(Conditioning; Condition Name; Location)

```
     A** ORDINQD  EXISTING ORDER REVIEW
     A          R SUB1                      SFL
     A            ITEM           5  0  10  2TEXT('ITEM NUMBER')
     A            QTYORD         3  0  10  9TEXT('QUANTITY ORDERED')
     A            DESCRP        30     10 14TEXT('ITEM DESCRIPTION')
     A            PRICE          6  2  10 46TEXT('SELLING PRICE')
     A            EXTENS         8  2  10 56EDTCDE(J)
     A                                      TEXT('EXTENSION AMOUNT OF +
     A                                      QTYORD X PRICE')
     A          R SUBCTL1                   SFLCTL(SUB1)
     A  58                                  SFLCLR
     A  57                                  SFLDSP
     A N58                                  SFLDSPCTL
     A                                      SFLSIZ(57)
     A                                      SFLPAG(14)
     A  57                                  SFLEND
     A                                      OVERLAY
     A                                      LOCK
     A N45
     AON47                                  ROLLUP(97 'CONTINUE DISPLAY')
     A                                      CA12(98 'END OF PROGRAM')
     A                                      SETOFF(57 'DISPLAY SUBFILE')
     A                                      SETOFF(58 'OFF=DISPLAY SUBCTL1 ON=+
     A                                      CLEAR SUBFILE')
     A                                  1  2'EXISTING ORDER INQUIRY'
     A                                  3  2'ORDER'
     A            ORDERN         5Y 0B  3  8TEXT('ORDER NUMBER')
     A  61                                  ERRMSG('ORDER NUMBER NOT FOUND' 61)
     A  47                                  ERRMSG('NO LINES FOR THIS ORDER' 47)
     A  62                                  ERRMSG('NO CUSTOMER RECORD FOUND FO+
     A                                      R THIS ORDER' 62)
     A                                  4  2'DATE'
     A            ORDDAT         6  0   4  7TEXT('DATE ORDER WAS ENTERED')
     A                                  5  2'CUST #'
     A            CUST           5      5  9TEXT('CUSTOMER NUMBER')
     A            NAME          25      3 16TEXT('CUSTOMER NAME')
     A            ADDR          20      4 16TEXT('CUSTOMER ADDRESS')
     A            CITY          20      5 16TEXT('CUSTOMER CITY')
     A            STATE          2      6 16TEXT('CUSTOMER STATE')
     A            ZIP            5  0   6 31TEXT('ZIP CODE')
     A                                  1 44'TOTAL'
     A            ORDAMT         8  2   1 51TEXT('TOTAL DOLLAR AMOUNT OF THE +
     A                                      ORDER')
     A                                  2 44'STATUS'
     A            STSORD        12      2 51
     A                                  3 44'OPEN'
     A            STSOPN        12      3 51
     A                                  4 44'CUSTOMER ORDER'
     A            CUSORD        15      4 59TEXT('CUSTOMER PURCHASE ORDER +
     A                                      NUMBER')
     A                                  5 44'SHIP VIA'
     A            SHPVIA        15      5 59TEXT('SHIPPING INSTRUCTIONS')
     A                                  6 44'PRINTED DATE'
     A            PRTDAT         6  0   6 57TEXT('DATE ORDER WAS PRINTED')
     A                                  7 29'INVOICE'
     A            INVNUM         5  0   7 38TEXT('INVOICE NUMBER')
     A                                  7 64'MTH'
     A            ACTMTH         2  0   7 68TEXT('ACCOUNTING MONTH OF SALE')
     A                                  7 72'YEAR'
     A            ACTYR          2  0   7 77TEXT('ACCOUNTING YEAR OF SALE')
     A                                  8  2'ITEM'
     A                                  8  8'QTY'
     A                                  8 14'ITEM DESCRIPTION'
     A                                  8 46'PRICE'
     A                                  8 55'EXTENSION'
```

Figure 71 (Part 2 of 3). Data Description Specifications for an Order Inquiry Program



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

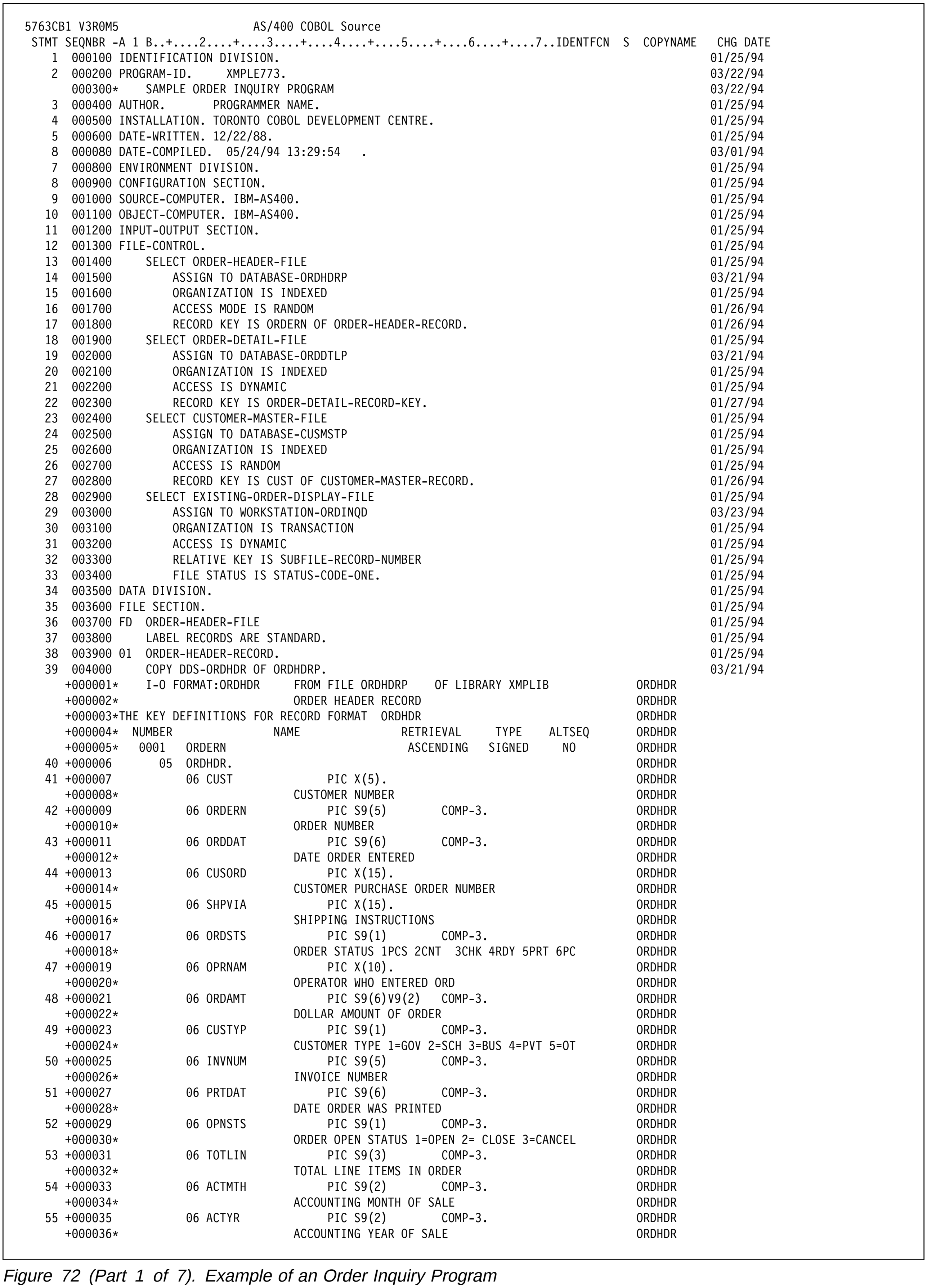
File
Programmer
Date
Keying Instruction
Graphic
Key
Description
Page of

A

Sequence Number | Form Type | And/Or/Comment (A/O/*) | Conditioning: Not (N), Indicator, Not (N), Indicator, Not (N), Indicator (Condition Name) | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A** PHYSICAL ORDHDRP   ORDER HEADER FILE
     A          R ORDHDR                    TEXT('ORDER HEADER RECORD')
     A            CUST           5          TEXT('CUSTOMER NUMBER')
     A            ORDERN         5 00       TEXT('ORDER NUMBER')
     A            ORDDAT         6 00       TEXT('DATE ORDER ENTERED')
     A            CUSORD        15          TEXT('CUSTOMER PURCHASE ORDER +
     A                                      NUMBER')
     A            SHPVIA        15          TEXT('SHIPPING INSTRUCTIONS')
     A            ORDSTS         1 00       TEXT('ORDER STATUS 1PCS 2CNT 3CHK +
     A                                      4RDY 5PRT 6PCK')
     A            OPRNAM        10          TEXT('OPERATOR WHO ENTERED +
     A                                      ORD')
     A            ORDAMT         8 02       TEXT('DOLLAR AMOUNT OF +
     A                                      ORDER')
     A            CUSTYP         1 00       TEXT('CUSTOMER TYPE 1=GOV 2=SCH +
     A                                      3=BUS 4=PVT 5=OT')
     A            INVNUM         5 00       TEXT('INVOICE NUMBER')
     A            PRTDAT         6 00       TEXT('DATE ORDER WAS PRINTED')
     A            OPNSTS         1 00       TEXT('ORDER OPEN STATUS 1=OPEN +
     A                                      2=CLOSE 3=CANCEL')
     A            TOTLIN         3 00       TEXT('TOTAL LINE ITEMS IN ORDER')
     A            ACTMTH         2 00       TEXT('ACCOUNTING MONTH OF SALE')
     A            ACTYR          2 00       TEXT('ACCOUNTING YEAR OF SALE')
     A            STATE          2          TEXT('STATE')
     A            AMPAID         8 02       TEXT('TOTAL AMOUNT PAID')
     A          K ORDERN
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 71 (Part 3 of 3). Data Description Specifications for an Order Inquiry Program

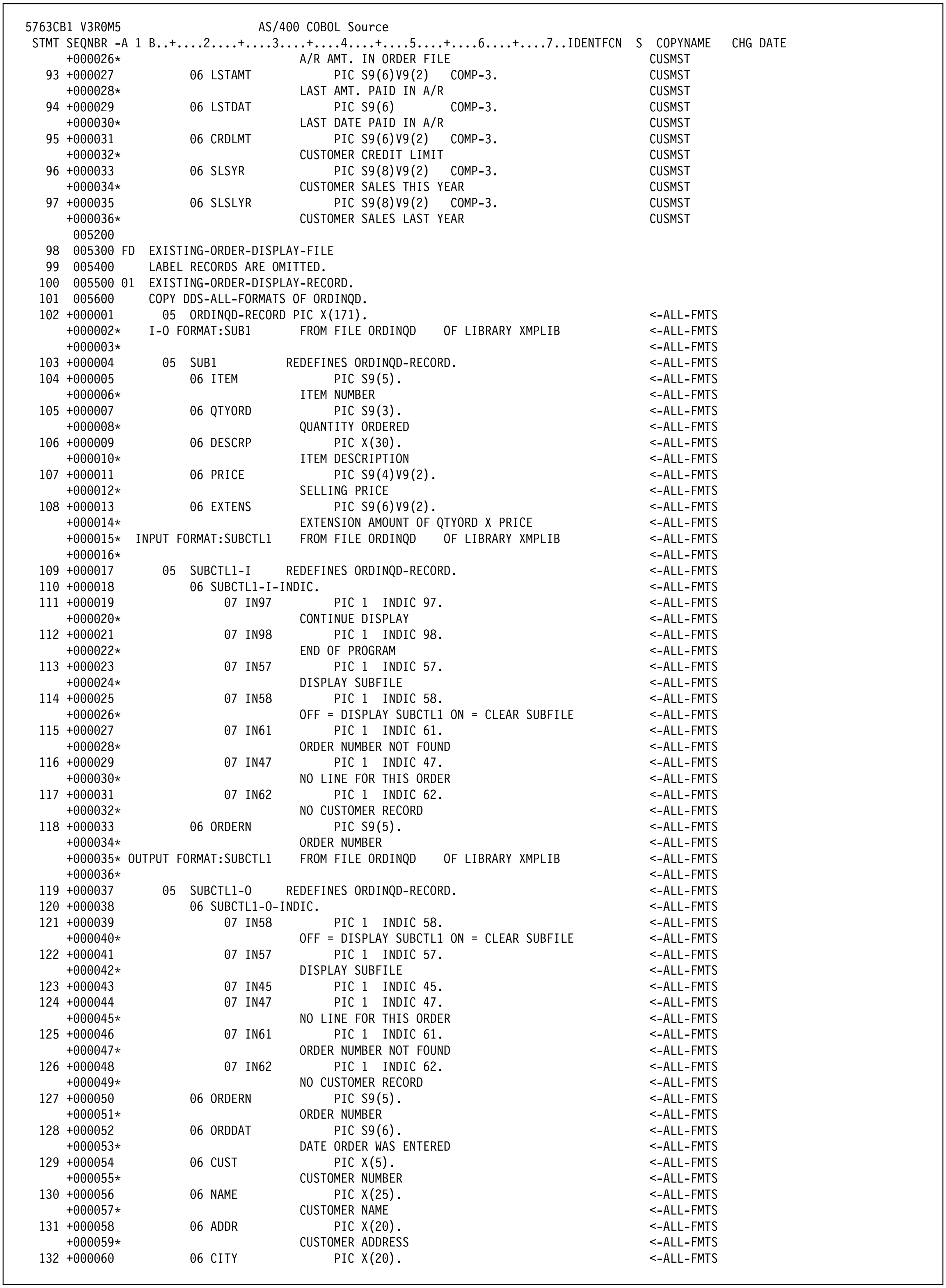


```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000100 IDENTIFICATION DIVISION.                                                                  01/25/94
     2  000200 PROGRAM-ID.     XMPLE773.                                                                 03/22/94
        000300*    SAMPLE ORDER INQUIRY PROGRAM                                                          03/22/94
     3  000400 AUTHOR.       PROGRAMMER NAME.                                                            01/25/94
     4  000500 INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                           01/25/94
     5  000600 DATE-WRITTEN. 12/22/88.                                                                   01/25/94
     8  000080 DATE-COMPILED.  05/24/94 13:29:54   .                                                     03/01/94
     7  000800 ENVIRONMENT DIVISION.                                                                     01/25/94
     8  000900 CONFIGURATION SECTION.                                                                    01/25/94
     9  001000 SOURCE-COMPUTER. IBM-AS400.                                                               01/25/94
    10  001100 OBJECT-COMPUTER. IBM-AS400.                                                               01/25/94
    11  001200 INPUT-OUTPUT SECTION.                                                                     01/25/94
    12  001300 FILE-CONTROL.                                                                             01/25/94
    13  001400     SELECT ORDER-HEADER-FILE                                                              01/25/94
    14  001500         ASSIGN TO DATABASE-ORDHDRP                                                        03/21/94
    15  001600         ORGANIZATION IS INDEXED                                                           01/25/94
    16  001700         ACCESS MODE IS RANDOM                                                             01/26/94
    17  001800         RECORD KEY IS ORDERN OF ORDER-HEADER-RECORD.                                      01/26/94
    18  001900     SELECT ORDER-DETAIL-FILE                                                              01/25/94
    19  002000         ASSIGN TO DATABASE-ORDDTLP                                                        03/21/94
    20  002100         ORGANIZATION IS INDEXED                                                           01/25/94
    21  002200         ACCESS IS DYNAMIC                                                                 01/25/94
    22  002300         RECORD KEY IS ORDER-DETAIL-RECORD-KEY.                                            01/27/94
    23  002400     SELECT CUSTOMER-MASTER-FILE                                                           01/25/94
    24  002500         ASSIGN TO DATABASE-CUSMSTP                                                        01/25/94
    25  002600         ORGANIZATION IS INDEXED                                                           01/25/94
    26  002700         ACCESS IS RANDOM                                                                  01/25/94
    27  002800         RECORD KEY IS CUST OF CUSTOMER-MASTER-RECORD.                                     01/26/94
    28  002900     SELECT EXISTING-ORDER-DISPLAY-FILE                                                    01/25/94
    29  003000         ASSIGN TO WORKSTATION-ORDINQD                                                     03/23/94
    30  003100         ORGANIZATION IS TRANSACTION                                                       01/25/94
    31  003200         ACCESS IS DYNAMIC                                                                 01/25/94
    32  003300         RELATIVE KEY IS SUBFILE-RECORD-NUMBER                                             01/25/94
    33  003400         FILE STATUS IS STATUS-CODE-ONE.                                                   01/25/94
    34  003500 DATA DIVISION.                                                                            01/25/94
    35  003600 FILE SECTION.                                                                             01/25/94
    36  003700 FD  ORDER-HEADER-FILE                                                                     01/25/94
    37  003800     LABEL RECORDS ARE STANDARD.                                                           01/25/94
    38  003900 01  ORDER-HEADER-RECORD.                                                                  01/25/94
    39  004000     COPY DDS-ORDHDR OF ORDHDRP.                                                           03/21/94
       +000001*    I-O FORMAT:ORDHDR     FROM FILE ORDHDRP    OF LIBRARY XMPLIB            ORDHDR
       +000002*                          ORDER HEADER RECORD                               ORDHDR
       +000003*THE KEY DEFINITIONS FOR RECORD FORMAT  ORDHDR                               ORDHDR
       +000004*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ      ORDHDR
       +000005*   0001   ORDERN                           ASCENDING   SIGNED     NO        ORDHDR
    40 +000006       05  ORDHDR.                                                           ORDHDR
    41 +000007           06 CUST              PIC X(5).                                    ORDHDR
       +000008*                          CUSTOMER NUMBER                                   ORDHDR
    42 +000009           06 ORDERN            PIC S9(5)        COMP-3.                     ORDHDR
       +000010*                          ORDER NUMBER                                      ORDHDR
    43 +000011           06 ORDDAT            PIC S9(6)        COMP-3.                     ORDHDR
       +000012*                          DATE ORDER ENTERED                                ORDHDR
    44 +000013           06 CUSORD            PIC X(15).                                   ORDHDR
       +000014*                          CUSTOMER PURCHASE ORDER NUMBER                    ORDHDR
    45 +000015           06 SHPVIA            PIC X(15).                                   ORDHDR
       +000016*                          SHIPPING INSTRUCTIONS                             ORDHDR
    46 +000017           06 ORDSTS            PIC S9(1)        COMP-3.                     ORDHDR
       +000018*                          ORDER STATUS 1PCS 2CNT  3CHK 4RDY 5PRT 6PC        ORDHDR
    47 +000019           06 OPRNAM            PIC X(10).                                   ORDHDR
       +000020*                          OPERATOR WHO ENTERED ORD                          ORDHDR
    48 +000021           06 ORDAMT            PIC S9(6)V9(2)   COMP-3.                     ORDHDR
       +000022*                          DOLLAR AMOUNT OF ORDER                            ORDHDR
    49 +000023           06 CUSTYP            PIC S9(1)        COMP-3.                     ORDHDR
       +000024*                          CUSTOMER TYPE 1=GOV 2=SCH 3=BUS 4=PVT 5=OT        ORDHDR
    50 +000025           06 INVNUM            PIC S9(5)        COMP-3.                     ORDHDR
       +000026*                          INVOICE NUMBER                                    ORDHDR
    51 +000027           06 PRTDAT            PIC S9(6)        COMP-3.                     ORDHDR
       +000028*                          DATE ORDER WAS PRINTED                            ORDHDR
    52 +000029           06 OPNSTS            PIC S9(1)        COMP-3.                     ORDHDR
       +000030*                          ORDER OPEN STATUS 1=OPEN 2= CLOSE 3=CANCEL        ORDHDR
    53 +000031           06 TOTLIN            PIC S9(3)        COMP-3.                     ORDHDR
       +000032*                          TOTAL LINE ITEMS IN ORDER                         ORDHDR
    54 +000033           06 ACTMTH            PIC S9(2)        COMP-3.                     ORDHDR
       +000034*                          ACCOUNTING MONTH OF SALE                          ORDHDR
    55 +000035           06 ACTYR             PIC S9(2)        COMP-3.                     ORDHDR
       +000036*                          ACCOUNTING YEAR OF SALE                           ORDHDR
```

Figure 72 (Part 1 of 7). Example of an Order Inquiry Program

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   56 +000037           06 STATE             PIC X(2).                                     ORDHDR
      +000038*                          STATE                                              ORDHDR
   57 +000039           06 AMPAID            PIC S9(6)V9(2)   COMP-3.                      ORDHDR
      +000040*                          AMOUNT PAID                                        ORDHDR
       004100
   58  004200 FD  ORDER-DETAIL-FILE
   59  004300     LABEL RECORDS ARE STANDARD.
   60  004400 01  ORDER-DETAIL-RECORD.
   61  004500     COPY DDS-ORDDTL OF ORDDTLP.
      +000001*    I-O FORMAT:ORDDTL     FROM FILE ORDDTLP    OF LIBRARY XMPLIB             ORDDTL
      +000002*                          ORDER DETAIL RECORD                                ORDDTL
      +000003*THE KEY DEFINITIONS FOR RECORD FORMAT  ORDDTL                                ORDDTL
      +000004*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ       ORDDTL
      +000005*   0001   ORDERN                           ASCENDING   SIGNED     NO         ORDDTL
      +000006*   0002   LINNUM                           ASCENDING   SIGNED     NO         ORDDTL
   62 +000007       05  ORDDTL.                                                            ORDDTL
   63 +000008           06 CUST              PIC X(5).                                     ORDDTL
      +000009*                          CUSTOMER NUMBER                                    ORDDTL
   64 +000010           06 ORDERN            PIC S9(5)        COMP-3.                      ORDDTL
      +000011*                          ORDER NUMBER                                       ORDDTL
   65 +000012           06 LINNUM            PIC S9(3)        COMP-3.                      ORDDTL
      +000013*                          LINE NUMBER OF LINE IN ORDER                       ORDDTL
   66 +000014           06 ITEM              PIC S9(5)        COMP-3.                      ORDDTL
      +000015*                          ITEM NUMBER                                        ORDDTL
   67 +000016           06 QTYORD            PIC S9(3)        COMP-3.                      ORDDTL
      +000017*                          QUANTITY ORDERED                                   ORDDTL
   68 +000018           06 DESCRP            PIC X(30).                                    ORDDTL
      +000019*                          ITEM DESCRIPTION                                   ORDDTL
   69 +000020           06 PRICE             PIC S9(4)V9(2)   COMP-3.                      ORDDTL
      +000021*                          SELLING PRICE                                      ORDDTL
   70 +000022           06 EXTENS            PIC S9(6)V9(2)   COMP-3.                      ORDDTL
      +000023*                          EXTENSION AMOUNT OF QTYORD X PRICE                 ORDDTL
   71 +000024           06 WHSLOC            PIC X(3).                                     ORDDTL
      +000025*                          BIN NO.                                            ORDDTL
   72 +000026           06 ORDDAT            PIC S9(6)        COMP-3.                      ORDDTL
      +000027*                          DATE ORDER WAS ENTERED                             ORDDTL
   73 +000028           06 CUSTYP            PIC S9(1)        COMP-3.                      ORDDTL
      +000029*                          CUSTOMER TYPE 1=GOV 2=SCH   3=BUS 4=PVT 5=         ORDDTL
   74 +000030           06 STATE             PIC X(2).                                     ORDDTL
      +000031*                          STATE                                              ORDDTL
   75 +000032           06 ACTMTH            PIC S9(2)        COMP-3.                      ORDDTL
      +000033*                          ACCOUNTING MONTH OF SALE                           ORDDTL
   76 +000034           06 ACTYR             PIC S9(2)        COMP-3.                      ORDDTL
      +000035*                          ACCOUNTING YEAR OF SALE                            ORDDTL
   77  004600 66  ORDER-DETAIL-RECORD-KEY RENAMES ORDERN THRU LINNUM.
       004700
   78  004800 FD  CUSTOMER-MASTER-FILE
   79  004900     LABEL RECORDS ARE STANDARD.
   80  005000 01  CUSTOMER-MASTER-RECORD.
   81  005100     COPY DDS-CUSMST OF CUSMSTP.
      +000001*    I-O FORMAT:CUSMST     FROM FILE CUSMSTP    OF LIBRARY XMPLIB             CUSMST
      +000002*                          CUSTOMER MASTER RECORD                             CUSMST
      +000003*THE KEY DEFINITIONS FOR RECORD FORMAT  CUSMST                                CUSMST
      +000004*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ       CUSMST
      +000005*   0001   CUST                             ASCENDING      AN      NO         CUSMST
   82 +000006       05  CUSMST.                                                            CUSMST
   83 +000007           06 CUST              PIC X(5).                                     CUSMST
      +000008*                          CUSTOMER NUMBER                                    CUSMST
   84 +000009           06 NAME              PIC X(25).                                    CUSMST
      +000010*                          CUSTOMER NAME                                      CUSMST
   85 +000011           06 ADDR              PIC X(20).                                    CUSMST
      +000012*                          CUSTOMER ADDRESS                                   CUSMST
   86 +000013           06 CITY              PIC X(20).                                    CUSMST
      +000014*                          CUSTOMER CITY                                      CUSMST
   87 +000015           06 STATE             PIC X(2).                                     CUSMST
      +000016*                          STATE                                              CUSMST
   88 +000017           06 ZIP               PIC S9(5)        COMP-3.                      CUSMST
      +000018*                          ZIP CODE                                           CUSMST
   89 +000019           06 SRHCOD            PIC X(6).                                     CUSMST
      +000020*                          CUSTOMER NUMBER SEARCH CODE                        CUSMST
   90 +000021           06 CUSTYP            PIC S9(1)        COMP-3.                      CUSMST
      +000022*                          CUSTOMER TYPE 1=GOV 2=SCH 3=BUS 4=PVT 5=OT         CUSMST
   91 +000023           06 ARBAL             PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000024*                          ACCOUNTS REC. BALANCE                              CUSMST
   92 +000025           06 ORDBAL            PIC S9(6)V9(2)   COMP-3.                      CUSMST
```

Figure 72 (Part 2 of 7). Example of an Order Inquiry Program

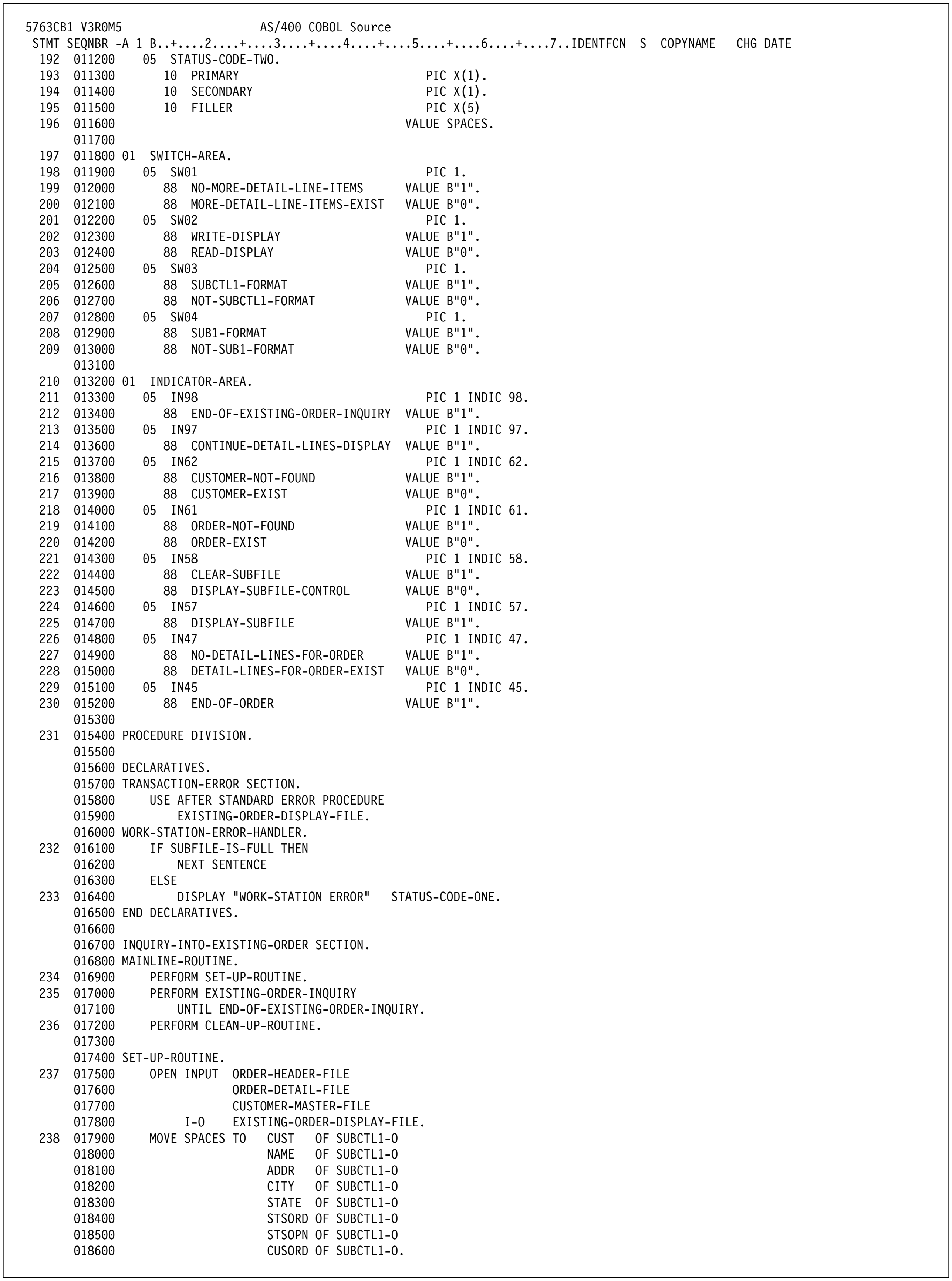


```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
      +000026*                          A/R AMT. IN ORDER FILE                             CUSMST
   93 +000027           06 LSTAMT            PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000028*                          LAST AMT. PAID IN A/R                              CUSMST
   94 +000029           06 LSTDAT            PIC S9(6)        COMP-3.                      CUSMST
      +000030*                          LAST DATE PAID IN A/R                              CUSMST
   95 +000031           06 CRDLMT            PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000032*                          CUSTOMER CREDIT LIMIT                              CUSMST
   96 +000033           06 SLSYR             PIC S9(8)V9(2)   COMP-3.                      CUSMST
      +000034*                          CUSTOMER SALES THIS YEAR                           CUSMST
   97 +000035           06 SLSLYR            PIC S9(8)V9(2)   COMP-3.                      CUSMST
      +000036*                          CUSTOMER SALES LAST YEAR                           CUSMST
       005200
   98  005300 FD  EXISTING-ORDER-DISPLAY-FILE
   99  005400     LABEL RECORDS ARE OMITTED.
  100  005500 01  EXISTING-ORDER-DISPLAY-RECORD.
  101  005600     COPY DDS-ALL-FORMATS OF ORDINQD.
  102 +000001       05  ORDINQD-RECORD PIC X(171).                                         <-ALL-FMTS
      +000002*    I-O FORMAT:SUB1       FROM FILE ORDINQD    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                                                                             <-ALL-FMTS
  103 +000004       05  SUB1          REDEFINES ORDINQD-RECORD.                            <-ALL-FMTS
  104 +000005           06 ITEM              PIC S9(5).                                    <-ALL-FMTS
      +000006*                          ITEM NUMBER                                        <-ALL-FMTS
  105 +000007           06 QTYORD            PIC S9(3).                                    <-ALL-FMTS
      +000008*                          QUANTITY ORDERED                                   <-ALL-FMTS
  106 +000009           06 DESCRP            PIC X(30).                                    <-ALL-FMTS
      +000010*                          ITEM DESCRIPTION                                   <-ALL-FMTS
  107 +000011           06 PRICE             PIC S9(4)V9(2).                               <-ALL-FMTS
      +000012*                          SELLING PRICE                                      <-ALL-FMTS
  108 +000013           06 EXTENS            PIC S9(6)V9(2).                               <-ALL-FMTS
      +000014*                          EXTENSION AMOUNT OF QTYORD X PRICE                 <-ALL-FMTS
      +000015*  INPUT FORMAT:SUBCTL1    FROM FILE ORDINQD    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000016*                                                                             <-ALL-FMTS
  109 +000017       05  SUBCTL1-I     REDEFINES ORDINQD-RECORD.                            <-ALL-FMTS
  110 +000018           06 SUBCTL1-I-INDIC.                                                <-ALL-FMTS
  111 +000019                07 IN97         PIC 1  INDIC 97.                              <-ALL-FMTS
      +000020*                          CONTINUE DISPLAY                                   <-ALL-FMTS
  112 +000021                07 IN98         PIC 1  INDIC 98.                              <-ALL-FMTS
      +000022*                          END OF PROGRAM                                     <-ALL-FMTS
  113 +000023                07 IN57         PIC 1  INDIC 57.                              <-ALL-FMTS
      +000024*                          DISPLAY SUBFILE                                    <-ALL-FMTS
  114 +000025                07 IN58         PIC 1  INDIC 58.                              <-ALL-FMTS
      +000026*                          OFF = DISPLAY SUBCTL1 ON = CLEAR SUBFILE           <-ALL-FMTS
  115 +000027                07 IN61         PIC 1  INDIC 61.                              <-ALL-FMTS
      +000028*                          ORDER NUMBER NOT FOUND                             <-ALL-FMTS
  116 +000029                07 IN47         PIC 1  INDIC 47.                              <-ALL-FMTS
      +000030*                          NO LINE FOR THIS ORDER                             <-ALL-FMTS
  117 +000031                07 IN62         PIC 1  INDIC 62.                              <-ALL-FMTS
      +000032*                          NO CUSTOMER RECORD                                 <-ALL-FMTS
  118 +000033           06 ORDERN            PIC S9(5).                                    <-ALL-FMTS
      +000034*                          ORDER NUMBER                                       <-ALL-FMTS
      +000035* OUTPUT FORMAT:SUBCTL1    FROM FILE ORDINQD    OF LIBRARY XMPLIB             <-ALL-FMTS
      +000036*                                                                             <-ALL-FMTS
  119 +000037       05  SUBCTL1-O     REDEFINES ORDINQD-RECORD.                            <-ALL-FMTS
  120 +000038           06 SUBCTL1-O-INDIC.                                                <-ALL-FMTS
  121 +000039                07 IN58         PIC 1  INDIC 58.                              <-ALL-FMTS
      +000040*                          OFF = DISPLAY SUBCTL1 ON = CLEAR SUBFILE           <-ALL-FMTS
  122 +000041                07 IN57         PIC 1  INDIC 57.                              <-ALL-FMTS
      +000042*                          DISPLAY SUBFILE                                    <-ALL-FMTS
  123 +000043                07 IN45         PIC 1  INDIC 45.                              <-ALL-FMTS
  124 +000044                07 IN47         PIC 1  INDIC 47.                              <-ALL-FMTS
      +000045*                          NO LINE FOR THIS ORDER                             <-ALL-FMTS
  125 +000046                07 IN61         PIC 1  INDIC 61.                              <-ALL-FMTS
      +000047*                          ORDER NUMBER NOT FOUND                             <-ALL-FMTS
  126 +000048                07 IN62         PIC 1  INDIC 62.                              <-ALL-FMTS
      +000049*                          NO CUSTOMER RECORD                                 <-ALL-FMTS
  127 +000050           06 ORDERN            PIC S9(5).                                    <-ALL-FMTS
      +000051*                          ORDER NUMBER                                       <-ALL-FMTS
  128 +000052           06 ORDDAT            PIC S9(6).                                    <-ALL-FMTS
      +000053*                          DATE ORDER WAS ENTERED                             <-ALL-FMTS
  129 +000054           06 CUST              PIC X(5).                                     <-ALL-FMTS
      +000055*                          CUSTOMER NUMBER                                    <-ALL-FMTS
  130 +000056           06 NAME              PIC X(25).                                    <-ALL-FMTS
      +000057*                          CUSTOMER NAME                                      <-ALL-FMTS
  131 +000058           06 ADDR              PIC X(20).                                    <-ALL-FMTS
      +000059*                          CUSTOMER ADDRESS                                   <-ALL-FMTS
  132 +000060           06 CITY              PIC X(20).                                    <-ALL-FMTS
```

Figure 72 (Part 3 of 7). Example of an Order Inquiry Program

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
      +000061*                          CUSTOMER CITY                                      <-ALL-FMTS
  133 +000062          06 STATE              PIC X(2).                                     <-ALL-FMTS
      +000063*                          CUSTOMER STATE                                     <-ALL-FMTS
  134 +000064          06 ZIP                PIC S9(5).                                    <-ALL-FMTS
      +000065*                          ZIP CODE                                           <-ALL-FMTS
  135 +000066          06 ORDAMT             PIC S9(6)V9(2).                               <-ALL-FMTS
      +000067*                          TOTAL AMOUNT OF ORDER                              <-ALL-FMTS
  136 +000068          06 STSORD             PIC X(12).                                    <-ALL-FMTS
  137 +000069          06 STSOPN             PIC X(12).                                    <-ALL-FMTS
  138 +000070          06 CUSORD             PIC X(15).                                    <-ALL-FMTS
      +000071*                          CUSTOMER PURCHASE ORDER NUMBER                     <-ALL-FMTS
  139 +000072          06 SHPVIA             PIC X(15).                                    <-ALL-FMTS
      +000073*                          SHIPPING INSTRUCTIONS                              <-ALL-FMTS
  140 +000074          06 PRTDAT             PIC S9(6).                                    <-ALL-FMTS
      +000075*                          DATE ORDER WAS PRINTED                             <-ALL-FMTS
  141 +000076          06 INVNUM             PIC S9(5).                                    <-ALL-FMTS
      +000077*                          INVOICE NUMBER                                     <-ALL-FMTS
  142 +000078          06 ACTMTH             PIC S9(2).                                    <-ALL-FMTS
      +000079*                          ACCOUNTING MONTH OF SALE                           <-ALL-FMTS
  143 +000080          06 ACTYR              PIC S9(2).                                    <-ALL-FMTS
      +000081*                          ACCOUNTING YEAR OF SALE                            <-ALL-FMTS
       005700
  144  005800 WORKING-STORAGE SECTION.
  145  005900 01  EXISTING-ORDER-DISPLAY-KEY.
  146  006000    05  SUBFILE-RECORD-NUMBER               PIC 9(2)
  147  006100                                         VALUE ZERO.
       006200
  148  006300 01  ORDER-STATUS-COMMENT-VALUES.
  149  006400    05  FILLER                              PIC X(12)
  150  006500                                         VALUE "1-IN PROCESS".
  151  006600    05  FILLER                              PIC X(12)
  152  006700                                         VALUE "2-CONTINUED ".
  153  006800    05  FILLER                              PIC X(12)
  154  006900                                         VALUE "3-CREDIT CHK".
  155  007000    05  FILLER                              PIC X(12)
  156  007100                                         VALUE "4-READY PRT ".
  157  007200    05  FILLER                              PIC X(12)
  158  007300                                         VALUE "5-PRINTED   ".
  159  007400    05  FILLER                              PIC X(12)
  160  007500                                         VALUE "6-PICKED    ".
  161  007600    05  FILLER                              PIC X(12)
  162  007700                                         VALUE "7-INVOICED  ".
  163  007800    05  FILLER                              PIC X(12)
  164  007900                                         VALUE "8-INVALID   ".
  165  008000    05  FILLER                              PIC X(12)
  166  008100                                         VALUE "9-CANCELED  ".
       008200
  167  008300 01  ORDER-STATUS-COMMENT-TABLE
  168  008400         REDEFINES ORDER-STATUS-COMMENT-VALUES.
  169  008500    05  ORDER-STATUS OCCURS 9 TIMES.
  170  008600       10 ORDER-STATUS-COMMENT              PIC X(12).
       008700
  171  008800 01  OPEN-STATUS-COMMENT-VALUES.
  172  008900    05  FILLER                              PIC X(12)
  173  009000                                         VALUE "1-OPEN      ".
  174  009100    05  FILLER                              PIC X(12)
  175  009200                                         VALUE "2-CLOSED    ".
  176  009300    05  FILLER                              PIC X(12)
  177  009400                                         VALUE "3-CANCELED  ".
       009500
  178  009600 01  OPEN-STATUS-COMMENT-TABLE
  179  009700         REDEFINES OPEN-STATUS-COMMENT-VALUES.
  180  009800    05  OPEN-STATUS OCCURS 3 TIMES.
  181  009900       10  OPEN-STATUS-COMMENT              PIC X(12).
       010000
  182  010100 01  ERRHDL-PARAMETERS.
  183  010200    05  STATUS-CODE-ONE                     PIC X(2).
  184  010300       88  SUBFILE-IS-FULL               VALUE "9M".
       010400
  185  010500 01  ERRPGM-PARAMETERS.
  186  010600    05  DISPLAY-PARAMETER                   PIC X(8)
  187  010700                                         VALUE "ORD220D ".
  188  010800    05  DUMMY-ONE                           PIC X(6)
  189  010900                                         VALUE SPACES.
  190  011000    05  DUMMY-TWO                           PIC X(8)
  191  011100                                         VALUE SPACES.
```

Figure 72 (Part 4 of 7). Example of an Order Inquiry Program



```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   192  011200    05  STATUS-CODE-TWO.
   193  011300       10  PRIMARY                           PIC X(1).
   194  011400       10  SECONDARY                         PIC X(1).
   195  011500       10  FILLER                            PIC X(5)
   196  011600                                          VALUE SPACES.
        011700
   197  011800 01  SWITCH-AREA.
   198  011900    05  SW01                              PIC 1.
   199  012000       88  NO-MORE-DETAIL-LINE-ITEMS      VALUE B"1".
   200  012100       88  MORE-DETAIL-LINE-ITEMS-EXIST   VALUE B"0".
   201  012200    05  SW02                              PIC 1.
   202  012300       88  WRITE-DISPLAY                  VALUE B"1".
   203  012400       88  READ-DISPLAY                   VALUE B"0".
   204  012500    05  SW03                              PIC 1.
   205  012600       88  SUBCTL1-FORMAT                 VALUE B"1".
   206  012700       88  NOT-SUBCTL1-FORMAT             VALUE B"0".
   207  012800    05  SW04                              PIC 1.
   208  012900       88  SUB1-FORMAT                    VALUE B"1".
   209  013000       88  NOT-SUB1-FORMAT                VALUE B"0".
        013100
   210  013200 01  INDICATOR-AREA.
   211  013300    05  IN98                              PIC 1 INDIC 98.
   212  013400       88  END-OF-EXISTING-ORDER-INQUIRY  VALUE B"1".
   213  013500    05  IN97                              PIC 1 INDIC 97.
   214  013600       88  CONTINUE-DETAIL-LINES-DISPLAY  VALUE B"1".
   215  013700    05  IN62                              PIC 1 INDIC 62.
   216  013800       88  CUSTOMER-NOT-FOUND             VALUE B"1".
   217  013900       88  CUSTOMER-EXIST                 VALUE B"0".
   218  014000    05  IN61                              PIC 1 INDIC 61.
   219  014100       88  ORDER-NOT-FOUND                VALUE B"1".
   220  014200       88  ORDER-EXIST                    VALUE B"0".
   221  014300    05  IN58                              PIC 1 INDIC 58.
   222  014400       88  CLEAR-SUBFILE                  VALUE B"1".
   223  014500       88  DISPLAY-SUBFILE-CONTROL        VALUE B"0".
   224  014600    05  IN57                              PIC 1 INDIC 57.
   225  014700       88  DISPLAY-SUBFILE                VALUE B"1".
   226  014800    05  IN47                              PIC 1 INDIC 47.
   227  014900       88  NO-DETAIL-LINES-FOR-ORDER      VALUE B"1".
   228  015000       88  DETAIL-LINES-FOR-ORDER-EXIST   VALUE B"0".
   229  015100    05  IN45                              PIC 1 INDIC 45.
   230  015200       88  END-OF-ORDER                   VALUE B"1".
        015300
   231  015400 PROCEDURE DIVISION.
        015500
        015600 DECLARATIVES.
        015700 TRANSACTION-ERROR SECTION.
        015800     USE AFTER STANDARD ERROR PROCEDURE
        015900         EXISTING-ORDER-DISPLAY-FILE.
        016000 WORK-STATION-ERROR-HANDLER.
   232  016100     IF SUBFILE-IS-FULL THEN
        016200         NEXT SENTENCE
        016300     ELSE
   233  016400         DISPLAY "WORK-STATION ERROR"   STATUS-CODE-ONE.
        016500 END DECLARATIVES.
        016600
        016700 INQUIRY-INTO-EXISTING-ORDER SECTION.
        016800 MAINLINE-ROUTINE.
   234  016900     PERFORM SET-UP-ROUTINE.
   235  017000     PERFORM EXISTING-ORDER-INQUIRY
        017100         UNTIL END-OF-EXISTING-ORDER-INQUIRY.
   236  017200     PERFORM CLEAN-UP-ROUTINE.
        017300
        017400 SET-UP-ROUTINE.
   237  017500     OPEN INPUT  ORDER-HEADER-FILE
        017600                 ORDER-DETAIL-FILE
        017700                 CUSTOMER-MASTER-FILE
        017800          I-O    EXISTING-ORDER-DISPLAY-FILE.
   238  017900     MOVE SPACES TO   CUST   OF SUBCTL1-O
        018000                      NAME   OF SUBCTL1-O
        018100                      ADDR   OF SUBCTL1-O
        018200                      CITY   OF SUBCTL1-O
        018300                      STATE  OF SUBCTL1-O
        018400                      STSORD OF SUBCTL1-O
        018500                      STSOPN OF SUBCTL1-O
        018600                      CUSORD OF SUBCTL1-O.
```

Figure 72 (Part 5 of 7). Example of an Order Inquiry Program

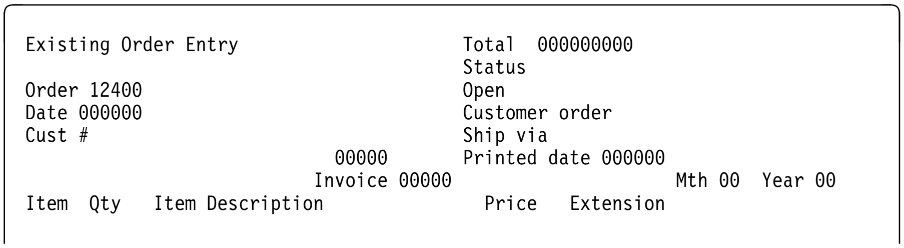
```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  239  018700     MOVE ZEROS TO    ORDERN OF SUBCTL1-O
       018800                      ORDDAT OF SUBCTL1-O
       018900                      ZIP    OF SUBCTL1-O
       019000                      ORDAMT OF SUBCTL1-O
       019100                      PRTDAT OF SUBCTL1-O
       019200                      INVNUM OF SUBCTL1-O
       019300                      ACTMTH OF SUBCTL1-O
       019400                      ACTYR  OF SUBCTL1-O.
  240  019500     MOVE ALL B'0' TO INDICATOR-AREA.
  241  019600     SET READ-DISPLAY
       019700         NOT-SUBCTL1-FORMAT
       019800         NOT-SUB1-FORMAT TO TRUE.
  242  019900     MOVE CORR INDICATOR-AREA TO SUBCTL1-O-INDIC.
  243  020000     WRITE EXISTING-ORDER-DISPLAY-RECORD FORMAT IS "SUBCTL1".
  244  020100     READ EXISTING-ORDER-DISPLAY-FILE RECORD.
  245  020200     MOVE CORR SUBCTL1-I-INDIC TO INDICATOR-AREA.
       020300
       020400 EXISTING-ORDER-INQUIRY.
  246  020500     IF CONTINUE-DETAIL-LINES-DISPLAY THEN
  247  020600         PERFORM READ-NEXT-ORDER-DETAIL-RECORD
  248  020700         IF MORE-DETAIL-LINE-ITEMS-EXIST THEN
  249  020800             IF ORDERN OF ORDER-DETAIL-RECORD IS NOT EQUAL TO
       020900                ORDERN OF ORDER-HEADER-RECORD THEN
  250  021000                    SET DISPLAY-SUBFILE TO TRUE
  251  021100                    SET NO-DETAIL-LINES-FOR-ORDER TO TRUE
       021200             ELSE
  252  021300                 PERFORM SUBFILE-SET-UP
       021400         ELSE
  253  021500             SET DISPLAY-SUBFILE TO TRUE
  254  021600             SET NO-DETAIL-LINES-FOR-ORDER TO TRUE
       021700     ELSE
  255  021800         PERFORM ORDER-NUMBER-VALIDATION.
  256  021900     MOVE CORR INDICATOR-AREA TO SUBCTL1-O-INDIC.
  257  022000     SET WRITE-DISPLAY TO TRUE.
  258  022100     SET SUBCTL1-FORMAT TO TRUE.
  259  022200     WRITE EXISTING-ORDER-DISPLAY-RECORD FORMAT IS "SUBCTL1".
  260  022300     READ EXISTING-ORDER-DISPLAY-FILE RECORD.
  261  022400     MOVE CORR SUBCTL1-I-INDIC TO INDICATOR-AREA.
       022500 ORDER-NUMBER-VALIDATION.
  262  022600     PERFORM READ-ORDER-HEADER-FILE.
  263  022700     IF ORDER-EXIST THEN
  264  022800         PERFORM READ-CUSTOMER-MASTER-FILE
  265  022900         IF CUSTOMER-EXIST THEN
  266  023000             PERFORM READ-FIRST-ORDER-DETAIL-RECORD
  267  023100             IF DETAIL-LINES-FOR-ORDER-EXIST THEN
  268  023200                 PERFORM SUBFILE-SET-UP
       023300             ELSE
       023400                 NEXT SENTENCE
       023500         ELSE
       023600             NEXT SENTENCE
       023700     ELSE
       023800         NEXT SENTENCE.
       023900 READ-ORDER-HEADER-FILE.
  269  024000     MOVE ORDERN OF SUBCTL1-I OF EXISTING-ORDER-DISPLAY-RECORD
       024100         TO ORDERN OF ORDER-HEADER-RECORD.
  270  024200     READ ORDER-HEADER-FILE
  271  024300         INVALID KEY SET ORDER-NOT-FOUND TO TRUE.
       024400 READ-CUSTOMER-MASTER-FILE.
  272  024500     MOVE CUST OF ORDER-HEADER-RECORD
       024600         TO CUST OF CUSTOMER-MASTER-RECORD.
  273  024700     READ CUSTOMER-MASTER-FILE
  274  024800         INVALID KEY SET CUSTOMER-NOT-FOUND TO TRUE.
       024900 READ-FIRST-ORDER-DETAIL-RECORD.
  275  025000     MOVE ORDERN OF ORDER-HEADER-RECORD
       025100         TO ORDERN OF ORDER-DETAIL-RECORD.
  276  025200     MOVE 1 TO LINNUM OF ORDER-DETAIL-RECORD.
  277  025300     READ ORDER-DETAIL-FILE
  278  025400         INVALID KEY SET NO-DETAIL-LINES-FOR-ORDER TO TRUE.
       025500 SUBFILE-SET-UP.
  279  025600     SET CLEAR-SUBFILE TO TRUE.
  280  025700     MOVE CORR INDICATOR-AREA TO SUBCTL1-O-INDIC.
  281  025800     SET WRITE-DISPLAY TO TRUE.
  282  025900     SET SUBCTL1-FORMAT TO TRUE.
  283  026000     WRITE EXISTING-ORDER-DISPLAY-RECORD FORMAT IS "SUBCTL1".
  284  026100     SET DISPLAY-SUBFILE-CONTROL TO TRUE.
```

Figure 72 (Part 6 of 7). Example of an Order Inquiry Program

```
5763CB1 V3R0M5                  AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  285  026200     PERFORM BUILD-DISPLAY-SUBFILE
       026300         UNTIL NO-MORE-DETAIL-LINE-ITEMS
       026400           OR SUBFILE-IS-FULL.
  286  026500     MOVE CORR ORDHDR OF ORDER-HEADER-RECORD
       026600         TO SUBCTL1-O OF EXISTING-ORDER-DISPLAY-RECORD.
  287  026700     MOVE CORR CUSMST OF CUSTOMER-MASTER-RECORD
       026800         TO SUBCTL1-O OF EXISTING-ORDER-DISPLAY-RECORD.
  288  026900     MOVE ORDER-STATUS(ORDSTS) TO STSORD.
  289  027000     MOVE OPEN-STATUS(OPNSTS) TO STSOPN.
  290  027100     SET MORE-DETAIL-LINE-ITEMS-EXIST TO TRUE.
  291  027200     MOVE ZEROS TO SUBFILE-RECORD-NUMBER.
       027300 BUILD-DISPLAY-SUBFILE.
  292  027400     MOVE CORR ORDDTL OF ORDER-DETAIL-RECORD
       027500         TO SUB1 OF EXISTING-ORDER-DISPLAY-RECORD.
  293  027600     SET WRITE-DISPLAY TO TRUE.
  294  027700     SET SUB1-FORMAT TO TRUE.
  295  027800     ADD 1 TO SUBFILE-RECORD-NUMBER.
  296  027900     WRITE SUBFILE EXISTING-ORDER-DISPLAY-RECORD FORMAT IS "SUB1".
  297  028000     IF SUBFILE-IS-FULL THEN
  298  028100         SET DISPLAY-SUBFILE TO TRUE
       028200     ELSE
  299  028300         PERFORM READ-NEXT-ORDER-DETAIL-RECORD
  300  028400         IF NO-MORE-DETAIL-LINE-ITEMS THEN
       028500             NEXT SENTENCE
       028600         ELSE
  301  028700             IF ORDERN OF ORDER-DETAIL-RECORD IS NOT EQUAL TO
       028800                ORDERN OF ORDER-HEADER-RECORD THEN
  302  028900                 SET DISPLAY-SUBFILE TO TRUE
  303  029000                 SET NO-MORE-DETAIL-LINE-ITEMS TO TRUE
       029100             ELSE
       029200                 NEXT SENTENCE.
       029300 READ-NEXT-ORDER-DETAIL-RECORD.
  304  029400     READ ORDER-DETAIL-FILE NEXT RECORD
  305  029500         AT END SET DISPLAY-SUBFILE TO TRUE
  306  029600                SET NO-MORE-DETAIL-LINE-ITEMS TO TRUE.
       029700 CLEAN-UP-ROUTINE.
  307  029800      CLOSE     ORDER-HEADER-FILE
       029900                ORDER-DETAIL-FILE
       030000                CUSTOMER-MASTER-FILE
       030100                EXISTING-ORDER-DISPLAY-FILE.
  308  030200      STOP RUN.
                            * * * * *   E N D   O F   S O U R C E   * * * * *
```

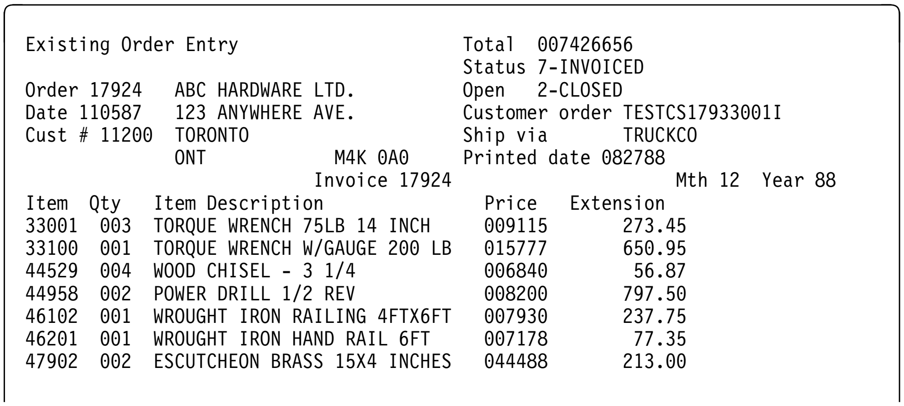
Figure 72 (Part 7 of 7). Example of an Order Inquiry Program

This is the initial order-entry prompt display written to the work station:



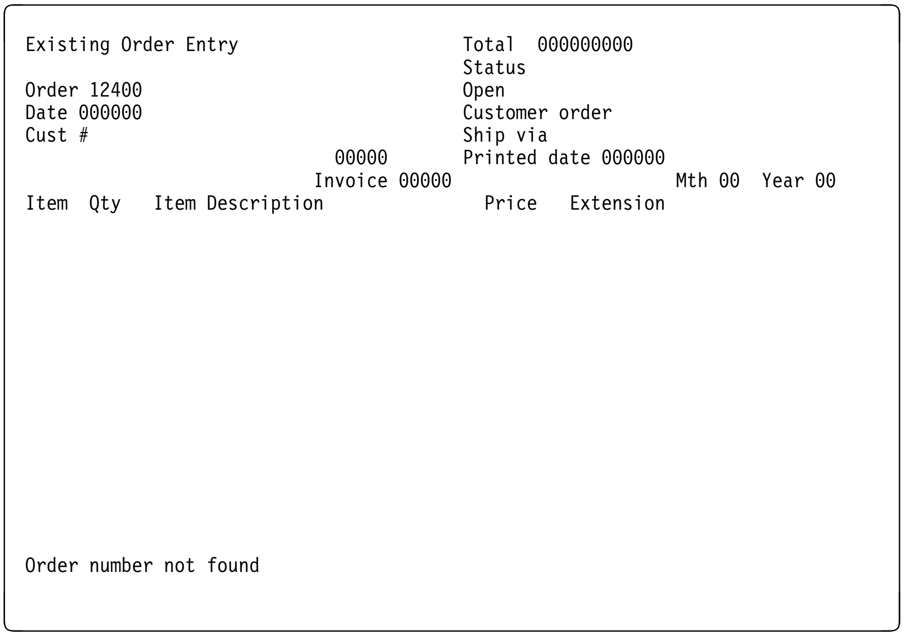
```
Existing Order Entry                    Total  000000000
                                        Status
Order 12400                             Open
Date 000000                             Customer order
Cust #                                  Ship via
                             00000      Printed date 000000
                           Invoice 00000                    Mth 00  Year 00
Item  Qty   Item Description              Price   Extension
```

This display appears if there are detail order records for the customer whose order number was entered in the first display:



```
Existing Order Entry                    Total  007426656
                                        Status 7-INVOICED
Order 17924   ABC HARDWARE LTD.         Open   2-CLOSED
Date 110587   123 ANYWHERE AVE.         Customer order TESTCS17933001I
Cust # 11200  TORONTO                   Ship via       TRUCKCO
              ONT           M4K 0A0     Printed date 082788
                          Invoice 17924                     Mth 12  Year 88
Item  Qty   Item Description              Price   Extension
33001  003  TORQUE WRENCH 75LB 14 INCH    009115       273.45
33100  001  TORQUE WRENCH W/GAUGE 200 LB  015777       650.95
44529  004  WOOD CHISEL - 3 1/4           006840        56.87
44958  002  POWER DRILL 1/2 REV           008200       797.50
46102  001  WROUGHT IRON RAILING 4FTX6FT  007930       237.75
46201  001  WROUGHT IRON HAND RAIL 6FT    007178        77.35
47902  002  ESCUTCHEON BRASS 15X4 INCHES  044488       213.00
```

This display appears if the ORDHDRP file does not contain a record for the order number entered on the first display:

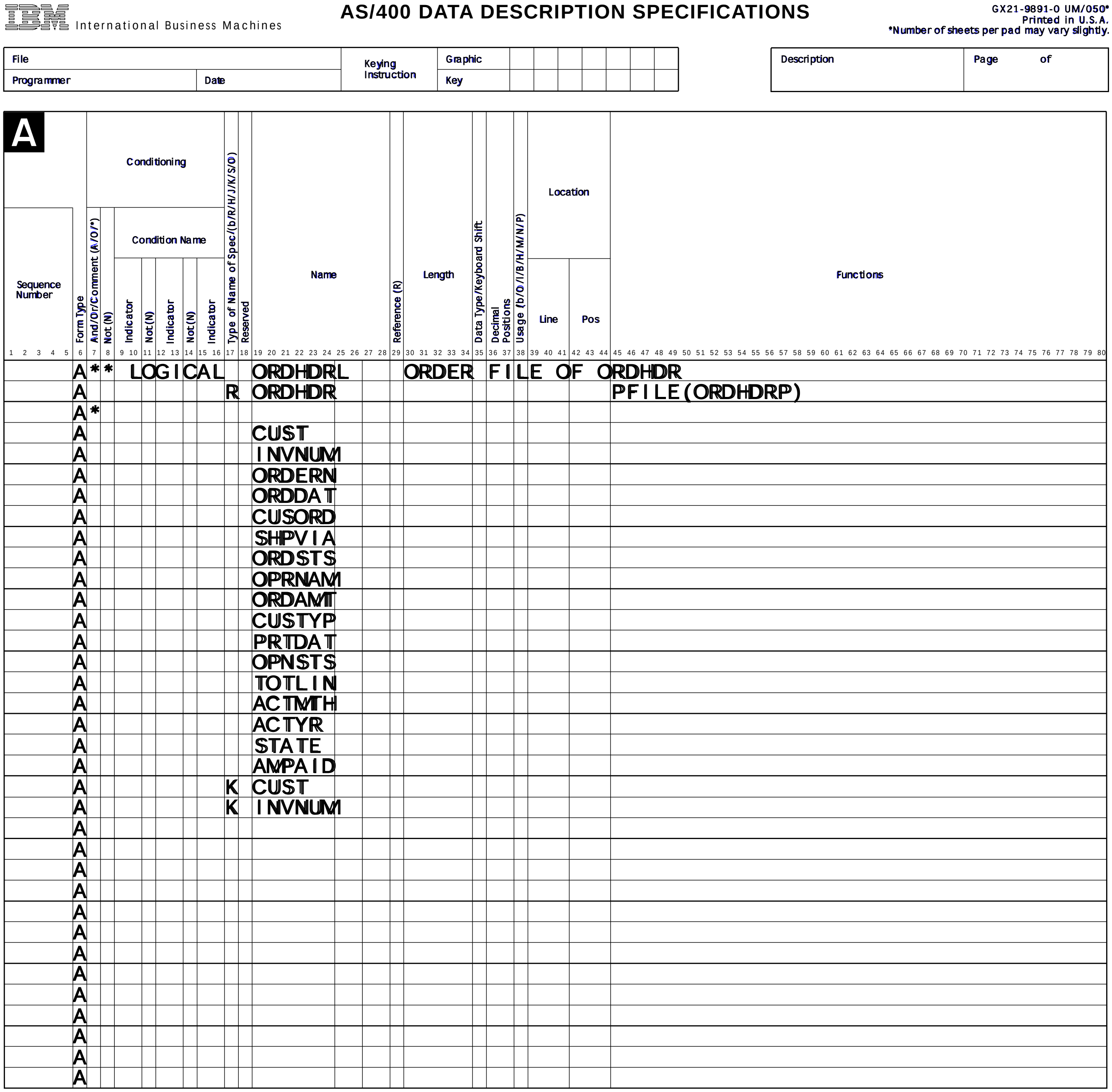


```
Existing Order Entry                    Total  000000000
                                        Status
Order 12400                             Open
Date 000000                             Customer order
Cust #                                  Ship via
                            00000       Printed date 000000
                          Invoice 00000                     Mth 00  Year 00
Item  Qty   Item Description              Price   Extension















Order number not found
```

A Payment Update Program

Figure 74 on page 221 shows an example of a payment update program, PAYUPDT. For the related DDS, see Figure 73 on page 218. For the related display-screen examples, see page 228. For the DDS for the customer master file, CUSMSTP, refer to Figure 69 on page 202.

In this example, payments from customers are registered. The clerk is prompted to enter one or more customer numbers and the amount of money to be credited to each customer's account. The program checks the customer number and unconditionally accepts any payment for an existing customer who has invoices outstanding. If an overpayment will result from the amount of the payment from a customer, the clerk is given the option to accept or reject the payment. If no customer record exists for a customer number, an error message is issued. Payments can be entered until the clerk ends the program by pressing F12.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File		Keying Instruction	Graphic
Programmer	Date		Key

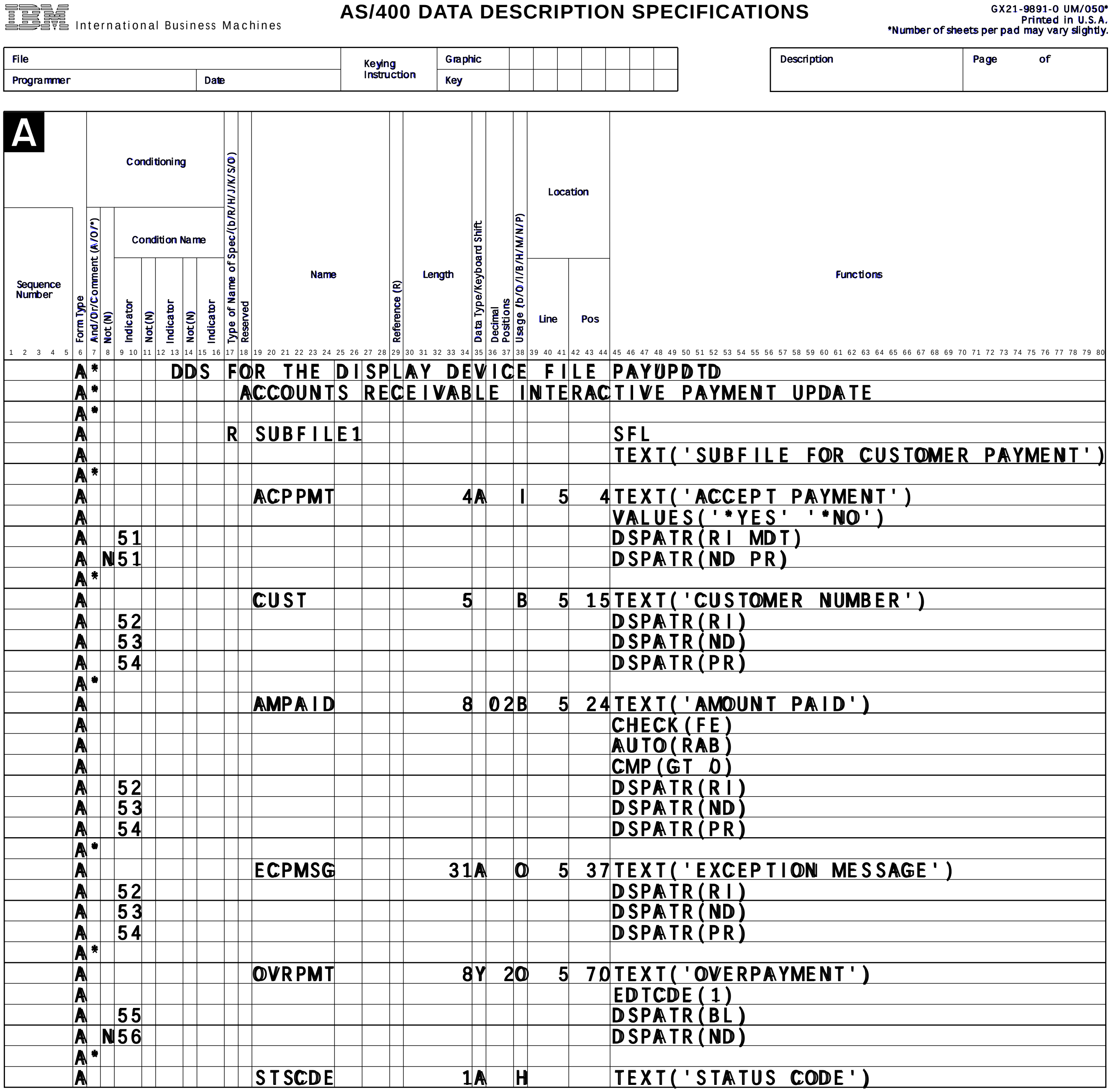
Description	Page of

A

Sequence Number · Form Type · And/Or/Comment (A/O/*) · Conditioning: Not (N), Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator · Type of Name of Spec/(b/R/H/J/K/S/O) · Reserved · Name · Reference (R) · Length · Data Type/Keyboard Shift · Decimal Positions · Usage (b/O/I/B/H/M/N/P) · Location: Line, Pos · Functions

```
         1         2         3         4         5
12345678901234567890123456789012345678901234567890123456789
     A** LOGICAL  ORDHDRL    ORDER FILE OF ORDHDR
     A          R ORDHDR                    PFILE(ORDHDRP)
     A*
     A            CUST
     A            INVNUM
     A            ORDERN
     A            ORDDAT
     A            CUSORD
     A            SHPVIA
     A            ORDSTS
     A            OPRNAM
     A            ORDAMT
     A            CUSTYP
     A            PRTDAT
     A            OPNSTS
     A            TOTLIN
     A            ACTMTH
     A            ACTYR
     A            STATE
     A            AMPAID
     A          K CUST
     A          K INVNUM
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 73 (Part 1 of 3). Example of a Data Description Specification for a Payment Update Program



IBM International Business Machines

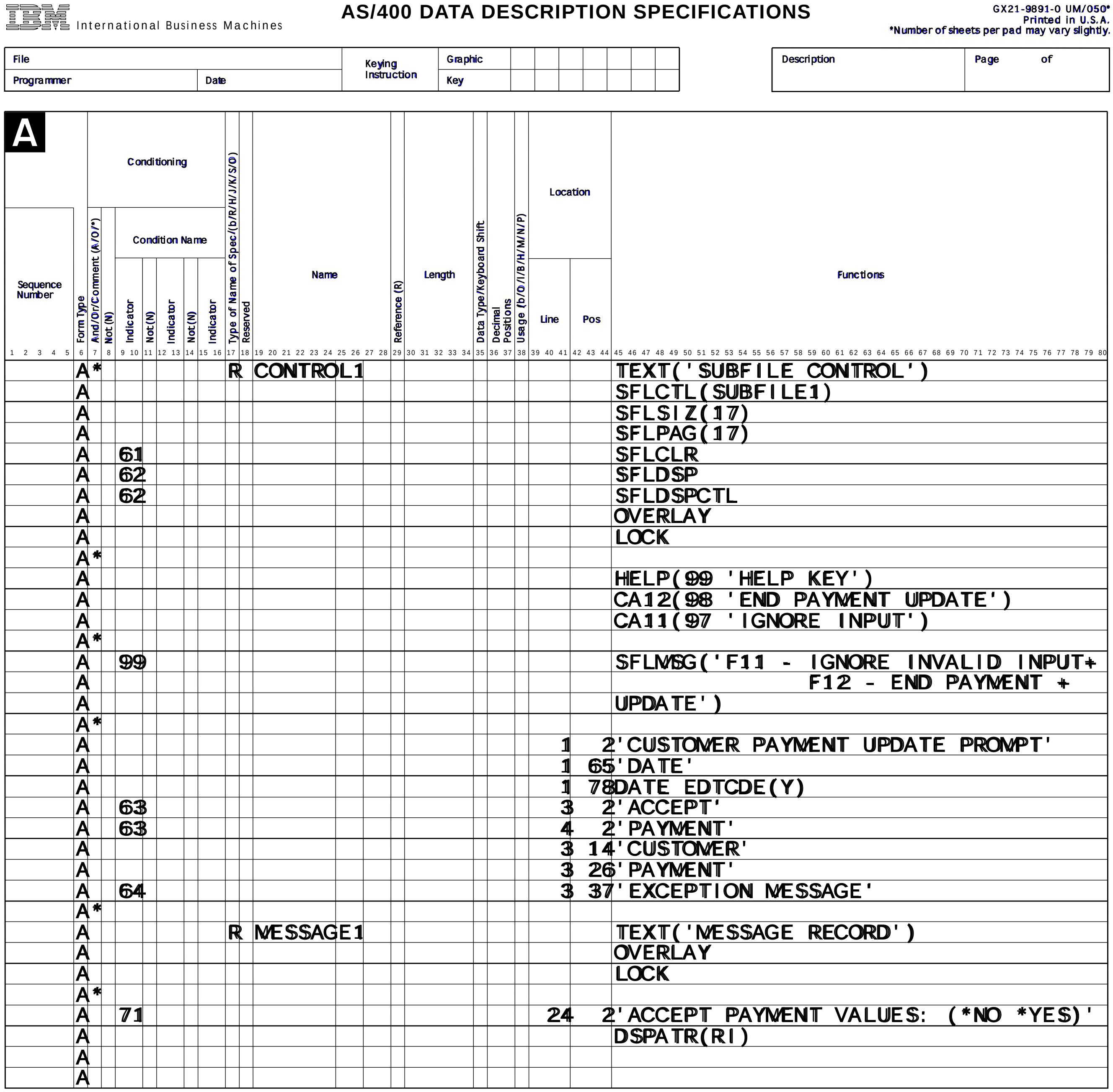
AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File | Programmer | Date | Keying Instruction | Graphic | Key | Description | Page of

```
     A*      DDS FOR THE DISPLAY DEVICE FILE PAYUPDTD
     A*          ACCOUNTS RECEIVABLE INTERACTIVE PAYMENT UPDATE
     A*
     A          R SUBFILE1                  SFL
     A                                      TEXT('SUBFILE FOR CUSTOMER PAYMENT')
     A*
     A            ACPPMT         4A  I  5  4TEXT('ACCEPT PAYMENT')
     A                                      VALUES('*YES' '*NO')
     A  51                                  DSPATR(RI MDT)
     A N51                                  DSPATR(ND PR)
     A*
     A            CUST           5   B  5 15TEXT('CUSTOMER NUMBER')
     A  52                                  DSPATR(RI)
     A  53                                  DSPATR(ND)
     A  54                                  DSPATR(PR)
     A*
     A            AMPAID         8 02B  5 24TEXT('AMOUNT PAID')
     A                                      CHECK(FE)
     A                                      AUTO(RAB)
     A                                      CMP(GT 0)
     A  52                                  DSPATR(RI)
     A  53                                  DSPATR(ND)
     A  54                                  DSPATR(PR)
     A*
     A            ECPMSG        31A  O  5 37TEXT('EXCEPTION MESSAGE')
     A  52                                  DSPATR(RI)
     A  53                                  DSPATR(ND)
     A  54                                  DSPATR(PR)
     A*
     A            OVRPMT         8Y 2O  5 70TEXT('OVERPAYMENT')
     A                                      EDTCDE(1)
     A  55                                  DSPATR(BL)
     A N56                                  DSPATR(ND)
     A*
     A            STSCDE         1A  H      TEXT('STATUS CODE')
```

Figure 73 (Part 2 of 3). Example of a Data Description Specification for a Payment Update Program



International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File		Keying Instruction	Graphic
Programmer	Date		Key

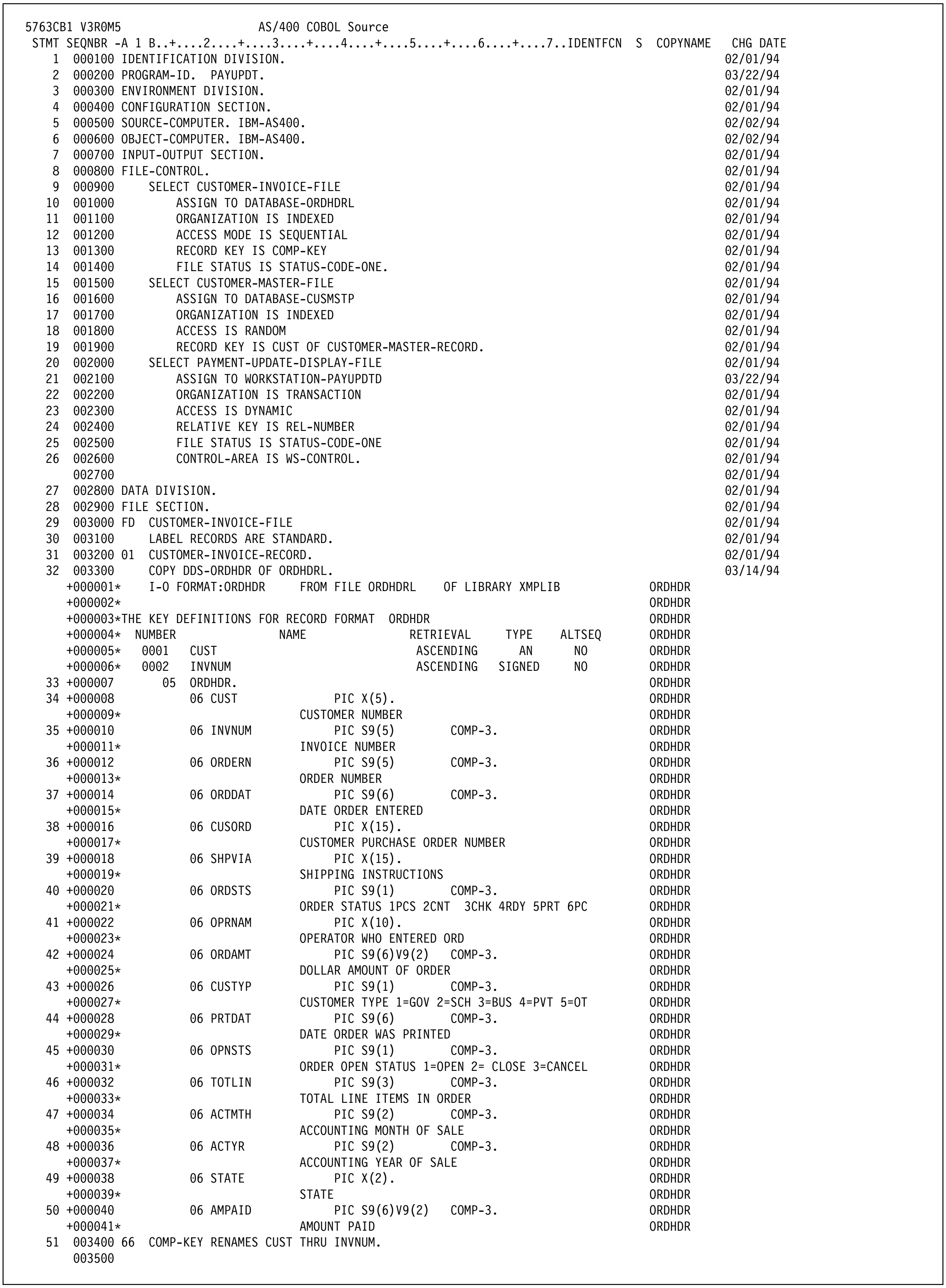
Description	Page of

A

Sequence Number (1–5) · Form Type (6) · And/Or/Comment (A/O/*) (7) · Not (N) (8) · Conditioning: Condition Name: Indicator (9–10), Not(N) (11), Indicator (12–13), Not(N) (14), Indicator (15–16) · Type of Name of Spec/(b/R/H/J/K/S/O) (17) · Reserved (18) · Name (19–28) · Reference (R) (29) · Length (30–34) · Data Type/Keyboard Shift (35) · Decimal Positions (36–37) · Usage (b/O/I/B/H/M/N/P) (38) · Location: Line (39–41), Pos (42–44) · Functions (45–80)

```
     A*         R CONTROL1                  TEXT('SUBFILE CONTROL')
     A                                      SFLCTL(SUBFILE1)
     A                                      SFLSIZ(17)
     A                                      SFLPAG(17)
     A  61                                  SFLCLR
     A  62                                  SFLDSP
     A  62                                  SFLDSPCTL
     A                                      OVERLAY
     A                                      LOCK
     A*
     A                                      HELP(99 'HELP KEY')
     A                                      CA12(98 'END PAYMENT UPDATE')
     A                                      CA11(97 'IGNORE INPUT')
     A*
     A  99                                  SFLMSG('F11 - IGNORE INVALID INPUT+
     A                                                    F12 - END PAYMENT +
     A                                      UPDATE')
     A*
     A                                  1  2'CUSTOMER PAYMENT UPDATE PROMPT'
     A                                  1 65'DATE'
     A                                  1 78DATE EDTCDE(Y)
     A  63                              3  2'ACCEPT'
     A  63                              4  2'PAYMENT'
     A                                  3 14'CUSTOMER'
     A                                  3 26'PAYMENT'
     A  64                              3 37'EXCEPTION MESSAGE'
     A*
     A          R MESSAGE1                  TEXT('MESSAGE RECORD')
     A                                      OVERLAY
     A                                      LOCK
     A*
     A  71                             24  2'ACCEPT PAYMENT VALUES:  (*NO *YES)'
     A                                      DSPATR(RI)
     A
     A
```

Figure 73 (Part 3 of 3). Example of a Data Description Specification for a Payment Update Program



```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 IDENTIFICATION DIVISION.                                                                02/01/94
    2  000200 PROGRAM-ID.  PAYUPDT.                                                                   03/22/94
    3  000300 ENVIRONMENT DIVISION.                                                                   02/01/94
    4  000400 CONFIGURATION SECTION.                                                                  02/01/94
    5  000500 SOURCE-COMPUTER. IBM-AS400.                                                             02/02/94
    6  000600 OBJECT-COMPUTER. IBM-AS400.                                                             02/02/94
    7  000700 INPUT-OUTPUT SECTION.                                                                   02/01/94
    8  000800 FILE-CONTROL.                                                                           02/01/94
    9  000900     SELECT CUSTOMER-INVOICE-FILE                                                        02/01/94
   10  001000         ASSIGN TO DATABASE-ORDHDRL                                                      02/01/94
   11  001100         ORGANIZATION IS INDEXED                                                         02/01/94
   12  001200         ACCESS MODE IS SEQUENTIAL                                                       02/01/94
   13  001300         RECORD KEY IS COMP-KEY                                                          02/01/94
   14  001400         FILE STATUS IS STATUS-CODE-ONE.                                                 02/01/94
   15  001500     SELECT CUSTOMER-MASTER-FILE                                                         02/01/94
   16  001600         ASSIGN TO DATABASE-CUSMSTP                                                      02/01/94
   17  001700         ORGANIZATION IS INDEXED                                                         02/01/94
   18  001800         ACCESS IS RANDOM                                                                02/01/94
   19  001900         RECORD KEY IS CUST OF CUSTOMER-MASTER-RECORD.                                   02/01/94
   20  002000     SELECT PAYMENT-UPDATE-DISPLAY-FILE                                                  02/01/94
   21  002100         ASSIGN TO WORKSTATION-PAYUPDTD                                                  03/22/94
   22  002200         ORGANIZATION IS TRANSACTION                                                     02/01/94
   23  002300         ACCESS IS DYNAMIC                                                               02/01/94
   24  002400         RELATIVE KEY IS REL-NUMBER                                                      02/01/94
   25  002500         FILE STATUS IS STATUS-CODE-ONE                                                  02/01/94
   26  002600         CONTROL-AREA IS WS-CONTROL.                                                     02/01/94
       002700                                                                                         02/01/94
   27  002800 DATA DIVISION.                                                                          02/01/94
   28  002900 FILE SECTION.                                                                           02/01/94
   29  003000 FD  CUSTOMER-INVOICE-FILE                                                               02/01/94
   30  003100     LABEL RECORDS ARE STANDARD.                                                         02/01/94
   31  003200 01  CUSTOMER-INVOICE-RECORD.                                                            02/01/94
   32  003300     COPY DDS-ORDHDR OF ORDHDRL.                                                         03/14/94
      +000001*    I-O FORMAT:ORDHDR     FROM FILE ORDHDRL    OF LIBRARY XMPLIB             ORDHDR
      +000002*                                                                             ORDHDR
      +000003*THE KEY DEFINITIONS FOR RECORD FORMAT  ORDHDR                                ORDHDR
      +000004*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ       ORDHDR
      +000005*   0001   CUST                             ASCENDING      AN      NO         ORDHDR
      +000006*   0002   INVNUM                           ASCENDING   SIGNED     NO         ORDHDR
   33 +000007       05  ORDHDR.                                                            ORDHDR
   34 +000008           06 CUST              PIC X(5).                                     ORDHDR
      +000009*                          CUSTOMER NUMBER                                    ORDHDR
   35 +000010           06 INVNUM            PIC S9(5)        COMP-3.                      ORDHDR
      +000011*                          INVOICE NUMBER                                     ORDHDR
   36 +000012           06 ORDERN            PIC S9(5)        COMP-3.                      ORDHDR
      +000013*                          ORDER NUMBER                                       ORDHDR
   37 +000014           06 ORDDAT            PIC S9(6)        COMP-3.                      ORDHDR
      +000015*                          DATE ORDER ENTERED                                 ORDHDR
   38 +000016           06 CUSORD            PIC X(15).                                    ORDHDR
      +000017*                          CUSTOMER PURCHASE ORDER NUMBER                     ORDHDR
   39 +000018           06 SHPVIA            PIC X(15).                                    ORDHDR
      +000019*                          SHIPPING INSTRUCTIONS                              ORDHDR
   40 +000020           06 ORDSTS            PIC S9(1)        COMP-3.                      ORDHDR
      +000021*                          ORDER STATUS 1PCS 2CNT  3CHK 4RDY 5PRT 6PC         ORDHDR
   41 +000022           06 OPRNAM            PIC X(10).                                    ORDHDR
      +000023*                          OPERATOR WHO ENTERED ORD                           ORDHDR
   42 +000024           06 ORDAMT            PIC S9(6)V9(2)   COMP-3.                      ORDHDR
      +000025*                          DOLLAR AMOUNT OF ORDER                             ORDHDR
   43 +000026           06 CUSTYP            PIC S9(1)        COMP-3.                      ORDHDR
      +000027*                          CUSTOMER TYPE 1=GOV 2=SCH 3=BUS 4=PVT 5=OT         ORDHDR
   44 +000028           06 PRTDAT            PIC S9(6)        COMP-3.                      ORDHDR
      +000029*                          DATE ORDER WAS PRINTED                             ORDHDR
   45 +000030           06 OPNSTS            PIC S9(1)        COMP-3.                      ORDHDR
      +000031*                          ORDER OPEN STATUS 1=OPEN 2= CLOSE 3=CANCEL         ORDHDR
   46 +000032           06 TOTLIN            PIC S9(3)        COMP-3.                      ORDHDR
      +000033*                          TOTAL LINE ITEMS IN ORDER                          ORDHDR
   47 +000034           06 ACTMTH            PIC S9(2)        COMP-3.                      ORDHDR
      +000035*                          ACCOUNTING MONTH OF SALE                           ORDHDR
   48 +000036           06 ACTYR             PIC S9(2)        COMP-3.                      ORDHDR
      +000037*                          ACCOUNTING YEAR OF SALE                            ORDHDR
   49 +000038           06 STATE             PIC X(2).                                     ORDHDR
      +000039*                          STATE                                              ORDHDR
   50 +000040           06 AMPAID            PIC S9(6)V9(2)   COMP-3.                      ORDHDR
      +000041*                          AMOUNT PAID                                        ORDHDR
   51  003400 66  COMP-KEY RENAMES CUST THRU INVNUM.
       003500
```

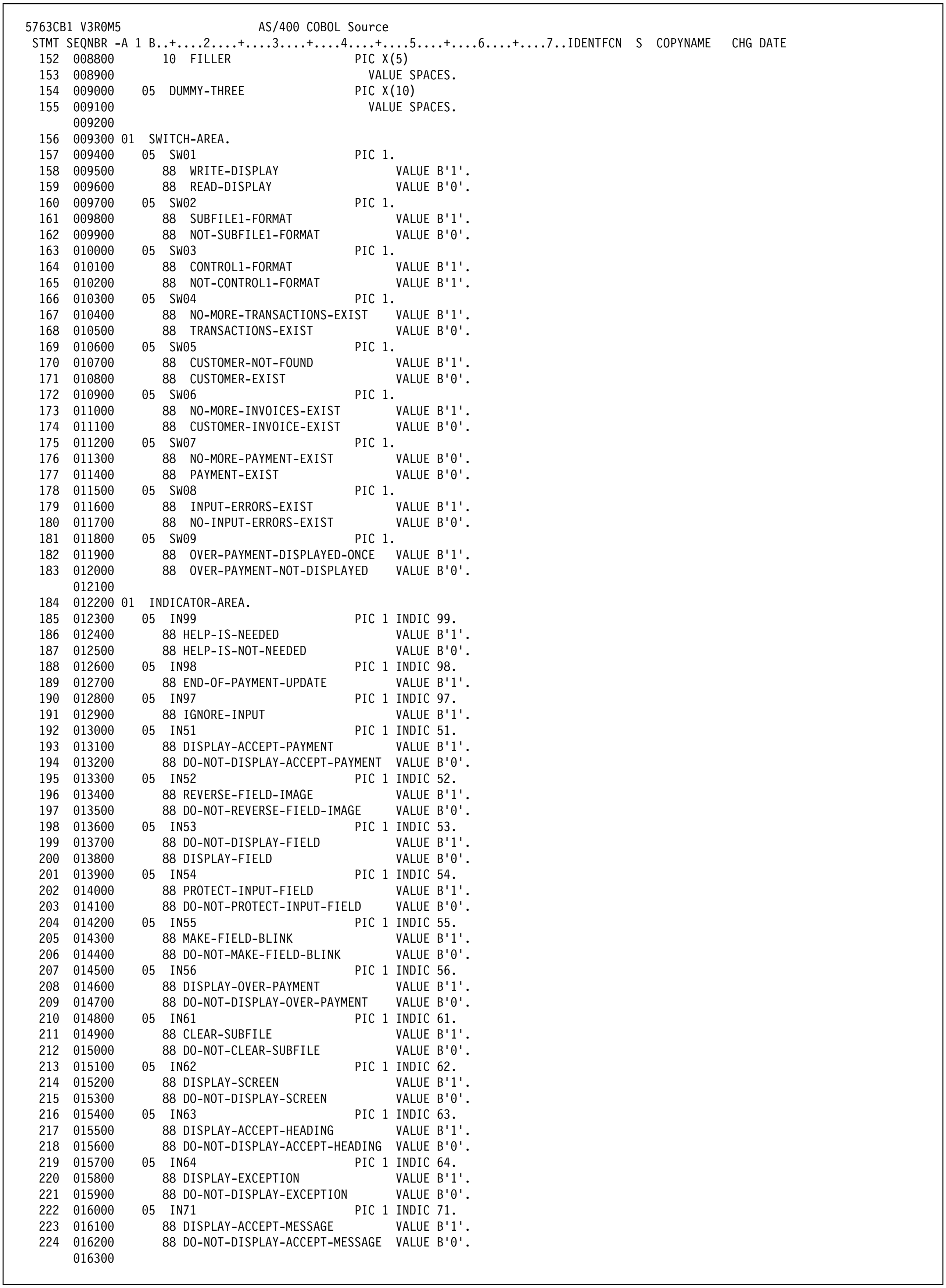
Figure 74 (Part 1 of 8). Source Listing of a Payment Update Program Example

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   52  003600 FD  CUSTOMER-MASTER-FILE
   53  003700     LABEL RECORDS ARE STANDARD.
   54  003800 01  CUSTOMER-MASTER-RECORD.
   55  003900     COPY DDS-CUSMST OF CUSMSTP.
      +000001*    I-O FORMAT:CUSMST     FROM FILE CUSMSTP    OF LIBRARY XMPLIB             CUSMST
      +000002*                          CUSTOMER MASTER RECORD                             CUSMST
      +000003*THE KEY DEFINITIONS FOR RECORD FORMAT  CUSMST                                CUSMST
      +000004*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ       CUSMST
      +000005*   0001   CUST                             ASCENDING      AN      NO         CUSMST
   56 +000006       05  CUSMST.                                                            CUSMST
   57 +000007           06 CUST              PIC X(5).                                     CUSMST
      +000008*                          CUSTOMER NUMBER                                    CUSMST
   58 +000009           06 NAME              PIC X(25).                                    CUSMST
      +000010*                          CUSTOMER NAME                                      CUSMST
   59 +000011           06 ADDR              PIC X(20).                                    CUSMST
      +000012*                          CUSTOMER ADDRESS                                   CUSMST
   60 +000013           06 CITY              PIC X(20).                                    CUSMST
      +000014*                          CUSTOMER CITY                                      CUSMST
   61 +000015           06 STATE             PIC X(2).                                     CUSMST
      +000016*                          STATE                                              CUSMST
   62 +000017           06 ZIP               PIC S9(5)        COMP-3.                      CUSMST
      +000018*                          ZIP CODE                                           CUSMST
   63 +000019           06 SRHCOD            PIC X(6).                                     CUSMST
      +000020*                          CUSTOMER NUMBER SEARCH CODE                        CUSMST
   64 +000021           06 CUSTYP            PIC S9(1)        COMP-3.                      CUSMST
      +000022*                          CUSTOMER TYPE 1=GOV 2=SCH 3=BUS 4=PVT 5=OT         CUSMST
   65 +000023           06 ARBAL             PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000024*                          ACCOUNTS REC. BALANCE                              CUSMST
   66 +000025           06 ORDBAL            PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000026*                          A/R AMT. IN ORDER FILE                             CUSMST
   67 +000027           06 LSTAMT            PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000028*                          LAST AMT. PAID IN A/R                              CUSMST
   68 +000029           06 LSTDAT            PIC S9(6)        COMP-3.                      CUSMST
      +000030*                          LAST DATE PAID IN A/R                              CUSMST
   69 +000031           06 CRDLMT            PIC S9(6)V9(2)   COMP-3.                      CUSMST
      +000032*                          CUSTOMER CREDIT LIMIT                              CUSMST
   70 +000033           06 SLSYR             PIC S9(8)V9(2)   COMP-3.                      CUSMST
      +000034*                          CUSTOMER SALES THIS YEAR                           CUSMST
   71 +000035           06 SLSLYR            PIC S9(8)V9(2)   COMP-3.                      CUSMST
      +000036*                          CUSTOMER SALES LAST YEAR                           CUSMST
       004000
   72  004100 FD  PAYMENT-UPDATE-DISPLAY-FILE
   73  004200     LABEL RECORDS ARE OMITTED.
   74  004300 01  PAYMENT-UPDATE-DISPLAY-RECORD.
   75  004400     COPY DDS-ALL-FORMATS OF PAYUPDTD.
   76 +000001       05  PAYUPDTD-RECORD PIC X(59).                                         <-ALL-FMTS
      +000002*  INPUT FORMAT:SUBFILE1   FROM FILE PAYUPDTD   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000003*                          SUBFILE FOR CUSTOMER PAYMENT                       <-ALL-FMTS
   77 +000004       05  SUBFILE1-I    REDEFINES PAYUPDTD-RECORD.                           <-ALL-FMTS
   78 +000005           06 ACPPMT            PIC X(4).                                     <-ALL-FMTS
      +000006*                          ACCEPT PAYMENT                                     <-ALL-FMTS
   79 +000007           06 CUST              PIC X(5).                                     <-ALL-FMTS
      +000008*                          CUSTOMER NUMBER                                    <-ALL-FMTS
   80 +000009           06 AMPAID            PIC S9(6)V9(2).                               <-ALL-FMTS
      +000010*                          AMOUNT PAID                                        <-ALL-FMTS
   81 +000011           06 ECPMSG            PIC X(31).                                    <-ALL-FMTS
      +000012*                          EXCEPTION MESSAGE                                  <-ALL-FMTS
   82 +000013           06 OVRPMT            PIC S9(6)V9(2).                               <-ALL-FMTS
      +000014*                          OVERPAYMENT                                        <-ALL-FMTS
   83 +000015           06 STSCDE            PIC X(1).                                     <-ALL-FMTS
      +000016*                          STATUS CODE                                        <-ALL-FMTS
      +000017* OUTPUT FORMAT:SUBFILE1   FROM FILE PAYUPDTD   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000018*                          SUBFILE FOR CUSTOMER PAYMENT                       <-ALL-FMTS
   84 +000019       05  SUBFILE1-O    REDEFINES PAYUPDTD-RECORD.                           <-ALL-FMTS
   85 +000020           06 SUBFILE1-O-INDIC.                                               <-ALL-FMTS
   86 +000021                07 IN51         PIC 1  INDIC 51.                              <-ALL-FMTS
   87 +000022                07 IN52         PIC 1  INDIC 52.                              <-ALL-FMTS
   88 +000023                07 IN53         PIC 1  INDIC 53.                              <-ALL-FMTS
   89 +000024                07 IN54         PIC 1  INDIC 54.                              <-ALL-FMTS
   90 +000025                07 IN55         PIC 1  INDIC 55.                              <-ALL-FMTS
   91 +000026                07 IN56         PIC 1  INDIC 56.                              <-ALL-FMTS
   92 +000027           06 CUST              PIC X(5).                                     <-ALL-FMTS
      +000028*                          CUSTOMER NUMBER                                    <-ALL-FMTS
   93 +000029           06 AMPAID            PIC S9(6)V9(2).                               <-ALL-FMTS
      +000030*                          AMOUNT PAID                                        <-ALL-FMTS
   94 +000031           06 ECPMSG            PIC X(31).                                    <-ALL-FMTS
      +000032*                          EXCEPTION MESSAGE                                  <-ALL-FMTS
```

Figure 74 (Part 2 of 8). Source Listing of a Payment Update Program Example

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   95 +000033           06 OVRPMT            PIC S9(6)V9(2).                               <-ALL-FMTS
      +000034*                          OVERPAYMENT                                        <-ALL-FMTS
   96 +000035           06 STSCDE            PIC X(1).                                     <-ALL-FMTS
      +000036*                          STATUS CODE                                        <-ALL-FMTS
      +000037*  INPUT FORMAT:CONTROL1   FROM FILE PAYUPDTD   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000038*                          SUBFILE CONTROL                                    <-ALL-FMTS
   97 +000039       05  CONTROL1-I    REDEFINES PAYUPDTD-RECORD.                           <-ALL-FMTS
   98 +000040           06 CONTROL1-I-INDIC.                                               <-ALL-FMTS
   99 +000041                07 IN99         PIC 1  INDIC 99.                              <-ALL-FMTS
      +000042*                          HELP KEY                                           <-ALL-FMTS
  100 +000043                07 IN98         PIC 1  INDIC 98.                              <-ALL-FMTS
      +000044*                          END PAYMENT UPDATE                                 <-ALL-FMTS
  101 +000045                07 IN97         PIC 1  INDIC 97.                              <-ALL-FMTS
      +000046*                          IGNORE INPUT                                       <-ALL-FMTS
      +000047* OUTPUT FORMAT:CONTROL1   FROM FILE PAYUPDTD   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000048*                          SUBFILE CONTROL                                    <-ALL-FMTS
  102 +000049       05  CONTROL1-O    REDEFINES PAYUPDTD-RECORD.                           <-ALL-FMTS
  103 +000050           06 CONTROL1-O-INDIC.                                               <-ALL-FMTS
  104 +000051                07 IN61         PIC 1  INDIC 61.                              <-ALL-FMTS
  105 +000052                07 IN62         PIC 1  INDIC 62.                              <-ALL-FMTS
  106 +000053                07 IN99         PIC 1  INDIC 99.                              <-ALL-FMTS
      +000054*                          HELP KEY                                           <-ALL-FMTS
  107 +000055                07 IN63         PIC 1  INDIC 63.                              <-ALL-FMTS
  108 +000056                07 IN64         PIC 1  INDIC 64.                              <-ALL-FMTS
      +000057*  INPUT FORMAT:MESSAGE1   FROM FILE PAYUPDTD   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000058*                          MESSAGE RECORD                                     <-ALL-FMTS
      +000059*      05  MESSAGE1-I    REDEFINES PAYUPDTD-RECORD.                           <-ALL-FMTS
      +000060* OUTPUT FORMAT:MESSAGE1   FROM FILE PAYUPDTD   OF LIBRARY XMPLIB             <-ALL-FMTS
      +000061*                          MESSAGE RECORD                                     <-ALL-FMTS
  109 +000062       05  MESSAGE1-O    REDEFINES PAYUPDTD-RECORD.                           <-ALL-FMTS
  110 +000063           06 MESSAGE1-O-INDIC.                                               <-ALL-FMTS
  111 +000064                07 IN71         PIC 1  INDIC 71.                              <-ALL-FMTS
       004500
  112  004600 WORKING-STORAGE SECTION.
       004700
  113  004800 01  REL-NUMBER                    PIC 9(05)
  114  004900                                     VALUE ZEROS.
       005000
  115  005100 01  WS-CONTROL.
  116  005200    05  WS-IND                     PIC X(02).
  117  005300    05  WS-FORMAT                  PIC X(10).
  118  005400 01  SYSTEM-DATE.
  119  005500    05  SYSTEM-YEAR                PIC 99.
  120  005600    05  SYSTEM-MONTH               PIC 99.
  121  005700    05  SYSTEM-DAY                 PIC 99.
  122  005800 01  PROGRAM-DATE.
  123  005900    05  PROGRAM-MONTH              PIC 99.
  124  006000    05  PROGRAM-DAY                PIC 99.
  125  006100    05  PROGRAM-YEAR               PIC 99.
  126  006200 01  FILE-DATE REDEFINES PROGRAM-DATE
  127  006300                                   PIC S9(6).
  128  006400 01  EXCEPTION-STATUS.
  129  006500    05  STATUS-CODE-ONE            PIC XX.
  130  006600        88  SUBFILE-IS-FULL        VALUE '9M'.
  131  006700 01  EXCEPTION-MESSAGES.
  132  006800    05  MESSAGE-ONE                PIC X(31)
  133  006900        VALUE 'CUSTOMER DOES NOT EXIST        '.
  134  007000    05  MESSAGE-TWO                PIC X(31)
  135  007100        VALUE 'NO INVOICES EXIST FOR CUSTOMER '.
  136  007200    05  MESSAGE-THREE              PIC X(31)
  137  007300        VALUE 'CUSTOMER HAS AN OVER PAYMENT OF'.
  138  007400 01  PROGRAM-VARIABLES.
  139  007500    05  AMOUNT-OWED                PIC S9(6)V99.
  140  007600    05  AMOUNT-PAID                PIC S9(6)V99.
  141  007700    05  INVOICE-BALANCE            PIC S9(6)V99.
  142  007800 01  ERRPGM-PARAMETERS.
  143  007900    05  DISPLAY-PARAMETER          PIC X(8)
  144  008000                                     VALUE 'PAYUPDTD'.
  145  008100    05  DUMMY-ONE                  PIC X(6)
  146  008200                                     VALUE SPACES.
  147  008300    05  DUMMY-TWO                  PIC X(6)
  148  008400                                     VALUE SPACES.
  149  008500    05  STATUS-CODE-TWO.
  150  008600       10  PRIMARY                 PIC X(1).
  151  008700       10  SECONDARY               PIC X(1).
```

Figure 74 (Part 3 of 8). Source Listing of a Payment Update Program Example



```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  152  008800       10  FILLER                  PIC X(5)
  153  008900                                     VALUE SPACES.
  154  009000    05  DUMMY-THREE                PIC X(10)
  155  009100                                     VALUE SPACES.
       009200
  156  009300 01  SWITCH-AREA.
  157  009400    05  SW01                       PIC 1.
  158  009500       88  WRITE-DISPLAY                 VALUE B'1'.
  159  009600       88  READ-DISPLAY                  VALUE B'0'.
  160  009700    05  SW02                       PIC 1.
  161  009800       88  SUBFILE1-FORMAT               VALUE B'1'.
  162  009900       88  NOT-SUBFILE1-FORMAT           VALUE B'0'.
  163  010000    05  SW03                       PIC 1.
  164  010100       88  CONTROL1-FORMAT               VALUE B'1'.
  165  010200       88  NOT-CONTROL1-FORMAT           VALUE B'1'.
  166  010300    05  SW04                       PIC 1.
  167  010400       88  NO-MORE-TRANSACTIONS-EXIST    VALUE B'1'.
  168  010500       88  TRANSACTIONS-EXIST            VALUE B'0'.
  169  010600    05  SW05                       PIC 1.
  170  010700       88  CUSTOMER-NOT-FOUND            VALUE B'1'.
  171  010800       88  CUSTOMER-EXIST                VALUE B'0'.
  172  010900    05  SW06                       PIC 1.
  173  011000       88  NO-MORE-INVOICES-EXIST        VALUE B'1'.
  174  011100       88  CUSTOMER-INVOICE-EXIST        VALUE B'0'.
  175  011200    05  SW07                       PIC 1.
  176  011300       88  NO-MORE-PAYMENT-EXIST         VALUE B'0'.
  177  011400       88  PAYMENT-EXIST                 VALUE B'0'.
  178  011500    05  SW08                       PIC 1.
  179  011600       88  INPUT-ERRORS-EXIST            VALUE B'1'.
  180  011700       88  NO-INPUT-ERRORS-EXIST         VALUE B'0'.
  181  011800    05  SW09                       PIC 1.
  182  011900       88  OVER-PAYMENT-DISPLAYED-ONCE   VALUE B'1'.
  183  012000       88  OVER-PAYMENT-NOT-DISPLAYED    VALUE B'0'.
       012100
  184  012200 01  INDICATOR-AREA.
  185  012300    05  IN99                       PIC 1 INDIC 99.
  186  012400       88 HELP-IS-NEEDED                 VALUE B'1'.
  187  012500       88 HELP-IS-NOT-NEEDED             VALUE B'0'.
  188  012600    05  IN98                       PIC 1 INDIC 98.
  189  012700       88 END-OF-PAYMENT-UPDATE          VALUE B'1'.
  190  012800    05  IN97                       PIC 1 INDIC 97.
  191  012900       88 IGNORE-INPUT                   VALUE B'1'.
  192  013000    05  IN51                       PIC 1 INDIC 51.
  193  013100       88 DISPLAY-ACCEPT-PAYMENT         VALUE B'1'.
  194  013200       88 DO-NOT-DISPLAY-ACCEPT-PAYMENT  VALUE B'0'.
  195  013300    05  IN52                       PIC 1 INDIC 52.
  196  013400       88 REVERSE-FIELD-IMAGE            VALUE B'1'.
  197  013500       88 DO-NOT-REVERSE-FIELD-IMAGE     VALUE B'0'.
  198  013600    05  IN53                       PIC 1 INDIC 53.
  199  013700       88 DO-NOT-DISPLAY-FIELD           VALUE B'1'.
  200  013800       88 DISPLAY-FIELD                  VALUE B'0'.
  201  013900    05  IN54                       PIC 1 INDIC 54.
  202  014000       88 PROTECT-INPUT-FIELD            VALUE B'1'.
  203  014100       88 DO-NOT-PROTECT-INPUT-FIELD     VALUE B'0'.
  204  014200    05  IN55                       PIC 1 INDIC 55.
  205  014300       88 MAKE-FIELD-BLINK               VALUE B'1'.
  206  014400       88 DO-NOT-MAKE-FIELD-BLINK        VALUE B'0'.
  207  014500    05  IN56                       PIC 1 INDIC 56.
  208  014600       88 DISPLAY-OVER-PAYMENT           VALUE B'1'.
  209  014700       88 DO-NOT-DISPLAY-OVER-PAYMENT    VALUE B'0'.
  210  014800    05  IN61                       PIC 1 INDIC 61.
  211  014900       88 CLEAR-SUBFILE                  VALUE B'1'.
  212  015000       88 DO-NOT-CLEAR-SUBFILE           VALUE B'0'.
  213  015100    05  IN62                       PIC 1 INDIC 62.
  214  015200       88 DISPLAY-SCREEN                 VALUE B'1'.
  215  015300       88 DO-NOT-DISPLAY-SCREEN          VALUE B'0'.
  216  015400    05  IN63                       PIC 1 INDIC 63.
  217  015500       88 DISPLAY-ACCEPT-HEADING         VALUE B'1'.
  218  015600       88 DO-NOT-DISPLAY-ACCEPT-HEADING  VALUE B'0'.
  219  015700    05  IN64                       PIC 1 INDIC 64.
  220  015800       88 DISPLAY-EXCEPTION              VALUE B'1'.
  221  015900       88 DO-NOT-DISPLAY-EXCEPTION       VALUE B'0'.
  222  016000    05  IN71                       PIC 1 INDIC 71.
  223  016100       88 DISPLAY-ACCEPT-MESSAGE         VALUE B'1'.
  224  016200       88 DO-NOT-DISPLAY-ACCEPT-MESSAGE  VALUE B'0'.
       016300
```

Figure 74 (Part 4 of 8). Source Listing of a Payment Update Program Example

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   225  016400 PROCEDURE DIVISION.
        016500
        016600 DECLARATIVES.
        016700
        016800 TRANSACTION-ERROR SECTION.
        016900     USE AFTER STANDARD ERROR PROCEDURE
        017000         PAYMENT-UPDATE-DISPLAY-FILE.
        017100 WORK-STATION-ERROR-HANDLER.
   226  017200     IF SUBFILE-IS-FULL THEN
        017300       NEXT SENTENCE
        017400     ELSE
   227  017500       DISPLAY 'ERROR IN PAYMENT-UPDATE' STATUS-CODE-ONE.
        017600 END DECLARATIVES.
        017700
        017800 CUSTOMER-PAYMENT-UPDATE SECTION.
        017900 MAINLINE-ROUTINE.
   228  018000     PERFORM SET-UP-ROUTINE.
   229  018100     PERFORM PROCESS-TRANSACTION-FILE
        018200       UNTIL END-OF-PAYMENT-UPDATE.
   230  018300     PERFORM CLEAN-UP-ROUTINE.
        018400
        018500 SET-UP-ROUTINE.
   231  018600     OPEN I-O      CUSTOMER-INVOICE-FILE
        018700                   CUSTOMER-MASTER-FILE
        018800                   PAYMENT-UPDATE-DISPLAY-FILE.
   232  018900     MOVE ALL B'0' TO INDICATOR-AREA
        019000                    SWITCH-AREA.
   233  019100     ACCEPT SYSTEM-DATE FROM DATE.
   234  019200     MOVE SYSTEM-YEAR  TO PROGRAM-YEAR.
   235  019300     MOVE SYSTEM-MONTH TO PROGRAM-MONTH.
   236  019400     MOVE SYSTEM-DATE  TO PROGRAM-DAY.
   237  019500     SET WRITE-DISPLAY
        019600         CONTROL1-FORMAT
        019700         DO-NOT-DISPLAY-OVER-PAYMENT
        019800         DO-NOT-PROTECT-INPUT-FIELD
        019900         DO-NOT-REVERSE-FIELD-IMAGE
        020000         DO-NOT-MAKE-FIELD-BLINK
        020100         CLEAR-SUBFILE TO TRUE.
   238  020200     MOVE CORR INDICATOR-AREA TO CONTROL1-O-INDIC.
   239  020300     WRITE PAYMENT-UPDATE-DISPLAY-RECORD
        020400         FORMAT IS 'CONTROL1'.
   240  020500     SET DO-NOT-CLEAR-SUBFILE TO TRUE.
   241  020600     PERFORM INITIALIZE-SUBFILE-RECORD 17 TIMES.
   242  020700     SET DISPLAY-SCREEN TO TRUE.
   243  020800     MOVE CORR INDICATOR-AREA TO CONTROL1-O-INDIC.
   244  020900     WRITE PAYMENT-UPDATE-DISPLAY-RECORD
        021000         FORMAT IS 'CONTROL1'.
   245  021100     READ PAYMENT-UPDATE-DISPLAY-FILE RECORD
        021200         FORMAT IS 'CONTROL1'.
   246  021300     MOVE CORR CONTROL1-I-INDIC TO INDICATOR-AREA.
        021400 PROCESS-TRANSACTION-FILE.
   247  021500     IF HELP-IS-NOT-NEEDED THEN
   248  021600        IF  IGNORE-INPUT THEN
   249  021700            SET WRITE-DISPLAY
        021800                CONTROL1-FORMAT
        021900                CLEAR-SUBFILE
        022000                DISPLAY-FIELD
        022100                DO-NOT-DISPLAY-OVER-PAYMENT
        022200                DO-NOT-PROTECT-INPUT-FIELD
        022300                DO-NOT-REVERSE-FIELD-IMAGE
        022400                DO-NOT-DISPLAY-ACCEPT-PAYMENT
        022500                DO-NOT-DISPLAY-ACCEPT-HEADING
        022600                DO-NOT-DISPLAY-ACCEPT-MESSAGE
        022700                DO-NOT-MAKE-FIELD-BLINK TO TRUE
   250  022800            MOVE CORR INDICATOR-AREA TO CONTROL1-O-INDIC
   251  022900            WRITE PAYMENT-UPDATE-DISPLAY-RECORD
        023000                FORMAT IS 'CONTROL1'
   252  023100            SET DO-NOT-CLEAR-SUBFILE TO TRUE
   253  023200            MOVE 0 TO REL-NUMBER
   254  023300            PERFORM INITIALIZE-SUBFILE-RECORD 17 TIMES
        023400         ELSE
   255  023500            SET TRANSACTIONS-EXIST
        023600                DO-NOT-DISPLAY-ACCEPT-HEADING
        023700                DO-NOT-DISPLAY-ACCEPT-MESSAGE
        023800                DO-NOT-DISPLAY-EXCEPTION TO TRUE
   256  023900            PERFORM READ-MODIFIED-SUBFILE-RECORD
```

Figure 74 (Part 5 of 8). Source Listing of a Payment Update Program Example

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  257  024000            PERFORM TRANSACTION-VALIDATION
       024100                UNTIL NO-MORE-TRANSACTIONS-EXIST
  258  024200            SET NO-INPUT-ERRORS-EXIST TO TRUE
  259  024300            PERFORM TEST-FOR-RECORD-INPUT-ERRORS
       024400                VARYING REL-NUMBER
       024500                FROM    1
       024600                BY      1
       024700                UNTIL   REL-NUMBER IS GREATER THAN 17
       024800                OR      INPUT-ERRORS-EXIST
  260  024900            IF  NO-INPUT-ERRORS-EXIST THEN
  261  025000                IF  OVER-PAYMENT-DISPLAYED-ONCE THEN
  262  025100                    SET WRITE-DISPLAY
       025200                        CONTROL1-FORMAT
       025300                        DO-NOT-DISPLAY-OVER-PAYMENT
       025400                        DO-NOT-PROTECT-INPUT-FIELD
       025500                        DO-NOT-REVERSE-FIELD-IMAGE
       025600                        DO-NOT-MAKE-FIELD-BLINK
       025700                        DO-NOT-DISPLAY-ACCEPT-PAYMENT
       025800                        DO-NOT-DISPLAY-ACCEPT-HEADING
       025900                        DO-NOT-DISPLAY-ACCEPT-MESSAGE
       026000                        DO-NOT-DISPLAY-EXCEPTION
       026100                        CLEAR-SUBFILE
       026200                        DISPLAY-FIELD
       026300                          TO TRUE
  263  026400                    MOVE CORR INDICATOR-AREA TO CONTROL1-O-INDIC
  264  026500                    WRITE PAYMENT-UPDATE-DISPLAY-RECORD
       026600                        FORMAT IS 'CONTROL1'
  265  026700                    SET DO-NOT-CLEAR-SUBFILE TO TRUE
  266  026800                    MOVE 0 TO REL-NUMBER
  267  026900                    PERFORM INITIALIZE-SUBFILE-RECORD 17 TIMES
       027000                ELSE
  268  027100                    SET OVER-PAYMENT-DISPLAYED-ONCE TO TRUE
       027200            ELSE
       027300                NEXT SENTENCE
       027400     ELSE
       027500         NEXT SENTENCE.
  269  027600     SET WRITE-DISPLAY, DISPLAY-SCREEN TO TRUE.
  270  027700     MOVE CORR INDICATOR-AREA TO MESSAGE1-O-INDIC.
  271  027800     WRITE PAYMENT-UPDATE-DISPLAY-RECORD
       027900         FORMAT IS 'MESSAGE1'.
  272  028000     SET WRITE-DISPLAY, CONTROL1-FORMAT TO TRUE.
  273  028100     MOVE CORR INDICATOR-AREA TO CONTROL1-O-INDIC.
  274  028200     WRITE PAYMENT-UPDATE-DISPLAY-RECORD
       028300         FORMAT IS 'CONTROL1'.
  275  028400     READ PAYMENT-UPDATE-DISPLAY-FILE RECORD
       028500         FORMAT IS 'CONTROL1'.
  276  028600     MOVE CORR CONTROL1-I-INDIC TO INDICATOR-AREA.
       028700 READ-MODIFIED-SUBFILE-RECORD.
  277  028800     READ SUBFILE PAYMENT-UPDATE-DISPLAY-FILE
       028900         NEXT MODIFIED RECORD FORMAT IS 'SUBFILE1'
  278  029000         AT END SET NO-MORE-TRANSACTIONS-EXIST TO TRUE.
       029100 TEST-FOR-RECORD-INPUT-ERRORS.
  279  029200     READ SUBFILE PAYMENT-UPDATE-DISPLAY-FILE RECORD
       029300         FORMAT IS 'SUBFILE1'.
  280  029400     IF  STSCDE OF SUBFILE1-I IS EQUAL TO '1' THEN
  281  029500         SET INPUT-ERRORS-EXIST TO TRUE
       029600     ELSE
       029700         NEXT SENTENCE.
       029800 TRANSACTION-VALIDATION.
  282  029900     MOVE CUST OF SUBFILE1-I OF PAYMENT-UPDATE-DISPLAY-RECORD
       030000         TO CUST OF CUSTOMER-MASTER-RECORD.
  283  030100     SET CUSTOMER-EXIST TO TRUE.
  284  030200     READ CUSTOMER-MASTER-FILE
  285  030300         INVALID KEY SET CUSTOMER-NOT-FOUND TO TRUE.
  286  030400     IF  CUSTOMER-EXIST THEN
  287  030500         MOVE CUST OF CUSMST TO CUST OF ORDHDR
  288  030600         MOVE ZEROES TO INVNUM
  289  030700         SET CUSTOMER-INVOICE-EXIST TO TRUE
  290  030800         PERFORM START-ON-CUSTOMER-INVOICE-FILE
  291  030900         IF  CUSTOMER-INVOICE-EXIST THEN
  292  031000             PERFORM READ-CUSTOMER-INVOICE-RECORD
  293  031100             IF CUSTOMER-INVOICE-EXIST THEN
  294  031200                 PERFORM CUSTOMER-MASTER-FILE-UPDATE
  295  031300                 MOVE AMPAID OF SUBFILE1-I TO AMOUNT-PAID
  296  031400                 SET PAYMENT-EXIST TO TRUE
```

Figure 74 (Part 6 of 8). Source Listing of a Payment Update Program Example

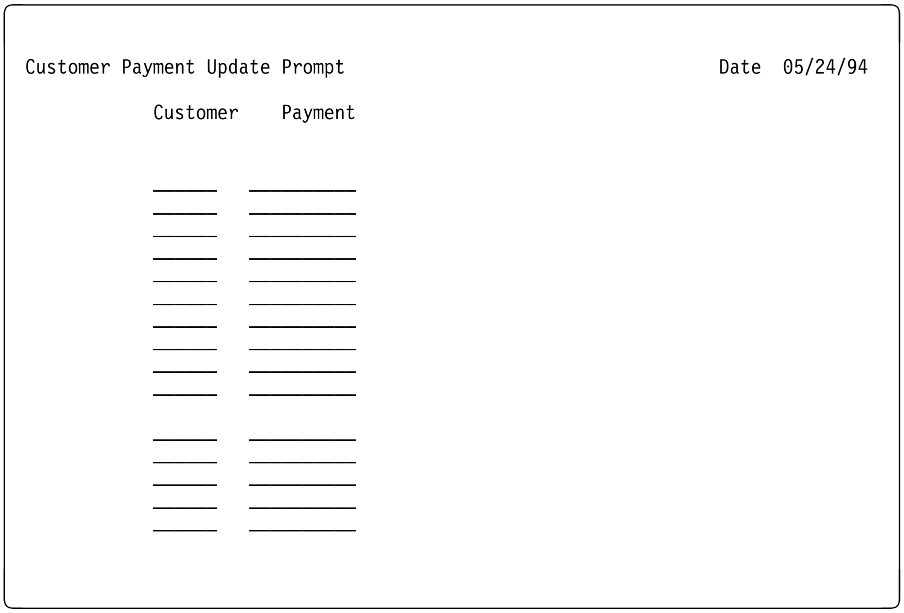
```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  297  031500                 PERFORM PAYMENT-UPDATE
       031600                     UNTIL NO-MORE-INVOICES-EXIST
       031700                     OR NO-MORE-PAYMENT-EXIST
  298  031800                 IF  ARBAL OF CUSTOMER-MASTER-RECORD IS NEGATIVE
  299  031900                     SET MAKE-FIELD-BLINK
       032000                         DISPLAY-FIELD
       032100                         DO-NOT-REVERSE-FIELD-IMAGE
       032200                         OVER-PAYMENT-NOT-DISPLAYED
       032300                         DISPLAY-OVER-PAYMENT
       032400                         DISPLAY-EXCEPTION
       032500                         DO-NOT-DISPLAY-ACCEPT-PAYMENT
       032600                         PROTECT-INPUT-FIELD TO TRUE
  300  032700                     MOVE ARBAL TO OVRPMT OF SUBFILE1-O
  301  032800                     MOVE MESSAGE-THREE TO ECPMSG OF SUBFILE1-O
  302  032900                     MOVE '0' TO STSCDE OF SUBFILE1-O
  303  033000                     PERFORM REWRITE-DISPLAY-SUBFILE-RECORD
       033100                 ELSE
  304  033200                     SET DO-NOT-DISPLAY-FIELD
       033300                         DO-NOT-DISPLAY-OVER-PAYMENT
       033400                         DO-NOT-REVERSE-FIELD-IMAGE
       033500                         DO-NOT-MAKE-FIELD-BLINK
       033600                         DO-NOT-DISPLAY-ACCEPT-PAYMENT
       033700                         PROTECT-INPUT-FIELD TO TRUE
  305  033800                     MOVE SPACES TO ECPMSG OF SUBFILE1-O
  306  033900                     MOVE ZEROES TO OVRPMT OF SUBFILE1-O
  307  034000                     MOVE '0' TO STSCDE OF SUBFILE1-O
  308  034100                     PERFORM REWRITE-DISPLAY-SUBFILE-RECORD
       034200             ELSE
  309  034300                 PERFORM NO-CUSTOMER-INVOICE-ROUTINE
       034400         ELSE
  310  034500             PERFORM NO-CUSTOMER-INVOICE-ROUTINE
       034600     ELSE
  311  034700         SET REVERSE-FIELD-IMAGE
       034800             DO-NOT-PROTECT-INPUT-FIELD
       034900             DISPLAY-FIELD
       035000             DO-NOT-DISPLAY-OVER-PAYMENT
       035100             DO-NOT-MAKE-FIELD-BLINK
       035200             DISPLAY-EXCEPTION
       035300             DO-NOT-DISPLAY-ACCEPT-PAYMENT
       035400             DO-NOT-PROTECT-INPUT-FIELD TO TRUE
  312  035500         MOVE ZEROES TO OVRPMT OF SUBFILE1-O
  313  035600         MOVE MESSAGE-ONE TO ECPMSG OF SUBFILE1-O
  314  035700         MOVE '1' TO STSCDE OF SUBFILE1-O
  315  035800         PERFORM REWRITE-DISPLAY-SUBFILE-RECORD.
  316  035900     PERFORM READ-MODIFIED-SUBFILE-RECORD.
       036000 START-ON-CUSTOMER-INVOICE-FILE.
  317  036100     START CUSTOMER-INVOICE-FILE
       036200         KEY IS GREATER THAN COMP-KEY
  318  036300         INVALID KEY SET NO-MORE-INVOICES-EXIST TO TRUE.
       036400 READ-CUSTOMER-INVOICE-RECORD.
  319  036500     READ CUSTOMER-INVOICE-FILE NEXT RECORD
  320  036600         AT END SET NO-MORE-INVOICES-EXIST TO TRUE.
  321  036700     IF  CUST OF CUSTOMER-MASTER-RECORD
       036800         IS NOT EQUAL TO CUST OF CUSTOMER-INVOICE-RECORD THEN
  322  036900         SET NO-MORE-INVOICES-EXIST TO TRUE
       037000     ELSE
       037100         NEXT SENTENCE.
       037200 CUSTOMER-MASTER-FILE-UPDATE.
  323  037300     MOVE FILE-DATE TO LSTDAT OF CUSTOMER-MASTER-RECORD.
  324  037400     MOVE AMPAID OF SUBFILE1-I
       037500         TO LSTAMT OF CUSTOMER-MASTER-RECORD.
  325  037600     SUBTRACT AMPAID OF SUBFILE1-I
       037700         FROM ARBAL OF CUSTOMER-MASTER-RECORD.
  326  037800     REWRITE CUSTOMER-MASTER-RECORD.
       037900  REWRITE-DISPLAY-SUBFILE-RECORD.
  327  038000     MOVE AMPAID OF SUBFILE1-I TO AMPAID OF SUBFILE1-O.
  328  038100     MOVE CUST OF SUBFILE1-I TO CUST OF SUBFILE1-O.
  329  038200     SET WRITE-DISPLAY TO TRUE.
  330  038300     SET SUBFILE1-FORMAT TO TRUE.
  331  038400     MOVE CORR INDICATOR-AREA TO SUBFILE1-O-INDIC.
  332  038500     REWRITE SUBFILE PAYMENT-UPDATE-DISPLAY-RECORD
       038600         FORMAT IS 'SUBFILE1'.
       038700 NO-CUSTOMER-INVOICE-ROUTINE.
  333  038800     IF  STSCDE OF SUBFILE1-I IS EQUAL TO '1' THEN
  334  038900        IF  ACPPMT OF SUBFILE1-I IS EQUAL TO '*NO' THEN
  335  039000           SET DO-NOT-DISPLAY-FIELD
```

Figure 74 (Part 7 of 8). Source Listing of a Payment Update Program Example

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
       039100               DO-NOT-DISPLAY-OVER-PAYMENT
       039200               DO-NOT-REVERSE-FIELD-IMAGE
       039300               DO-NOT-MAKE-FIELD-BLINK
       039400               DO-NOT-DISPLAY-ACCEPT-PAYMENT
       039500               PROTECT-INPUT-FIELD
       039600                 TO TRUE
  336  039700            MOVE SPACES TO ECPMSG OF SUBFILE1-O
  337  039800            MOVE ZEROES TO OVRPMT OF SUBFILE1-O
  338  039900            MOVE '0' TO STSCDE OF SUBFILE1-O
  339  040000            PERFORM REWRITE-DISPLAY-SUBFILE-RECORD
       040100        ELSE
  340  040200            PERFORM CUSTOMER-MASTER-FILE-UPDATE
  341  040300            SET MAKE-FIELD-BLINK
       040400                DISPLAY-FIELD
       040500                DO-NOT-REVERSE-FIELD-IMAGE
       040600                OVER-PAYMENT-NOT-DISPLAYED
       040700                DISPLAY-OVER-PAYMENT
       040800                DISPLAY-EXCEPTION
       040900                DO-NOT-DISPLAY-ACCEPT-PAYMENT
       041000                PROTECT-INPUT-FIELD
       041100                  TO TRUE
  342  041200            MOVE ARBAL TO OVRPMT OF SUBFILE1-O
  343  041300            MOVE MESSAGE-THREE TO ECPMSG OF SUBFILE1-O
  344  041400            MOVE '0' TO STSCDE OF SUBFILE1-O
  345  041500            PERFORM REWRITE-DISPLAY-SUBFILE-RECORD
       041600     ELSE
  346  041700         SET REVERSE-FIELD-IMAGE
       041800             DISPLAY-FIELD
       041900             DO-NOT-PROTECT-INPUT-FIELD
       042000             DO-NOT-DISPLAY-OVER-PAYMENT
       042100             DISPLAY-EXCEPTION
       042200             DISPLAY-ACCEPT-PAYMENT
       042300             DISPLAY-ACCEPT-HEADING
       042400             DISPLAY-ACCEPT-MESSAGE
       042500             DO-NOT-MAKE-FIELD-BLINK
       042600               TO TRUE
  347  042700         MOVE ZEROS TO OVRPMT OF SUBFILE1-O
  348  042800         MOVE MESSAGE-TWO TO ECPMSG OF SUBFILE1-O
  349  042900         MOVE '1' TO STSCDE OF SUBFILE1-O
  350  043000         PERFORM REWRITE-DISPLAY-SUBFILE-RECORD.
       043100 PAYMENT-UPDATE.
  351  043200     SUBTRACT AMPAID OF CUSTOMER-INVOICE-RECORD
       043300         FROM ORDAMT OF CUSTOMER-INVOICE-RECORD
       043400         GIVING AMOUNT-OWED.
  352  043500     SUBTRACT AMOUNT-PAID
       043600         FROM AMOUNT-OWED
       043700         GIVING INVOICE-BALANCE.
  353  043800     IF  INVOICE-BALANCE IS LESS THAN .01 THEN
  354  043900         MOVE 2 TO OPNSTS OF CUSTOMER-INVOICE-RECORD
  355  044000         MOVE ORDAMT OF CUSTOMER-INVOICE-RECORD
       044100           TO AMPAID OF CUSTOMER-INVOICE-RECORD
  356  044200         SUBTRACT AMOUNT-OWED
       044300             FROM AMOUNT-PAID
       044400     ELSE
  357  044500         ADD AMOUNT-PAID TO AMPAID OF CUSTOMER-INVOICE-RECORD
  358  044600         SET NO-MORE-PAYMENT-EXIST TO TRUE.
  359  044700     REWRITE CUSTOMER-INVOICE-RECORD.
  360  044800     IF  NO-MORE-PAYMENT-EXIST THEN
       044900         NEXT SENTENCE
       045000     ELSE
  361  045100         PERFORM READ-CUSTOMER-INVOICE-RECORD.
       045200 INITIALIZE-SUBFILE-RECORD.
  362  045300     MOVE SPACES TO CUST OF SUBFILE1-O.
  363  045400     MOVE SPACES TO ECPMSG OF SUBFILE1-O.
  364  045500     MOVE '0' TO STSCDE OF SUBFILE1-O.
  365  045600     MOVE ZEROS TO AMPAID OF SUBFILE1-O.
  366  045700     MOVE ZEROS TO OVRPMT OF SUBFILE1-O.
  367  045800     ADD 1 TO REL-NUMBER.
  368  045900     MOVE CORR INDICATOR-AREA TO SUBFILE1-O-INDIC.
  369  046000     WRITE SUBFILE PAYMENT-UPDATE-DISPLAY-RECORD
       046100         FORMAT IS 'SUBFILE1'.
       046200 CLEAN-UP-ROUTINE.
  370  046300     CLOSE CUSTOMER-INVOICE-FILE
       046400           CUSTOMER-MASTER-FILE
       046500           PAYMENT-UPDATE-DISPLAY-FILE.
  371  046600     STOP RUN.
                           * * * * *   E N D   O F   S O U R C E   * * * * *
```

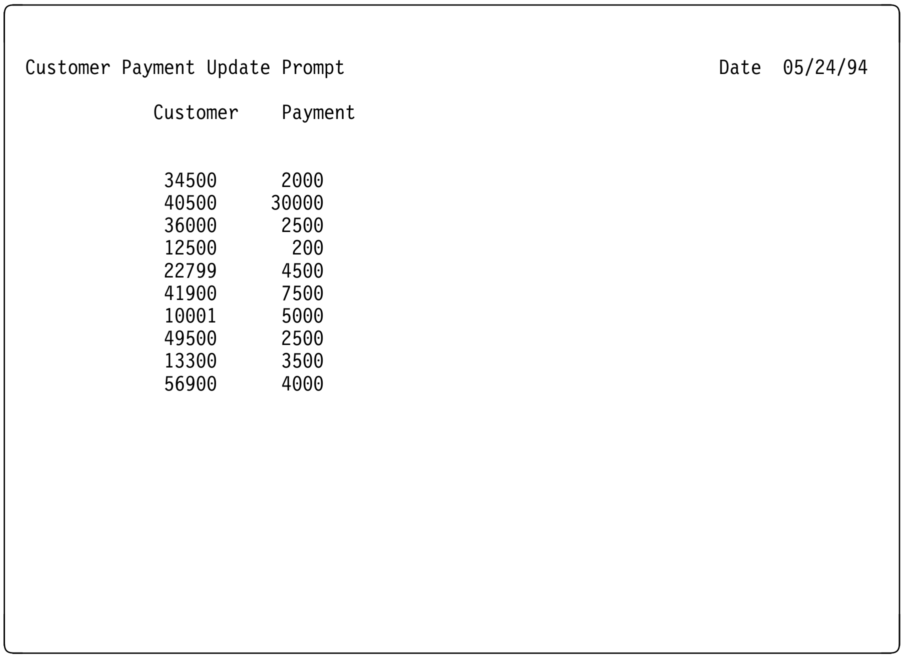
Figure 74 (Part 8 of 8). Source Listing of a Payment Update Program Example

This is the initial display that is written to the work station to prompt you to enter the customer number and payment:



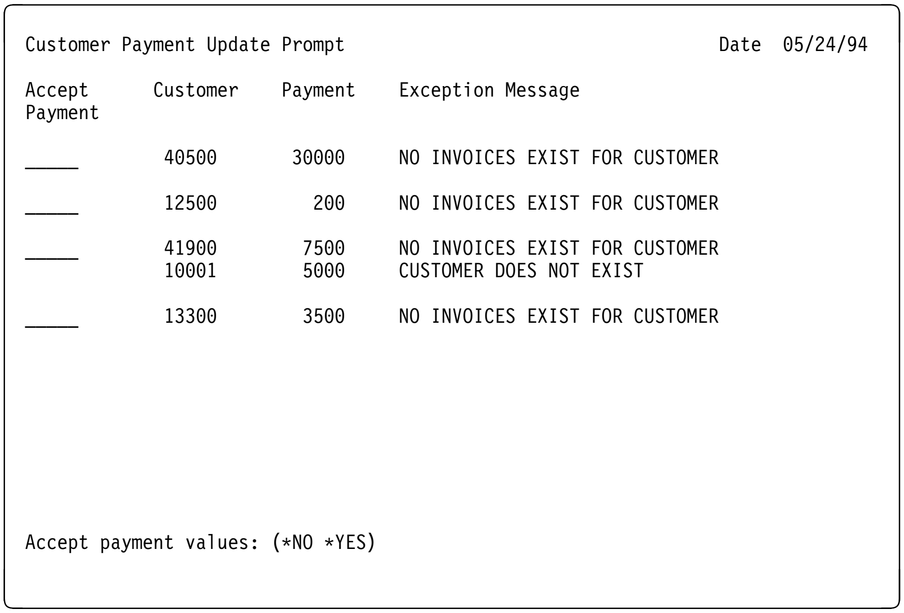
```
Customer Payment Update Prompt                                   Date  05/24/94

            Customer    Payment


            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________

            ______   __________
            ______   __________
            ______   __________
            ______   __________
            ______   __________
```

Enter the customer numbers and payments:



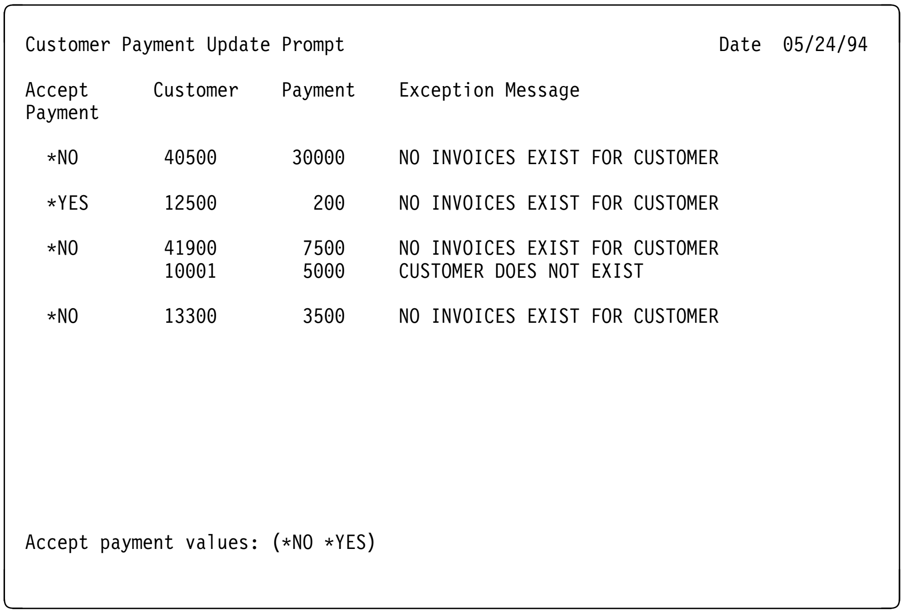
```
Customer Payment Update Prompt                                   Date  05/24/94

            Customer    Payment


             34500      2000
             40500     30000
             36000      2500
             12500       200
             22799      4500
             41900      7500
             10001      5000
             49500      2500
             13300      3500
             56900      4000
```

Payments that would result in overpayments or that have incorrect customer numbers are left on the display and appropriate messages are added:



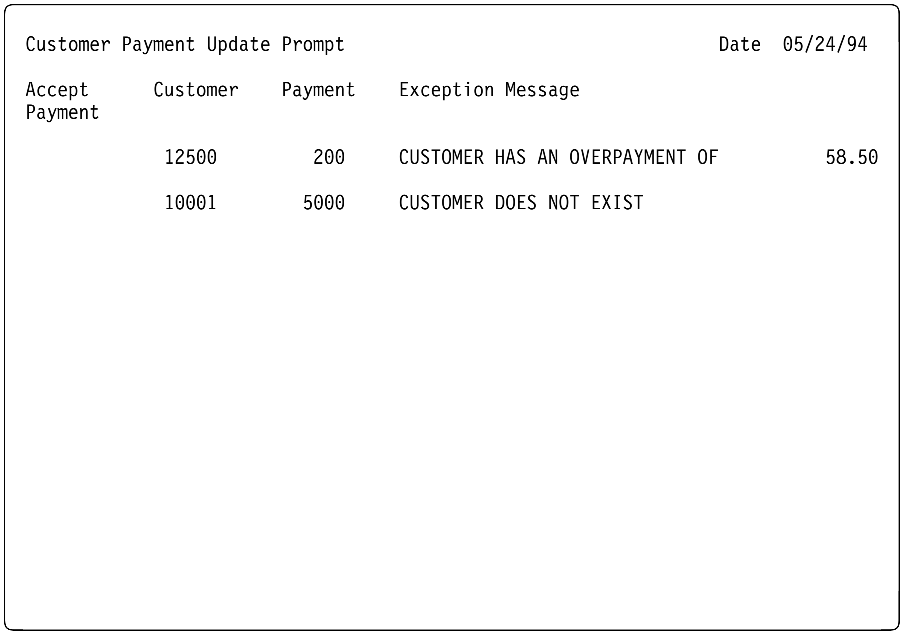
```
Customer Payment Update Prompt                                 Date  05/24/94

Accept      Customer    Payment    Exception Message
Payment

_____        40500       30000     NO INVOICES EXIST FOR CUSTOMER

_____        12500         200     NO INVOICES EXIST FOR CUSTOMER

_____        41900        7500     NO INVOICES EXIST FOR CUSTOMER
             10001        5000     CUSTOMER DOES NOT EXIST

_____        13300        3500     NO INVOICES EXIST FOR CUSTOMER








Accept payment values: (*NO *YES)
```

Indicate which payments to accept:



```
Customer Payment Update Prompt                                 Date  05/24/94

Accept      Customer    Payment    Exception Message
Payment

  *NO        40500       30000     NO INVOICES EXIST FOR CUSTOMER

  *YES       12500         200     NO INVOICES EXIST FOR CUSTOMER

  *NO        41900        7500     NO INVOICES EXIST FOR CUSTOMER
             10001        5000     CUSTOMER DOES NOT EXIST

  *NO        13300        3500     NO INVOICES EXIST FOR CUSTOMER








Accept payment values: (*NO *YES)
```

The accepted payments are processed, and overpayment information is displayed:



```
Customer Payment Update Prompt                                 Date  05/24/94

Accept      Customer    Payment    Exception Message
Payment

             12500         200     CUSTOMER HAS AN OVERPAYMENT OF         58.50

             10001        5000     CUSTOMER DOES NOT EXIST
```

End of IBM Extension

Chapter 9. Printer Files

This chapter describes how COBOL/400 interacts with the different kinds of printer files.

You can obtain printed output from a COBOL program by issuing WRITE statements to one or more printer files. Each printer file must have a unique name and be assigned to a device of PRINTER or FORMATFILE in the ASSIGN clause of that file's FILE-CONTROL entry.

A device of PRINTER must be used for program-described files, and a device of FORMATFILE must be used for externally described printer files. The Create Print File (CRTPRTF) command can be used to create a printer file (see the *CL Reference* for further information on the CRTPRTF command), or one of the IBM-supplied printer-device files, such as QPRINT can be used.

The file operations that are valid for a printer file are WRITE, OPEN, and CLOSE. For a complete description of these operations, see the *COBOL/400 Reference*.

See the *DDS Reference* for information on the DDS for externally described printer files. For more information on FORMATFILE files, see "FORMATFILE Files" on page 234.

SPECIAL-NAMES Paragraph and the ADVANCING Phrase

When the mnemonic-name associated with the function-name CSP is specified in the ADVANCING phrase of a WRITE statement for a printer file, it has the same effect as specifying ADVANCING 0 LINES.

When the mnemonic-name associated with the function-name C01 is specified in the ADVANCING phrase of a WRITE statement for a printer file, it has the same effect as specifying ADVANCING PAGE.

The ADVANCING phrase cannot be specified in WRITE statements for files assigned to FORMATFILE.

LINAGE Clause

When the LINAGE clause is specified for a file assigned to PRINTER, all spacing and paging controls are handled internally by compiler generated code.

Paper positioning is done only when the first WRITE statement is run. The paper in the printer is positioned to a new physical page, and the LINAGE-COUNTER is set to 1. When the printer file is shared and other programs have written records to the file, the COBOL WRITE statement is still considered to be the first WRITE statement. Paper positioning is handled by the COBOL/400 compiler even though it is not the first WRITE statement for that file.

All spacing and paging for WRITE statements is controlled internally. The physical size of the page is ignored when paper positioning is not properly defined for the COBOL/400 compiler. For a file that has a LINAGE clause and is assigned to PRINTER, paging consists of spacing to the end of the logical page (page body) and then spacing past the bottom and top margins.

Use of the LINAGE clause degrades performance. The LINAGE clause should be used only as necessary. If the physical paging is acceptable, the LINAGE clause is not necessary.

The LINAGE clause should not be used for files assigned to FORMATFILE.

FORMATFILE Files

Externally described printer files must be assigned to a device of FORMATFILE. The term FORMATFILE is used because the FORMAT phrase is valid in WRITE statements for the file, and the data formatting is specified in the DDS for the file.

When you have specified a device of FORMATFILE, you can obtain formatting of printed output in two ways:

1. Choose the formats to print and their order by using appropriate values in the FORMAT phrases specified for WRITE statements. For example, use one format once per page to produce a heading, and use another format to produce the detail lines on the page.
2. Choose the appropriate options to be taken when each format is printed by setting indicator values and passing these indicators through the INDICATOR phrase for the WRITE statement. For example, fields may be underlined, blank lines may be produced before or after the format is printed, or the printing of certain fields may be skipped.

The use of external descriptions for printer files has the following advantages over program descriptions:

- Multiple lines can be printed by one WRITE statement. When multiple lines are written by one WRITE statement and the END-OF-PAGE condition is reached, the END-OF-PAGE imperative statement is processed after all of the lines are printed. It is possible to print lines in the overflow area, and onto the next page before the END-OF-PAGE imperative statement is processed.

  Figure 75 on page 235 shows an example of an occurrence of the END-OF-PAGE condition through FORMATFILE.
- Optional printing of fields based on indicator values is possible.
- Editing of field values is easily defined.
- Maintenance of print formats, especially those used by multiple programs, is easier.

Use of the ADVANCING phrase for FORMATFILE files causes a compilation error to be issued. Advancing of lines is controlled in a FORMATFILE file through DDS keywords, such as SKIPA and SKIPB, and through the use of line numbers.

For FORMATFILE files, the LINAGE clause is invalid.

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000100 IDENTIFICATION DIVISION.                                                               02/01/94
     2  000200 PROGRAM-ID.     FRMTFILE.                                                              03/22/94
     3  000300   AUTHOR.       PROGRAMMER NAME.                                                       01/27/94
     4  000400   INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.                                      01/27/94
     5  000500   DATE-WRITTEN. 02/02/89.                                                              02/04/94
     8  000080   DATE-COMPILED.  05/24/94 14:29:31   .                                                03/01/94
     7  000700 ENVIRONMENT DIVISION.                                                                  01/27/94
     8  000800 CONFIGURATION SECTION.                                                                 01/27/94
     9  000900 SOURCE-COMPUTER. IBM-AS400.                                                            01/27/94
    10  001000 OBJECT-COMPUTER. IBM-AS400.                                                            01/27/94
    11  001100 INPUT-OUTPUT SECTION.                                                                  01/27/94
    12  001200 FILE-CONTROL.                                                                          01/27/94
    13  001300     SELECT PERSREPT ASSIGN TO FORMATFILE-PERSREPT-SI  1                                02/04/94
    14  001400         ORGANIZATION IS SEQUENTIAL.                                                    02/04/94
    15  001500     SELECT PERSFILE ASSIGN TO DATABASE-PERSFILE                                        02/04/94
    16  001600         ORGANIZATION IS INDEXED                                                        02/04/94
    17  001700         ACCESS MODE IS SEQUENTIAL                                                      02/04/94
    18  001800         RECORD IS EXTERNALLY-DESCRIBED-KEY.                                            02/04/94
    19  001900 DATA DIVISION.                                                                         01/27/94
    20  002000 FILE SECTION.                                                                          01/27/94
    21  002100 FD  PERSREPT                                                                           02/04/94
    22  002200     LABEL RECORDS ARE STANDARD.                                                        02/04/94
    23  002300 01  PERSREPT-REC.                                                                      02/04/94
    24  002400     COPY DDS-ALL-FORMATS-O OF PERSREPT.  2
    25 +000001       05  PERSREPT-RECORD PIC X(130).                                <-ALL-FMTS
       +000002* OUTPUT FORMAT:HEADING    FROM FILE PERSREPT   OF LIBRARY XMPLIB     <-ALL-FMTS
       +000003*                                                                 <-ALL-FMTS
    26 +000004       05  HEADING-O     REDEFINES PERSREPT-RECORD.                   <-ALL-FMTS
    27 +000005           06 ORDERTYPE         PIC X(15).                            <-ALL-FMTS
       +000006* OUTPUT FORMAT:DETAIL     FROM FILE PERSREPT   OF LIBRARY XMPLIB     <-ALL-FMTS
       +000007*                                                                 <-ALL-FMTS
    28 +000008       05  DETAIL-O      REDEFINES PERSREPT-RECORD.  3                <-ALL-FMTS
    29 +000009           06 NAME              PIC X(30).                            <-ALL-FMTS
    30 +000010           06 EMPLNO            PIC S9(6).                            <-ALL-FMTS
    31 +000011           06 BIRTHDATE         PIC X(6).                             <-ALL-FMTS
    32 +000012           06 ADDRESS1          PIC X(35).                            <-ALL-FMTS
    33 +000013           06 MARSTAT           PIC X(1).                             <-ALL-FMTS
    34 +000014           06 SPOUSENAME        PIC X(30).                            <-ALL-FMTS
    35 +000015           06 ADDRESS2          PIC X(20).                            <-ALL-FMTS
    36 +000016           06 NUMCHILD          PIC S9(2).                            <-ALL-FMTS
    37  002500 FD  PERSFILE
    38  002600     LABEL RECORDS ARE STANDARD.
    39  002700 01  PERSFILE-REC.
    40  002800     COPY DDS-ALL-FORMATS-O OF PERSFILE.
    41 +000001       05  PERSFILE-RECORD PIC X(130).                                <-ALL-FMTS
       +000002*    I-O FORMAT:PERSREC    FROM FILE PERSFILE   OF LIBRARY XMPLIB     <-ALL-FMTS
       +000003*                                                                 <-ALL-FMTS
       +000004*THE KEY DEFINITIONS FOR RECORD FORMAT  PERSREC                       <-ALL-FMTS
       +000005*  NUMBER               NAME               RETRIEVAL     TYPE    ALTSEQ     <-ALL-FMTS
       +000006*   0001   EMPLNO                           ASCENDING   SIGNED     NO       <-ALL-FMTS
    42 +000007       05  PERSREC       REDEFINES PERSFILE-RECORD.                   <-ALL-FMTS
    43 +000008           06 EMPLNO            PIC S9(6).                            <-ALL-FMTS
    44 +000009           06 NAME              PIC X(30).                            <-ALL-FMTS
    45 +000010           06 ADDRESS1          PIC X(35).                            <-ALL-FMTS
    46 +000011           06 ADDRESS2          PIC X(20).                            <-ALL-FMTS
    47 +000012           06 BIRTHDATE         PIC X(6).                             <-ALL-FMTS
    48 +000013           06 MARSTAT           PIC X(1).                             <-ALL-FMTS
    49 +000014           06 SPOUSENAME        PIC X(30).                            <-ALL-FMTS
    50 +000015           06 NUMCHILD          PIC S9(2).                            <-ALL-FMTS
    51  002900 WORKING-STORAGE SECTION.
    52  003000 77  HEAD-ORDER                    PIC X(15)
    53  003100                                    VALUE "EMPLOYEE NUMBER".
    54  003200 01  PERSREPT-INDICS.
    55  003300     COPY DDS-ALL-FORMATS-O-INDIC OF PERSREPT.  4
    56 +000001       05  PERSREPT-RECORD.                                           <-ALL-FMTS
       +000002* OUTPUT FORMAT:HEADING    FROM FILE PERSREPT   OF LIBRARY XMPLIB     <-ALL-FMTS
       +000003*                                                                 <-ALL-FMTS
       +000004*          06 HEADING-O-INDIC.                                        <-ALL-FMTS
       +000005* OUTPUT FORMAT:DETAIL     FROM FILE PERSREPT   OF LIBRARY XMPLIB     <-ALL-FMTS
       +000006*                                                                 <-ALL-FMTS
    57 +000007           06 DETAIL-O-INDIC.                                         <-ALL-FMTS
    58 +000008                07 IN01        PIC 1  INDIC 01.                       <-ALL-FMTS
        003400
    59  003500 77  EOF-FLAG                      PIC X(1)
    60  003600                                    VALUE "0".
    61  003700    88  NOT-END-OF-FILE             VALUE "0".
```

Figure 75 (Part 1 of 2). Example of the END-OF-PAGE Condition

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   62  003800    88  END-OF-FILE                 VALUE "1".
   63  003900 77  MARRIED                       PIC X(1)
   64  004000                                    VALUE "M".
       004100
   65  004200 PROCEDURE DIVISION.
       004300 FIRST-SECT SECTION.
       004400 FIRST-PARA.
   66  004500     OPEN INPUT PERSFILE
       004600          OUTPUT PERSREPT.
   67  004700     PERFORM HEADING-LINE.
   68  004800     PERFORM PROCESS-RECORD UNTIL END-OF-FILE.
   69  004900     CLOSE  PERSFILE
       005000            PERSREPT.
   70  005100     STOP RUN.
       005200
       005300 PROCESS-RECORD.
   71  005400     READ PERSFILE AT END SET END-OF-FILE TO TRUE.
   73  005500     IF NOT-END-OF-FILE THEN
   74  005600         PERFORM PRINT-RECORD.  5
       005700
       005800 PRINT-RECORD.
   75  005900     MOVE CORR PERSREC TO DETAIL-O.  6
   76  006000     IF MARSTAT IN PERSFILE-REC IS EQUAL MARRIED THEN  7
   77  006100         MOVE B"1" TO IN01 IN DETAIL-O-INDIC
       006200     ELSE
   78  006300         MOVE B"0" TO IN01 IN DETAIL-O-INDIC.
   79  006400     WRITE PERSREPT-REC FORMAT IS "DETAIL"  8
       006500         INDICATORS ARE DETAIL-O-INDIC
   80  006600           AT EOP PERFORM HEADING-LINE.  9
       006700 HEADING-LINE.
   81  006800         MOVE HEAD-ORDER TO ORDERTYPE
   82  006900         WRITE PERSREPT-REC FORMAT IS "HEADING".
       007000
                           * * * * *   E N D   O F   S O U R C E   * * * * *
```

Figure 75 (Part 2 of 2). Example of the END-OF-PAGE Condition

1 The externally described printer file is assigned to device FORMATFILE.

2 The Format 2 COPY statement is used to copy the fields for the printer file into the program.

3 Note that, although the fields in format DETAIL will be printed on three separate lines, they are defined in one record.

4 COPY-DDS is used to copy the indicators used in the printer file into the program.

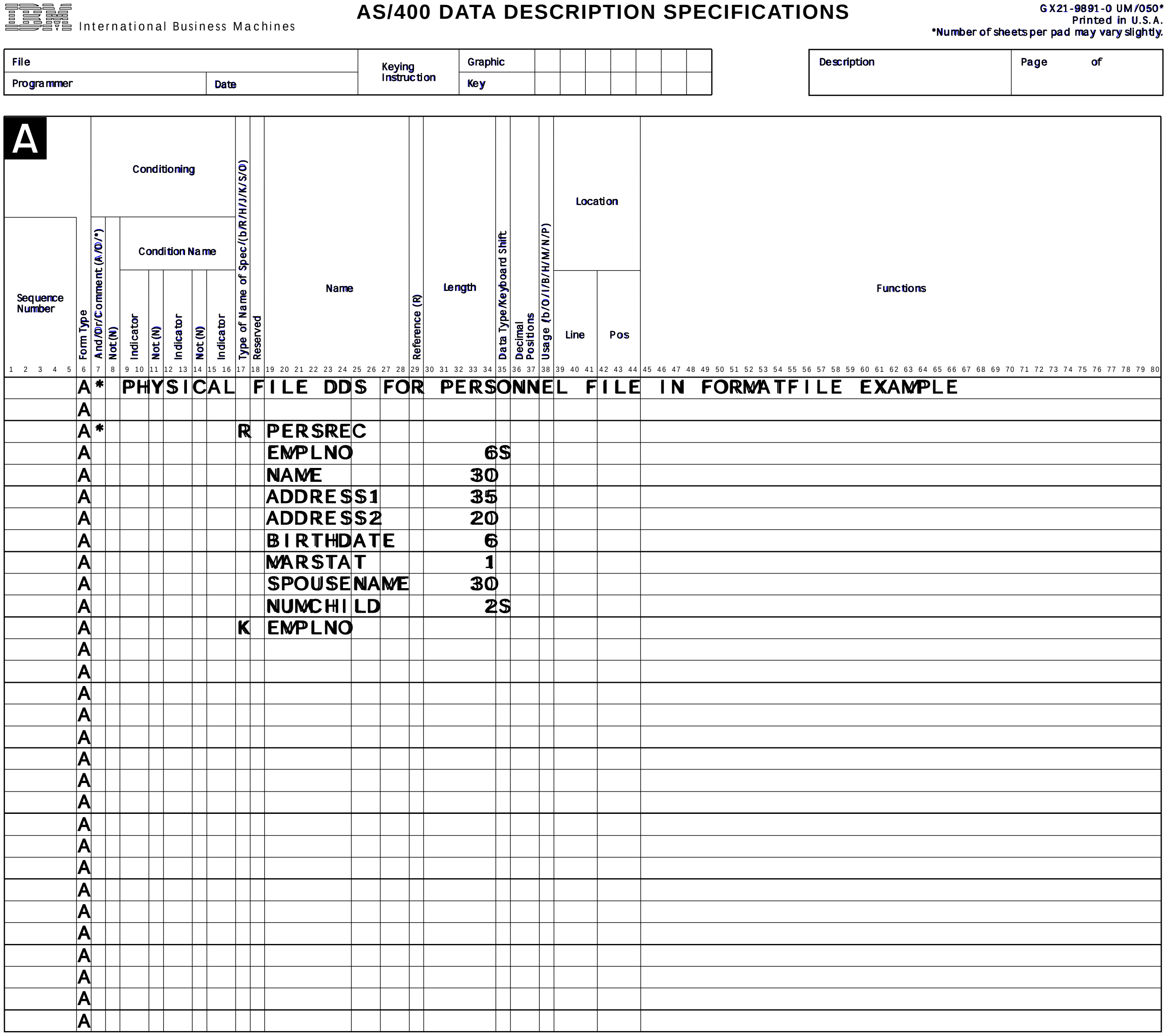
5 Paragraph PROCESS-RECORD processes PRINT-RECORD for each employee record.

6 All fields in the employee record are moved to the record for format DETAIL.

7 If the employee is married, indicator 01 is turned on; if not, the indicator is turned off, preventing the spouse's name field in DETAIL from being printed.

8 Format DETAIL is printed with indicator 01 passed to control printing.

9 If the number of lines per page has been exceeded, END-OF-PAGE occurs. The format HEADING is printed on a new page.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File		Keying Instruction	Graphic
Programmer	Date		Key

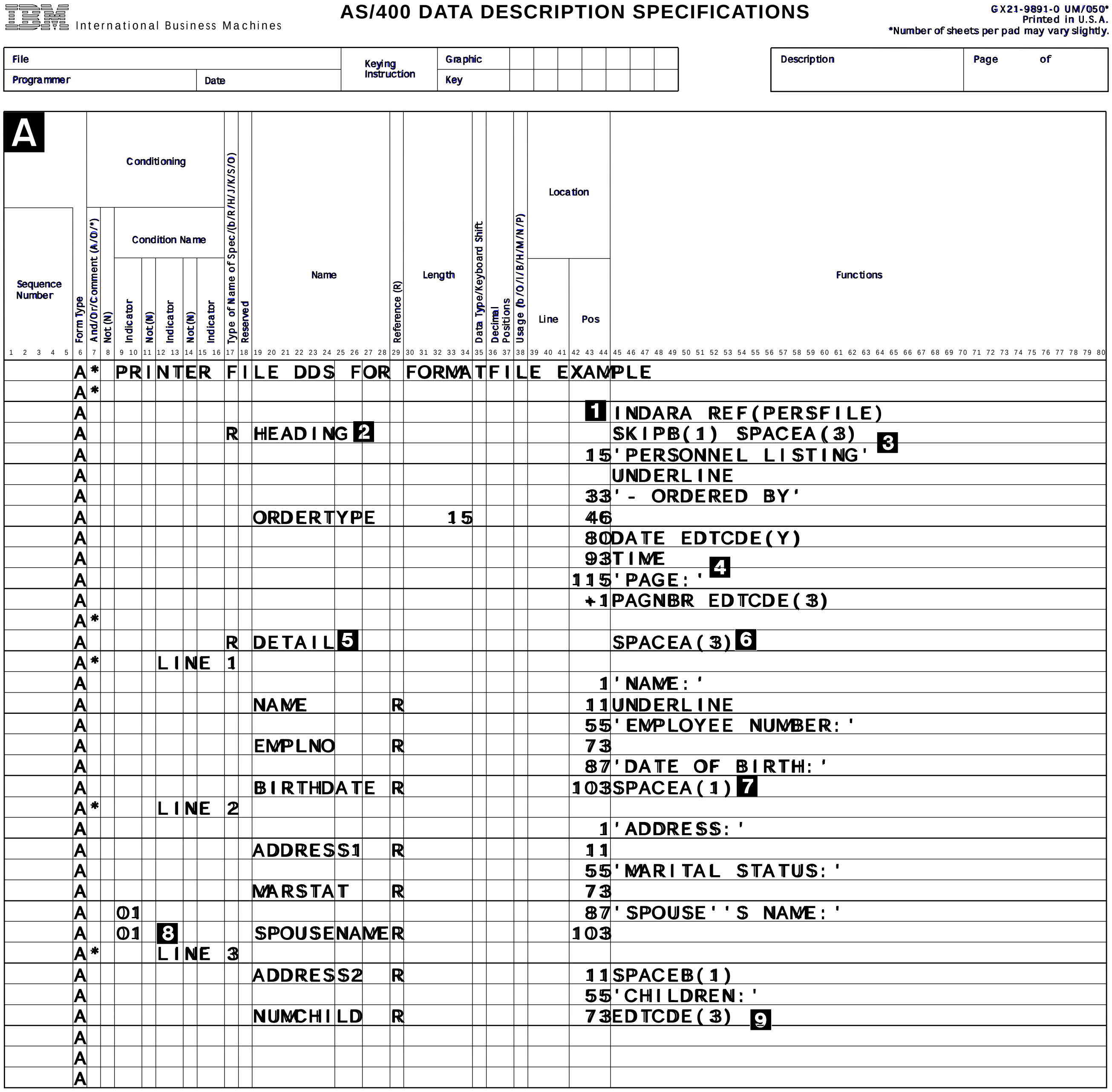
Description	Page of

A

Sequence Number | Form Type | And/Or/Comment (A/O/*) | Not (N) | Conditioning: Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A* PHYSICAL FILE DDS FOR PERSONNEL FILE IN FORMATFILE EXAMPLE
     A
     A*         R PERSREC
     A            EMPLNO         6S
     A            NAME          30
     A            ADDRESS1      35
     A            ADDRESS2      20
     A            BIRTHDATE      6
     A            MARSTAT        1
     A            SPOUSENAME    30
     A            NUMCHILD       2S
     A          K EMPLNO
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 76 (Part 1 of 2). DDS Example of the Use of Externally Described Printer Files Assigned to a Device of FORMATFILE


IBM International Business Machines
AS/400 DATA DESCRIPTION SPECIFICATIONS
GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.
File
Programmer
Date
Keying Instruction
Graphic
Key
Description
Page of
A
Sequence Number
Form Type
And/Or/Comment (A/O/*)
Not (N)
Conditioning
Condition Name
Indicator
Not (N)
Indicator
Not (N)
Indicator
Type of Name of Spec (b/R/H/J/K/S/O)
Reserved
Name
Reference (R)
Length
Data Type/Keyboard Shift
Decimal Positions
Usage (b/O/I/B/H/M/N/P)
Location
Line
Pos
Functions
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
1
2
3
4
5
6
7
8
9

```
     A* PRINTER FILE DDS FOR FORMATFILE EXAMPLE
     A*
     A                                      INDARA REF(PERSFILE)
     A          R HEADING                   SKIPB(1) SPACEA(3)
     A                                    15'PERSONNEL LISTING'
     A                                      UNDERLINE
     A                                    33'- ORDERED BY'
     A            ORDERTYPE     15        46
     A                                    80DATE EDTCDE(Y)
     A                                    93TIME
     A                                   115'PAGE:'
     A                                    +1PAGNBR EDTCDE(3)
     A*
     A          R DETAIL                    SPACEA(3)
     A*    LINE 1
     A                                     1'NAME:'
     A            NAME      R             11UNDERLINE
     A                                    55'EMPLOYEE NUMBER:'
     A            EMPLNO    R             73
     A                                    87'DATE OF BIRTH:'
     A            BIRTHDATE R            103SPACEA(1)
     A*    LINE 2
     A                                     1'ADDRESS:'
     A            ADDRESS1  R             11
     A                                    55'MARITAL STATUS:'
     A            MARSTAT   R             73
     A  01                                87'SPOUSE''S NAME:'
     A  01        SPOUSENAMER            103
     A*    LINE 3
     A            ADDRESS2  R             11SPACEB(1)
     A                                    55'CHILDREN:'
     A            NUMCHILD  R             73EDTCDE(3)
     A
     A
     A
```

Figure 76 (Part 2 of 2). DDS Example of the Use of Externally Described Printer Files Assigned to a Device of FORMATFILE

1 INDARA specifies that a separate indicator area is to be used for the file.

2 HEADING is the format name that provides headings for each page.

3 SKIPB(1) and SPACEA(3) are used to:

1. Skip to line 1 of the next page before format HEADING is printed.
2. Leave 3 blank lines after format HEADING is printed.

4 DATE, TIME, and PAGNBR are used to have the current date, time and page number printed automatically when format HEADING is printed.

5 DETAIL is the format name used to print the detail line for each employee in the personnel file.

6 SPACEA(3) causes three lines to be left blank after each employee detail line.

7 SPACEA(1) causes a blank line to be printed after the field BIRTHDATE is printed. As a result, subsequent fields in the same format are printed on a new line.

8 01 means that these fields are printed only if the COBOL program turns indicator 01 on and passes it when format DETAIL is printed.

9 EDTCDE(3) is used to remove leading zeros when printing this numeric field.

Chapter 10. DISK and DATABASE Files

Database files, which are associated with the COBOL devices of DATABASE and DISK, can be:

- Externally described files, whose fields are described to OS/400 through DDS
- Program-described files, whose fields are described in the program that uses the file.

All database files are created by OS/400 Create File commands. See the *Database Guide* for a description of the Create File commands for database files.

DATABASE versus DISK Files

Assigning a file to DISK in COBOL restricts the user to traditional DISK processing. The use of DATABASE as the device permits the user to make use of the special COBOL/400 database features such as formats and duplicate record keys.

Processing Methods for DISK and DATABASE Files

COBOL Indexed Files

An indexed file is a file whose access path is built on key values. The user must create a keyed access path for an indexed file by using DDS.

To write standard ANSI X3.23-1985 COBOL programs that access an indexed file, you must create the file with certain characteristics. The following table lists these characteristics and what controls them:

Characteristic	**Control**
The file must be a physical file.	The CL command CRTPF
The file cannot have records with duplicate key values.	The DDS keyword UNIQUE
The file cannot be a shared file.	The CL command CRTPF
A key must be defined for the file.	DDS
Keys must be in ascending sequence.	DDS
Keys must be contiguous within the record.	DDS
Key fields must be alphanumeric. They cannot be numeric only.	DDS
The value of the key used for sequencing must include all 8 bits of every byte.	DDS
A starting position for retrieving records cannot be specified.	The CL command OVRDBF
Select/omit level keywords cannot be used for the file.	DDS

An indexed file is identified by the ORGANIZATION IS INDEXED clause of the SELECT statement.

The key fields identify the records in an indexed file. The user specifies the key field in the RECORD KEY clause of the SELECT statement. The RECORD KEY data item must be defined within a record description for the indexed file. If there are multiple record descriptions for the file, only one need contain the RECORD KEY data name. However, the same positions within the record description that contain the RECORD KEY data item are accessed in the other record descriptions as the KEY value for any references to the other record descriptions for that file.

An indexed file can be accessed sequentially, randomly by key, or dynamically.

Valid RECORD KEYS

The DDS for the file specifies the fields to be used as the key field. If the file has multiple key fields, the key fields must be contiguous in each record unless RECORD KEY IS EXTERNALLY-DESCRIBED-KEY is specified.

When the DDS specifies only one key field for the file, the RECORD KEY must be a single field of the same length as the key field defined in the DDS.

If a Format 2 COPY statement is specified for the file, the RECORD KEY clause must specify one of the following:

- The name used in the DDS for the key field if the name is not a COBOL reserved word.
- The name used in the DDS for the key field with -DDS added to the end if the name is a COBOL reserved word.
- The data name defined with the proper length and at the proper location in a program-described record description for the file.
- EXTERNALLY-DESCRIBED-KEY. This keyword specifies that the keys defined in DDS for each record format are to be used for accessing the file. These keys can be noncontiguous. They can be defined at different positions within the record format.

When the DDS specifies multiple contiguous key fields, the RECORD KEY data name must be a single field with its length equal to the sum of the lengths of the multiple key fields in the DDS. If a Format 2 COPY statement is specified for the file, there must also be a program-described record description for the file that defines the RECORD KEY data name with the proper length and at the proper position in the record.

Contiguous items are consecutive elementary or group items in the Data Division that are contained in a single data hierarchy.

Referring to a Partial Key

A generic START statement allows the use of a partial key. The KEY IS phrase is required.

Refer to the “START Statement” in the *COBOL/400 Reference* for information about the rules for specifying a search argument that refers to a partial key.

Figure 77 on page 243 shows an example of generic START statements using a program-described file.

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    7  000700 FILE-CONTROL.
    8  000800     SELECT FILE-1 ASSIGN TO DISK-FILE1
    9  000900     ACCESS IS DYNAMIC RECORD KEY IS FULL-NAME IN FILE-1
   10  001000     ORGANIZATION IS INDEXED.
   11  001100 DATA DIVISION.
   12  001200 FILE SECTION.
   13  001300 FD  FILE-1 LABEL RECORDS ARE STANDARD.
   14  001400 01  RECORD-DESCRIPTION.
   15  001500     03 FULL-NAME.
   16  001600        05 LAST-AND-FIRST-NAMES.
   17  001700           07 LAST-NAME             PIC X(20).
   18  001800           07 FIRST-NAME            PIC X(20).
   19  001900        05 MIDDLE-NAME              PIC X(20).
   20  002000     03 LAST-FIRST-MIDDLE-INITIAL-NAME REDEFINES FULL-NAME
   21  002100                                    PIC X(41).
   22  002200     03 REST-OF-RECORD
       002300/
   23  002400 PROCEDURE DIVISION.
       002500 START-PROGRAM.
   24  002600     OPEN INPUT FILE-1.
       002700*
       002800* POSITION THE FILE STARTING WITH RECORDS THAT HAVE A LAST NAME OF
       002900* "SMITH"
   25  003000     MOVE "SMITH" TO LAST-NAME.
   26  003100     START FILE-1 KEY IS EQUAL TO LAST-NAME
   27  003200           INVALID KEY DISPLAY "NO DATA IN SYSTEM FOR " LAST-NAME
   28  003300                       GO-TO ERROR ROUTINE.
       003400*
       003500*
       003600*
       003700*
       003800* POSITION THE FILE STARTING WITH RECORDS THAT HAVE A LAST NAME OF
       003900* "SMITH" AND A FIRST NAME OF "ROBERT"
   29  004000     MOVE "SMITH" TO LAST-NAME.
   30  004100     MOVE "ROBERT" TO FIRST-NAME.
   31  004200     START FILE-1 KEY IS EQUAL TO LAST-AND-FIRST-NAMES
   32  004300           INVALID KEY DISPLAY "NO DATA IN SYSTEM FOR "
       004400                               LAST-AND-FIRST-NAMES
   33  004500                       GO-TO ERROR ROUTINE.
       004600*
       004700*
       004800*
       004900*
       005000* POSITION THE FILE STARTING WITH RECORDS THAT HAVE A LAST NAME OF
       005100* "SMITH", AND A FIRST NAME OF "ROBERT", AND A MIDDLE INITIAL OF "M"
   34  005200     MOVE "SMITH" TO LAST-NAME.
   35  005300     MOVE "ROBERT" TO FIRST-NAME.
   36  005400     MOVE "M" TO MIDDLE-NAME.
   37  005500     START FILE-1 KEY IS EQUAL TO LAST-AND-FIRST-MIDDLE-INITIAL-NAME
   38  005600           INVALID KEY DISPLAY "NO DATA IN SYSTEM FOR "
       005700                               LAST-FIRST-MIDDLE-INITIAL-NAME
   39  005800                       GO-TO ERROR ROUTINE.
       005900
       006000
       006100 ERROR-ROUTINE.
   40  006200     STOP-RUN.
```

Figure 77. Generic START Statements Using a Program-Described File

Figure 78 and Figure 79 show an example of generic START statements using an externally described file.

```
                                DATA DESCRIPTION SOURCE
SEQNBR *... ... 1 ... ... 2 ... ... 3 ... ... 4 ... ... 5 ... ... 6 ... ... 7 ... ... 8  DATE
   100      A                                      UNIQUE
   200      A          R RDE                       TEXT('RECORD DESCRIPTION')
   300      A            FNAME         20          TEXT('FIRST NAME')
   400      A            MINAME         1          TEXT('MIDDLE INITIAL NAME')
   500      A            MNAME         19          TEXT('REST OF MIDDLE NAME')
   600      A            LNAME         20          TEXT('LAST NAME')
   700      A            PHONE         10  0       TEXT('PHONE NUMBER')
   800      A            DATA          40          TEXT('REST OF DATA')
   900      A          K LNAME
  1000      A          K FNAME
  1100      A          K MINAME
  1200      A          K MNAME
```

Figure 78. Generic START Statements Using an Externally Described File -- DDS

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    7  000700 FILE-CONTROL.
    8  000800     SELECT FILE-1 ASSIGN TO DATABASE-NAMES
    9  000900     ACCESS IS DYNAMIC RECORD KEY IS EXTERNALLY-DESCRIBED-KEY
   10  001000     ORGANIZATION IS INDEXED.
   11  001100 DATA DIVISION.
   12  001200 FILE SECTION.
   13  001300 FD  FILE-1 LABEL RECORDS ARE STANDARD.
   14  001400 01  RECORD-DESCRIPTION
   15  001500     COPY DDS-RDE IN NAMES-PUBS.
   17 +000001                                                                              RDE
      +000002*    FROM FILE NAMES      OF LIBRARY XMPLIB                                   RDE
      +000003*    RECORD DESCRIPTION                                                       RDE
   18 +000004       05  RDE.                                                               RDE
      +000005*    RECORD KEY FOR INDEXED FILE, KEY'0002 KEY FIELD NAME FNAME     .         RDE
   19 +000006           06 FNAME             PIC X(20).                                    RDE
      +000007*    FIRST NAME                                                               RDE
      +000008*    RECORD KEY FOR INDEXED FILE, KEY'0003 KEY FIELD NAME MINAME    .         RDE
   20 +000009           06 MINAME            PIC X(1).                                     RDE
      +000010*    MIDDLE INITIAL NAME                                                      RDE
      +000011*    RECORD KEY FOR INDEXED FILE, KEY'0004 KEY FIELD NAME MNAME     .         RDE
   21 +000012           06 MNAME             PIC X(19).                                    RDE
      +000013*    REST OF MIDDLE NAME                                                      RDE
      +000014*    RECORD KEY FOR INDEXED FILE, KEY'0001 KEY FIELD NAME LNAME     .         RDE
   22 +000015           06 LNAME             PIC X(20).                                    RDE
      +000016*    LAST NAME                                                                RDE
   23 +000017           06 PHONE             PIC S9(10).      COMP-3                       RDE
      +000018*    PHONE NUMBER                                                             RDE
   24 +000019           06 DATA-DDS          PIC X(40).                                    RDE
      +000020*    REST OF DATA                                                             RDE
   25  001600 66  MIDDLE-NAME RENAMES MINAME THRU MNAME.
       001700/
   26  001800 PROCEDURE DIVISION.
       001900 START PROGRAM.
   27  002000     OPEN INPUT FILE-1.
       002100*
       002200* POSITION THE FILE STARTING WITH RECORDS THAT HAVE A LAST NAME
       002300* OF "SMITH"
   28  002400     MOVE "SMITH" TO LNAME.
   29  002500     START FILE-1 KEY IS EQUAL TO LNAME
   30  002600           INVALID KEY DISPLAY "NO DATA IN SYSTEM FOR " LNAME
   31  002700                       GO TO ERROR-ROUTINE.
       002800*          .
       002900*          .
       003000*          .
       003100*
       003200* POSITION THE FILE STARTING WITH RECORDS THAT HAVE A LAST NAME
       003300* OF "SMITH" AND A FIRST NAME OF "ROBERT"
   32  003400     MOVE "SMITH" TO LNAME.
   33  003500     MOVE "ROBERT" TO FNAME.
   34  003600     START FILE-1 KEY IS EQUAL TO LNAME, FNAME
   35  003700           INVALID KEY DISPLAY "NO DATA IN SYSTEM FOR "
       003800                               LNAME " " FNAME
   36  003900                       GO TO ERROR-ROUTINE.
       004000*          .
       004100*          .
       004200*          .
       004300*
       004400* POSITION THE FILE STARTING WITH RECORDS THAT HAVE A LAST NAME OF
       004500* "SMITH", A FIRST NAME OF "ROBERT", AND A MIDDLE INITIAL OF "M"
   32  004600     MOVE "SMITH" TO LNAME.
   33  004700     MOVE "ROBERT" TO FNAME.
   33  004800     MOVE "M" TO MINAME.
   34  004900     START FILE-1 KEY IS EQUAL TO LNAME, FNAME, MINAME
   35  005000           INVALID KEY DISPLAY "NO DATA IN SYSTEM FOR "
       005100                               LNAME SPACE FNAME SPACE MINAME
   42  005200                       GO TO ERROR-ROUTINE.
       005300
       005400
       005500 ERROR-ROUTINE.
       005600     STOP-RUN.
```

Figure 79. Generic START Statements Using an Externally Described File

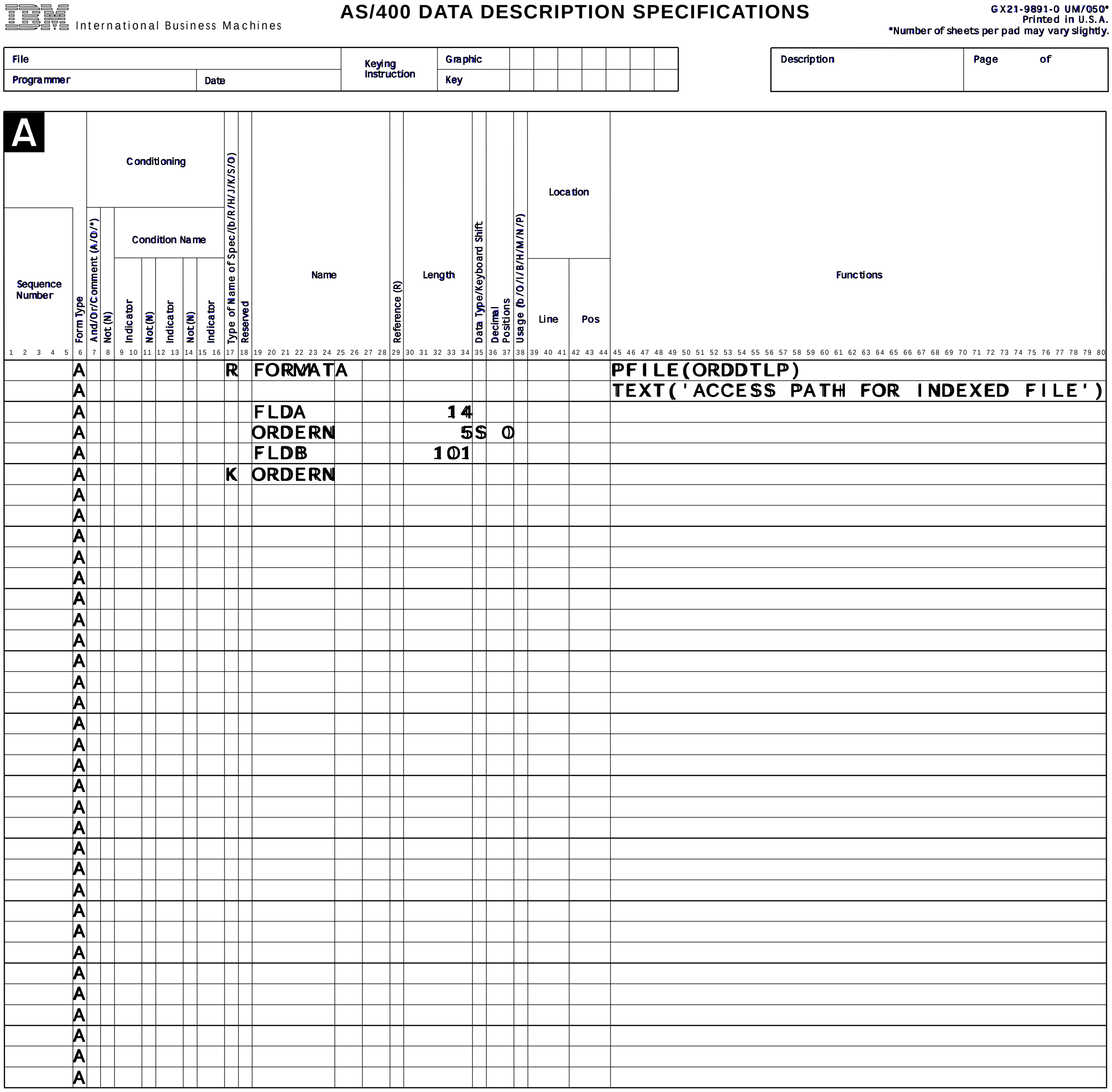
Logical File Considerations

When a logical file with multiple record formats, each having associated key fields, is processed as an indexed file in COBOL, the following restrictions and considerations apply:

- The FORMAT phrase must be specified on all WRITE statements to the file unless a Record Format Selector Program exists and has been specified in the FMTSLR parameter of the Create Logical File (CRTLF) command, the Change Logical File (CHGLF) command, or the Override Database File (OVRDBF) command. For information on the use of format selector programs, refer to the *Database Guide*.
- If the access mode is RANDOM or DYNAMIC, and the DUPLICATES phrase is not specified for the file, the FORMAT phrase must be specified on all DELETE and REWRITE statements.
- When the FORMAT phrase is not specified, only the portion of the RECORD KEY data item that is common to all record formats for the file is used by the system as the key for the I/O statement. When the FORMAT phrase is specified, only the portion of the RECORD KEY data item that is defined for the specified record format is used by the system as the key. See the *Database Guide* for more information on logical file processing.
- When *NONE is specified as the first key field for any format in a file, records can only be accessed sequentially. When a file is read randomly:
  - If a format name is specified, the first record with the specified format is returned.
  - If a format name is not specified, the first record in the file is returned.

  In both cases, the value of the RECORD KEY data item is ignored.
- For a program-defined key field:
  - Key fields within each record format must be contiguous.
  - The first key field for each record format must begin at the same relative position within each record.
  - The length of the RECORD KEY data item must be equal to the length of the longest key for any format in the file.
- For an EXTERNALLY-DESCRIBED-KEY:
  - Key fields within each record format can be noncontiguous.
  - The key fields can begin at different positions in each record format.

Figure 80 on page 247 and Figure 81 on page 248 show examples of how to use DDS to describe the access path for indexed files.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File
Programmer
Date
Keying Instruction
Graphic
Key
Description
Page of

A

Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Not (N), Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A          R FORMATA                   PFILE(ORDDTLP)
     A                                      TEXT('ACCESS PATH FOR INDEXED FILE')
     A            FLDA          14
     A            ORDERN         5S 0
     A            FLDB         101
     A          K ORDERN
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

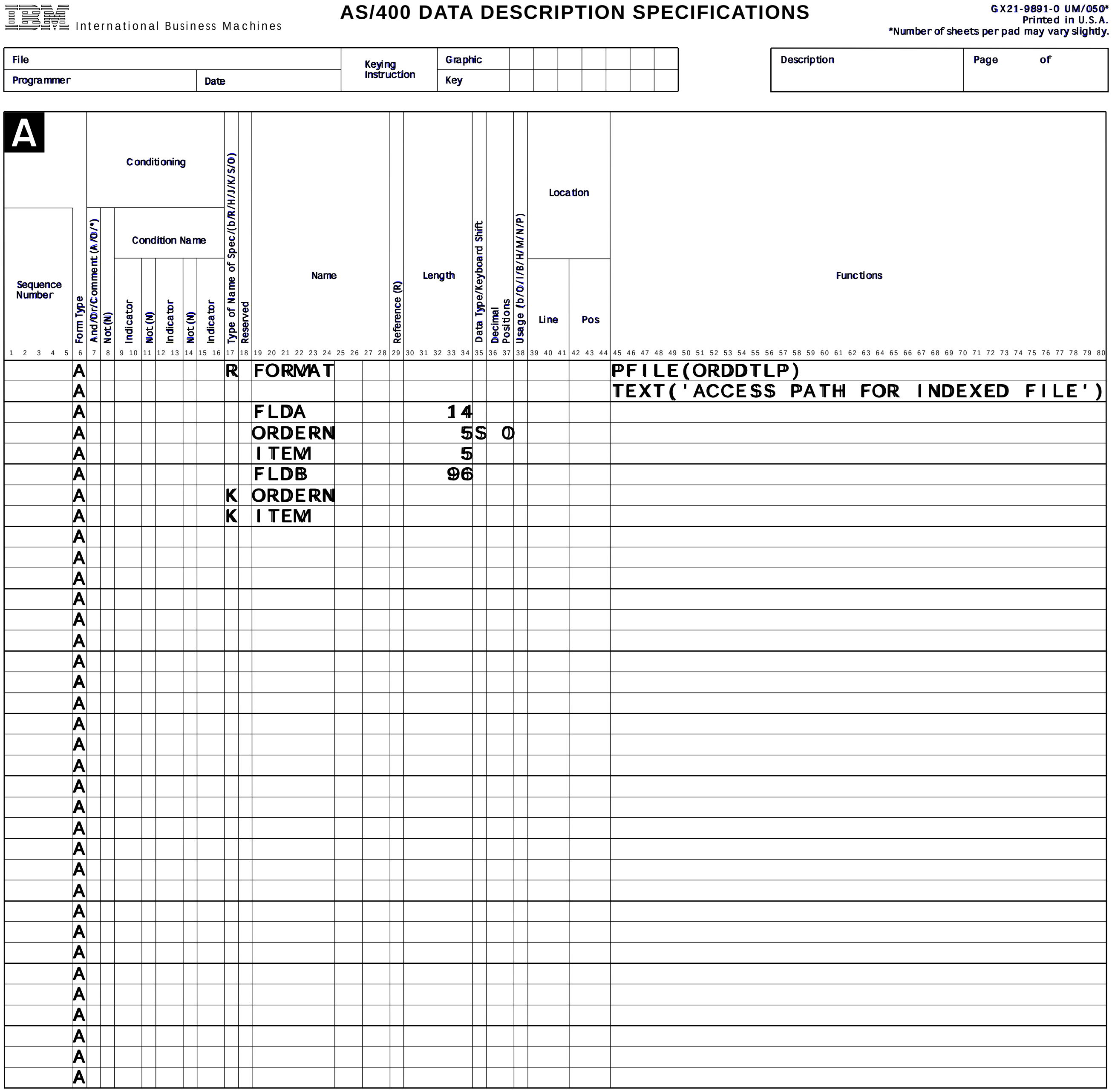
Figure 80. Using Data Description Specifications to Define the Access Path for an Indexed File

Data description specifications must be used to create the access path for a program-described indexed file.

In the DDS for the record format FORMATA for the logical file ORDDTLL, the field ORDERN, which is five digits long, is defined as the key field. The definition of ORDERN as the key field establishes the keyed access for this file. Two other fields, FLDA and FLDB, describe the remaining positions in this record as character fields.

The program-described input field ORDDTLL is described in the FILE-CONTROL section in the SELECT clause as an indexed file.

The COBOL descriptions of each field in the FD entry must agree with the corresponding description in the DDS file. The RECORD KEY data item must be defined as a five-digit numeric integer beginning in position 15 of the record.



IBM International Business Machines

AS/400 DATA DESCRIPTION SPECIFICATIONS

GX21-9891-0 UM/050*
Printed in U.S.A.
*Number of sheets per pad may vary slightly.

File
Programmer Date
Keying Instruction
Graphic
Key
Description
Page of

A

Sequence Number | Form Type | Conditioning: And/Or/Comment (A/O/*), Not (N), Condition Name: Indicator, Not (N), Indicator, Not (N), Indicator | Type of Name of Spec (b/R/H/J/K/S/O) | Reserved | Name | Reference (R) | Length | Data Type/Keyboard Shift | Decimal Positions | Usage (b/O/I/B/H/M/N/P) | Location: Line, Pos | Functions

```
     A          R FORMAT                    PFILE(ORDDTLP)
     A                                      TEXT('ACCESS PATH FOR INDEXED FILE')
     A            FLDA          14
     A            ORDERN         5S 0
     A            ITEM           5
     A            FLDB          96
     A          K ORDERN
     A          K ITEM
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
     A
```

Figure 81. Data Description Specifications for Defining the Access Path (a Composite Key) of an Indexed File

In this example, the data description specifications define two key fields for the record format FORMAT in the logical file ORDDTLL. For the two fields to be used as a composite key for a program-described indexed file, the key fields must be contiguous in the record.

The COBOL description of each field must agree with the corresponding description in the DDS file. A 10-character item beginning in position 15 of the record must be defined in the RECORD KEY clause of the file-control entry. The COBOL descriptions of the DDS fields ORDERN and ITEM would be subordinate to the 10-character item defined in the RECORD KEY clause.

COBOL Relative Files

A COBOL relative file is a file to be processed by a relative record number. To process a file by relative record number, you must specify ORGANIZATION IS RELATIVE in the SELECT statement for the file. A relative file can be accessed sequentially, randomly by record number, or dynamically.

To write standard ANSI X3.23-1985 COBOL programs that access a relative file, you must create the file with certain characteristics. The following table lists these characteristics and what controls them.

Characteristic	**Control**
The file must be a physical file.	The CL command CRTPF
The file cannot be a shared file.	The CL command CRTPF
No key can be specified for the file.	DDS
A starting position for retrieving records cannot be specified.	The CL command OVRDBF
Select/omit level keywords cannot be used for the file.	DDS
Records in the file cannot be reused.	The CL command CRTPF

For a COBOL file with an organization of RELATIVE, the Reorganize Physical File Member (RGZPFM) CL command can:

- Remove all deleted records from the file. Because COBOL initializes all relative file records to deleted records, any record that has not been explicitly written will be removed from the file. The relative record numbers of all records after the first deleted record in the file will change.
- Change the relative record numbers if the file has a key and the arrival sequence is changed to match a key sequence (with the KEYFILE parameter).

In addition, a Change Physical File (CHGPF) CL command bearing the REUSEDLT option can change the order of retrieved or written records when the file is operated on sequentially, because it allows the reuse of deleted records.

COBOL Sequential Files

A COBOL sequential file is a file in which records are processed in the order in which they were placed in the file, that is, in arrival sequence. For example, the tenth record placed in the file occupies the tenth record position and is the tenth record to be processed. To process a file as a sequential file, you must specify ORGANIZATION IS SEQUENTIAL in the SELECT clause, or omit the ORGANIZATION clause. A sequential file can only be accessed sequentially.

To write standard ANSI X3.23-1985 COBOL programs that access a sequential file, you must create the file with certain characteristics. The following table lists these characteristics and what controls them.

Characteristic	**Control**
The file must be a physical file.	The CL command CRTPF
The file cannot be a shared file.	The CL command CRTPF
No key can be specified for the file.	DDS
The file must have a file type of DATA.	The CL command CRTPF
Field editing cannot be used.	DDS
Line and position information cannot be specified.	DDS
Spacing and skipping keywords cannot be specified.	DDS
Indicators cannot be used.	DDS
System-supplied functions such as date, time, and page number cannot be used.	DDS
Select/omit level keywords cannot be used for the file.	DDS
Records in the file cannot be reused.	The CL command CRTPF

To preserve the sequence of records in a file that you open in I/O (update) mode, do not change the file so that you can reuse the records in it. That is, do not use a Change Physical File (CHGPF) CL command bearing the REUSEDLT option.

Note: The COBOL/400 compiler does not check that the device associated with the external file is of the type specified in the device portion of assignment-name. The device specified in the assignment-name must match the actual device to which the file is assigned. See the “ASSIGN Clause” section of the *COBOL/400 Reference* for more information.

COBOL File Organization and AS/400 File Access Path Considerations

A file with a keyed sequence access path can be processed in COBOL as a file with INDEXED, RELATIVE, or SEQUENTIAL organization.

For a keyed sequence file to be processed as a relative file in COBOL, it must be a physical file, or a logical file whose members are based on one physical file member. For a keyed sequence file to be processed as a sequential file in COBOL, it must be a physical file, or a logical file that is based on one physical file member and that does not contain select/omit logic.

A file with an arrival sequence access path can be processed in COBOL as a file with RELATIVE or SEQUENTIAL organization. The file must be a physical file or a logical file where each member of the logical file is based on only one physical file member.

When sequential access is specified for a logical file, records in the file are accessed through the access path created with create file options.

File Processing Methods

Figure 82 on page 252 shows the valid processing methods and expected operation for combinations of organization, access mode, open state, I/O verb, and I/O verb modifiers.

All physical database files that are opened for OUTPUT are cleared. Database files with RELATIVE organization, and with dynamic or random access mode, are also initialized with deleted records.

New relative files opened for OUTPUT in sequential access mode are treated differently. Table 4 summarizes conditions affecting them.

Table 4. Initialization of Relative Output Files

File Access and CL Specifications	Conditions at Opening Time	Conditions at Closing Time	File Boundary
Sequential *INZDLT		Records not written are initialized	All increments
Sequential *INZDLT *NOMAX size		CLOSE succeeds File status is 0Q	Up to boundary of records written
Sequential *NOINZDLT			Up to boundary of records written
Random or dynamic	Records are initialized File is open		All increments
Random or dynamic *NOMAX size	OPEN fails File status is 9Q		File is empty

To extend a file boundary beyond the current number of records, but remaining within the file size, use the INZPFM command to add deleted records before processing the file. You need to do this if you receive a file status of 0Q, and you still want to add more records to the file.

Any attempt to extend a relative file beyond its current size results in a boundary violation.

To recover from a file status of 9Q, use the CHGPF command as described in the associated run-time message text.

Lengthy delays are normal when there remains an extremely large number of records (over 1 000 000) to be initialized to deleted records when the CLOSE statement runs.

When the first OPEN statement for the file is not OPEN OUTPUT, relative files should be cleared and initialized with deleted records before they are used. See the discussion of the CLRPFM and INZPFM commands in the *CL Reference* for more information.

The RECORDS parameter of the INZPFM command must specify *DLT. Overrides are applied when the clear and initialize operations are processed by COBOL, but not when they are processed with CL commands.

Lengthy delays in OPEN OUTPUT processing are normal for extremely large relative files (over 1 000 000 records) that you access in dynamic or random mode.

ORG	ACC	DEV	OPEN	READ	WRITE	START	REWRITE	DELETE	CLOSE	FORMAT	SELECT CLAUSE KEY IS
S	S	ANY	INPUT	X					X		
S	S	ANY	OUTPUT		X(F1)				X	A1	
S	S	ANY	I-O	X			X		X		
S	S	ANY	EXTEND		X				X		
I	S	D/DB	INPUT	X		X			X	B1	C1
I	S	D/DB	OUTPUT		X(F1)				X	B1	C1
I	S	D/DB	I-O	X		X	X	X	X	B1	C1
I	R	D/DB	INPUT	X					X	B1	D1
I	R	D/DB	OUTPUT		X(F1)				X	B1	D1
I	R	D/DB	I-O	X	X		X	X	X	B1	D1
I	D	D/DB	INPUT	X		X			X	B1	D1
I	D	D/DB	OUTPUT		X(F1)				X	B1	D1
I	D	D/DB	I-O	X	X	X	X	X	X	B1	D1
R	S	D/DB	INPUT	X		X			X		C1
R	S	D/DB	OUTPUT		X(G1)				X		C1
R	S	D/DB	I-O	X		X	X	X	X		C1
R	R	D/DB	INPUT	X					X		E1
R	R	D/DB	OUTPUT		X(G1)				X		E1
R	R	D/DB	I-O	X	X		X	X	X		E1
R	D	D/DB	INPUT	X		X			X		E1
R	D	D/DB	OUTPUT		X(G1)				X		E1
R	D	D/DB	I-O	X	X	X	X	X	X		E1
T	S	W	I-O	X	X				X	H1	
T	D	W	I-O	X(K1)	X(K1)		X		X	I1	J1

ORG:

S = Sequential
R = Relative
I = Indexed
T = TRANSACTION

ACC:

S = Sequential
R = Random
D = Dynamic

DEV:

ANY = Any Device
D = DISK
DB = DATABASE
W = WORKSTATION

Figure 82. Processing Methods Summary Chart

The following paragraphs explain the keys used in Figure 82.

X The combination is allowed.

A1 The FORMAT phrase is required for FORMATFILE files with multiple formats, and is not allowed for all other device files.

B1 The FORMAT phrase is optional for DATABASE files, and not allowed for DISK files. If the FORMAT phrase is not specified, the default format name of the file is used. The default format name of the file is the first format name defined in the file.

The special register, DB-FORMAT-NAME, can be used to retrieve the format name used on the last successful I/O operation.

C1 The SELECT clause KEY phrase is ignored except for the START statement. If the KEY phrase is not specified on the START statement, the RECORD KEY phrase or the RELATIVE KEY phrase in the SELECT clause is used and KEY = is assumed.

D1 The SELECT clause KEY phrase is used except for the START statement. If the KEY phrase is not specified on the START statement, the RECORD KEY phrase in the SELECT clause is used and KEY = is assumed.

NEXT, PRIOR, FIRST, or LAST can be specified only for the READ statement for DATABASE files with DYNAMIC access. If NEXT, PRIOR, FIRST, or LAST is specified, the SELECT clause KEY phrase is ignored.

E1 The SELECT clause RELATIVE KEY phrase is used.

The NEXT phrase can be specified only for the READ statement for a file with DYNAMIC access mode. If NEXT is specified, the SELECT clause KEY phrase is ignored.

The RELATIVE KEY data item is updated with the relative record number for files with sequential access on READ operations.

F1 A physical file opened for output is cleared.

G1 A physical file opened for output is cleared and initialized to deleted records. There are some exceptions depending on the file size and the options specified. For more information, refer to Table 4 on page 251.

H1 The FORMAT phrase is required for the WRITE statement.

I1 The FORMAT phrase is required to distinguish between the subfile records and the subfile control record. The WRITE FORMAT IS control-record-format-name displays the subfile, but a READ FORMAT IS control-record-format-name is required to allow data to be entered and to cause the operator input for the subfile records on the display to be placed in the subfile.

J1 The SELECT clause RELATIVE KEY phrase is used for READ, WRITE, and REWRITE statements that use the SUBFILE phrase, except that the READ SUBFILE NEXT MODIFIED uses the current system relative record number rather than the RELATIVE KEY data item. The RELATIVE KEY data item is updated with the relative record number for subfile records for READ statements with the NEXT MODIFIED clause.

K1 The SUBFILE phrase is required when an I/O operation deals with a particular record rather than an entire file.

Descending File Considerations

Files created with a descending keyed sequence (in DDS) cause the READ statement NEXT, PRIOR, FIRST, and LAST phrases to work in a fashion exactly opposite that of a file with an ascending key sequence. In **descending key sequence**, the data is arranged in order from the highest value of the key field to the lowest value of the key field.

For example, READ FIRST retrieves the record with the highest key value, and READ LAST retrieves the record with the lowest key value. Files with a descending key sequence also cause the START qualifiers to work in the opposite manner. For example, START GREATER THAN positions the current record pointer to a record with a key less than the current key.

Chapter 11. COBOL/400 Programming Considerations

This chapter describes:

- Issuing a CL command from a COBOL program
- The CORRESPONDING phrase
- The LIKE clause
- Reference modification
- De-editing
- Performance considerations.

General-Use Programming Interface

Issuing a CL Command from a COBOL Program

You can issue a CL command from a COBOL program through a CALL to `QCMDEXC`.

In the following example program, the CALL to `QCMDEXC` (at sequence number 001600) results in the processing of the Add Library List Entry (ADDLIBLE) CL command (at sequence number 001100). The successful completion of the CL command results in the addition of the library, COBOLTEST, to the library list.

```
            -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..
000100       IDENTIFICATION DIVISION.
000200       PROGRAM-ID. CMDXMPLE.
000300       ENVIRONMENT DIVISION.
000400       CONFIGURATION SECTION.
000500         SOURCE-COMPUTER. IBM-AS400.
000600         OBJECT-COMPUTER. IBM-AS400.
000700       DATA DIVISION.
000800       WORKING-STORAGE SECTION.
000900       01  PROGRAM-VARIABLES.
001000           05  CL-CMD       PIC X(33)
001100                            VALUE "ADDLIBLE COBOLTEST".
001200           05  PACK-VAL     PIC 9(10)V9(5) COMP-3
001300                            VALUE 18.
001400       PROCEDURE DIVISION.
001500       MAINLINE.
001600           CALL "QCMDEXC" USING CL-CMD PACK-VAL.
001700           STOP RUN.
```

Note: Do not use the Reclaim Resource (RCLRSC) Command in this situation. It cancels all programs higher in the program stack so that the STOP RUN statement in the program will cause a run-time exception.

For more information about `QCMDEXC`, see the *CL Programmer's Guide*.

End of General-Use Programming Interface

Using the CORRESPONDING Phrase

In the following example program, the ADD CORRESPONDING statement at sequence number 000270 adds GROUP1 ITEM1 to GROUP2 ITEM1, and adds GROUP1 ITEM2 to GROUP2 ITEM2. The MOVE CORRESPONDING statement at sequence number 000290 moves GROUP1 ITEM1, ITEM2, ITEM3, and ITEM4 to GROUP2 ITEM1, ITEM2, ITEM3, and ITEM4.

The MOVE CORRESPONDING statement at sequence number 000300 is not processed because there are no corresponding items to move, and an error message is generated.

Figure 83 on page 257 was produced with the PRTCORR option in effect.

```
 5763CB1 V3R0M5                   AS/400 COBOL Source              XMPLIB/CORR
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 IDENTIFICATION DIVISION.
     2  000020 PROGRAM-ID.     CORRPHRASE.
     3  000030   AUTHOR.       PROGRAMMER NAME.
     4  000040   INSTALLATION. TORONTO COBOL DEVELOPMENT CENTRE.
     5  000050   DATE-WRITTEN. 05/24/91.
     6  000060   DATE-COMPILED.  05/24/94 11:09:11   .
     7  000070 ENVIRONMENT DIVISION.
     8  000080 CONFIGURATION SECTION.
     9  000090 SOURCE-COMPUTER. IBM-AS400.
    10  000100 OBJECT-COMPUTER. IBM-AS400.
    11  000110 DATA DIVISION.
    12  000120 WORKING-STORAGE SECTION.
    13  000130 01  GROUP1.
    14  000140     05  ITEM1    PIC 99        VALUE 1.
    15  000150     05  ITEM2    PIC 99        VALUE 2.
    16  000160     05  ITEM3    PIC X(10)     VALUE "GREEN".
    17  000170     05  ITEM4    PIC X(10)     VALUE "BLUE".
    18  000180 01  GROUP2.
    19  000190     05  ITEM1    PIC 99        VALUE 8.
    20  000200     05  ITEM2    PIC 99        VALUE 9.
    21  000210     05  ITEM3    PIC XXBX(8)   VALUE SPACES.
    22  000220     05  ITEM4    PIC X(10)     VALUE SPACES.
    23  000230 01  GROUP3.
    24  000240     05  SPECIAL  PIC XX.
    25  000250 PROCEDURE DIVISION.
        000260 MAINLINE.
    26  000270     ADD CORRESPONDING GROUP1 TO GROUP2.
              *       ** CORRESPONDING items for statement 26:
              *       **     ITEM1
              *       **     ITEM2
              *       ** End of CORRESPONDING items for statement 26
    27  000280     SUBTRACT CORRESPONDING GROUP1 FROM GROUP2.
              *       ** CORRESPONDING items for statement 27:
              *       **     ITEM1
              *       **     ITEM2
              *       ** End of CORRESPONDING items for statement 27
    28  000290     MOVE CORRESPONDING GROUP1 TO GROUP2.
              *       ** CORRESPONDING items for statement 28:
              *       **     ITEM1
              *       **     ITEM2
              *       **     ITEM3
              *       **     ITEM4
              *       ** End of CORRESPONDING items for statement 28
    29  000300     MOVE CORRESPONDING GROUP3 TO GROUP2.
              *       ** CORRESPONDING items for statement 29:
              *       **     No CORRESPONDING items found
              *       ** End of CORRESPONDING items for statement 29
    30  000310     STOP RUN.
                           * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                   AS/400 COBOL Messages            XMPLIB/CORR
  STMT
*   29  MSGID: LBL0336  SEVERITY: 10  SEQNBR:  000300
        Message . . . . :   No CORRESPONDING items found. Statement
          ignored.
                       * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                     Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1         0            1               0               0                0
 Source records read . . . . . . . . :   31
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   10
  LBL0901 00  Program CORR created in library XMPLIB.
                      * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 83. Example of the CORRESPONDING Phrase

LIKE Clause

The LIKE clause allows you to define the PICTURE, USAGE, SIGN, and BLANK WHEN ZERO characteristics of a data name by copying them from a previously defined data name. LIKE can only refer to a data name or index name, and such names must be uniquely qualified if they have been previously defined. It also allows you to change the length of the data name you define.

This clause is particularly helpful because you can use it to define identifiers in the Working-Storage Section of your program that have the same attributes as variables that you define using the COPY statement.

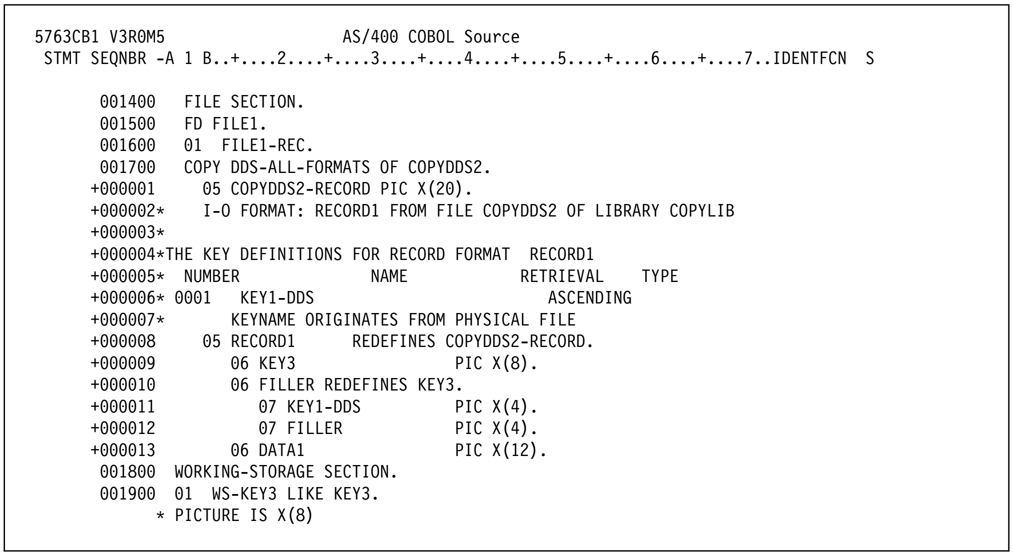
To create data name DEPTH with the same attributes as data name HEIGHT, write:

```
DEPTH LIKE HEIGHT
```

To create data name PROVINCE with the same attributes as data name STATE, except 1 byte longer, write:

```
PROVINCE LIKE STATE (+1)
```

This example shows how you can create data item WS-KEY3 with the same attributes as data item KEY3 in the Working-Storage Section:



```
5763CB1 V3R0M5                  AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S

       001400   FILE SECTION.
       001500   FD FILE1.
       001600   01  FILE1-REC.
       001700   COPY DDS-ALL-FORMATS OF COPYDDS2.
      +000001     05 COPYDDS2-RECORD PIC X(20).
      +000002*    I-O FORMAT: RECORD1 FROM FILE COPYDDS2 OF LIBRARY COPYLIB
      +000003*
      +000004*THE KEY DEFINITIONS FOR RECORD FORMAT  RECORD1
      +000005*  NUMBER              NAME            RETRIEVAL    TYPE
      +000006* 0001   KEY1-DDS                         ASCENDING
      +000007*       KEYNAME ORIGINATES FROM PHYSICAL FILE
      +000008     05 RECORD1      REDEFINES COPYDDS2-RECORD.
      +000009        06 KEY3                PIC X(8).
      +000010        06 FILLER REDEFINES KEY3.
      +000011           07 KEY1-DDS         PIC X(4).
      +000012           07 FILLER           PIC X(4).
      +000013        06 DATA1               PIC X(12).
       001800  WORKING-STORAGE SECTION.
       001900  01  WS-KEY3 LIKE KEY3.
             * PICTURE IS X(8)
```

Figure 84. COPY DDS with the LIKE Clause

The LIKE clause cannot be used in conjunction with the REDEFINES, SIGN, USAGE, or PICTURE clauses. If you use any of these clauses with the LIKE clause, a duplication error occurs. Similarly, BLANK WHEN ZERO can only be specified in conjunction with the LIKE clause if the BLANK WHEN ZERO attribute has not been inherited by the LIKE clause.

A valid LIKE clause has the format of one of the following:

data-name-1 LIKE-clause xxxxx.

data-name-1 xxxxx LIKE-clause.

data-name-1 xxxxx LIKE-clause xxxxx.

The xxxxx is one or a combination of the following clauses: JUSTIFIED, SYNCHRONIZED, BLANK WHEN ZERO, VALUE, OCCURS.

The following show what the LIKE clause can do:

```
 01  INCOME.
     05  ANNUAL-WAGES   PIC 9(6)V9(2) COMP-3.
 01  YTD-WAGES LIKE ANNUAL-WAGES.
* PICTURE IS 9(6)V9(2)
* USAGE IS PACKED-DECIMAL
```

```
 01  RATES.
     05  MONTHLY-RATE   PIC 9(3).
 66  GROSS-RATE RENAMES MONTHLY-RATE.
 01  NET-RATE LIKE GROSS-RATE.
* PICTURE IS 9(3)
```

```
 01  FAMILY-NAME        PIC X(20)   VALUE "JONES".
 01  GIVEN-NAME LIKE FAMILY-NAME.
* PICTURE IS X(20)
```

```
 01  EMPLOYEE-NUMBER    PIC X(6).
 01  DEPARTMENT-MEMBERS.
     05  DEPT-EMPLOYEE-NUMBER LIKE EMPLOYEE-NUMBER
         OCCURS 10 TIMES.
* PICTURE IS X(6)
```

Note: DEPARTMENT-MEMBERS in the above example is 60 bytes long.

```
     05  TENANT-NAME    PIC X(20)  OCCURS 10 TIMES.
 01  RENEWAL-RECORD.
     05  RENEWAL-MONTH  PIC X(3).
     05  RENEWAL-NAME LIKE TENANT-NAME.
* PICTURE IS X(20)
```

Note: RENEWAL-RECORD in the above example is only 23 bytes long.

The PICTURE portion of the generated comment is shown in a concise format.

Note: A numeric field with the BLANK WHEN ZERO attribute is considered to be a numeric edited field.

```
 01  ORDER-DETAILS.
     05  ORDER-TYPE     PIC XX.
     05  ORDER-CODE LIKE ORDER-TYPE.
* PICTURE IS X(2)


 01  FASTENINGS.
     05  NAILS          PIC 9V99  BLANK WHEN ZERO.
     05  RIVETS LIKE NAILS.
* PICTURE IS 9V9(2)
* BLANK WHEN ZERO


 01  MORTGAGE-PAYMENT.
     05  MORTGAGE-TOTAL PIC S999V99 SIGN IS LEADING SEPARATE.
     05  MORTGAGE-INTEREST LIKE MORTGAGE-TOTAL.
* PICTURE IS S9(3)V9(2)
* SIGN IS LEADING SEPARATE


 01  PROFIT.
     05  GROSS-PROFIT   PIC 999(3)PP(5).
     05  NET-PROFIT LIKE GROSS-PROFIT.
* PICTURE IS 9(5)P(6)
```

You can use an integer to increase or decrease the length of the field. The following example shows how to increase the field length of WEEKLY-AMOUNT:

```
 01  WEEKLY-AMOUNT      PIC 9(3).
 01  ANNUAL-AMOUNT LIKE WEEKLY-AMOUNT (+3).
* PICTURE IS 9(6)
```

You should also be aware of the following:

- Any field that has attributes of BLANK WHEN ZERO is considered to be an edited field
- If an integer of zero is specified, an informational message is generated.

Only the integer portion of the field length can be increased or decreased. You cannot change the number of decimal places in a data item.

The default attributes, SIGN IS TRAILING and USAGE IS DISPLAY, are never printed as comments following a LIKE operation.

When you use the LIKE clause, the normal data name qualification rules apply to the parent data name; however, the referenced data name must be uniquely qualified if it has previously been defined more than once. For example:

```
 01  COMBINATIONS.
     05  PHENOTYPE      PIC XX.
     05  GENOTYPE LIKE PHENOTYPE.
* PICTURE IS X(2)
 01  PHENOTYPE-TRAITS.
     05  PHENOTYPE      PIC X(30).
     05  PHENO-GROUP LIKE PHENOTYPE OF COMBINATIONS.
* PICTURE IS X(2)
```

If you do not uniquely qualify the parent data name, the compiler assigns it a picture clause of X(2), and you receive an error message.

The use of the LIKE clause can sometimes result in group items that are not valid. For example, if you define a COMP-4 group item and then use the LIKE clause to define a COMP-3 item that is subordinate to it, an error will result.

The following example is valid:

```
 77  SWITCHES-IN-STOCK  PIC S99.
 01  PARTS-ON-ORDER  SIGN IS LEADING SEPARATE.
     05  SWITCHES-ON-ORDER LIKE SWITCHES-IN-STOCK.
* PICTURE IS S9(2)
```

Note: SWITCHES-ON-ORDER has the same SIGN attribute (SIGN IS TRAILING) as SWITCHES-IN-STOCK.

In the case of B LIKE A where A is a group item, B cannot be subordinate to A. In all other cases, B will be defined as an alphanumeric item with a length in bytes equal to the length of group A.

```
 01  GARAGE-1.
     05  STD-PARKING-1  PIC 9(3).
 01  GARAGE-2.
     05  STD-PARKING-2  PIC 9(3)  COMP-3.
 77  VACANCIES-1 LIKE GARAGE-1.
* PICTURE IS X(3)
 77  VACANCIES-2 LIKE GARAGE-2.
* PICTURE IS X(2)
```

STD-PARKING-1 is a zoned numeric field, so VACANCIES-1 requires 3 bytes of storage. STD-PARKING-2 is a packed numeric field, so VACANCIES-2 requires only 2 bytes of storage.

You can use the LIKE clause with the USAGE IS POINTER clause:

```
  01  CUSTOMER-RECORD.
      05 CUST-NAME           PIC X(16).
      05 CUST-ADDR-POINTER   POINTER.
      05 CUST-STATS-POINTER  LIKE CUST-ADDR-POINTER.
 * USAGE IS POINTER
      05 CUST-NUMBER         PIC S9(8).
```

Note: You cannot use the LIKE clause to change the length of a pointer.

For additional information about the LIKE clause, see the *COBOL/400 Reference*.

End of IBM Extension

Reference Modification

Reference modification allows you to reference substrings of a data item. You simply specify the position within the data item at which you want the substring to start, and the length of the substring. The length is optional: if you omit it, it automatically extends to the end of the data item.

You can write both the starting position and the length value as integer literals, data items, or arithmetic expressions.

The starting position must be at least 1, and cannot be greater than the length of the referenced data item. The length must be at least 1.

The result of adding the starting position to the length specification, then subtracting 1, must fall between 1 and the total length of the referenced data item, inclusive. When the length value is greater than the total length of the data item, an error results.

For additional information on reference modification, see the *COBOL/400 Reference*.

The *RANGE generation option produces code to detect out-of-range reference modification conditions, and to flag violations with a run-time message.

Suppose you want to retrieve the current time from the system, and display its value in an expanded format. You can retrieve it with the ACCEPT statement, which returns the hours, minutes, seconds, and hundredths of seconds in the format:

```
HHMMSSss
```

However, you may want to view the current time in the format:

```
HH:MM:SS
```

Without reference modification, you must define the following data items:

```
01  TIME-GROUP.
  05  INTERESTING-FIELDS.
    10  HOURS                            PIC XX.
    10  MINUTES                          PIC XX.
    10  SECONDS                          PIC XX.
  05  UNINTERESTING-FIELDS.
    10  HUNDREDTHS-OF-SECONDS            PIC XX.
01  EXPANDED-TIME-GROUP.
  05  INTERESTING-FIELDS.
    10  HOURS                            PIC XX.
    10  FILLER                           PIC X   VALUE ":".
    10  MINUTES                          PIC XX.
    10  FILLER                           PIC X   VALUE ":".
    10  SECONDS                          PIC XX.
```

The following code would retrieve the time value, convert it to its expanded format, and display the new value:

```
ACCEPT TIME-GROUP FROM TIME
MOVE CORRESPONDING
   INTERESTING-FIELDS OF TIME-GROUP TO
   INTERESTING-FIELDS OF EXPANDED-TIME-GROUP
DISPLAY "CURRENT TIME IS: " EXPANDED-TIME-GROUP
```

With reference modification, you do not need to provide names for the subfields that describe the time elements. The only data definition you must have is:

```
01  REFMOD-TIME-ITEM                       PIC X(8).
```

The code to retrieve and expand the time value appears as follows:

```
ACCEPT REFMOD-TIME-ITEM FROM TIME
DISPLAY "CURRENT TIME IS: "
   REFMOD-TIME-ITEM (1:2)
   ":"
   REFMOD-TIME-ITEM (3:2)
   ":"
   REFMOD-TIME-ITEM (5:2)
```

The following example shows a reference beginning at character position 1, for a length of 2, thus retrieving the portion of the time value that corresponds to the number of hours:

```
REFMOD-TIME-ITEM (1:2)
```

The following example shows a reference beginning at character position 3, for a length of 2, thus retrieving the portion of the time value that corresponds to the number of minutes:

```
REFMOD-TIME-ITEM (3:2)
```

The following example shows a reference beginning at character position 5, for a length of 2, thus retrieving the portion of the time value that corresponds to the number of seconds:

```
REFMOD-TIME-ITEM (5:2)
```

Reference Modification with Variable-length Tables

Suppose you are using variable-length tables to contain names:

```
01  NAME-GROUP.
  05  NAME-LENGTH                          PIC 99.
  05  NAME-PORTION.
    10  FILLER                             PIC X
              OCCURS 1 TO 17 TIMES
              DEPENDING ON NAME-LENGTH.
01  NEW-NAME-GROUP.
  05  NEW-NAME-LENGTH                      PIC 99.
  05  NEW-NAME-PORTION.
    10  FILLER                             PIC X
              OCCURS 1 TO 17 TIMES
              DEPENDING ON NEW-NAME-LENGTH.
```

The OCCURS DEPENDING ON object of the NAME-PORTION table is set to 8 so that only the first eight occurrences of the table are referenced, even though the entire 17 bytes of NAME-PORTION are filled in.

0	8	W	I	L	L	I	A	M	S		T	H	O	M	A	S		J

Suppose you want to change the value in the item NAME-PORTION without changing the portion of the item that is defined beyond the currently defined length. You might try coding:

```
MOVE NEW-NAME-GROUP TO NAME-GROUP
```

in which the contents of NEW-NAME-GROUP are:

0	5	S	M	I	T	H						M	I	C	H	A	E	L

According to the rules for the MOVE statement, the entire contents of the receiving field NAME-GROUP would be replaced. This problem can be avoided by using reference modification in the MOVE statement:

```
MOVE NEW-NAME-GROUP TO NAME-GROUP ( 1 :LENGTH OF NAME-GROUP )
```

By specifying the reference modification with the LENGTH OF special register, the length of NAME-GROUP is now determined by the value in the NAME-LENGTH variable.

The new value of NAME-GROUP will be:

0	5	S	M	I	T	H					T	H	O	M	A	S		J

Reference Modification Using Data Names

So far, all of the reference modification examples have shown simple numeric literals as the reference modification starting position and length values. These values can also be data items or arithmetic expressions.

Suppose a field contains some right-justified characters, and you want to move them to another field, but left-justified instead of right. Using reference modification and an INSPECT statement, you can do it.

The program would have the following data:

```
01  LEFTY                                   PIC X(30).
01  RIGHTY                                  PIC X(30)
                                            JUSTIFIED RIGHT.
01  I                                       PIC 9(9)
                                            USAGE BINARY.
```

The program then counts the number of leading spaces, and, using arithmetic expressions in a reference modification expression, moves the right-justified characters into another (left-justified) field:

```
MOVE SPACES TO LEFTY
MOVE ZERO TO I
INSPECT RIGHTY
   TALLYING I FOR LEADING SPACE
IF I IS LESS THAN 30 THEN
   MOVE RIGHTY ( I + 1 : 30 - I ) TO LEFTY
END-IF
```

The MOVE statement transfers characters from RIGHTY, beginning at the position computed in I + 1, for a length that is computed in 30 – I, into the field LEFTY.

Reference Modification with Subscripting

define a table like this:

```
01  ANY-TABLE.
  05  TABLE-ELEMENT                        PIC X(10)
         OCCURS 3 TIMES
         VALUE "ABCDEFGHIJ".
```

You can change both the third and fourth bytes of the first element of TABLE-ELEMENT to the value “??” with the following MOVE statement:

```
MOVE "??" TO TABLE-ELEMENT ( 1 ) ( 3 : 2 )
```

This statement will move the value “??” into table element number 1, beginning at character position 3, for a length of 2.

ANY-TABLE would look like this before the change:

ABCDEFGHIJ
ABCDEFGHIJ
ABCDEFGHIJ

It would look like this after the change:

AB??EFGHIJ
ABCDEFGHIJ
ABCDEFGHIJ

De-editing

De-editing allows you to move a numeric-edited data item into a numeric or numeric-edited receiving data item. The compiler accomplishes this by first establishing the unedited value of the numeric-edited item. It then moves the unedited value to the receiver.

De-editing can occur in operations such as MOVE and INITIALIZE. A VALUE clause does not de-edit.

Note that unedited numeric values can involve signs.

Suppose that you use a character field to contain a numeric value that displays on the terminal, and also to contain a value that the computer operator supplies. Suppose that this field has the following definition:

- One character position for a sign (to contain a space if the numeric field is positive or zero, or a minus sign if the numeric field is negative);
- Six digit positions, in which leading zeros are represented by spaces;

- A decimal point;
- Two decimal-digit positions.

The data item that you use to define this field would look like this:

```
01 NUM-EDIT  PIC –Z(6).9(2)  USAGE IS DISPLAY.
```

You could initialize this field using this statement:

```
MOVE ZEROS TO NUM-EDIT
```

and when it displays on the terminal, it would contain the value ƀƀƀƀƀƀƀ.00.

Later, the computer operator might use this field for data entry. If the operator puts ƀƀƀƀ123.45 into the field, you can obtain the numeric value of the field by moving it into a data item defined as:

```
01 NUMERIC-ITEM  PIC S9(6)V9(2)  USAGE IS PACKED-DECIMAL.
```

This statement:

```
MOVE NUM-EDIT TO NUMERIC-ITEM
```

causes de-editing to take place, whereby the numeric item receives the numeric value of the numeric-edited field NUM-EDIT. As a result, the numeric item contains the value +123.45.

De-editing Examples

Table 5 and Table 6 show examples of COBOL/400 de-editing.

Table 5. Moving Numeric-edited Items into Numeric Receivers

Source Picture	Source Value	Receiving Picture	Receiving Value
$+++,+++.++	$ƀƀƀ+123.45	S9(5)V9(5) USAGE IS DISPLAY	+123.45
$+++,+++.++	$ƀ–1,234.56	S9(5)V9(5) USAGE IS BINARY	–1234.56
*****.999+	**123.450–	S9(5)V9(5) USAGE IS PACKED-DECIMAL	–123.45

Table 6. Moving Numeric-edited Items into Numeric-edited Receivers

Source Picture	Source Value	Receiving Picture	Receiving Value
$+++,+++.++	$ƀƀƀ+123.45	$$$$,$$$.$$CR	ƀƀƀƀ$123.45ƀƀ
$+++,+++.++	$ƀ–1,234.56	––––,–––.99	ƀƀ–1,234.56
*****.999+	**123.450–	ZZZBZZZBVZZZ	ƀƀƀƀ123ƀ450
ZZZ999CR	ƀ12345ƀƀ	$++++9999	$ƀƀ+12345
ZZZ999CR	ƀ12345CR	999999.99–	012345.00–

Handling Data Errors

The compiler provides some run-time error checking for move operations that involve de-editing.

The compiler does not perform this checking for source values of zero, and it ignores simple insertion characters (such as / B 0 , .).

Sign Test

The compiler validates signs in numeric-edited source items according to the following rules.

PICTURE Definition	**Allowable Contents**
Fixed +	+ or −
Fixed −	ƀ or −
CR	ƀƀ or CR
DB	ƀƀ or DB

If these rules are disobeyed, a sign error occurs, and the program stops.

Float Test

If the source has a string of floating characters, this test verifies the correctness of leading floating characters in the data field.

The rules for the float test are:

- If the source PICTURE clause contains floating $ symbols, the first non-blank character in the relevant portion of the source field (positions 2 through 7 in the example) must be a $, and its location must be correct according to the rules for PICTURE clause editing. (See the *COBOL/400 Reference* for more information about these rules.)

  For example:

  Location of a Leading Floating Character

  ```
  01 A PIC +$$B,$$$.
    .
    .
  /* Note that "b" represents one space   */
  /* PIC String:            +$$B,$$$     */
  /* Position indexes:      12345678     */
  MOVE 1 TO A.       /* A = "+bbbbb$1"    */
  MOVE 12 TO A.      /* A = "+bbbb$12"    */
  MOVE 123 TO A.     /* A = "+bbb$123"    */
  MOVE 1234 TO A.    /* A = "+$1b,234"    */
  ```

  In this example, the $ must be located at position 2, 5, 6, or 7.

- If the source PICTURE clause contains floating + symbols, the first non-blank character in the relevant portion of the source field must be + or −, and its location must be correct according to the rules for PICTURE clause editing.

- If the source PICTURE clause contains floating – symbols, the relevant portion of the source field must start with:
  - One or more contiguous spaces, the last of which must be correctly located according to the rules for PICTURE clause editing
  - One or more contiguous spaces, with a – immediately following it. The location of the – must be correct according to the rules for PICTURE clause editing.
  - A –.

If these rules are disobeyed, a float error occurs, and the program stops.

Performance Considerations

PICTURE Clauses for Numeric Items

Because hardware instructions use signs, you can improve performance by including an S in a picture clause whenever possible.

You can also improve performance by specifying odd numbers of numeric character positions in the picture clauses for COMP-3 (packed decimal) items. Internally, the rightmost byte of a packed decimal item contains a digit and a sign, and any other bytes contain two digits. If you use the more efficient configuration, the compiler does not need to supply the missing digit.

Eight-Byte Binary Items

Avoid using 8-byte binary items. You can specify these items for convenience, but the compiler must make conversions in order to use them.

Segmentation

Use of segmentation increases the compile and run times of the COBOL program. The segmentation feature is provided only for compatibility with other systems. You do not have to be concerned with storage management when using COBOL/400 programs.

Calling a COBOL Program from a Non-COBOL Program

Repeated calls of a COBOL program from a non-COBOL program can result in a marked decrease in compiler performance due to the fact that exiting from the main COBOL program (the program that initiated the COBOL run unit) causes the program to be deactivated.

A new function, MGTFUNC has been added to the COBOL run-time routine, QRLMAIN to prevent this deactivation by causing the main COBOL program to be treated as a subprogram. Because this fix depends on the size of MGT, it is recommended that the run-time routine, QLRMAIN be called from the main COBOL program with MGTFUNC = 9, as shown in the following example:

```
01  mgtstruc.
    03  FILLER PIC X(277).
    03  mgtfunc pic 9(2) comp-4 value 9.
77  TEST-VAR  PIC X(10) value spaces.

      if test-var = spaces then
        display 'spaces'
        move 'faked' to test-var
        call 'QLRMAIN' using mgtstruc
      else
        display 'not spaces ' test-var.
```

Notes:

1. The `01 mgtstruc` must be on a 16 byte boundary. If a boundary error occurs, add `77 aa PIC X.` in front of the `01`.
2. Because the call to QLRMAIN changes the main COBOL program to a subprogram, you should use the EXIT PROGRAM command and not STOP RUN, which may cause errors.
3. RCLRSC will deactivate the main program (now a subprogram)

Debugging

COBOL source language debugging is provided to help the COBOL programmer debug a program that is not functioning as expected. Use of this facility increases the compile and run times of a COBOL program.

*NORANGE Option

This GENOPT parameter option of the CRTCBLPGM command removes the run-time checks for subscript and reference modification ranges.

This option can improve performance when:

- You make frequent references to tables, and the subscripts always reference elements that are in the tables
- You use reference modification often.

Note: The *RANGE option generates code for checking subscript ranges. For example, it ensures that you are not attempting to access the 21st element of a 20-element array.

The *NORANGE option does not generate code to check subscript or reference modification ranges.

These options do not eliminate the zero subscript checking performed by the operating system. If zero subscripts occur, the operating system will not permit their use and issues message MCH0603.

*DUPKEYCHK Option

This GENOPT parameter option of the CRTCBLPGM command indicates that duplicate key checking for INDEXED files will be performed. Using DUPKEYCHK while reading INDEXED files can adversely affect performance.

Relative Files

You can experience lengthy delays if you open or close relative files in which very large volumes of records are being initialized to deleted records.

See Table 4 on page 251 for more information.

Indicators

If you use indicators in a separate indicator area (INDARA keyword specified in DDS) instead of in the record area, the use of the OCCURS clause to specify a table with up to 99 indicators can improve performance. See Figure 60 on page 155 for more information.

Commitment Control

Generally, the use of commitment control increases the run time of a COBOL program. In addition, the record locking that results from the use of commitment control by a job may cause delays for other users attempting to access the same file.

Reading without Record Locks

To avoid unnecessary record locks, you can include the NO LOCK phrase in your READ statement. For more information about this phrase, refer to the section on the READ statement in the *COBOL/400 Reference*.

Initializing Variables

You can reduce program run time by choosing **not** to initialize program variables that have no value clauses associated with them. You can specify no initialization by specifying `*NOSTDINZ` for the GENOPT parameter of the CRTCBLPGM command, or by specifying `NOSTDINZ` in the PROCESS statement. The compiler then initializes only those variables that have value clauses declared. An additional benefit to this option is that you can also compile larger programs with a greater number of variables.

If you specify `*NOSTDINZ`, you must ensure that all data items contain valid data before you attempt to manipulate the items. If an item does not contain valid data, decimal data errors can occur.

Blocking Records

You can use record blocking to improve your run-time performance. The key benefits for blocking are realized when you read multiple records sequentially, such as a random read followed by sequential reads.

For information on blocking, refer to “Unblocking Input Records and Blocking Output Records” on page 102.

Program Loops

When a program repeatedly processes the same series of instructions, and it is apparent that this will continue indefinitely, the program is in a loop. To identify loops, you can use information known about the program itself, as follows:

- Time: If the actual run time is substantially exceeding the expected run time, the program could be in a loop.
- I/O operations: If no input/output operations are taking place and I/O is expected to be occurring repeatedly, the program is probably in a loop.

Tracing a Loop in a Program

Frequently, a loop encompasses many instructions in a program. In this case, you can use the COBOL debugging features as described in Chapter 5, "Debugging Your Program" on page 55.

Errors That Can Cause a Loop

A PERFORM statement with an UNTIL clause can cause a loop when the condition specified in the UNTIL clause cannot be met. For example:

```
PERFORM ... UNTIL COUNTR LESS THAN ZERO
```

where COUNTR is an unsigned numeric item.

A GO TO statement that refers to a previous procedure-name can cause a loop when no conditional statement exists to prevent the GO TO statement from being processed again. For example:

```
PARA-1.
  MOVE ...
  MOVE ...
  MOVE ...
PARA-2.
  MOVE ...
  GO TO PARA-1.
```

A possible variation of this case occurs when a conditional statement exists, but the condition cannot be met or the statement does not branch (through a GO TO statement) to a paragraph outside the range of the loop.

Chapter 12. Communicating Between Programs

Sometimes an application is simple enough to be coded as a single, self-sufficient program. In many cases, however, an application's solution will consist of several, separately compiled programs used together.

The AS/400 system provides communication between COBOL programs, and between COBOL and non-COBOL programs.

A COBOL **run unit** is a set of one or more programs that function as a unit at run time to provide a problem solution. A COBOL run unit starts with the first COBOL program in the program stack, and includes all programs (of any type) that are below it. A **program stack** is a list of programs linked together as a result of programs calling other programs, or implicitly from some other event within the same job.

When a run unit consists of several, separately compiled programs that call each other, the programs must be able to communicate with each other. They need to transfer control and usually need to have access to common data. This chapter describes the methods that accomplish this interprogram communication between separately compiled programs.

Transferring Control to Another Program

In the Procedure Division, a program can call another program (generally called a subprogram in COBOL terms), and this called program may itself call another program. The program that calls another program is referred to as the **calling** program, and the program it calls is referred to as the **called** program.

The called COBOL program starts running at the top of the Procedure Division.

When the called program processing is completed, the program can either transfer control back to the calling program or end the run unit.

A called program must not directly or indirectly execute its caller (such as program X calling program Y; program Y calling program Z; and program Z then calling program X). This is called a **recursive** call. COBOL/400 allows recursion in both main programs and subprograms. However, if you want your programs to conform to SAA standards, do not use recursive calls.

Main Programs and Subprograms

The first COBOL program to be executed begins the COBOL run unit, and is the **main program**. No specific source statements or options identify a COBOL program to be a main program or a subprogram. A **subprogram** is a program in the run unit below the main program in the program stack. For more information about program stacks and other terms concerning interprogram communication, see the *CL Programmer's Guide*.

Returning Control from a Called Program

It is important to know if a COBOL program is a main program or a subprogram to determine how control is returned from a called program when an error occurs, or a program ends.

You can issue a STOP RUN, EXIT PROGRAM, or GOBACK statement to return control from a called program.

If execution ends in the main program, either STOP RUN or GOBACK is used. These statements end the run unit, and control is returned to the caller of the main program.

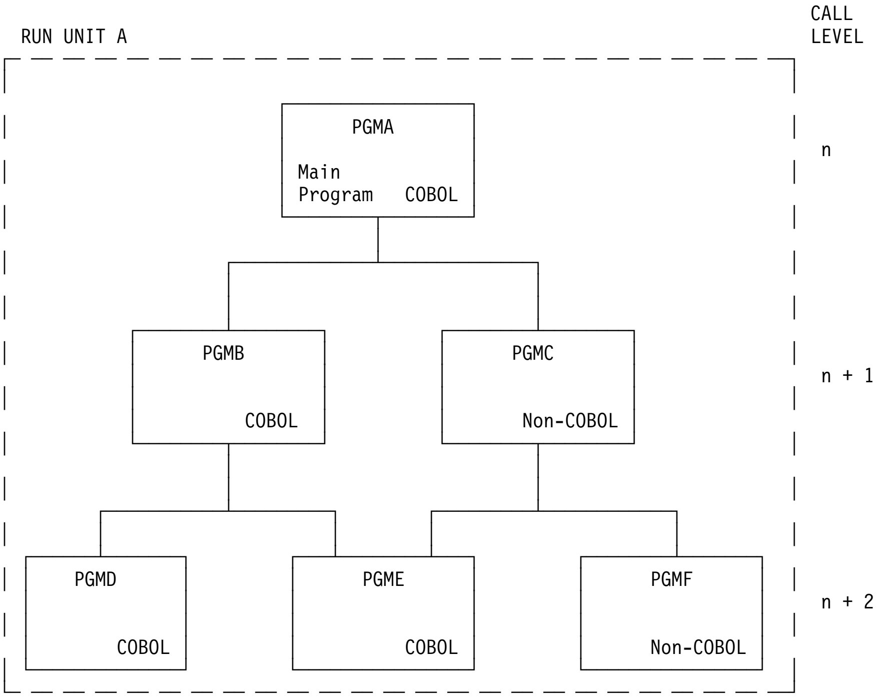
If execution ends in a subprogram, the subprogram may end with an EXIT PROGRAM, a GOBACK, or a STOP RUN statement. If the subprogram ends with an EXIT PROGRAM or a GOBACK statement, control returns to its immediate caller without ending the run unit. An implicit EXIT PROGRAM statement is generated if there is no next executable statement in a called program. If it ends with a STOP RUN statement, the effect is the same as it is in a main program: all COBOL programs in the run unit are terminated, and control returns to the caller of the main program.

A subprogram is left in its **last-used state** when it terminates with EXIT PROGRAM or GOBACK. The next time it is called in the run unit, its internal values will be as they were left, except that return values for PERFORM statements will be reset to their initial values. In contrast, a main program is initialized each time it is called.

The following examples illustrate the use of the EXIT PROGRAM and STOP RUN statements in different parts of a run unit.

- The example in Figure 85 on page 275 shows a single run unit.
- The example in Figure 86 on page 276 shows multiple run units that run consecutively
- The example in Figure 87 on page 277 shows a run unit with a shared program that is both a subprogram and a main program.
- The example in Figure 88 on page 278 shows multiple run units that run concurrently.

Note: You can substitute a GOBACK statement for an EXIT PROGRAM statement that appears in a subprogram, or a STOP RUN statement that appears in a main program.



	PROGRAM RUNNING STATEMENT			
STATEMENT	PGMA	PGMB	PGMD	PGME
EXIT PROGRAM	1	2	2	2
STOP RUN	3	3	3	3

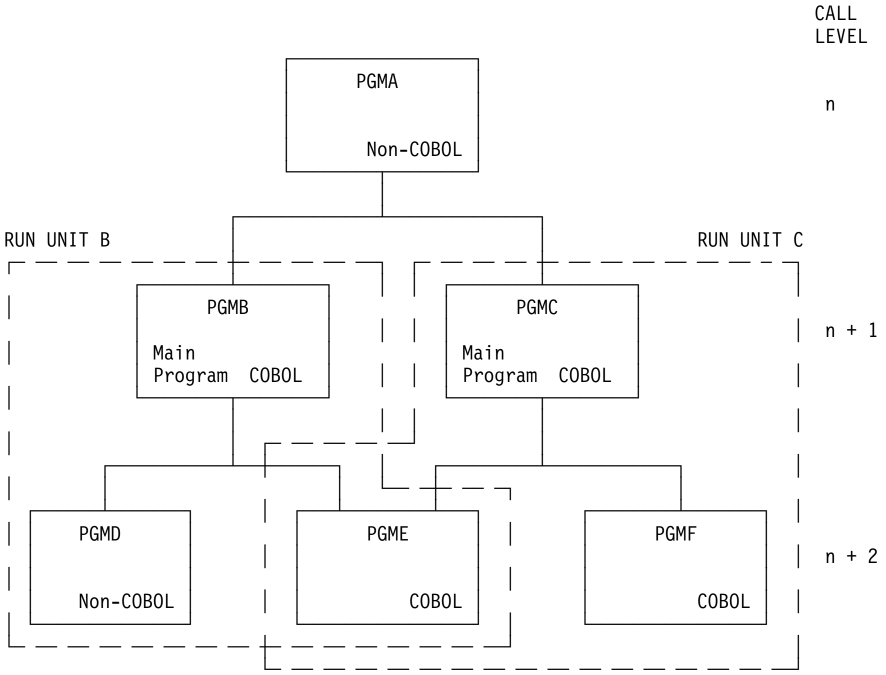
Figure 85. Example of a Single Run Unit

1 No operation is processed because the statement is processed in a main program. Processing continues with the next statement in PGMA.

2 Control returns to the caller of the program that processes the EXIT PROGRAM statement.

3 Run unit A ends. For all programs in the run unit, open files are closed. Storage is freed for all programs in the run unit. Control returns to the program that is at call level n-1. If n=1, the following considerations apply:

- Run unit A operates as a job step. See the *CL Programmer's Guide* for more information.
- For batch jobs, the STOP RUN statement ends the job. For interactive jobs, control returns to the system and the system ends the job step.



	PROGRAM RUNNING STATEMENT				
STATEMENT	PGMB	PGMC	PGME (RUN UNIT B)	PGME (RUN UNIT C)	PGMF
EXIT PROGRAM	1	1	2	2	2
STOP RUN	3	4	3	4	4

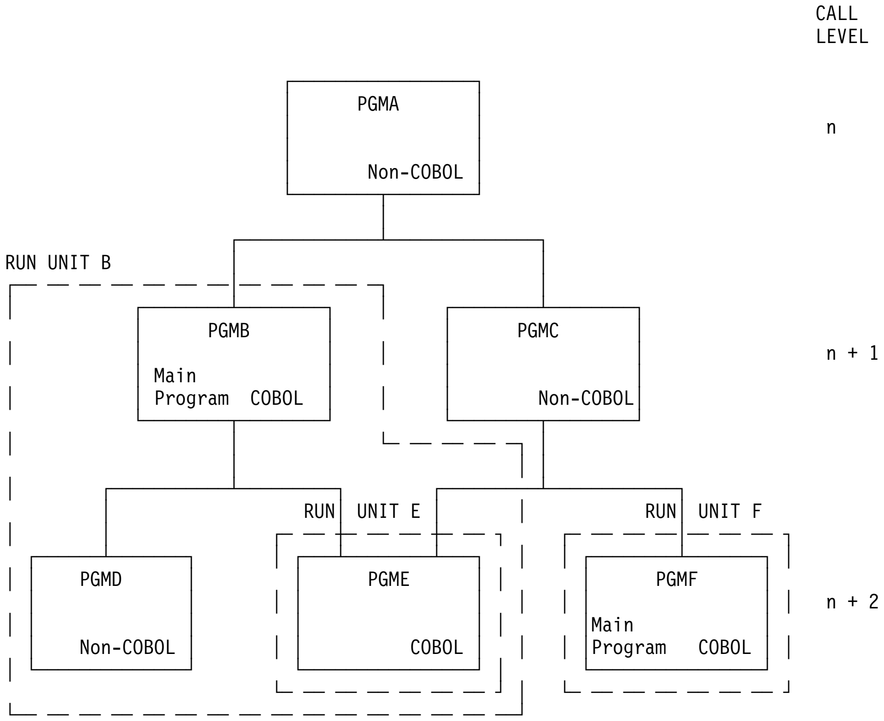
Figure 86. Example of Multiple Run Units That Run Consecutively

1 No operation is processed because the statement is processed in a main program. Processing continues with the next statement in the main program.

2 Control returns to the caller of the program that processes the EXIT PROGRAM statement.

3 Run unit B ends. All open files in run unit B are closed. Storage is freed for all programs in run unit B. Control returns to the caller of the main program for the run unit (PGMA).

4 Run unit C ends. All open files in run unit C are closed. Storage is freed for all programs in run unit C. Control returns to the caller of the main program for the run unit (PGMA).



	PROGRAM RUNNING STATEMENT			
STATEMENT	PGMB	PGME (RUN UNIT B)	PGME (RUN UNIT E)	PGMF
EXIT PROGRAM	1	2	1	1
STOP RUN	3	3	4	5

Figure 87. Example of a Run Unit with a Shared Program that is Both a Subprogram and a Main Program

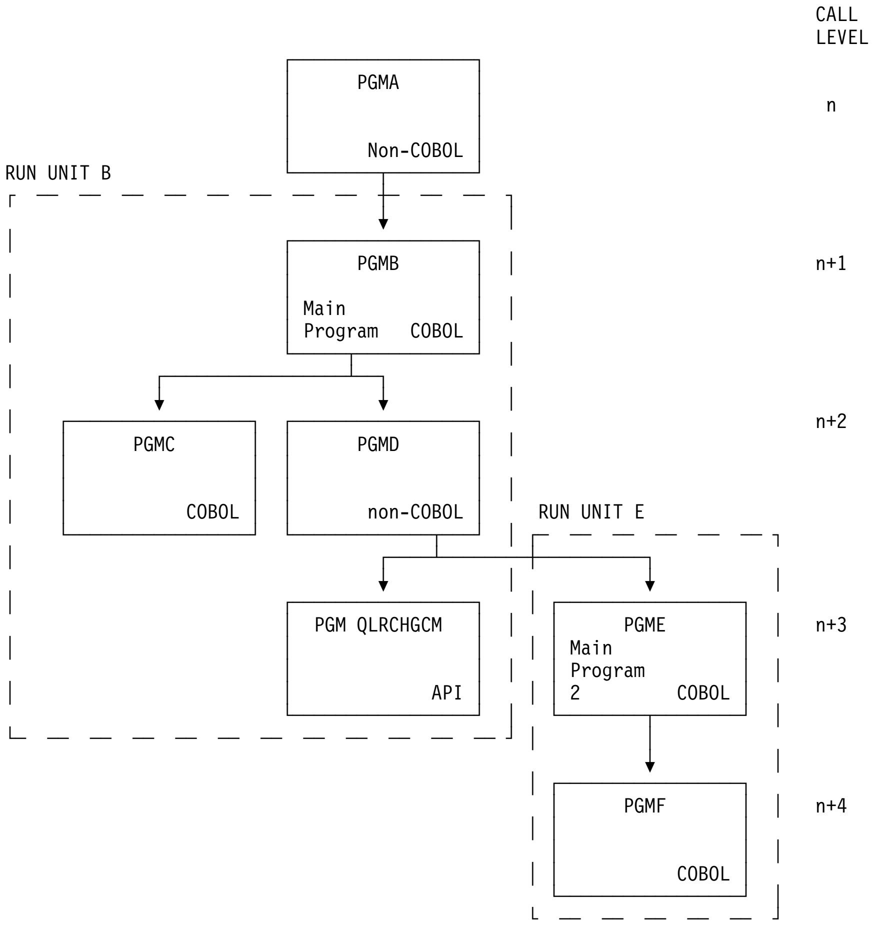
1 No operation is processed because the statement is processed in a main program. Processing continues with the next statement in the main program.

2 Control returns to the caller of the program that processes the EXIT PROGRAM statement.

3 Run unit B ends. All open files in run unit B are closed. Storage is freed for all programs in run unit B. Control returns to the caller of the main program for the run unit (PGMA).

4 Run unit E ends. All open files in run unit E are closed. Storage is freed for PGME. Control returns to the caller of the main program for the run unit (PGMC).

5 Run unit F ends. All open files in run unit F are closed. Storage is freed for PGMF. Control returns to the caller of the main program for the run unit (PGMC).



PROGRAM RUNNING STATEMENT

STATEMENT	PGMB	PGMC (RUN UNIT B)	PGME	PGMF (RUN UNIT E)
EXIT PROGRAM	1	2	1	2
STOP RUN	3	3	4	4

Figure 88. Example of Multiple Run Units That Run Concurrently

1 No operation is processed because the statement is processed in a main program. Processing continues with the next statement in the main program.

2 Control returns to the caller of the program that processes the EXIT PROGRAM statement.

3 Run unit B can only end after run unit E completes a STOP RUN. When run unit B ends, all open files in run unit B are closed. Storage is freed for all programs in run unit B, and control returns to the caller of the main program (PGMA).

4 Run unit E ends. All open files in run unit E are closed. Storage is freed for all programs in run unit E. Control returns to PGMD in run unit B.

Concurrent run units are achieved by using the QLRCHGCM API. Refer to the *System Programmer's Interface Reference* for more information on this API.

Initialization of Storage

The first time a COBOL program in a run unit is called, its storage is initialized. Storage is initialized again under the following conditions:

- The run unit is terminated, then reinitiated.
- The program is canceled (using the CANCEL statement for COBOL, the FREE operation for the RPG/400* programming language, or the Reclaim Resource (RCLRSC) command), and then called again.

If a non-COBOL program is named in a CANCEL statement, its name must conform to the rules for formation of a COBOL program name.

Calling Another Program

You will often want your COBOL programs to communicate with other COBOL and non-COBOL programs.

Passing Data Using BY REFERENCE or BY CONTENT

BY REFERENCE means that the subprogram is referring to and processing the data items in the calling program's storage, rather than working on a copy of the data.

BY CONTENT means that the calling program is passing only the **contents** of the *literal*, or *identifier*. With a CALL . . . BY CONTENT, the called program cannot change the value of the *literal* or *identifier* in the calling program, even if it modifies the variable in which it received the *literal* or *identifier*.

Whether you pass data items BY REFERENCE or BY CONTENT depends on what you want your program to do with the data:

- If you want the definition of the argument of the CALL statement in the calling program and the definition of the parameter in the called program to share the same memory, specify:

  CALL . . . BY REFERENCE *identifier*.

  Any changes made by the subprogram to the parameter affect the argument in the calling program.

  An identifier in the USING phrase of the CALL . . . BY REFERENCE statement may be a file-name, in addition to a data-name.

  File-names as CALL operands are allowed by the compiler as an extension.

- If you want to pass the address of a record area to a called program, specify:

  CALL . . . BY REFERENCE ADDRESS OF *record-name*.

  The subprogram receives the ADDRESS OF special register for the record-name you specify.

  You must define the record name as a level-01 or level-77 item in the Linkage Section of the called and calling programs. A separate ADDRESS OF special register is provided for each record in the Linkage Section.

- If you do not want the definition of the argument of the CALL statement in the calling program and the definition of the parameter in the called subprogram to share the same memory, specify:

  CALL . . . BY CONTENT *identifier*.

- If you want to pass a literal value to a called program, specify:

  CALL . . . BY CONTENT *literal*.

  The called program cannot change the value of the literal. The literal cannot be numeric.

- If you want to pass the length of a data item, specify:

  CALL . . . BY CONTENT LENGTH OF *identifier*.

  The calling program passes the length of *identifier* from its LENGTH OF special register. When literals are passed BY CONTENT, the called program cannot change their values.

- If you want to pass both a data item and its length to a subprogram, specify a combination of BY REFERENCE and BY CONTENT. For example:

  ```
  CALL 'ERRPROC' USING BY REFERENCE A
        BY CONTENT LENGTH OF A.
  ```

Data items in a calling program can be described in the Linkage Section of all the programs it calls directly or indirectly. In this case, storage for these items is allocated in the highest calling program. That is, program A calls program B, which calls program C. Data items in program A can be described in the Linkage Sections of programs B and C, so that one set of data can be made available to all three programs.

Describing Arguments in the Calling Program

In the calling program, the arguments are described in the Data Division in the same manner as other data items in the Data Division. Unless they are in the Linkage Section, storage is allocated for these items in the calling program. If you reference data in a file, the file must be open when the data is referenced. Code the USING clause of the CALL statement to pass the arguments.

Describing Parameters in the Called Program

In the called program, parameters are described in the Linkage Section. Code the USING clause after the PROCEDURE-DIVISION header to receive the parameters.

In the Linkage Section

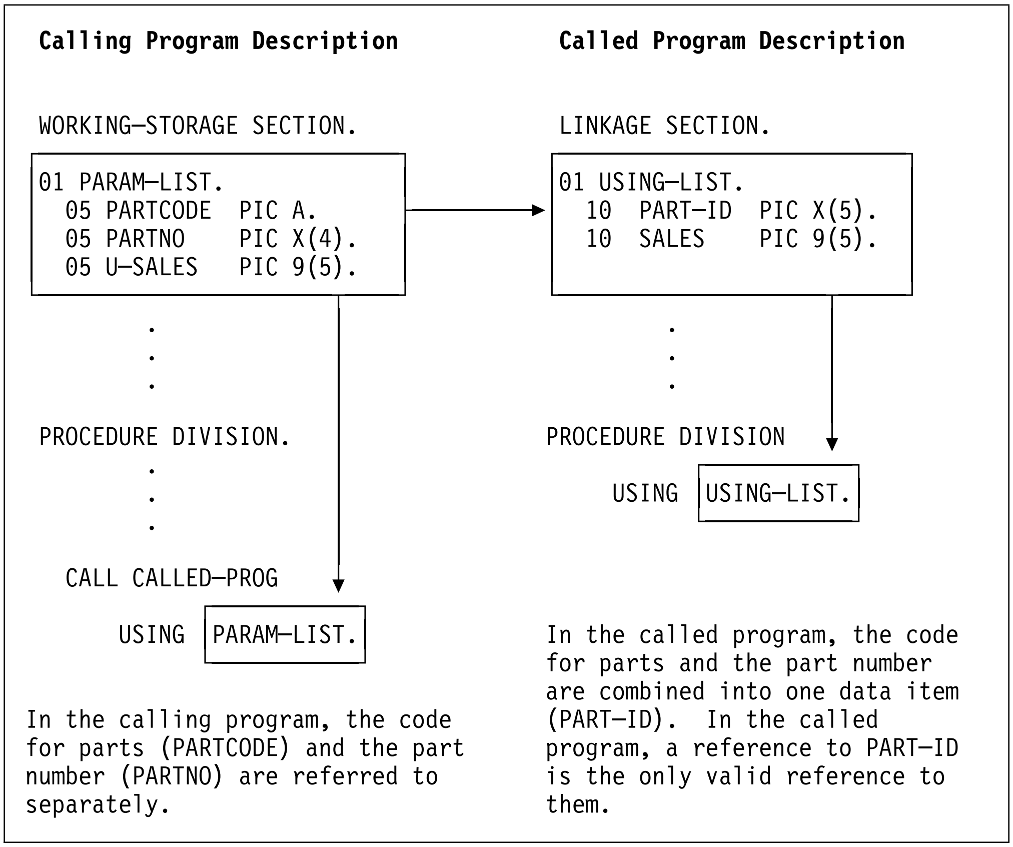
You must know what is being passed from the calling program and set up the Linkage Section in the called program to accept it. To the called program, it doesn't matter which clause of the CALL statement you use to pass the data (BY REFERENCE or BY CONTENT). In either case, the called program must describe the data it is receiving. It does this in the Linkage Section.

The number of *data-names* in the *identifier* list of a called program must not be greater than the number of *data-names* in the *identifier* list of the calling program. There is a one-to-one positional correspondence; that is, the first *identifier* of the calling program is passed to the first *identifier* of the called program, and so forth. The compiler makes no attempt to match arguments and parameters.

Grouping Data to be Passed

Consider grouping all the data items you want to pass between programs and putting them under one level-01 item. If you do this, you can pass a single level-01 record between programs. For an example of this method, see Figure 89.

To make the possibility of mismatched records even smaller, put the level-01 record in a copy member, and copy it in both programs. (That is, copy it in the Working-Storage Section of the calling program and in the Linkage Section of the called program.)



Calling Program Description

```
WORKING-STORAGE SECTION.

01 PARAM-LIST.
  05 PARTCODE  PIC A.
  05 PARTNO    PIC X(4).
  05 U-SALES   PIC 9(5).
         .
         .
         .
PROCEDURE DIVISION.
         .
         .
         .
  CALL CALLED-PROG
      USING PARAM-LIST.
```

In the calling program, the code for parts (PARTCODE) and the part number (PARTNO) are referred to separately.

Called Program Description

```
LINKAGE SECTION.

01 USING-LIST.
  10  PART-ID  PIC X(5).
  10  SALES    PIC 9(5).
         .
         .
         .
PROCEDURE DIVISION
     USING USING-LIST.
```

In the called program, the code for parts and the part number are combined into one data item (PART-ID). In the called program, a reference to PART-ID is the only valid reference to them.

Figure 89. Common Data Items in Subprogram Linkage

Call by Identifier

A system pointer that associates an identifier with an object is set the first time you use the identifier in a CALL statement.

Important for compatibility!

If you carry out a call by an identifier to a program that you subsequently delete or rename, you must use the CANCEL statement to null the system pointer associated with the identifier. This ensures that when you next use the identifier to call your program, the associated system pointer will be set again.

The following example shows how to apply the CANCEL statement to an identifier:

```
MOVE "ABCD" TO IDENT-1.
CALL IDENT-1.
CANCEL IDENT-1.
```

If you apply the CANCEL statement directly to the literal "ABCD", you do *not* null the system pointer associated with IDENT-1. Instead, you can continue to call program ABCD simply by using IDENT-1 in your CALL statement.

The value of the system pointer also changes if you change the value of the identifier and perform a call using this new value.

Using Pointers in a COBOL/400 Program

You can use a **pointer** (a data item in which address values can be stored) within a COBOL program when you want to pass and receive addresses of a variably-located data item, and to accomplish limited base addressing.

On the AS/400 system, pointers are 16 bytes long. COBOL pointers are AS/400 **space pointers** since they point to system space objects. One part of the pointer describes its attributes, such as which AS/400 space object it is pointing to. Another part of the pointer contains the offset into the AS/400 system space object.

To define a COBOL pointer, called a **pointer data item**, code a USAGE IS POINTER clause on the data item. A pointer data item is a 16-byte elementary item that can be compared for equality, or used to set the value of other pointer items.

A pointer data item can be used only in:

A SET statement (Format 5 only)
A relation condition
The USING phrase of a CALL statement, or the Procedure Division header.
The operand for the LENGTH OF and ADDRESS OF special registers.

If pointers are used in a relational condition, the only valid operators are equal to, or not equal to.

Because pointer data items are not simply binary numbers on the AS/400 system, manipulating pointers as integers does not work.

Pointer data items are defined explicitly with the USAGE IS POINTER clause, and are implicit when using an ADDRESS OF special register or the ADDRESS OF an item.

If a group item is described with the USAGE IS POINTER clause, the elementary items within the group item are pointer items. The group itself is not a pointer data item, and cannot be used in the syntax where a pointer data item is allowed. The USAGE clause of an elementary item cannot contradict the USAGE clause of a group to which the item belongs.

Pointer data items can be part of a group that is referred to in a MOVE statement or an input/output statement; however, if a pointer data item is part of a group, there is no conversion of pointer values to another form of internal representation when the statement is executed.

Defining Pointers and Pointer Alignment

Pointer data items can be defined at any level (except 88) in the File, Working-Storage, or Linkage sections of a program.

When a pointer is referenced on the AS/400 system, it must be on a 16-byte storage boundary. **Pointer alignment** refers to the COBOL/400 compiler's process of positioning pointer items within a group item to offsets that are multiples of 16 bytes from the beginning of the record. If a pointer item is not on a 16-byte boundary, a pointer alignment exception (MCH0602) is sent to the COBOL/400 program. In general, pointer alignment exceptions occur in the Linkage Section, where it is up to the user to align these items.

In the File and Working-Storage sections, the compiler ensures that this exception does not occur by adding implicit FILLER items. Every time an implicit FILLER item is added by the compiler, a warning is issued. In the Linkage Section, no implicit FILLER items are added by the compiler; however, warnings are issued indicating how many bytes of FILLER would have been added had the group item appeared in the File or Working-Storage sections.

You can define a data item as a pointer by specifying the USAGE IS POINTER clause as shown in the following example:

```
WORKING-STORAGE SECTION.
 77  APTR USAGE POINTER.
 01  AB.
     05 BPTR  USAGE POINTER.
     05 BVAR  PIC S9(3) PACKED-DECIMAL.
LINKAGE SECTION.
 01  AVAR.
     05 CVAR  PIC X(30).
PROCEDURE DIVISION.
     SET APTR TO ADDRESS OF AVAR.
```

Figure 90. Defining a Pointer Data Item

In the above example, AVAR is an 01-level data item, so the ADDRESS OF AVAR is the ADDRESS OF special register. Because a special register is an actual storage area, the SET statement moves the contents of ADDRESS OF AVAR into pointer data item APTR.

In the above example, if the SET statement used ADDRESS OF CVAR, no special register exists. Instead, the pointer data item APTR is assigned the calculated address of CVAR.

In File and Working-Storage Sections

In the File and Working-Storage sections, all 01-level items (and some 66 and 77-level items) are placed on 16-byte boundaries.

Within a group structure, pointer data items must also occur on a 16-byte boundary. To ensure this, the COBOL/400 compiler adds FILLER items immediately before the pointer data item. To avoid these FILLER items, you should place pointer data items at the beginning of a group item.

If the pointer data item is part of a table, the first item in the table is placed on a 16-byte boundary. To ensure that all subsequent occurrences of the pointer fall on a 16-byte boundary, a FILLER item is added to the end of the table if necessary.

An example of pointer data item alignment follows:

```
WORKING-STORAGE SECTION.
 77  APTR USAGE POINTER.
 01  AB.
     05 ALPHA-NUM PIC X(10).
     05 BPTR  USAGE POINTER.
 01  EF.
     05 ARRAY-1 OCCURS 3 TIMES.
        10 ALPHA-NUM-TWO PIC X(14).
        10 CPTR  USAGE POINTER.
        10 ALPHA-NUM-THREE PIC X(5).
```

Figure 91. Aligning Pointer Data Items

In the above example, APTR is a pointer data item. The 77-level item, therefore, is placed on a 16-byte boundary. The group item AB is an 01-level item and is automatically placed on a 16-byte boundary. Within the group item AB, BPTR is not on a 16-byte boundary. To align it properly, the compiler inserts a 6-byte FILLER item after ALPHA-NUM. Finally, CPTR requires a FILLER of 2 bytes to align its first occurrence. Because ALPHA-NUM-THREE is only 5 bytes long, another 11-byte FILLER must be added to the end of ARRAY-1 to align all subsequent occurrences of CPTR.

When a pointer is defined in the File Section, and a file does not have blocking in effect, each 01-level item will be on a 16-byte boundary. If a file has blocking in effect, only the first record of a block is guaranteed to be on a 16-byte boundary. Thus pointer data items should not be defined for files with blocking in effect. For more information on blocking, refer to “Unblocking Input Records and Blocking Output Records” on page 102.

Pointers and the REDEFINES Clause

A pointer data item may be the subject or object of a REDEFINES clause.

When a pointer is the subject of a REDEFINES clause, the object data item must be on a 16-byte boundary.

For example:

```
WORKING-STORAGE SECTION.
 01  AB.
     05 ALPHA-NUM PIC X(16).
     05 APTR REDEFINES ALPHA-NUM USAGE POINTER.
     05 BPTR  USAGE POINTER.
     05 CPTR REDEFINES BPTR USAGE POINTER.
```

Figure 92. REDEFINES and Aligned Pointer Data Items

In the above example, both APTR and CPTR are pointer data items that redefine 16-byte aligned items. In the following example, the redefined item would result in a severe compiler error:

```
WORKING-STORAGE SECTION.
 01  EF.
     05 ALPHA-NUM PIC X(5).
     05 HI.
        10 ALPHA-NUM-TWO PIC X(11).
        10 APTR  USAGE POINTER.
     05 BPTR REDEFINES HI USAGE POINTER.
```

Figure 93. REDEFINES and Aligned Pointer Data Items - Incorrect Method

In the above example, APTR is aligned on a 16-byte boundary. That is, the COBOL/400 compiler did not need to add FILLER items to align APTR. The group item HI is not on a 16-byte boundary, and so neither is pointer data item BPTR. Because the COBOL/400 compiler cannot add FILLER items to place BPTR on a 16-byte boundary, a severe error will result. In the following example, similar to the above, the COBOL/400 compiler is able to place the pointer data item on a 16-byte boundary:

```
WORKING-STORAGE SECTION.
 01  EF.
     05 ALPHA-NUM PIC X(5).
     05 HI.
        10 ALPHA-NUM-TWO PIC X(11).
        10 APTR  USAGE POINTER.
        10 ALPHA-NUM-THREE PIC X(5).
     05 KL REDEFINES HI.
        10 BPTR USAGE POINTER.
```

Figure 94. REDEFINES and Unaligned Pointer Data Items - Correct Method

In the above example, group item KL is not on a 16-byte boundary; however, the compiler adds an 11-byte FILLER before pointer data item BPTR to ensure that it falls on a 16-byte boundary.

Reading and Writing Pointers

Pointer data items can be defined in the File Section, and can be set and used as can any other Working-Storage pointer data items. There are, however, some restrictions:

- If a file has blocking in effect, only the first record of a block is guaranteed to be on a 16-byte boundary. Thus pointer data items should not be defined for files with blocking in effect.

- A record containing pointers can be written to a file; however, on subsequent reading of that record, the pointer data items equal NULL.

Initializing Pointers Using the NULL Figurative Constant

The NULL figurative constant represents a value used to indicate that data items defined with USAGE IS POINTER, ADDRESS OF, or the ADDRESS OF special register do not contain a valid address. For example:

```
WORKING-STORAGE SECTION.
 77 APTR  USAGE POINTER VALUE NULL.
PROCEDURE DIVISION.
    IF APTR = NULL THEN
      DISPLAY 'APTR IS NULL'
    END-IF.
```

Figure 95. Using NULL to Initialize a Pointer

In the above example, pointer APTR is set to NULL in the Working-Storage section. The comparison in the procedure division will be true and the display statement is executed.

On the AS/400 system, the initial value of a pointer data item with or without a VALUE clause of NULL, equals NULL.

LENGTH OF Special Register

The LENGTH OF special register contains the number of bytes used by an identifier. It returns a value of 16 for a pointer data item.

You can use LENGTH OF in the Procedure Division anywhere a numeric data item having the same definition as the implied definition of the LENGTH OF special register is used; however, LENGTH OF cannot be used as a subscript or a receiving data item. LENGTH OF has the implicit definition:

```
USAGE IS BINARY, PICTURE 9(9)
```

The following example shows how you can use LENGTH OF with pointers:

```
WORKING-STORAGE SECTION.
 77  APTR  USAGE POINTER.
 01  AB.
     05  BPTR  USAGE POINTER.
     05  BVAR  PIC S9(3) PACKED-DECIMAL.
     05  CVAR  PIC S9(3) PACKED-DECIMAL.
PROCEDURE DIVISION.
     MOVE LENGTH OF AB TO BVAR.
     MOVE LENGTH OF BPTR TO CVAR.
```

Figure 96. Using LENGTH OF with Pointers

In the above example, the length of group item AB is moved to variable BVAR. BVAR has a value of 20 because BPTR is 16 bytes long, and both variables BVAR and CVAR are 2 bytes long. CVAR receives a value of 16.

You can also use the LENGTH OF special register to set up data structures within user spaces, or to increment addresses received from another program. To see an example of a program that uses the LENGTH OF special register to define data structures within user spaces, refer to Figure 99 on page 291.

Setting the Address of Linkage Items

Generally, when one COBOL program calls another, data passes between the two programs in the following manner: the calling program uses the CALL USING statement to pass operands to the called program, and the called program specifies the USING phrase in the Procedure Division header. There should be a one-to-one mapping between the operands in the USING phrases of each program.

When using the ADDRESS OF special register, you no longer need to ensure a one-to-one mapping between the USING phrases of the two programs. For those data items in the Linkage Section that are not specified in the USING phrase of the Procedure Division header, you can use a SET statement to specify the starting address of the data structure. Once the SET statement is run, the data item is then treated as if it was passed from another program. For an example of a SET statement used in this manner, refer to Figure 100 on page 292. **16** on page 295 illustrates how the SET statement is used to set the starting address of the data structures *ls-header-record* and *ls-user-space* at the beginning of the user space.

Using ADDRESS OF and the ADDRESS OF Special Register

When you specify ADDRESS OF in a COBOL program, the compiler determines whether to use the calculated address of a data item, referred to as ADDRESS OF, or the ADDRESS OF special register. The ADDRESS OF special register is the starting address of the data structure from which all calculated addresses are determined. Because the ADDRESS OF special register is the starting address of a structure, it must be an 01-level or 77-level data item. If you reference modify this data item, it is no longer the starting address of the data structure. It is a calculated address, or ADDRESS OF. If you are taking the ADDRESS OF an elementary item, and the ADDRESS OF the 01-level item has been set to NULL, a pointer exception (MCH3601) results.

You cannot use the calculated ADDRESS OF where an item can be changed. Only the ADDRESS OF special register can be changed. For example, in Figure 100, the SET statement at **18** on page 295 uses the ADDRESS OF special register because it is an 01-level item. At **19** on page 295 ADDRESS OF is used because, although it is an 01-level item, it is reference-modified.

Using Pointers in a MOVE Statement

Elementary pointer data items cannot be moved using the MOVE statement; a SET statement must be used; however, pointer data items are implicitly moved when they are part of a group item.

When compiling a MOVE statement, the COBOL/400 compiler generates code to maintain (a pointer MOVE) or not maintain (a non-pointer MOVE) pointers within a group item.

A pointer MOVE is done when all of the following conditions are met:

1. The source or receiver of a MOVE statement contains a pointer
2. Both of the items are at least 16 bytes long

3. The data items are properly aligned
4. The data items are alphanumeric or group items.

Of the conditions listed above, determining if two data items are properly aligned can be the most difficult.

If the items being moved are 01-level items, or are part of an 01-level item, they must be on the same offset relative to a 16-byte boundary for a pointer MOVE to occur. (A warning is issued if this is not true.) The following example shows three data structures, and the results when a MOVE statement is issued:

```
WORKING-STORAGE SECTION.
   01  A.
       05  B      PIC X(10).
       05  C.
           10  D      PIC X(6).
           10  E      POINTER.
   01  A2.
       05  B2     PIC X(6).
       05  C2.
           10  D2     PIC X(10).
           10  E2     POINTER.
   01  A3.
       05  B3     PIC X(22).
       05  C3.
           10  D3     PIC X(10).
           10  E3     POINTER.

PROCEDURE DIVISION.
MOVE  A  to A2. 1
MOVE  A  to A3. 1
MOVE  C  to C2. 2
MOVE  C2 to C3. 3
```

1 This results in a pointer move because the offset of each group item to be moved is zero. Pointer integrity is maintained.

2 This results in a non-pointer move, because the offsets do not match. The offset of group item C is 10, and the offset of group item C2 is 6. Pointer integrity is not maintained.

3 This results in a pointer move, because the offset of group item C2 is 6, and the offset of C3 relative to a 16-byte boundary is also 6. (When the offset is greater than 16, the offset relative to a 16-byte boundary is calculated by dividing the offset by 16. The remainder is the relative offset. In this case, the offset was 22, which, when divided by 16, leaves a remainder, or relative offset, of 6.) Pointer integrity is maintained.

If a group item contains a pointer, and the compiler cannot determine the offset relative to a 16-byte boundary, the compiler issues a warning message, and the pointer move is attempted. However, pointer integrity may not be maintained. The compiler cannot determine the offset if the item is defined in the Linkage Section, or if the item is reference-modified with an unknown starting position. You must ensure that pointer alignment is maintained, or MCH0602 may result.

The COBOL/400 compiler places all 01-level items on a 16-byte boundary whether or not they contain pointer data items.

If one of the items in a MOVE statement is an 01-level item with a pointer, and the other a 77-level Working-Storage item, the 77-level Working-Storage item is forced to a 16-byte boundary.

Using Pointers in a CALL Statement

When a pointer data item is passed in a CALL statement, the item is treated as all other USING items. In other words, a pointer to the pointer data item (or copy of the pointer data item) is passed to the called program.

Special consideration must be given when a CALL statement with the BY CONTENT phrase is used to pass pointers and group items containing pointers. This is similar to the case of a MOVE statement. For a CALL BY CONTENT, an implicit MOVE of an item is done to create it in a temporary area. If the compiler can determine the offset of an item relative to a 16-byte boundary, that same offset is used when the implicit MOVE of the BY CONTENT item is done into the temporary area. When the compiler cannot determine the offset of an item relative to a 16-byte boundary, the implicit MOVE of the BY CONTENT item is done into a temporary area that is aligned on a 16-byte boundary.

The compiler is not able to determine the offset of an item relative to a 16-byte boundary when the BY CONTENT item is:

- Reference modified with an unknown starting position, or
- Defined in the Linkage Section.

When an operand is reference-modified, the offset is the reference modification starting position minus one, plus the operand's offset within the data structure. When an operand is in the Linkage Section, its offset can be determined from the calling program.

To avoid pointer alignment problems, pass items by reference.

The following is an example of passing items containing pointers, where pointer integrity is maintained in some cases, and not in others.

```
WORKING-STORAGE SECTION.

01  A.  1
    05  B    PIC X(3).
    05  C. 2
        10  FILLER   PIC X(13).
        10  D        POINTER.

PROCEDURE DIVISION.

CALL "B" USING A C.
```

Figure 97. Program A -- Main Program

```
WORKING-STORAGE SECTION.

01  E.
    05  F    PIC X(16).
    05   G   POINTER.
77  K   PIC S9(3)    VALUE 8.

LINKAGE SECTION.

01  A. 3
    05  B    PIC X(3).
    05  C.
        10   FILLER   PIC X(13).
        10   D   POINTER.
01  C2. 4
    05  FILLER   PIC X(13).
    05  D2   POINTER.

PROCEDURE DIVISION USING A C2.

CALL "C" USING BY CONTENT
      A, C2, 5  E(5: ), 6  E(K: ), 7  F.  8
```

Figure 98. Program B -- Subprogram

In the previous example, Program A passes two group items to Program B. 1 is an 01-level group item, with an offset of zero. 2 is an 05-level group item, and has an offset of 3. Because the items are passed by reference, pointer integrity is maintained for both group items A and C.

Program B passes five items to another program, C. The items are passed by content to Program C. Because they are passed by content, Program C receives a copy of the items, and pointer integrity is not maintained in all cases.

- 3 Because this item is defined in the Linkage Section, it has an unknown offset. The compiler assumes it is 16-byte aligned, and in this case, when A is passed, pointer integrity of D is maintained, but a compiler warning message is issued on the CALL.
- 4 This item contains a pointer, and a pointer move is accomplished by 5. However, because the item is defined in the Linkage Section and the offset is unknown, pointer integrity is not maintained. The compiler attempts to move C2 to a 16-byte aligned area, and a compiler warning message is issued.
- 6 Because E contains a pointer, a pointer move is accomplished. The offset can be calculated because the reference modification start position is a numeric literal. In this case, pointer integrity is maintained, and the item is placed at an offset of 4 from the 16-byte boundary.
- 7 Because E contains a pointer, a pointer move is attempted. Because E is reference-modified with an unknown starting position (K), the compiler cannot calculate the offset, and assumes it is aligned on a 16-byte boundary. A compiler warning message is issued. If the value of K causes E to be aligned on a 16-byte boundary, pointer integrity is maintained. For this to occur, K must be 1 or 17.
- 8 F is an item defined in the Working-Storage Section, and contains no pointers, so no pointer moves are expected.

Using Pointers and APIs to Access User Spaces

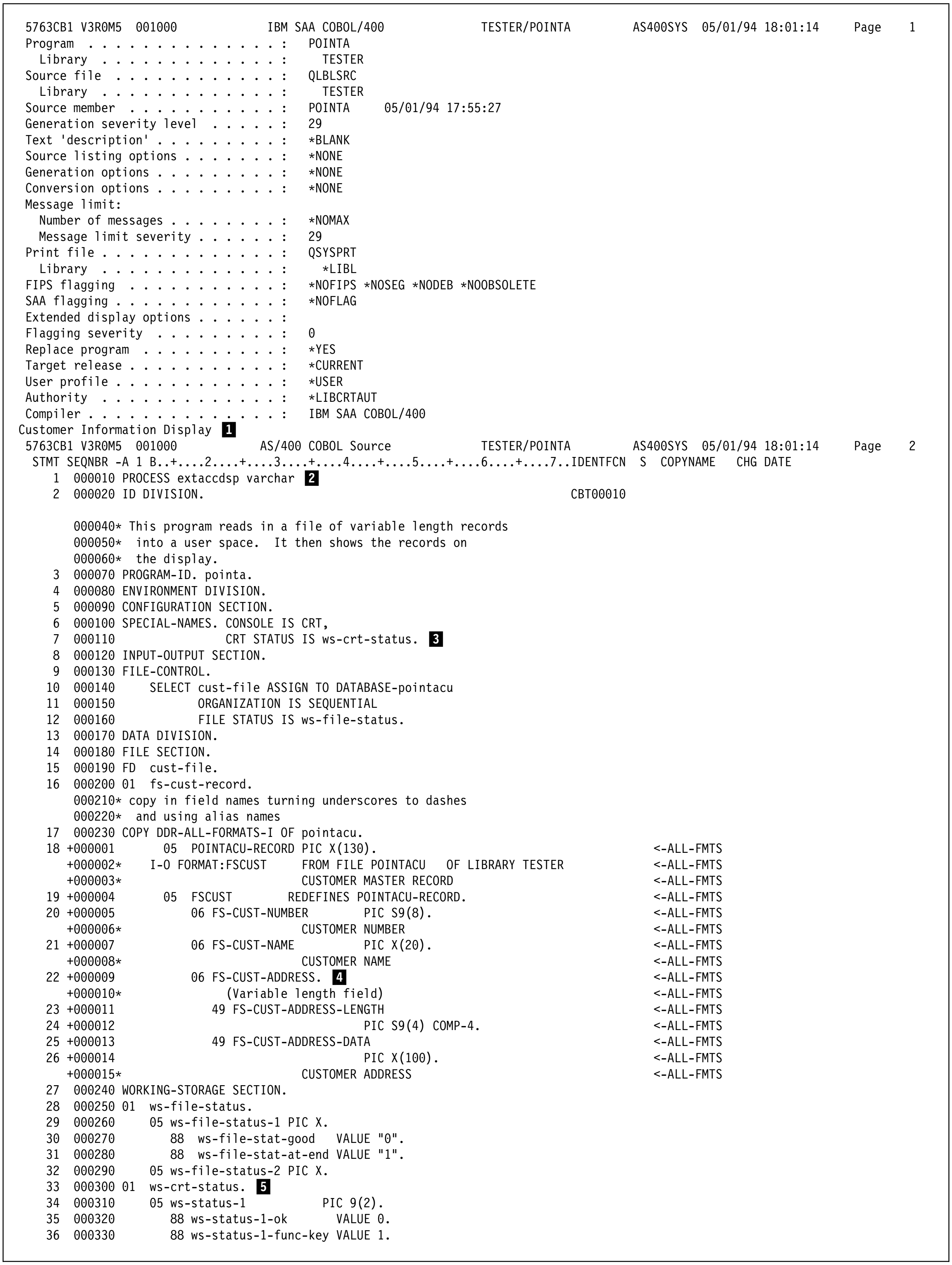
The following example shows how you can use pointers to access user spaces and to chain records together.

POINTA is a program that reads customer names and addresses into a user space, and then displays the information in a list. The program assumes that the customer information exists in a file called POINTACU.

The customer address field is a variable-length field, to allow for lengthy addresses.

```
A* THIS IS THE CUSTOMER INFORMATION FILE  - POINTACUST
A
A
A          R FSCUST                    TEXT('CUSTOMER MASTER RECORD')
A            FS_CUST_NO     8S00       TEXT('CUSTOMER NUMBER')
A                                      ALIAS(FS_CUST_NUMBER)
A            FS_CUST_NM    20          TEXT('CUSTOMER NAME')
A                                      ALIAS(FS_CUST_NAME)
A            FS_CUST_AD   100          TEXT('CUSTOMER ADDRESS')
A                                      ALIAS(FS_CUST_ADDRESS)
A                                      VARLEN
```

Figure 99. Example Using Pointers to Access User Spaces -- DDS



```
 5763CB1 V3R0M5  001000            IBM SAA COBOL/400             TESTER/POINTA        AS400SYS  05/01/94 18:01:14     Page    1
 Program  . . . . . . . . . . . . . . . :   POINTA
   Library  . . . . . . . . . . . . . . :     TESTER
 Source file  . . . . . . . . . . . . . :   QLBLSRC
   Library  . . . . . . . . . . . . . . :     TESTER
 Source member  . . . . . . . . . . . . :   POINTA     05/01/94 17:55:27
 Generation severity level  . . . . . . :   29
 Text 'description' . . . . . . . . . . :   *BLANK
 Source listing options . . . . . . . . :   *NONE
 Generation options . . . . . . . . . . :   *NONE
 Conversion options . . . . . . . . . . :   *NONE
 Message limit:
   Number of messages . . . . . . . . . :   *NOMAX
   Message limit severity . . . . . . . :   29
 Print file . . . . . . . . . . . . . . :   QSYSPRT
   Library  . . . . . . . . . . . . . . :     *LIBL
 FIPS flagging  . . . . . . . . . . . . :   *NOFIPS *NOSEG *NODEB *NOOBSOLETE
 SAA flagging . . . . . . . . . . . . . :   *NOFLAG
 Extended display options . . . . . . . :
 Flagging severity  . . . . . . . . . . :   0
 Replace program  . . . . . . . . . . . :   *YES
 Target release . . . . . . . . . . . . :   *CURRENT
 User profile . . . . . . . . . . . . . :   *USER
 Authority  . . . . . . . . . . . . . . :   *LIBCRTAUT
 Compiler . . . . . . . . . . . . . . . :   IBM SAA COBOL/400
Customer Information Display 1
 5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/POINTA        AS400SYS  05/01/94 18:01:14     Page    2
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 PROCESS extaccdsp varchar 2
     2  000020 ID DIVISION.                                                    CBT00010

        000040* This program reads in a file of variable length records
        000050*  into a user space.  It then shows the records on
        000060*  the display.
     3  000070 PROGRAM-ID. pointa.
     4  000080 ENVIRONMENT DIVISION.
     5  000090 CONFIGURATION SECTION.
     6  000100 SPECIAL-NAMES. CONSOLE IS CRT,
     7  000110                CRT STATUS IS ws-crt-status. 3
     8  000120 INPUT-OUTPUT SECTION.
     9  000130 FILE-CONTROL.
    10  000140     SELECT cust-file ASSIGN TO DATABASE-pointacu
    11  000150            ORGANIZATION IS SEQUENTIAL
    12  000160            FILE STATUS IS ws-file-status.
    13  000170 DATA DIVISION.
    14  000180 FILE SECTION.
    15  000190 FD  cust-file.
    16  000200 01  fs-cust-record.
        000210* copy in field names turning underscores to dashes
        000220*  and using alias names
    17  000230 COPY DDR-ALL-FORMATS-I OF pointacu.
    18 +000001       05  POINTACU-RECORD PIC X(130).                                <-ALL-FMTS
       +000002*    I-O FORMAT:FSCUST     FROM FILE POINTACU   OF LIBRARY TESTER     <-ALL-FMTS
       +000003*                          CUSTOMER MASTER RECORD                     <-ALL-FMTS
    19 +000004       05  FSCUST        REDEFINES POINTACU-RECORD.                   <-ALL-FMTS
    20 +000005           06 FS-CUST-NUMBER        PIC S9(8).                        <-ALL-FMTS
       +000006*                          CUSTOMER NUMBER                            <-ALL-FMTS
    21 +000007           06 FS-CUST-NAME          PIC X(20).                        <-ALL-FMTS
       +000008*                          CUSTOMER NAME                              <-ALL-FMTS
    22 +000009           06 FS-CUST-ADDRESS. 4                                      <-ALL-FMTS
       +000010*              (Variable length field)                                <-ALL-FMTS
    23 +000011              49 FS-CUST-ADDRESS-LENGTH                               <-ALL-FMTS
    24 +000012                            PIC S9(4) COMP-4.                         <-ALL-FMTS
    25 +000013              49 FS-CUST-ADDRESS-DATA                                 <-ALL-FMTS
    26 +000014                            PIC X(100).                               <-ALL-FMTS
       +000015*                          CUSTOMER ADDRESS                           <-ALL-FMTS
    27  000240 WORKING-STORAGE SECTION.
    28  000250 01  ws-file-status.
    29  000260     05 ws-file-status-1 PIC X.
    30  000270        88  ws-file-stat-good   VALUE "0".
    31  000280        88  ws-file-stat-at-end VALUE "1".
    32  000290     05 ws-file-status-2 PIC X.
    33  000300 01  ws-crt-status. 5
    34  000310     05 ws-status-1          PIC 9(2).
    35  000320        88 ws-status-1-ok       VALUE 0.
    36  000330        88 ws-status-1-func-key VALUE 1.
```

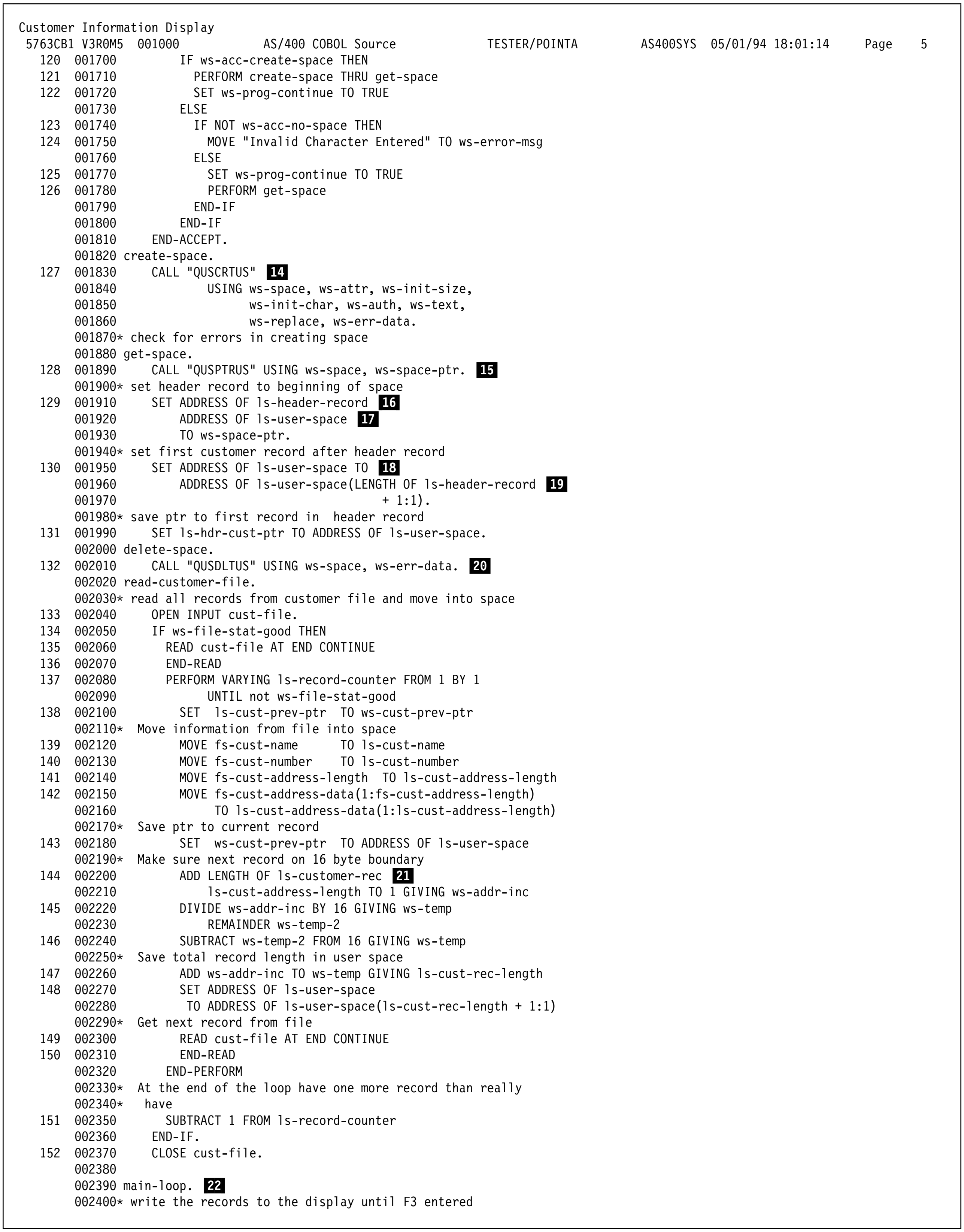
Figure 100 (Part 1 of 7). Example Using Pointers to Access User Spaces

```
Customer Information Display
 5763CB1 V3R0M5  001000            AS/400 COBOL Source             TESTER/POINTA         AS400SYS  05/01/94 18:01:14      Page    3
   STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     37  000340       88 ws-status-1-error    VALUE 9.
     38  000350     05 ws-status-2          PIC 9(2).
     39  000360       88 ws-func-03           VALUE 3.
     40  000370       88 ws-func-07           VALUE 7.
     41  000380       88 ws-func-08           VALUE 8.
     42  000390     05 ws-status-3          PIC 9(2).
     43  000400 01  ws-params. 6
     44  000410     05  ws-space.
     45  000420       10  ws-space-name      PIC X(10) VALUE "MYSPACE".
     46  000430       10  ws-space-lib       PIC X(10) VALUE "QTEMP".
     47  000440     05  ws-attr              PIC X(10) VALUE "PF".
     48  000450     05  ws-init-size         PIC S9(5) VALUE 32000 BINARY.
     49  000460     05  ws-init-char         PIC X     VALUE SPACE.
     50  000470     05  ws-auth              PIC X(10) VALUE "*ALL".
     51  000480     05  ws-text              PIC X(50) VALUE
     52  000490       "Customer Information Records".
     53  000500     05  ws-replace           PIC X(10) VALUE "*YES".
     54  000510     05  ws-err-data. 7
     55  000520         10 ws-input-l        PIC S9(6) BINARY VALUE ZERO.
     56  000530         10 ws-output-l       PIC S9(6) BINARY VALUE ZERO.
     57  000540         10 ws-exception-id   PIC X(7).
     58  000550         10 ws-reserved       PIC X(1).
     59  000560         10 ws-exception-data PIC X(87).
     60  000570     05  ws-space-ptr         POINTER. 8
     61  000580     05  ws-map-ptr           POINTER.
         000590
     62  000600 77  ws-accept-data           PIC X.
     63  000610   88 ws-acc-create-space      VALUE "Y", "y".
     64  000620   88 ws-acc-delete-space      VALUE "Y", "y".
     65  000630   88 ws-acc-no-space          VALUE "N", "n".
         000640
     66  000650 77  ws-prog-indicator        PIC X   VALUE "G".
     67  000660   88  ws-prog-continue        VALUE "G".
     68  000670   88  ws-prog-end             VALUE "C".
     69  000680   88  ws-prog-loop            VALUE "L".
         000690
     70  000700 77  ws-line                  PIC S99.
         000710* error message line
     71  000720 77  ws-error-msg             PIC X(50) VALUE SPACES.
         000730* more address information indicator
     72  000740 77  ws-plus                  PIC X.
         000750* length of address information to display
     73  000760 77  ws-temp-size             PIC 9(2).
         000770
     74  000780 77  ws-current-rec           PIC S9(4) VALUE 1.
     75  000790 77  ws-old-rec               PIC S9(4) VALUE 1.
     76  000800 77  ws-old-space-ptr         POINTER.
         000810* max number of lines to display
     77  000820 77  ws-displayed-lines       PIC S99 VALUE 20.
         000830* line on which to start displaying records
     78  000840 77  ws-start-line            PIC S99 VALUE 5.
         000850* variables to create new record in space
     79  000860 77  ws-addr-inc              PIC S9(4) PACKED-DECIMAL.
     80  000870 77  ws-temp                  PIC S9(4) PACKED-DECIMAL.
     81  000880 77  ws-temp-2                PIC S9(4) PACKED-DECIMAL.
         000890* pointer to previous record
     82  000900 77  ws-cust-prev-ptr         POINTER VALUE NULL.
     83  000910 LINKAGE SECTION.
     84  000920 01 ls-header-record. 9
     85  000930    05  ls-hdr-cust-ptr             USAGE POINTER.
         000940* number of records read in from file
     86  000950    05  ls-record-counter           PIC S9(3) BINARY.
     87  000960    05  FILLER                      PIC X(14). 10
     88  000970 01 ls-user-space. 11
     89  000980     05  ls-customer-rec.
         000990* pointer to previous customer record
     90  001000         10 ls-cust-prev-ptr        USAGE POINTER.
     91  001010         10 ls-cust-rec-length      PIC S9(4) BINARY.
     92  001020         10 ls-cust-name            PIC X(20).
     93  001030         10 ls-cust-number          PIC S9(8).
```

Figure 100 (Part 2 of 7). Example Using Pointers to Access User Spaces

```
Customer Information Display
 5763CB1 V3R0M5  001000            AS/400 COBOL Source             TESTER/POINTA         AS400SYS  05/01/94 18:01:14     Page    4
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        001040* total length of this record including filler bytes
        001050*  to make sure next record on 16 byte boundary
    94  001060         10 ls-cust-address-length  PIC S9(4) BINARY.
    95  001070     05  ls-cust-address-data       PIC X(116).
        001080
        001090* Size of ls-user-space is 16 more than actually needed.  This
        001100*   allows the start address of the next record
        001110*   record to be established without exceeding the declared size
        001120* The size is 16 bigger to allow for pointer alignment
        001130
    96  001140 PROCEDURE DIVISION.
        001150* note no need for "USING" entry on PROC... DIV.
        001160 DECLARATIVES.
        001170 cust-file-para SECTION.
        001180     USE AFTER ERROR PROCEDURE ON cust-file.
        001190 cust-file-para-2.
    97  001200     MOVE "Error XX on file pointacu" TO ws-error-msg.
    98  001210     MOVE ws-file-status TO ws-error-msg(7:2).
        001220 END DECLARATIVES.
        001230 main-section section.
        001240 main-proc.
        001250* keep reading initial display until entered data correct
    99  001260     SET ws-prog-loop to TRUE.
   100  001270     PERFORM initial-display THRU read-initial-display
        001280         UNTIL NOT ws-prog-loop.
        001290* if want to continue with program and want to create
        001300*   customer information area, fill the space with
        001310*   records from the customer file
   101  001320     IF ws-prog-continue and
        001330        ws-acc-create-space THEN
   102  001340       PERFORM read-customer-file
   103  001350       MOVE 1 TO ws-current-rec
        001360* set ptr to header record
   104  001370       SET ADDRESS OF ls-header-record TO ws-space-ptr
        001380* set to first customer record in space
   105  001390       SET ADDRESS OF ls-user-space TO ls-hdr-cust-ptr
        001400     END-IF.
   106  001410     IF ws-prog-continue THEN
   107  001420       PERFORM main-loop UNTIL ws-prog-end
        001430     END-IF.
        001440 end-program.
   108  001450     PERFORM clean-up.
   109  001460     STOP RUN.
        001470 initial-display.  12
   110  001480     DISPLAY "Create Customer Information Area" AT 0118 WITH
        001490                BLANK SCREEN REVERSE-VIDEO
        001500             "Create customer information area (Y/N)=>   <="
        001510                AT 1015
        001520             "F3=Exit" AT 2202.
   111  001530     IF ws-error-msg NOT = SPACES THEN
   112  001540       DISPLAY ws-error-msg at 2302 with beep highlight
   113  001550       MOVE SPACES TO ws-error-msg
        001560     END-IF.
        001570 read-initial-display.  13
   114  001580     ACCEPT ws-accept-data AT 1056 WITH REVERSE-VIDEO
        001590       ON EXCEPTION
   115  001600         IF ws-status-1-func-key THEN
   116  001610           IF ws-func-03 THEN
   117  001620             SET ws-prog-end TO TRUE
        001630           ELSE
   118  001640             MOVE "Invalid Function Key" TO ws-error-msg
        001650           END-IF
        001660         ELSE
   119  001670           MOVE "Unknown Error" TO ws-error-msg
        001680         END-IF
        001690       NOT ON EXCEPTION
```

Figure 100 (Part 3 of 7). Example Using Pointers to Access User Spaces

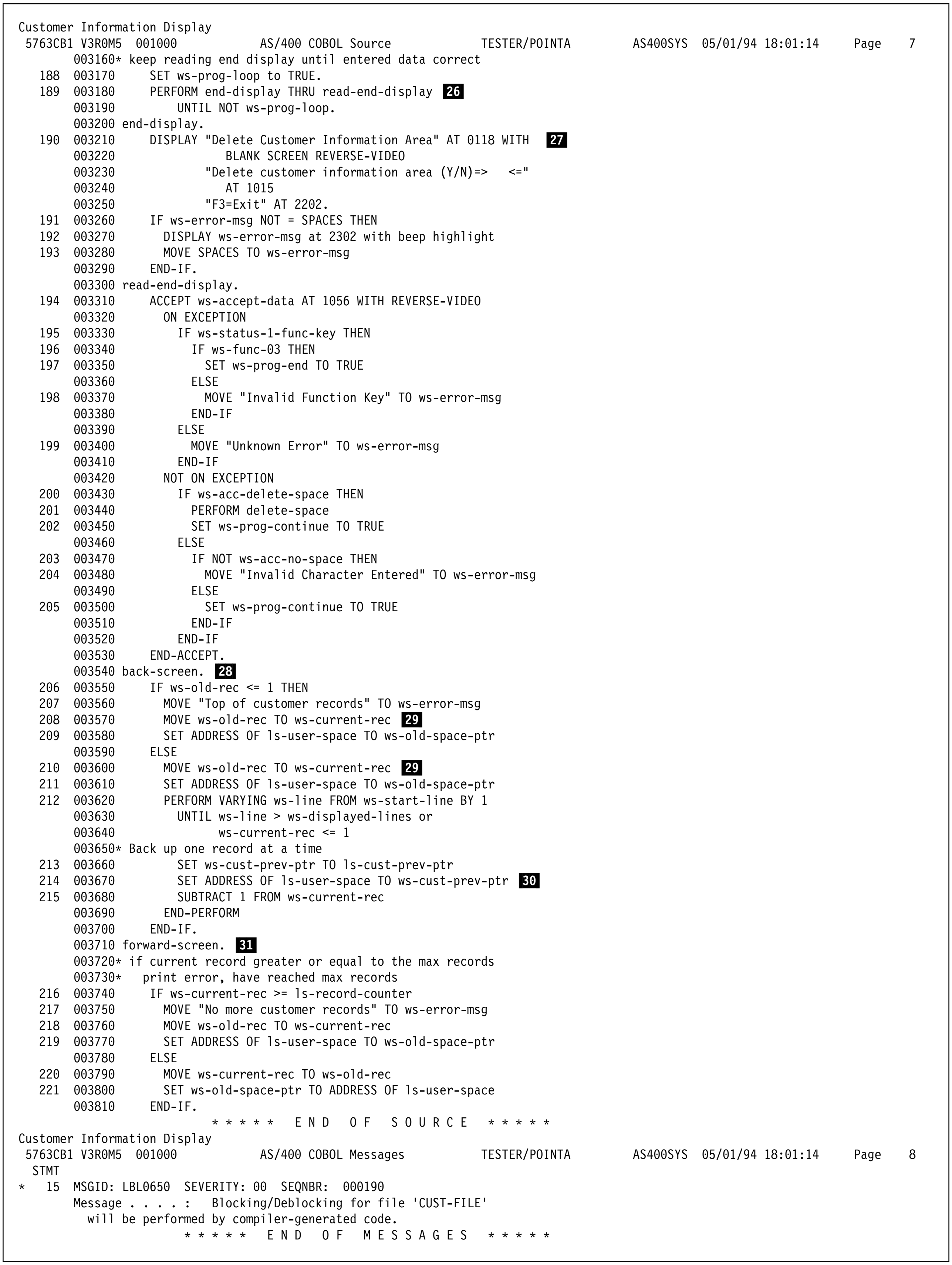


```
Customer Information Display
 5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/POINTA        AS400SYS  05/01/94 18:01:14     Page    5
   120  001700        IF ws-acc-create-space THEN
   121  001710          PERFORM create-space THRU get-space
   122  001720          SET ws-prog-continue TO TRUE
        001730        ELSE
   123  001740          IF NOT ws-acc-no-space THEN
   124  001750            MOVE "Invalid Character Entered" TO ws-error-msg
        001760          ELSE
   125  001770            SET ws-prog-continue TO TRUE
   126  001780            PERFORM get-space
        001790          END-IF
        001800        END-IF
        001810    END-ACCEPT.
        001820 create-space.
   127  001830    CALL "QUSCRTUS" 14
        001840            USING ws-space, ws-attr, ws-init-size,
        001850                  ws-init-char, ws-auth, ws-text,
        001860                  ws-replace, ws-err-data.
        001870* check for errors in creating space
        001880 get-space.
   128  001890    CALL "QUSPTRUS" USING ws-space, ws-space-ptr.  15
        001900* set header record to beginning of space
   129  001910    SET ADDRESS OF ls-header-record  16
        001920        ADDRESS OF ls-user-space  17
        001930        TO ws-space-ptr.
        001940* set first customer record after header record
   130  001950    SET ADDRESS OF ls-user-space TO  18
        001960        ADDRESS OF ls-user-space(LENGTH OF ls-header-record  19
        001970                                     + 1:1).
        001980* save ptr to first record in  header record
   131  001990    SET ls-hdr-cust-ptr TO ADDRESS OF ls-user-space.
        002000 delete-space.
   132  002010    CALL "QUSDLTUS" USING ws-space, ws-err-data.  20
        002020 read-customer-file.
        002030* read all records from customer file and move into space
   133  002040    OPEN INPUT cust-file.
   134  002050    IF ws-file-stat-good THEN
   135  002060      READ cust-file AT END CONTINUE
   136  002070      END-READ
   137  002080      PERFORM VARYING ls-record-counter FROM 1 BY 1
        002090            UNTIL not ws-file-stat-good
   138  002100        SET  ls-cust-prev-ptr  TO ws-cust-prev-ptr
        002110*  Move information from file into space
   139  002120        MOVE fs-cust-name      TO ls-cust-name
   140  002130        MOVE fs-cust-number    TO ls-cust-number
   141  002140        MOVE fs-cust-address-length  TO ls-cust-address-length
   142  002150        MOVE fs-cust-address-data(1:fs-cust-address-length)
        002160             TO ls-cust-address-data(1:ls-cust-address-length)
        002170*  Save ptr to current record
   143  002180        SET  ws-cust-prev-ptr  TO ADDRESS OF ls-user-space
        002190*  Make sure next record on 16 byte boundary
   144  002200        ADD LENGTH OF ls-customer-rec  21
        002210            ls-cust-address-length TO 1 GIVING ws-addr-inc
   145  002220        DIVIDE ws-addr-inc BY 16 GIVING ws-temp
        002230            REMAINDER ws-temp-2
   146  002240        SUBTRACT ws-temp-2 FROM 16 GIVING ws-temp
        002250*  Save total record length in user space
   147  002260        ADD ws-addr-inc TO ws-temp GIVING ls-cust-rec-length
   148  002270        SET ADDRESS OF ls-user-space
        002280         TO ADDRESS OF ls-user-space(ls-cust-rec-length + 1:1)
        002290*  Get next record from file
   149  002300        READ cust-file AT END CONTINUE
   150  002310        END-READ
        002320      END-PERFORM
        002330*  At the end of the loop have one more record than really
        002340*   have
   151  002350      SUBTRACT 1 FROM ls-record-counter
        002360    END-IF.
   152  002370    CLOSE cust-file.
        002380
        002390 main-loop.  22
        002400* write the records to the display until F3 entered
```

Figure 100 (Part 4 of 7). Example Using Pointers to Access User Spaces

```
 Customer Information Display
  5763CB1 V3R0M5  001000           AS/400 COBOL Source            TESTER/POINTA        AS400SYS  05/01/94 18:01:14     Page    6
    153  002410     DISPLAY "Customer Information" AT 0124 WITH
         002420                BLANK SCREEN REVERSE-VIDEO
         002430             "Cust     Customer Name        Customer"
         002440                AT 0305
         002450             " Address"
         002460             "Number"   AT 0405
         002470             "F3=Exit" AT 2202.
         002480* if a pending error put on the display
    154  002490     IF ws-error-msg NOT = SPACES THEN
    155  002500       DISPLAY ws-error-msg at 2302 with beep highlight
    156  002510       MOVE SPACES TO ws-error-msg
         002520     END-IF.
         002530* if in the middle of the list put F7 on the display
    157  002540     IF ws-current-rec > 1 THEN  23
    158  002550       DISPLAY "F7=Back" AT 2240
         002560     END-IF.
         002570* save the current record
    159  002580     MOVE ws-current-rec TO ws-old-rec.
    160  002590     SET  ws-old-space-ptr TO ADDRESS OF ls-user-space.  24
         002600* move each record to the display
    161  002610     PERFORM VARYING ws-line FROM  ws-start-line BY 1
         002620         UNTIL ws-line > ws-displayed-lines or
         002630               ws-current-rec > ls-record-counter
         002640* if address is greater than display width show "+"
    162  002650         IF ls-cust-address-length > 40 THEN
    163  002660           MOVE "+" TO ws-plus
    164  002670           MOVE 40 TO ws-temp-size
         002680         ELSE
    165  002690           MOVE ls-cust-address-length TO ws-temp-size
    166  002700           MOVE SPACE TO ws-plus
         002710         END-IF
    167  002720         DISPLAY ls-cust-number at line ws-line column 5
         002730                 ls-cust-name ls-cust-address-data with
         002740                   size ws-temp-size ws-plus at line
         002750                   ws-line column 78
         002760* get next record in the space
    168  002770         ADD 1 TO ws-current-rec
    169  002780         SET ADDRESS OF ls-user-space
         002790          TO ADDRESS OF ls-user-space
         002800            (ls-cust-rec-length + 1:1)
         002810     END-PERFORM.
         002820* if can go forward put F8 on the display
    170  002830     IF ws-current-rec < ls-record-counter THEN  23
    171  002840       DISPLAY "F8=Forward" AT 2250
         002850     END-IF.
         002860* check to see if continue, exit, or get next records or
         002870*   previous records
    172  002880     ACCEPT ws-accept-data WITH SECURE  25
         002890       ON EXCEPTION
    173  002900         IF ws-status-1-func-key THEN
    174  002910           IF ws-func-03 THEN
    175  002920             SET ws-prog-end TO TRUE
         002930           ELSE
    176  002940            IF ws-func-07 THEN
    177  002950             PERFORM back-screen
         002960            ELSE
    178  002970            IF ws-func-08 THEN
    179  002980             PERFORM forward-screen
         002990            ELSE
    180  003000             MOVE "Invalid Function Key" TO ws-error-msg
    181  003010             MOVE ws-old-rec TO ws-current-rec
    182  003020             SET ADDRESS OF ls-user-space TO ws-old-space-ptr
         003030            END-IF
         003040           END-IF
         003050         ELSE
    183  003060           MOVE "Unknown Error" TO ws-error-msg
    184  003070           MOVE ws-old-rec TO ws-current-rec
    185  003080           SET ADDRESS OF ls-user-space TO ws-old-space-ptr
         003090         END-IF
         003100       NOT ON EXCEPTION
    186  003110         MOVE ws-old-rec TO ws-current-rec
    187  003120         SET ADDRESS OF ls-user-space TO ws-old-space-ptr
         003130     END-ACCEPT.
         003140 clean-up.
         003150* do clean up for program
```

Figure 100 (Part 5 of 7). Example Using Pointers to Access User Spaces



```
Customer Information Display
 5763CB1 V3R0M5  001000            AS/400 COBOL Source            TESTER/POINTA        AS400SYS  05/01/94 18:01:14     Page    7
        003160* keep reading end display until entered data correct
   188  003170     SET ws-prog-loop to TRUE.
   189  003180     PERFORM end-display THRU read-end-display  26
        003190         UNTIL NOT ws-prog-loop.
        003200 end-display.
   190  003210     DISPLAY "Delete Customer Information Area" AT 0118 WITH   27
        003220                BLANK SCREEN REVERSE-VIDEO
        003230             "Delete customer information area (Y/N)=>   <="
        003240                AT 1015
        003250             "F3=Exit" AT 2202.
   191  003260     IF ws-error-msg NOT = SPACES THEN
   192  003270       DISPLAY ws-error-msg at 2302 with beep highlight
   193  003280       MOVE SPACES TO ws-error-msg
        003290     END-IF.
        003300 read-end-display.
   194  003310     ACCEPT ws-accept-data AT 1056 WITH REVERSE-VIDEO
        003320       ON EXCEPTION
   195  003330         IF ws-status-1-func-key THEN
   196  003340           IF ws-func-03 THEN
   197  003350             SET ws-prog-end TO TRUE
        003360           ELSE
   198  003370             MOVE "Invalid Function Key" TO ws-error-msg
        003380           END-IF
        003390         ELSE
   199  003400           MOVE "Unknown Error" TO ws-error-msg
        003410         END-IF
        003420       NOT ON EXCEPTION
   200  003430         IF ws-acc-delete-space THEN
   201  003440           PERFORM delete-space
   202  003450           SET ws-prog-continue TO TRUE
        003460         ELSE
   203  003470           IF NOT ws-acc-no-space THEN
   204  003480             MOVE "Invalid Character Entered" TO ws-error-msg
        003490           ELSE
   205  003500             SET ws-prog-continue TO TRUE
        003510           END-IF
        003520         END-IF
        003530     END-ACCEPT.
        003540 back-screen.  28
   206  003550     IF ws-old-rec <= 1 THEN
   207  003560       MOVE "Top of customer records" TO ws-error-msg
   208  003570       MOVE ws-old-rec TO ws-current-rec  29
   209  003580       SET ADDRESS OF ls-user-space TO ws-old-space-ptr
        003590     ELSE
   210  003600       MOVE ws-old-rec TO ws-current-rec  29
   211  003610       SET ADDRESS OF ls-user-space TO ws-old-space-ptr
   212  003620       PERFORM VARYING ws-line FROM ws-start-line BY 1
        003630         UNTIL ws-line > ws-displayed-lines or
        003640               ws-current-rec <= 1
        003650* Back up one record at a time
   213  003660         SET ws-cust-prev-ptr TO ls-cust-prev-ptr
   214  003670         SET ADDRESS OF ls-user-space TO ws-cust-prev-ptr  30
   215  003680         SUBTRACT 1 FROM ws-current-rec
        003690       END-PERFORM
        003700     END-IF.
        003710 forward-screen.  31
        003720* if current record greater or equal to the max records
        003730*   print error, have reached max records
   216  003740     IF ws-current-rec >= ls-record-counter
   217  003750       MOVE "No more customer records" TO ws-error-msg
   218  003760       MOVE ws-old-rec TO ws-current-rec
   219  003770       SET ADDRESS OF ls-user-space TO ws-old-space-ptr
        003780     ELSE
   220  003790       MOVE ws-current-rec TO ws-old-rec
   221  003800       SET ws-old-space-ptr TO ADDRESS OF ls-user-space
        003810     END-IF.
                            * * * * *   E N D   O F   S O U R C E   * * * * *
Customer Information Display
 5763CB1 V3R0M5  001000            AS/400 COBOL Messages          TESTER/POINTA        AS400SYS  05/01/94 18:01:14     Page    8
  STMT
*   15  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000190
        Message . . . . :   Blocking/Deblocking for file 'CUST-FILE'
          will be performed by compiler-generated code.
                        * * * * *   E N D   O F   M E S S A G E S   * * * * *
```

Figure 100 (Part 6 of 7). Example Using Pointers to Access User Spaces

```
                                          Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1         1            0                0                0                 0
 Source records read . . . . . . . . :   381
 Copy records read . . . . . . . . . :   15
 Copy members processed  . . . . . . :   1
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program POINTA created in library TESTER.
                      * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 100 (Part 7 of 7). Example Using Pointers to Access User Spaces

1 The compiler directive TITLE is used to create this title that appears at the beginning of each page.

3 CRT STATUS IS specifies a data name into which a status value is placed after the termination of an extended ACCEPT statement. In this example, the STATUS key value is used to determine which function key was pressed.

4 *fs-cust-address* is a variable-length field. To see meaningful names here rather than FILLER, specify *VARCHAR for the CVTOPT parameter of the CRTCBLPGM command, or VARCHAR in the PROCESS statement, as shown in 2. For more information about variable-length fields, refer to “Declaring Data Items Using CVTOPT Data Types” on page 130.

5 CRT STATUS as mentioned in 3 is defined here.

6 The *ws-params* structure contains the parameters used when calling the APIs to access user spaces.

7 *ws-err-data* is the structure for the error parameter for the user space APIs. Note that the *ws-input-l* is zero, meaning that any exceptions are signalled to the program, and not passed in the error code parameter. For more information on error code parameters, refer to the *System Programmer’s Interface Reference*.

8 *ws-space-ptr* defines a pointer data item set by the API QUSPTRUS. This points to the beginning of the user space, and is used to set the addresses of items in the Linkage Section.

9 The first data structure (*ls-header-record*) to be defined in the user space.

10 FILLER is used to maintain pointer alignment, because it makes *ls-header-record* a multiple of 16 bytes long.

11 The second data structure (*ls-user-space*) to be defined in the user space.

12 *initial-display* shows the Create Customer Information Area display. This display is shown in Figure 101 on page 300.

13 *read-initial-display* reads the first display, and determines if the user chooses to continue or end the program. If the user continues the program by pressing Enter, then the program checks *ws-accept-data* to see if the customer information area is to be created.

14 QUSCRTUS is an API used to create user spaces.

15 QUSPTRUS is an API used to return a pointer to the beginning of a user space.

16 Maps the first data structure (*ls-header-record*) over the beginning of the user space.

17 Maps the second data structure (*ls-user-space*) over the beginning of the user space.

18 Uses ADDRESS OF special register

19 Uses ADDRESS OF, not the ADDRESS OF special register, because it is reference modified.

20 QUSDLTUS is an API used to delete a user space.

21 The following four arithmetic statements calculate the total length of each record, and ensure that each record is a multiple of 16 bytes in length.

22 *main-loop* puts up the Customer Information display. Refer to Figure 102 on page 300.

23 These statements determine if the program should display function keys F7 and F8.

24 Saves a pointer to the first customer record on the display.

25 This ACCEPT statement waits for input from the Customer Information display. Based on the function key pressed, it calls the appropriate paragraph to display the next set of records (*forward-screen*), or the previous set of records (*back-screen*), or sets an indicator to end the routine if F3 is pressed.

26 The clean up routine displays the Delete Customer Information Area display until an appropriate key is pressed.

27 This statement puts up the Delete Customer Information Area display.

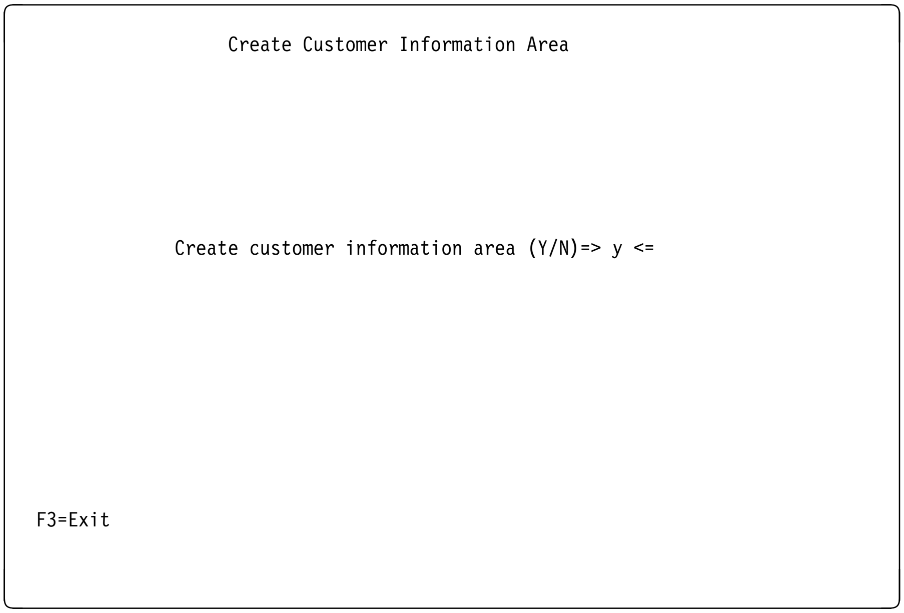
28 Each record contains a pointer to the previous customer record. The ADDRESS OF special register points to the current customer record. By changing the ADDRESS OF special register, the current customer record is changed.

back-screen moves the current record pointer backward one record at a time **30**, by moving the pointer to the previous customer record into the pointer to the current customer record (ADDRESS OF). Before moving backward one record at a time, the program sets the current customer record to the first record currently displayed **29**.

31 *forward-screen* sets *ws-old-space-ptr* (which points to the first record in the display) to point to the current record (which is after the last record displayed.)

A user space always begins on a 16-byte boundary, so the method illustrated here ensures that **all** records are aligned. *ls-cust-rec-length* is also used to chain the records together.

When you run POINTA, you see the following displays:

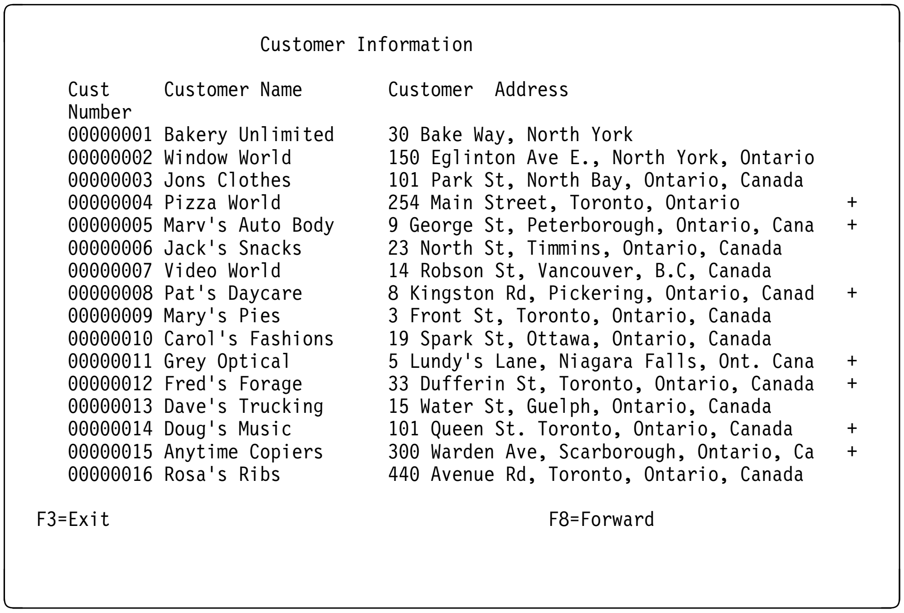


```
                     Create Customer Information Area




               Create customer information area (Y/N)=> y <=







 F3=Exit
```

Figure 101. Create Customer Information Area Display

If you specify `Y` to create the user space, the program reads the customer records from the file and puts the information in the user space. The records are chained together.

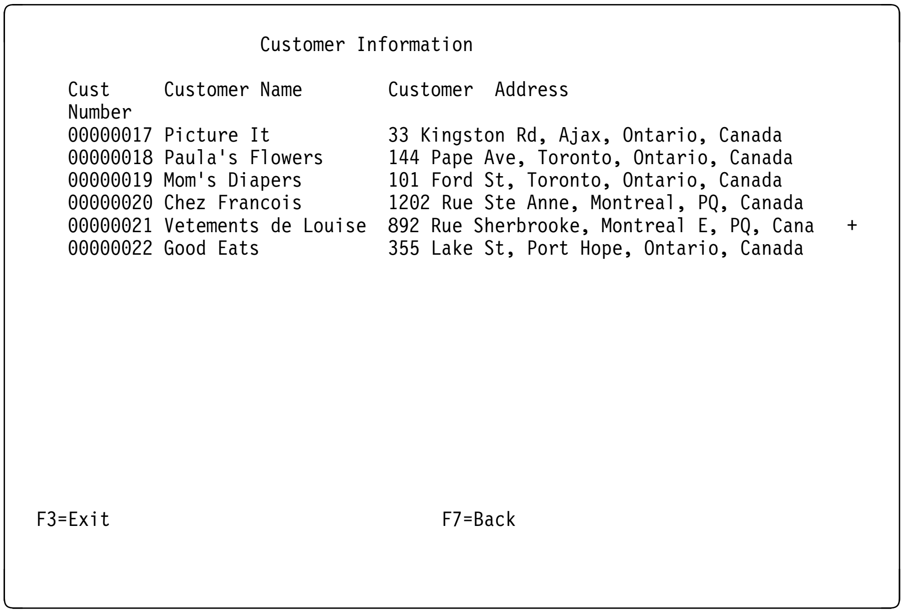
When you press enter from the previous display, the Customer Information display appears:



```
                        Customer Information

    Cust     Customer Name        Customer  Address
    Number
    00000001 Bakery Unlimited     30 Bake Way, North York
    00000002 Window World         150 Eglinton Ave E., North York, Ontario
    00000003 Jons Clothes         101 Park St, North Bay, Ontario, Canada
    00000004 Pizza World          254 Main Street, Toronto, Ontario         +
    00000005 Marv's Auto Body     9 George St, Peterborough, Ontario, Cana  +
    00000006 Jack's Snacks        23 North St, Timmins, Ontario, Canada
    00000007 Video World          14 Robson St, Vancouver, B.C, Canada
    00000008 Pat's Daycare        8 Kingston Rd, Pickering, Ontario, Canad  +
    00000009 Mary's Pies          3 Front St, Toronto, Ontario, Canada
    00000010 Carol's Fashions     19 Spark St, Ottawa, Ontario, Canada
    00000011 Grey Optical         5 Lundy's Lane, Niagara Falls, Ont. Cana  +
    00000012 Fred's Forage        33 Dufferin St, Toronto, Ontario, Canada  +
    00000013 Dave's Trucking      15 Water St, Guelph, Ontario, Canada
    00000014 Doug's Music         101 Queen St. Toronto, Ontario, Canada    +
    00000015 Anytime Copiers      300 Warden Ave, Scarborough, Ontario, Ca  +
    00000016 Rosa's Ribs          440 Avenue Rd, Toronto, Ontario, Canada

 F3=Exit                                         F8=Forward
```

Figure 102. Customer Information Area Display

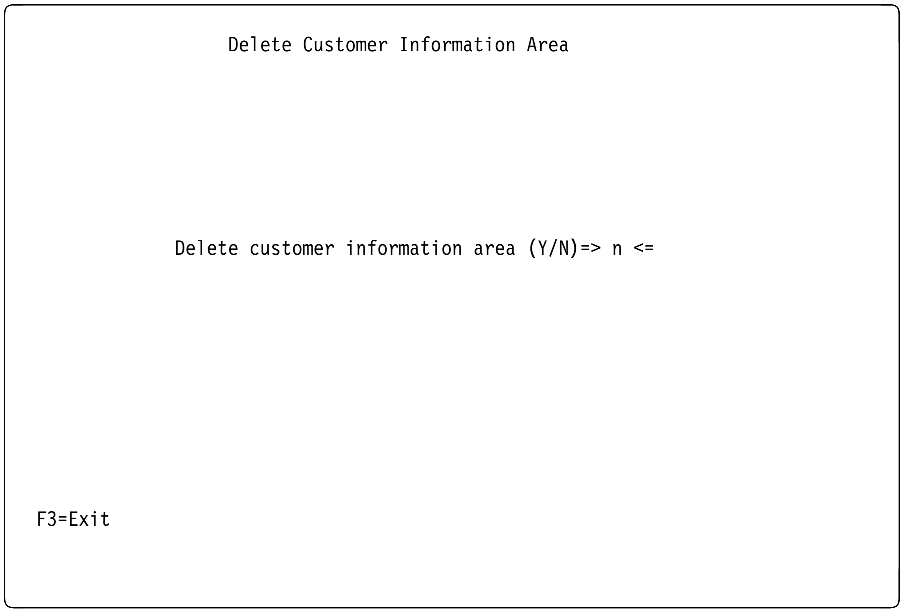
If there are more than 16 records in the user space (based on the starting line in *ws-start-line*), the program enables the F8=Forward key, to allow the user to page forward in the list. Once the user has rolled forward, the F7=Backward key is enabled to allow the user to page backward in the list, as shown in the following display:



```
                      Customer Information

      Cust     Customer Name        Customer  Address
      Number
      00000017 Picture It           33 Kingston Rd, Ajax, Ontario, Canada
      00000018 Paula's Flowers      144 Pape Ave, Toronto, Ontario, Canada
      00000019 Mom's Diapers        101 Ford St, Toronto, Ontario, Canada
      00000020 Chez Francois        1202 Rue Ste Anne, Montreal, PQ, Canada
      00000021 Vetements de Louise  892 Rue Sherbrooke, Montreal E, PQ, Cana   +
      00000022 Good Eats            355 Lake St, Port Hope, Ontario, Canada













   F3=Exit                                F7=Back
```

Figure 103. Customer Information Display (Second Display)

When the user exits from the above display, the option to delete the user space is presented, as shown in the following display:



```
                   Delete Customer Information Area








              Delete customer information area (Y/N)=> n <=









   F3=Exit
```

Figure 104. Delete Customer Information Display

Processing a Chained List

A typical application for using pointer data items is in processing a chained list (a series of records where each one points to the next).

For this example, picture a chained list of data that is composed of individual salary records. Figure 105 shows one way to visualize how these records are linked in storage:

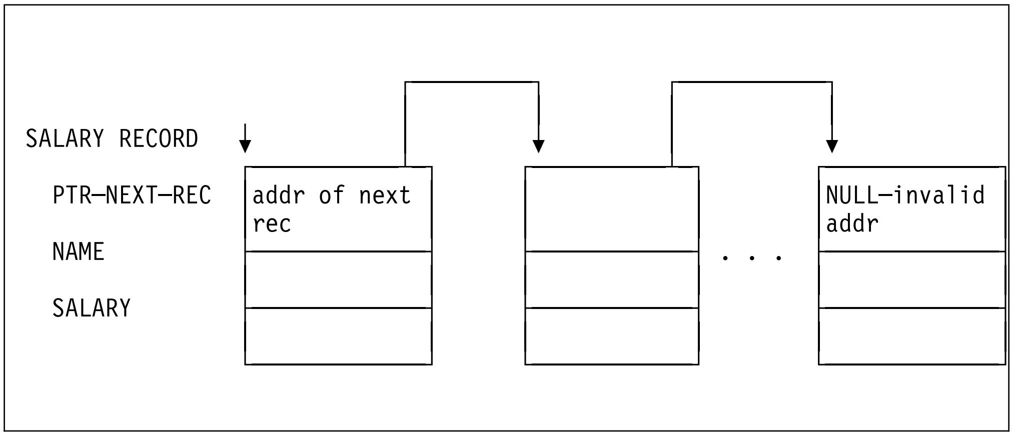


Figure 105. Representation of a Chained List Ending with NULL

The first item in each record (except for the last record) points to the next record. The first item in the last record, in order to indicate that it is the last record, contains a null value instead of an address.

The high-level logic of an application that processes these records might look something like this:

```
OBTAIN ADDRESS OF FIRST RECORD IN CHAINED LIST FROM ROUTINE
CHECK FOR END OF THE CHAINED LIST
DO UNTIL END OF THE CHAINED LIST
   PROCESS RECORD
   GO ON TO THE NEXT RECORD
END
```

Figure 106 on page 303 contains an outline of the processing program, LISTS, used in this example of processing a chained list.

```
 IDENTIFICATION DIVISION.
 PROGRAM-ID. LISTS.
 ENVIRONMENT DIVISION.
 DATA DIVISION.
******
 WORKING-STORAGE SECTION.
 77  PTR-FIRST         POINTER  VALUE IS NULL.
 77  DEPT-TOTAL        PIC 9(4) VALUE IS 0.
******
 LINKAGE SECTION.
 01  SALARY-REC.
   02  PTR-NEXT-REC    POINTER.
   02  NAME            PIC X(20).
   02  DEPT            PIC 9(4).
   02  SALARY          PIC 9(6).
 01  DEPT-X            PIC 9(4).
******
 PROCEDURE DIVISION USING DEPT-X.
******
* FOR EVERYONE IN THE DEPARTMENT RECEIVED AS DEPT-X,
* GO THROUGH ALL OF THE RECORDS IN THE CHAINED LIST BASED ON THE
* ADDRESS OBTAINED FROM THE PROGRAM CHAIN-ANCH
* AND ACCUMULATE THE SALARIES.
* IN EACH RECORD, PTR-NEXT-REC IS A POINTER TO THE NEXT RECORD
* IN THE LIST; IN THE LAST RECORD, PTR-NEXT-REC IS NULL.
* DISPLAY THE TOTAL.
******
     CALL "CHAIN-ANCH" USING PTR-FIRST
     SET ADDRESS OF SALARY-REC TO PTR-FIRST
******
     PERFORM WITH TEST BEFORE UNTIL ADDRESS OF SALARY-REC = NULL
      IF DEPT = DEPT-X
        THEN ADD SALARY TO DEPT-TOTAL
        ELSE CONTINUE
      END-IF
      SET ADDRESS OF SALARY-REC TO PTR-NEXT-REC
     END-PERFORM
******
     DISPLAY DEPT-TOTAL
     GOBACK.
```

Figure 106. Program for Processing a Chained List

Passing Addresses between Programs

To obtain the address of the first SALARY-REC record area, the LISTS program calls the program CHAIN-ANCH:

```
             CALL "CHAIN-ANCH" USING PTR-FIRST
```

PTR-FIRST is defined in WORKING-STORAGE in the calling program (LISTS) as a pointer data item:

```
        WORKING-STORAGE SECTION.
        77  PTR-FIRST         POINTER  VALUE IS NULL.
```

Upon return from the call to CHAIN-ANCH, PTR-FIRST contains the address of the first record in the chained list.

PTR-FIRST is initially defined as having a null value as a logic check. If an error occurs with the call, and PTR-FIRST never receives the value of the address of the first record in the chain, a null value remains in PTR-FIRST and, according to the logic of the program, the records will not be processed.

NULL is a figurative constant used to assign the value of a non-valid address to pointer items. It can be used in the VALUE IS NULL clause, in the SET statement, and as an operand in a relation condition with a pointer data item.

The Linkage Section of the calling program contains the description of the records in the chained list. It also contains the description of the department code that is passed through the USING phrase of the CALL statement.

```
LINKAGE SECTION.
01  SALARY-REC.
  02  PTR-NEXT-REC    POINTER.
  02  NAME            PIC X(20).
  02  DEPT            PIC 9(4).
  02  SALARY          PIC 9(6).
01  DEPT-X            PIC 9(4).
```

To “base” the record description SALARY-REC on the address contained in PTR-FIRST, use a SET statement:

```
CALL "CHAIN-ANCH" USING PTR-FIRST
SET ADDRESS OF SALARY-REC TO PTR-FIRST
```

Check for the End of the Chained List

The chained list in this example is set up so that the last record contains a non-valid address. To do this, the pointer data item in the last record would be assigned the value NULL.

A pointer data item can be assigned the value NULL in two ways:

- A pointer data item can be defined with a VALUE IS NULL clause in its data definition.
- NULL can be the sending field in a SET statement.
- The initial value of a pointer data item with or without a VALUE clause of NULL equals NULL.

In the case of a chained list in which the pointer in the last record contains a null value, the code to check for the end of the list would be:

```
 IF PTR-NEXT-REC = NULL
⋮

 (logic for end of chain)
```

If you have not reached the end of the list, process the record and move on to the next record.

In the program LISTS, this test for the end of the chained list is accomplished with a “do while” structure:

```
PERFORM WITH TEST BEFORE UNTIL ADDRESS OF SALARY-REC = NULL
 IF DEPT = DEPT-X
   THEN ADD SALARY TO DEPT-TOTAL
   ELSE CONTINUE
 END-IF
 SET ADDRESS OF SALARY-REC TO PTR-NEXT-REC
END-PERFORM
```

Continuing Processing the Next Record

To move on to the next record, set the address of the record in the Linkage Section to be equal to the address of the next record. This is accomplished through the pointer data item sent as the first field in SALARY-REC:

```
SET ADDRESS OF SALARY-REC TO PTR-NEXT-REC
```

Then repeat the record-processing routine, which will process the next record in the chained list.

Incrementing Addresses Received from Another Program

The data passed from a calling program might contain header information that you want to ignore (for example, in data received from a CICS application that is not migrated to the command level).

Because pointer data items are not numeric, you cannot directly perform arithmetic on them. You can, however, use the SET verb to increment the passed address in order to bypass header information.

You could set up the Linkage Section as follows:

```
       LINKAGE SECTION.
       01  RECORD-A.
         02  HEADER          PIC X(16).
         02  REAL-SALARY-REC PIC X(30).
  ⋮
       01  SALARY-REC.
         02  PTR-NEXT-REC    POINTER.
         02  NAME            PIC X(20).
         02  DEPT            PIC 9(4).
         02  SALARY          PIC 9(6).
```

Within the Procedure Division, base the address of SALARY-REC on the address of REAL-SALARY-REC:

```
SET ADDRESS OF SALARY-REC TO ADDRESS OF REAL-SALARY-REC
```

SALARY-REC is now based on the address of RECORD-A + 16.

Data Areas

A data area is an object used to communicate data such as variable values between programs within a job and between jobs. A data area can be created and declared to a program before it is used in that program or job. For information on how to create and declare a data area, see the *CL Programmer's Guide*.

Local Data Area

The local data area can be used to pass any desired information between programs in a job. This information may be free-form data, such as informal messages, or may consist of a fully structured or formatted set of fields.

The system automatically creates a local data area for each job. The local data area is defined outside the COBOL program as an area of 1024 bytes.

When a job is submitted, the submitting job's local data area is copied into the submitted job's local data area. If there is no submitting job, the local data area is initialized to blanks.

A COBOL program can access the local data area for its job with the ACCEPT and DISPLAY statements, using a mnemonic name associated with the function-name LOCAL-DATA.

There is only one local data area associated with each job. Even if several work stations are acquired by a single job, only one local data area exists for that job. There is *not* a local data area for each work station.

Program Initialization Parameters (PIP) Data Area

The PIP data area is used by a prestart job. Generally, a prestart job is a job from a remote system under ICF that you start and keep ready to run until you call it.

If you use a prestart job, you do not have to wait for a program that you call to go through job initiation processing. Job initiation is performed before a program can actually start. Because job initiation has already taken place, a prestart job allows your program to start more quickly after the program start request is received.

A COBOL program can access the PIP data area for its job with the ACCEPT statement, using a mnemonic name associated with the function-name PIP-DATA.

The PIP data area is a 2 000-byte alphanumeric item and contains parameters received from a calling program. It provides the program initialization parameters that, in non-prestart jobs, is provided through standard COBOL parameters.

You use a Format 5 ACCEPT statement to access the PIP data area, similar to the way in which you use a Format 4 ACCEPT statement to read from the local data area. Note that you cannot update the PIP data area using COBOL. See the *COBOL/400 Reference* for detailed syntax information.

For more information regarding prestart jobs and the PIP data area, refer to the *Work Management Guide* and the *CL Programmer's Guide*.

File Considerations

You can pass a file name as a parameter in a COBOL program, but you cannot use that file in the called program. If a file is defined in both a calling program and a called program, it is treated as two separate files. The contents of the record area and the current record pointer in each program are independent, unless shared files are specified in CL commands. See the *Data Management Guide* for further information on shared files.

The following statements affect file status differently:

- An EXIT PROGRAM statement does not change the status of any of the files in a run unit.
- A STOP RUN statement closes all of the files in a run unit.

IBM Extension

- A GOBACK statement issued from a main program closes all of the files in a run unit. A GOBACK statement issued from a subprogram does not change the status of any of the files in a run unit.

End of IBM Extension

- A CANCEL statement does not change the status of any of the files in the program that is canceled. It does free the storage that contains information about the file. If the program has files that are open when the CANCEL statement is processed, those files are closed when that program is cancelled. The program can no longer use the file. If the canceled program is called again, the program considers the file closed. If the program opens the file, a new linkage to the file is established. This can cause additional system storage to be used.

Appendix A. Segmentation Feature

You do not have to be concerned with storage management when writing COBOL/400 programs. Storage segmentation is, however, available for compatibility with other systems.

The segmentation feature provides programmer-controlled storage optimization of the Procedure Division by allowing that division to be subdivided both physically and logically.

Segmentation Concepts

Although it is not required, the Procedure Division of a source program is often written as a consecutive group of sections, each of which is made up of a series of related operations that perform a particular function. Thus, the entire Procedure Division is made up of a number of logical subdivisions. Segmentation allows the programmer to physically divide the Procedure Division into segments, each of which has specific physical and logical attributes.

When Segmentation is used, the entire Procedure Division must be divided into sections. Each section must then be classified as to its physical and logical attributes. Classification is specified by means of segment numbers. All sections given the same segment number make up one program segment.

Segment numbers must be integers from 0 through 99.

Program Segments

There are three types of program segments; fixed permanent, fixed overlayable, and independent.

Fixed Segments

Fixed-permanent segments and fixed-overlayable segments make up the fixed portion, the part of the Procedure Division that is logically treated as if it were always physically present in main storage. Fixed-portion segment numbers must be integers from 0 through 49.

A fixed-permanent segment is always made available in its last-used state.

A fixed-overlayable segment is logically always in main storage during program processing; therefore, it is always available in its last-used state. Any overlay of such a segment is transparent to the user. Thus, a fixed-overlayable segment is logically identical with a fixed-permanent segment.

Independent Segments

Logically, an independent segment can overlay and be overlaid by other segments during a program's run.

An independent segment is made available in its initial state the first time control is passed to it (explicitly or implicitly) during a program's run.

An independent segment is made available in its initial state during subsequent transfers of control when:

- The transfer is the result of an implicit transfer of control between consecutive statements that are in different segments (that is, when control drops through into the independent segment from the physically preceding segment).
- The transfer is the result of an implicit transfer from a SORT or MERGE statement in one segment to a SORT input procedure or SORT/MERGE output procedure in an independent segment.
- An explicit transfer of control from a section with a different segment number takes place (as, for example, during the transfer of control in a PERFORM n TIMES statement).

An independent segment is made available in its last-used state during subsequent transfers of control when:

- With the exception of the two preceding kinds of implied transfers, an implicit transfer from a section with a different priority takes place (as, for example, when control is returned to the independent segment from a Declarative procedure).
- An explicit transfer results from an EXIT PROGRAM or GOBACK statement.

Independent segments must be assigned segment numbers 50 through 99.

Segmentation Logic

In a segmented program, the sections are classified by a system of segment numbers according to the following criteria:

- *Frequency of Reference*–Much-referenced sections, or those that must be available for reference at all times, should be placed within fixed permanent segments. Less frequently used sections can be within either fixed overlayable or independent segments, depending on the program logic.
- *Frequency of Use*–The more frequently a section is used, the lower its segment number; the less frequently it is referred to, the higher its segment number.
- *Logical Relationships*–Sections that frequently communicate with each other should be given identical segment numbers.

Segmentation Control

Except for specific transfers of control, the logical sequence and the physical sequence of program instructions are the same. The compiler inserts any instructions necessary to initialize a segment. It is not necessary to transfer control to the beginning of a segment, or to the beginning of a section within a segment. Instead, control can be transferred to any paragraph in the Procedure Division.

COBOL Source Program Considerations

The following elements of a COBOL source program implement the Segmentation feature:

- The SEGMENT-LIMIT clause in the OBJECT-COMPUTER paragraph of the Environment Division. This clause allows you to control the specification of fixed-permanent and fixed-overlayable segments.

- Procedure Division segment numbers, which group sections into segments. The segment numbering scheme also allows specifications of independent segments, fixed-permanent segments, and (in conjunction with the SEGMENT-LIMIT clause) of fixed-overlayable segments.

Segmentation–Environment Division

In the OBJECT-COMPUTER paragraph, the SEGMENT-LIMIT clause allows the user to reclassify fixed permanent segments while retaining the properties of fixed portion segments for the reclassified segments.

Format

```
►►──SEGMENT-LIMIT──┬────┬──segment-number────────── . ─────────────────►◄
                   └─IS─┘
```

The SEGMENT-LIMIT clause allows the programmer to specify certain permanent segments as capable of being overlaid by independent segments without losing the logical properties of fixed portion segments.

`segment-number` must be an integer ranging in value from 1 through 49.

When the SEGMENT-LIMIT clause is specified:

- Fixed-permanent segments are those with segment numbers from 0 up to, but not including, the segment number specified.
- Fixed-overlayable segments are those with segment numbers from the segment number specified through 49.

For example, if SEGMENT-LIMIT IS 25 is specified, sections with segment numbers 0 through 24 are fixed-permanent segments, and sections with segment numbers 25 through 49 are fixed-overlayable segments.

When the SEGMENT-LIMIT clause is omitted, all sections with segment numbers 0 through 49 are fixed-permanent segments.

Segmentation–Procedure Division

In the Procedure Division of a segmented program, section classification is specified through segment numbers in the section headers. The segment number must be an integer from 0 through 99.

Format

```
►►──section-name──SECTION──┬────────────────┬─.──────────────────────►◄
                           └─segment-number─┘
```

All sections with the same segment number make up one program segment. Such sections need not be contiguous in the source program.

Segments with segment numbers 0 through 49 are in the fixed portion of the program. Declarative sections can be assigned only these segment numbers. Segments with segment numbers from 50 through 99 are independent segments. If the segment number is omitted from the section header, the segment number is assumed to be 0.

Segmentation–Special Considerations

When segmentation is used, there are restrictions on the ALTER, PERFORM, SORT, and MERGE statements. There are also special considerations for calling and called programs.

ALTER Statement

A GO TO statement in an independent segment must not be referred to by an ALTER statement in a different segment. All other uses of the ALTER statement are valid and are performed, even if the GO TO statement referred to is in a fixed-overlayable segment.

PERFORM Statement

A PERFORM statement in the fixed portion can have in its range, in addition to any Declarative procedures, the processing of which is caused within that range, only one of the following:

- Sections and/or paragraphs in the fixed portion
- Sections and/or paragraphs contained within a single independent segment.

A PERFORM statement in an independent segment can have within its range, in addition to any Declarative procedures, the processing of which is caused within that range, only one of the following:

- Sections and/or paragraphs in the fixed portion
- Sections and/or paragraphs wholly contained in the same independent segment as the PERFORM statement.

SORT and MERGE Statements

If a SORT or MERGE statement appears in the fixed portion, any SORT input procedures or SORT/MERGE output procedures must appear completely in one of the following:

- The fixed portion
- A single independent segment.

If a SORT or MERGE statement appears in an independent segment, any SORT input procedures or SORT/MERGE output procedures must appear completely in one of the following:

- The fixed portion
- The same independent segment as the SORT or MERGE statement.

Calling and Called Programs

The CALL statement can appear anywhere within a segmented program. When a CALL statement appears in an independent segment, that segment is in its last-used state when control is returned to the calling program.

Appendix B. Debugging Features

The debugging features specify the conditions under which procedures are to be monitored during program run time.

COBOL source language debugging statements are provided. You must decide what to monitor, and what information you need to retrieve for debugging purposes. The COBOL debugging features simply provide access to pertinent information.

COBOL Source Language Debugging

COBOL language elements that implement the Debugging Feature are a compile-time switch (WITH DEBUGGING MODE), a run-time switch, a USE FOR DEBUGGING Declarative, the special register DEBUG-ITEM, and debugging lines that can be written in the Environment, Data, and Procedure Divisions.

Compile-Time Switch

In the SOURCE-COMPUTER paragraph of the Configuration Section, the WITH DEBUGGING MODE clause acts as a compile-time switch.

Format

```
►►──SOURCE-COMPUTER.─┬─────────────────────────────────────────────┬─.──────►◄
                     └─computer name─┬───────────────────────────┬─┘
                                     └─┬──────┬──DEBUGGING MODE──┘
                                       └─WITH─┘
```

The WITH DEBUGGING MODE clause serves as a compile-time switch for the debugging statements written in the source program.

When WITH DEBUGGING MODE is specified, all debugging sections and debugging lines are compiled as specified in this appendix. When WITH DEBUGGING MODE is omitted, all debugging sections and debugging lines are treated as documentation.

Run-Time Switch

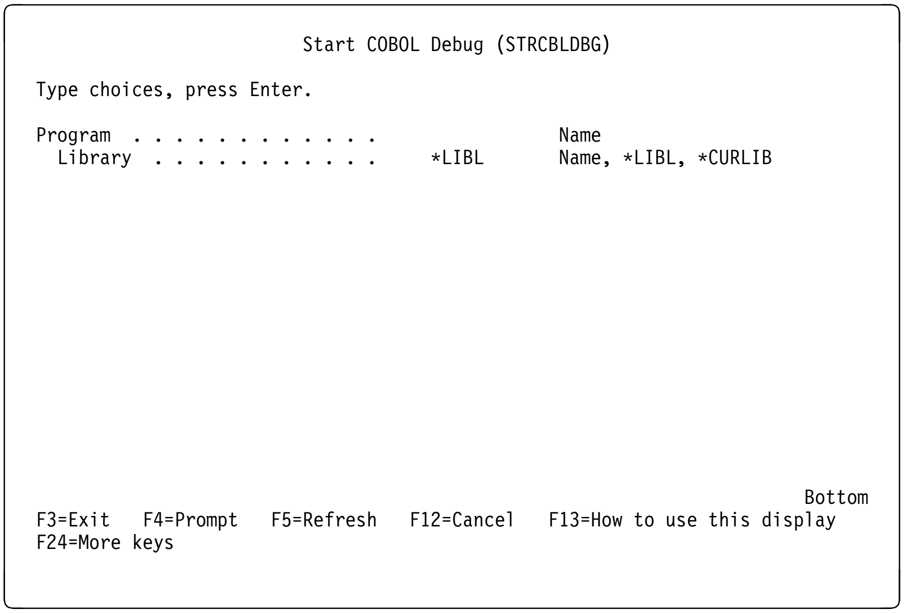
The run-time switch dynamically activates the debugging code that is generated when WITH DEBUGGING MODE is specified.

Two commands are provided to control the run-time switch. To set the run-time switch on, enter the command:

```
STRCBLDBG
```

and press F4.

You see the following display:



```
                            Start COBOL Debug (STRCBLDBG)

 Type choices, press Enter.

 Program  . . . . . . . . . . . .                 Name
   Library  . . . . . . . . . . .     *LIBL       Name, *LIBL, *CURLIB





















                                                                       Bottom
 F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
 F24=More keys
```

The following diagram shows the syntax of the STRCBLDBG command:

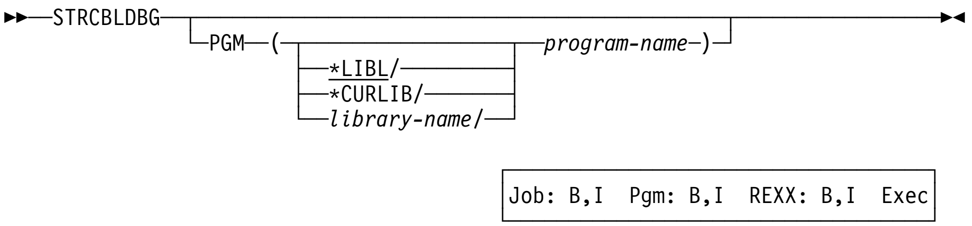


Figure 107. Syntax of the STRCBLDBG Command

This command is allowed in interactive and batch processing, and in CL programs.

General-Use Programming Interface

You can use this command in QCMDEXC.

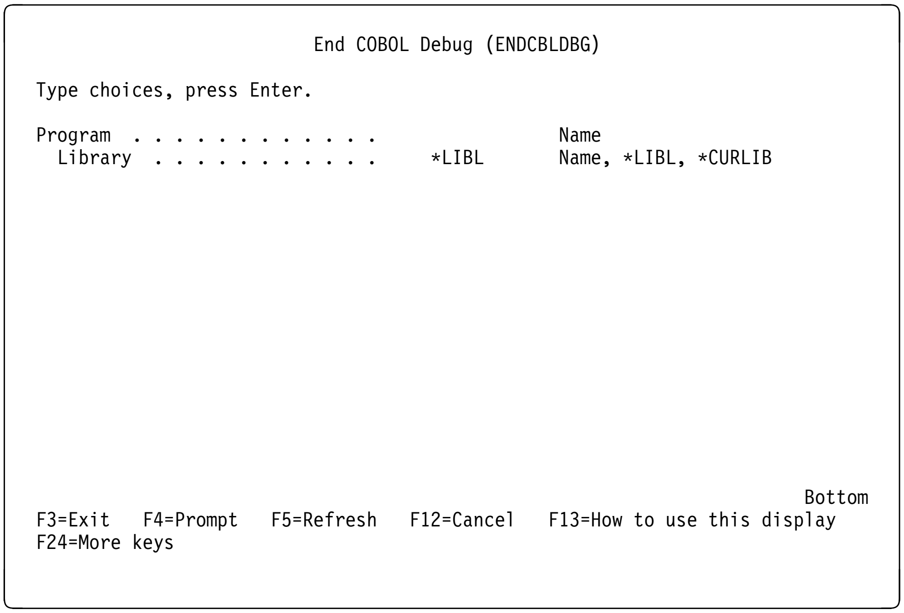
End of General-Use Programming Interface

To set the run-time switch off, enter the command:

```
ENDCBLDBG
```

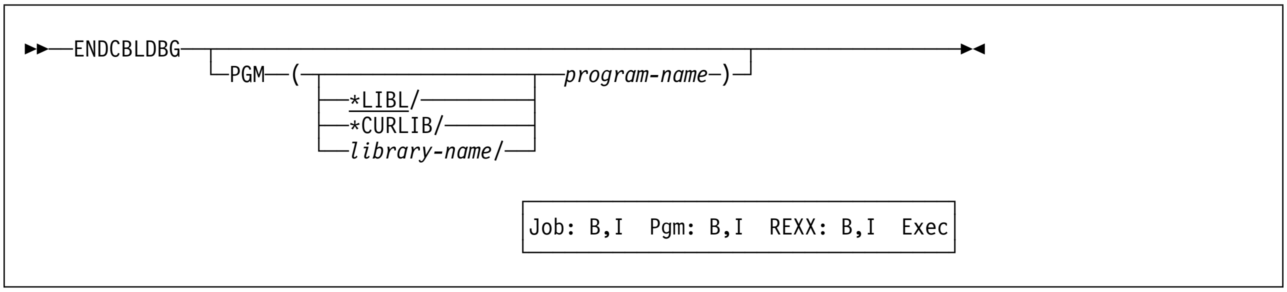
and press F4.

You see the following display:



```
                              End COBOL Debug (ENDCBLDBG)

Type choices, press Enter.

Program  . . . . . . . . . . . .                 Name
  Library  . . . . . . . . . . .     *LIBL       Name, *LIBL, *CURLIB

























                                                                      Bottom
F3=Exit   F4=Prompt   F5=Refresh   F12=Cancel   F13=How to use this display
F24=More keys
```

The following diagram shows the syntax of the ENDCBLDBG command:



```
►►──ENDCBLDBG──┬──────────────────────────────────────────────┬──────────────►◄
               └─PGM──(──┬──────────────────┬──program-name─)─┘
                         ├─*LIBL/───────────┤
                         ├─*CURLIB/─────────┤
                         └─library-name/────┘

                                       Job: B,I  Pgm: B,I  REXX: B,I  Exec
```

Figure 108. Syntax of the ENDCBLDBG Command

This command is allowed in interactive and batch processing, and in CL programs.

General-Use Programming Interface

You can use this command in QCMDEXC.

End of General-Use Programming Interface

The default for the run-time switch is off.

When debugging mode is specified through the run-time switch, all the debugging sections and debugging lines (**D** in column 7) compiled into the program are activated.

You must enter the STRCBLDBG command for each COBOL program (main program or called program) to be debugged in the next COBOL run unit. At the end of the run unit, all run-time switches that are on are set off. If a switch must be set off before starting a COBOL run unit, use the ENDCBLDBG command. Run-time switches for up to 15 programs can be on at once.

When the STRCBLDBG or ENDCBLDBG command is issued in a CL program, concatenation expressions can be used for all parameter values. See the *CL Programmer's Guide* for more information about concatenation expressions.

When debugging mode is suppressed, through the run-time switch, any USE FOR DEBUGGING Declarative procedures are inhibited. All debugging lines (**D** in column 7) remain in effect.

Recompilation of the source program is not required to activate or deactivate the run-time switch.

When WITH DEBUGGING MODE is not specified in the SOURCE-COMPUTER paragraph, the run-time switch has no effect on the running of the program.

USE FOR DEBUGGING Declarative

The USE FOR DEBUGGING sentence in the Procedure Division identifies the items in the source program that are to be monitored by the associated debugging declarative procedure.

Format

```
                                     ┌────────────────────────────────────────────────┐
                                     ↓                                                │
►►──USE──┬─────┬──DEBUGGING──┬────┬──┬──┬──────────────────────────┬──identifier-1──┴──►◄
         └─FOR─┘             └─ON─┘  │  └─ALL──┬─────────────────┬─┘                  │
                                     │         └─REFERENCES OF───┘                    │
                                     ├──file-name-1───────────────────────────────────┤
                                     ├──procedure-name-1──────────────────────────────┤
                                     └──ALL PROCEDURES────────────────────────────────┘
```

`Identifier-1` cannot be reference modified.

When specified, all debugging sections must be written immediately after the DECLARATIVES header. Except for the USE FOR DEBUGGING sentence there must be no reference to any non-declarative procedure within the debugging procedure.

Note that the USE FOR DEBUGGING declarative causes all subsequent statements to be ignored up to a valid USE AFTER EXCEPTION/ERROR statement, or END DECLARATIVES delimiter. Entire programs can be ignored because of this.

Automatic running of a debugging section is not caused by a statement appearing in a debugging section.

A debugging section for a specific operand is processed only once as the result of the running of a single statement, no matter how many times the operand is specified in the statement. An exception to this rule is that each specification of a subscripted or indexed identifier where the subscripts or indexes are different causes the calling of the debugging Declarative. For a PERFORM statement that causes repeated running of a procedure, any associated procedure name debugging Declarative section is run only once for each processing of the procedure.

For debugging purposes, each separate occurrence of an imperative verb within an imperative statement begins a separate statement.

Statements appearing outside the debugging sections must not refer to procedure names defined within the debugging sections.

Except for the USE FOR DEBUGGING sentence itself, statements within a debugging Declarative section can only refer to procedure names defined in a different USE procedure through the PERFORM statement. Procedure names within debugging Declarative sections must not appear in USE FOR DEBUGGING sentences.

Table 7 defines the points during program run time when the USE FOR DEBUGGING procedures are processed. Identifier-n, file-name-n, and procedure-name-n refer to the first and all subsequent specifications of that type of operand in one USE FOR DEBUGGING sentence. Any particular identifier, file name, or procedure name can appear in only one USE FOR DEBUGGING sentence, and only once in that sentence.

An identifier in a USE FOR DEBUGGING sentence:

- Must be specified without the subscripting or indexing normally required if it contains an OCCURS clause or is subordinate to an entry containing an OCCURS clause. (A SEARCH or SEARCH ALL statement that refers to such an identifier does not call the USE FOR DEBUGGING procedures.)
- Must not be a special register.

When ALL PROCEDURES is specified in a USE FOR DEBUGGING sentence, procedure-name-1, procedure-name-2, procedure-name-3, and so on, must not be specified in any USE FOR DEBUGGING sentence. The ALL PROCEDURES phrase can be specified only once in a program.

When a USE FOR DEBUGGING operand is used as a qualifier, such a reference in the program does not activate the debugging procedures.

References to the DEBUG-ITEM special register can be made only from within a debugging Declarative procedure.

Table 7. Running Debugging Declaratives

USE FOR DEBUGGING Operand	**The USE FOR DEBUGGING procedures run immediately after the following:**
identifier-n	Before REWRITE/WRITE identifier-n and after FROM phrase move, if applicable. After each initialization, modification, or evaluation of identifier-n in PERFORM/VARYING/AFTER/UNTIL identifier-n. After any other COBOL statement that explicitly refers to identifier-n and could change its contents. (See note.)
ALL REFERENCES OF identifier-n	Before GO TO DEPENDING ON identifier-n, control is transferred, and before any associated debugging section for the procedure name runs. Before REWRITE/WRITE identifier-n and FROM phrase move, if applicable. After each initialization, modification or evaluation of identifier-n in PERFORM/VARYING/AFTER/UNTIL identifier-n. After any other COBOL statement explicitly referring to identifier-n. (See note.)
file-name-n	After CLOSE/DELETE/OPEN/START file-name-n. After READ file-name-n where AT END/INVALID KEY was not run.
procedure-name-n	Before each running of the named procedure. After running an ALTER statement referring to the named procedure.
ALL PROCEDURES	Before each running of every non-debugging procedure. After running every ALTER statement (except ALTER statements in Declarative procedures).

Note: Operands acted upon but not explicitly named in such statements as ADD, MOVE, or SUBTRACT CORRESPONDING never cause activation of a USE FOR DEBUGGING procedure when such statements are run. If identifier-n is specified in a phrase that is not processed, the associated debugging section is not run.

DEBUG-ITEM Special Register

The DEBUG-ITEM special register provides information for a debugging Declarative procedure. DEBUG-ITEM has the following implicit description:

```
01 DEBUG-ITEM.
   02 DEBUG-LINE      PICTURE IS X(6).
   02 FILLER          PICTURE IS X VALUE SPACE.
   02 DEBUG-NAME      PICTURE IS X(30).
   02 FILLER          PICTURE IS X VALUE SPACE.
   02 DEBUG-SUB-1     PICTURE IS S9999 SIGN IS
                      LEADING SEPARATE CHARACTER.
   02 FILLER          PICTURE IS X VALUE SPACE.
   02 DEBUG-SUB-2     PICTURE IS S9999 SIGN IS
                      LEADING SEPARATE CHARACTER.
   02 FILLER          PICTURE IS X VALUE SPACE.
   02 DEBUG-SUB-3     PICTURE IS S9999 SIGN IS
                      LEADING SEPARATE CHARACTER.
   02 FILLER          PICTURE IS X VALUE SPACE.
   02 DEBUG-CONTENTS  PICTURE IS X(n).
```

The DEBUG-ITEM special register provides information about the conditions causing the running of a debugging section.

Before each debugging section is processed, DEBUG-ITEM is filled with spaces. The contents of the DEBUG-ITEM subfields are then updated according to the rules for the MOVE statement, with one exception: DEBUG-CONTENTS is updated as if the move were an alphanumeric-to-alphanumeric elementary move without conversion of data from one form of internal representation to another. After updating, each field contains:

- DEBUG-LINE: The compiler-generated statement number, right justified and padded on the left with zeros. For example, 000112.
- DEBUG-NAME: The first 30 characters of the name causing the debugging section to run. All qualifiers are separated by the word OF (subscripts or indexes are not entered in DEBUG-NAME).
- DEBUG-SUB-1, DEBUG-SUB-2, DEBUG-SUB-3: If the DEBUG-NAME is subscripted or indexed, the occurrence number of each level is entered in the respective DEBUG-SUB-n. If the item is not subscripted or indexed, these fields remain spaces.
- DEBUG-CONTENTS: Data is moved into DEBUG-CONTENTS as shown in Table 8. DEBUG-CONTENTS is the same size as the largest identifier in the program.

Table 8. DEBUG-ITEM Subfield Contents

Item Causing Debug Section To Run	DEBUG-LINE Contains Number of COBOL Statement Referring to	DEBUG-NAME Contains	DEBUG-CONTENTS Contains
identifier-n	identifier-n	identifier-n	Contents of identifier-n when control passes to debug section.
file-name-n	file-name-n	file-name-n	For READ: contents of record retrieved. Other references: spaces.
procedure-name-n ALTER reference	ALTER statement	procedure-name-n	procedure-name-n in TO PROCEED TO phrase
GO TO procedure-name-n	GO TO statement	procedure-name-n	
procedure-name-n in SORT/MERGE INPUT/OUTPUT PROCEDURE	SORT/MERGE statement	procedure-name-n	“SORT INPUT” “SORT OUTPUT” “MERGE OUTPUT” as applicable
PERFORM statement transfer of control	This PERFORM statement	procedure-name-n	“PERFORM LOOP”
procedure-name-n in a USE procedure	Statement causing USE procedure running	procedure-name-n	“USE PROCEDURE”
Implicit transfer from previous sequential procedure	Previous statement processed in previous sequential procedure (see note)	procedure-name-n	“FALL THROUGH”
First entry into first non-declarative procedure	Line number of first statement in the procedure	First non-declarative procedure name	“START PROGRAM”

Note: If this paragraph is preceded by a section header and control is passed through the section header, the statement number refers to the section header.

Debugging Lines

Debugging lines can help determine the cause of an error. A debugging line is any line in a source program with a **D** coded in column 7 (the continuation area). If a debugging line contains nothing but spaces in Area A and Area B, it is considered a blank line.

Each debugging line must be written so that a syntactically correct program results whether the debugging lines are compiled into the program or syntax-checked, but are treated as documentation.

Successive debugging lines are permitted. Debugging lines can be continued. However, each continuation line must contain a **D** in column 7, and character-strings must not be broken across two lines.

Debugging lines can be specified only after the OBJECT-COMPUTER paragraph.

When the WITH DEBUGGING MODE clause is specified in the SOURCE-COMPUTER paragraph, all debugging lines are compiled as part of the object program.

When the WITH DEBUGGING MODE clause is omitted, all debugging lines are syntax-checked, but are treated as documentation.

Appendix C. Level of Language Support

ANSI X3.23-1985 COBOL Standard

The ANSI X3.23-1985 COBOL standard consists of eleven functional processing modules, seven of which are required and four of which are optional.

The seven required modules are: Nucleus, Sequential I-O, Relative I-O, Indexed I-O, Inter-Program Communication, Sort-Merge, and Source Text Manipulation. The four optional modules are: Report Writer, Communication, Debug and Segmentation.

Language elements within the modules may be classified as level 1 elements and level 2 elements. Elements within nine of the modules are divided into level 1 elements and level 2 elements. Two of the modules (SORT-MERGE and REPORT WRITER) contain only level 1 elements. For instance, Nucleus level 1 elements perform basic internal operations. Nucleus level 2 elements provide for more extensive and sophisticated internal processing.

The three subsets of Standard COBOL are the high subset, the intermediate subset, and the minimum subset. Each subset is composed of a level of the seven required modules: Nucleus, Sequential I-O, Relative I-O, Indexed I-O, Inter-Program Communication, Sort-Merge, and Source Text Manipulation. The four optional modules (Report Writer, Communication, Debug and Segmentation) are not required in the three subsets of Standard COBOL.

> The high subset is composed of all language elements of the highest level of all required modules. That is:
>
> - Level 2 elements from Nucleus, Sequential I-O, Relative I-O, Indexed I-O, Inter-Program Communication, and Source Text Manipulation
> - Level 1 elements from Sort-Merge.
>
> The intermediate subset is composed of all language elements of level 1 of all required modules. That is:
>
> - Level 1 elements from Nucleus, Sequential I-O, Relative I-O, Indexed I-O, Inter-Program Communication, Sort-Merge, and Source Text Manipulation.
>
> The minimum subset is composed of all language elements of level 1 of the Nucleus, Sequential I-O, and Inter-Program Communication modules.

The four optional modules are not an integral part of any of the subsets. However, none, all, or any combination of the optional modules may be associated with any of the subsets.

COBOL/400 Level of Language Support

The COBOL/400 compiler supports:

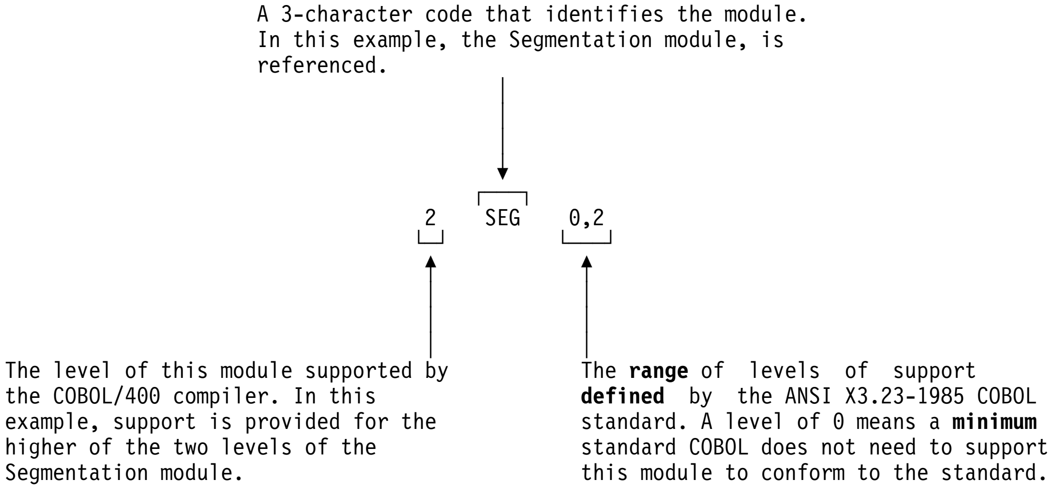
- Level 1 of the Nucleus, Sequential I-O, Relative I-O, Indexed I-O, Inter-Program Communication, Sort-Merge, and Source Text Manipulation modules
- Level 2 of the Debug and Segmentation modules.

The Report Writer and Communication modules of ANSI X3.23-1985 COBOL are not supported by the COBOL/400 compiler.

The level of support provided by the COBOL/400 compiler is represented in the table below. The table:

- Shows the level of COBOL/400 compiler support for each functional processing module of the ANSI X3.23-1985 COBOL standard
- Describes each module.

Following is an explanation of the notation used within the table:



A 3-character code that identifies the module. In this example, the Segmentation module, is referenced.

The level of this module supported by the COBOL/400 compiler. In this example, support is provided for the higher of the two levels of the Segmentation module.

The **range** of levels of support **defined** by the ANSI X3.23-1985 COBOL standard. A level of 0 means a **minimum** standard COBOL does not need to support this module to conform to the standard.

Table 9 (Page 1 of 2). Level of COBOL/400 Compiler Support

COBOL/400 Level of Language Supported	**Module Description**
Nucleus 1 NUC 1,2	Contains the language elements necessary for internal processing of data within the four basic divisions of a program and the capability for defining and accessing tables.
Sequential I-O 1 SEQ 1,2	Provides access to file records by the established sequence in which they were written to the file.
Relative I-O 1 REL 0,2	Provides access to records in either a random or sequential manner. Each record is uniquely identified by an integer that represents the record's logical position in the file.
Indexed I-O 1 INX 0,2	Provides access to records in either random or sequential manner. Each record in an indexed file is uniquely identified by a record key.
Inter-program Communication 1 IPC 1,2	Allows a COBOL program to communicate with other programs through transfers of control and access to common data items.
Sort-Merge 1 SRT 0,1	Orders one or more files of records, or combines two or more identically ordered files according to user-specified keys.
Source-Text Manipulation 1 STM 0,2	Allows insertion of predefined COBOL text into a program at compile time.

Table 9 (Page 2 of 2). Level of COBOL/400 Compiler Support

COBOL/400 Level of Language Supported	**Module Description**
Report Writer 0 RPW 0,1	Provides semiautomatic production of printed reports.
Communications 0 COM 0,2	Provides the ability to access, process, and create messages or portions of messages; also allows communication through a Message Control System with local and remote communication devices.
Debug 2 DEB 0,2	Allows you to specify statements and procedures for debugging.
Segmentation 2 SEG 0,2	Provides the overlaying at object time of Procedure Division sections.

SAA Common Programming Interface (CPI) Support

Source file QILBINC in product libraries QLBL and QLBLP contains members that hold specifications for multiple SAA Common Programming Interfaces. These specifications describe parameter interfaces. This file is IBM-owned and should not be changed.

If you want to customize any of the specifications, you must copy any members that you want to change to a source file in one of your libraries. You can use the Copy File (CPYF) command to do this. For more information about the CPYF command, refer to the *CL Reference*.

If you copy these specifications to your library, you must refresh your copies when a new product release is installed, or when any changes are made using a Program Temporary Fix (PTF). IBM provides maintenance for these specifications only in the libraries in which they are distributed.

Appendix D. COBOL/400 Messages, the FIPS Flagger, and SAA Flagging

COBOL/400 Messages

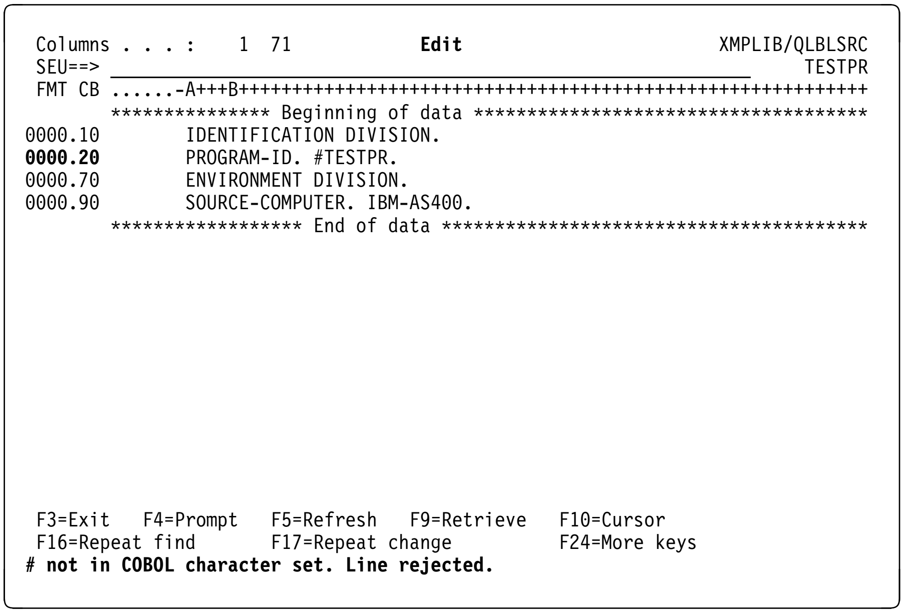
This appendix provides a general description of messages that IBM supplies with the COBOL/400 licensed program.

Interactive Messages

In an interactive environment, messages are displayed on the work station display. They can appear on the current display as a result of the running of the program or in response to your keyed input to prompts, menus, command entry displays, or Application Development Tools (Appl Dev Tools). The messages can also appear on request, as a result of a display command or an option on a menu.

The messages for the COBOL/400 licensed program begin with an LSC, LBE, or LBL prefix.

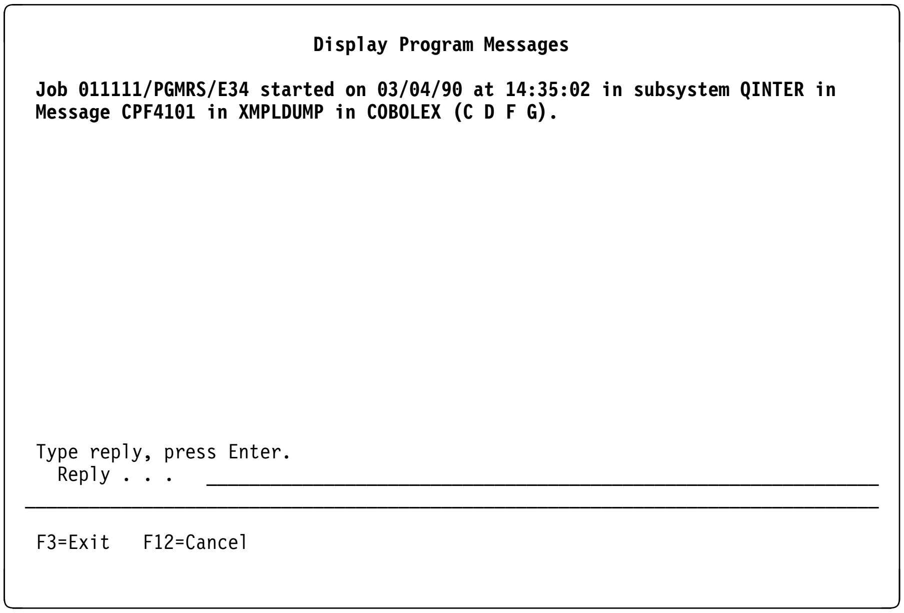
The LSC messages are issued by the COBOL/400 syntax checker when the Source Entry Utility (SEU) is used to enter your COBOL/400 source. For example, you see the following display after incorrectly entering the program name in the PROGRAM-ID paragraph.



```
 Columns . . . :    1  71           Edit                       XMPLIB/QLBLSRC
 SEU==> ____________________________________________________________     TESTPR
 FMT CB ......-A+++B++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        *************** Beginning of data ************************************
0000.10        IDENTIFICATION DIVISION.
0000.20        PROGRAM-ID. #TESTPR.
0000.70        ENVIRONMENT DIVISION.
0000.90        SOURCE-COMPUTER. IBM-AS400.
        ****************** End of data ****************************************













 F3=Exit   F4=Prompt   F5=Refresh   F9=Retrieve   F10=Cursor
 F16=Repeat find       F17=Repeat change          F24=More keys
# not in COBOL character set. Line rejected.
```

Figure 109. Example of a COBOL/400 Syntax Checker Message

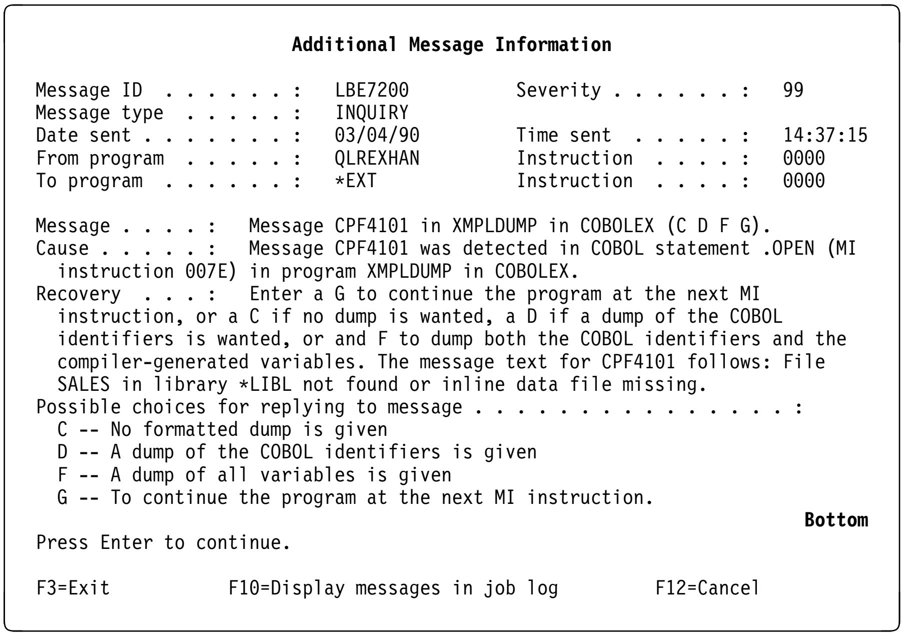
LBE messages provide you with additional information about system operation during run time. For example, you might see the following display if you have a run-time error:



```
                            Display Program Messages

 Job 011111/PGMRS/E34 started on 03/04/90 at 14:35:02 in subsystem QINTER in
 Message CPF4101 in XMPLDUMP in COBOLEX (C D F G).


















 Type reply, press Enter.
   Reply . . .   ______________________________________________________________
________________________________________________________________________________

 F3=Exit   F12=Cancel
```

Figure 110. Run-Time Error Message

If you move the cursor to the line on which message number CPF4101 is indicated and press either the HELP key or F1, the LBE message information is displayed as shown:



```
                          Additional Message Information

 Message ID . . . . . . :   LBE7200         Severity . . . . . . :   99
 Message type  . . . . . :   INQUIRY
 Date sent . . . . . . . :   03/04/90        Time sent  . . . . . :   14:37:15
 From program  . . . . . :   QLREXHAN        Instruction  . . . . :   0000
 To program  . . . . . . :   *EXT            Instruction  . . . . :   0000

 Message . . . . :   Message CPF4101 in XMPLDUMP in COBOLEX (C D F G).
 Cause . . . . . :   Message CPF4101 was detected in COBOL statement .OPEN (MI
   instruction 007E) in program XMPLDUMP in COBOLEX.
 Recovery  . . . :   Enter a G to continue the program at the next MI
   instruction, or a C if no dump is wanted, a D if a dump of the COBOL
   identifiers is wanted, or and F to dump both the COBOL identifiers and the
   compiler-generated variables. The message text for CPF4101 follows: File
   SALES in library *LIBL not found or inline data file missing.
 Possible choices for replying to message . . . . . . . . . . . . . . . :
   C -- No formatted dump is given
   D -- A dump of the COBOL identifiers is given
   F -- A dump of all variables is given
   G -- To continue the program at the next MI instruction.
                                                                       Bottom
 Press Enter to continue.

 F3=Exit          F10=Display messages in job log        F12=Cancel
```

Figure 111. Run-Time Error Message—Second-Level Text

LBE messages 7900 to 7999 are used as headings for information printed during a COBOL/400 formatted dump.

The LBL messages are described under "Compilation Messages" below.

"Responding to Messages" on page 329 explains how to display second-level message text and how to reply to messages.

Compilation Messages

LBL messages are printed in the program listing when errors are found during program compilation. The LBL messages include the message issued when Federal Information Processing Standard (FIPS) flagging is requested; for more information on the FIPS messages, refer to page 331 in this appendix.

Program Listings

In the compiler output, the COBOL/400 messages listing follows the source listing. The COBOL/400 messages listing gives the message identifier, severity, text, usually the location of the error, and the messages summary.

For more information about Program Listings, see "Source Listing" on page 41.

Responding to Messages

In an interactive environment, a message is indicated by one or several of these conditions:

- A brief message (called first-level text) on the message line
- Reverse image highlighting of the input field in error
- A locked keyboard
- The sound of an alarm (if the alarm option is installed).

The following paragraphs briefly describe some methods of responding to error messages; more information is available in the *New User's Guide* and the *Application Development Tools* publications.

If the necessary correction is obvious from the initial display, you can press the Error Reset key (if the keyboard is locked), enter the correct information, and continue your work.

If the message requires that you choose a reply (such as **C** to cancel, **D** to dump COBOL identifiers, **F** to dump all variables, or **G** to resume processing at the next COBOL statement), the reply options are shown in parentheses in the first-level message text. For an example, see Figure 110 on page 328.

If the information on the initial information display does not provide sufficient data for you to handle the error, you can press the HELP key (after positioning the cursor to the message line, if required) to get a second-level display with additional information about how to correct this error. To return to the initial display, press the Enter key; then press the Error Reset key (if the keyboard is locked), and make your correction or response.

If the error occurs when you are compiling or running a program, you might need to modify your COBOL/400 source statements or control language (CL) commands. Refer to the *SEU User's Guide and Reference* for information on how to change the statements.

COBOL Message Descriptions

The messages for the COBOL/400 licensed program begin with prefixes LSC, LBE, or LBL.

The LSC messages are issued by the COBOL syntax checker when SEU is used to enter your COBOL source.

The LBE messages provide you with additional information about system operation during run time.

The LBL messages are compiler-generated messages.

Message numbers are assigned as follows:

Error Message	Description
LBE7000 through LBE7199	Escape Messages
LBE7200 through LBE7999	Run-time messages
LBE9001	Escape message
LBL0000 through LBL0999	Messages with severity less than 30
LBL1000 through LBL1999	Messages with severity greater than or equal to 30
LBL8000 through LBL8799	FIPS Flagger messages
LBL8800 through LBL8899	SAA Flagging messages
LSC0000 through LSC1999	Syntax checker messages

Severity Levels

The COBOL/400 licensed program provides the following message severity levels:

Severity **Meaning**

00 Informational: This level is used to convey information to the user. No error has occurred. Informational messages are listed only when the FLAG (00) option is specified.

10 Warning: This level indicates that an error was detected but is not serious enough to interfere with the running of the program.

20 Error: This level indicates that an error was made, but the compiler is taking a recovery that might yield the desired code.

30 Severe Error: This level indicates that a serious error was detected. Compilation is completed, but running of the program cannot be attempted.

40 Unrecoverable: This level usually indicates a user error that forces termination of processing.

50 Unrecoverable: This level usually indicates a compiler error that forces termination of processing.

99 Action: Some manual action is required, such as entering a reply, changing printer forms, or replacing diskettes.

Note: 00, 10, and 20 messages are suppressed when the FLAG(30) option of the PROCESS statement is used or the CRTCBLPGM command specifies FLAG(30) and is not overridden by the PROCESS statement. See “Using the PROCESS Statement to Specify Compiler Options” on page 32 for further information.

The compiler always attempts to provide full diagnostics of all source text in the program, even when errors have been detected. If the compiler cannot continue on a given statement, the message states that the compiler cannot continue and that it will ignore the rest of the statement. When this error occurs, the programmer should examine the entire statement.

The OS/400 message facility is used to produce all messages. The COBOL/400 compiler messages reside in the message file, QLBLMSG, and the run-time messages reside in the message file, QLBLMSGE.

Substitution variables and valid reply values are determined by the program sending the message, *not* by the message description stored in the message file. However, certain elements of a message description can be changed: for example, the text, severity level, default response, or dump list. To effect such changes, you need to define another message description using an Add Message Description (ADDMSGD) command, place the modified description in a user-created message file,[1] and specify that file in the Override Message File (OVRMSGF) command. Using the OVRMSGF command allows the compiler to retrieve messages from the specified file. See the ADDMSGD and OVRMSGF commands in the *CL Reference* for additional information.

CAUTION: Overriding an IBM-supplied message with a user-created message can produce results you do not anticipate. If reply values are not retained, the program might not respond to any replies. Changing default replies on *NOTIFY type messages could affect the ability of the program to run in unattended mode. Changing the severity could cancel a job not previously canceled. Be cautious when overriding IBM-supplied messages with user-created messages.

The Federal Information Processing Standard (FIPS) Flagger

The FIPS flagger can be specified to monitor a FIPS COBOL subset, any of the optional modules, all of the obsolete language elements, or a combination of a FIPS COBOL subset, optional modules and all obsolete elements.

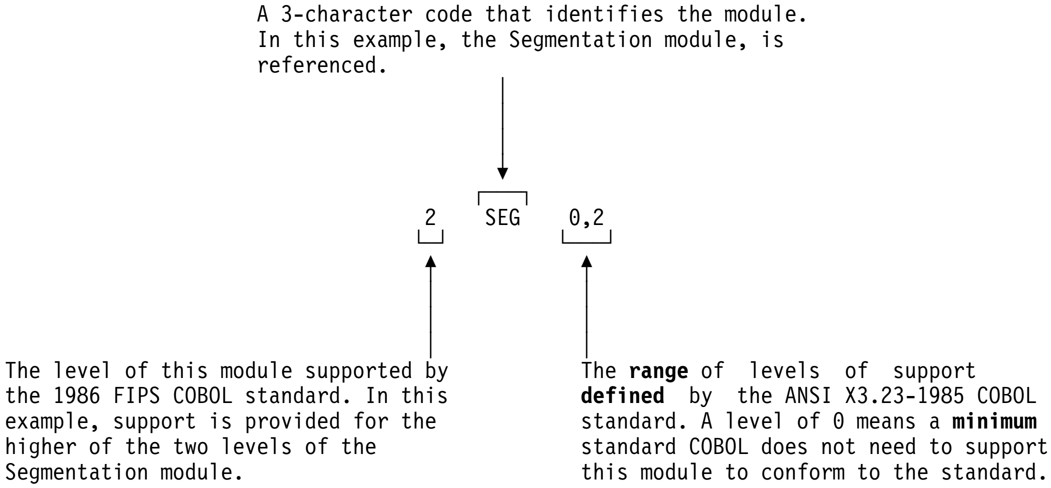
The monitoring is an analysis that compares the syntax used in the source program with the syntax included in the user-selected FIPS subset and optional modules. Any syntax used in the source program that does not conform to the selected FIPS COBOL subset and optional modules is identified. Any syntax for an obsolete language element used in the source program will also be identified (depending on the compiler option chosen). See page 25 for more information on the parameters for FIPS flagging.

1986 FIPS COBOL specifications are the language specifications contained in ANSI X3.23-1985 COBOL. FIPS COBOL is subdivided into three subsets and four optional modules. The three subsets are identified as Minimum, Intermediate and High. The four optional modules are Report Writer, Communication, Debug, and Segmentation. These four optional modules are not an integral part of any of the subsets; however, none, all, or any combination of the optional modules may be associated with any of the subsets. Any program written to conform to the 1986 FIPS standard must conform to one of the subsets of 1986 FIPS COBOL.

[1] If an IBM-supplied message must be changed and replaced in *its* message file, call your service representative.

Table 10 on page 332 shows the 1985 ANSI Standard COBOL processing modules included in each of the subsets of 1986 FIPS COBOL.

Following is an explanation of the notation used within the table:



A 3-character code that identifies the module. In this example, the Segmentation module, is referenced.

The level of this module supported by the 1986 FIPS COBOL standard. In this example, support is provided for the higher of the two levels of the Segmentation module.

The **range** of levels of support **defined** by the ANSI X3.23-1985 COBOL standard. A level of 0 means a **minimum** standard COBOL does not need to support this module to conform to the standard.

Table 10. 1985 American National Standard COBOL and 1986 FIPS Levels

1985 ANSI Module Name	**High FIPS**	**Intermediate FIPS**	**Minimum FIPS**
Nucleus	2 NUC 1,2	1 NUC 1,2	1 NUC 1,2
Sequential I-O	2 SEQ 1,2	1 SEQ 1,2	1 SEQ 1,2
Relative I-O	2 REL 0,2	1 REL 0,2	0 REL 0,2
Indexed I-O	2 INX 0,2	1 INX 0,2	0 INX 0,2
Source-Text Manipulation	2 STM 0,2	1 STM 0,2	0 STM 0,2
Sort-Merge	1 SRT 0,1	1 SRT 0,1	0 SRT 0,1
Inter-Program Communication	2 IPC 1,2	1 IPC 1,2	1 IPC 1,2
Report Writer	0, or 1 RPW 0,1	0, or 1 RPW 0,1	0, or 1 RPW 0,1
Segmentation	0,1 or 2 SEG 0,2	0,1 or 2 SEG 0,2	0,1 or 2 SEG 0,2
Debug	0,1 or 2 DEB 0,2	0,1 or 2 DEB 0,2	0,1 or 2 DEB 0,2
Communications	0,1 or 2 COM 0,2	0,1 or 2 COM 0,2	0,1 or 2 COM 0,2

Note: The COBOL/400 compiler supports the Segmentation and Debug optional modules.

Elements that are specified in the COBOL/400 source program and that are not included in 1986 FIPS COBOL are flagged as described in Appendix C, “Level of Language Support” on page 323.

SAA Flagging

You can choose to perform SAA flagging to determine if the COBOL/400 functions that you are using are portable to other SAA COBOL environments.

Flagging is performed on those COBOL/400 functions that are *outside* of SAA COBOL, such as:

COBOL/400 extensions
COBOL/400 compiler limits
Non-SAA reserved words
Compiler options.

In this way, you can write programs that conform to the SAA COBOL definition.

For an example of SAA flagging in a compiler listing, see Figure 12 on page 47. To perform SAA flagging through the CRTCBLPGM CL command, specify SAAFLAG(*FLAG). To perform SAA flagging through a PROCESS statement, specify SAAFLAG.

To compile a program to conform to the SAA definition, using the CRTCBLPGM command, specify the following:

```
OPTION(*QUOTE *NOSEQUENCE *NONUMBER)
GENOPT(*CRTF *DUPKEYCHK *SYNC)
SAAFLAG(*FLAG)
```

If you use the PROCESS statement, specify the following:

```
QUOTE, NOSEQUENCE, NONUMBER, CRTF,
DUPKEYCHK, SYNC, SAAFLAG.
```

For more information about specifying the option for SAA flagging, see the SAAFLAG parameter on page 25, and the “Using the PROCESS Statement to Specify Compiler Options” on page 32.

For information about compiler limits, see the Compiler Limits appendix in the *COBOL/400 Reference*.

Appendix E. Differences Between ANSI 74 COBOL and ANSI 85 COBOL

This appendix identifies the ANSI 85 COBOL language elements that are incompatible with ANSI 74 COBOL. These items identify the changes and conditions that ANSI 74 COBOL users need to be aware of when migrating to ANSI 85 COBOL.

See "Industry Standards Used in Compiler Design" on page xiii for more information on ANSI 85 COBOL.

Migrating ANSI 74 COBOL Programs to ANSI 85 COBOL

The following are some of the new features or changes to ANSI 85 COBOL that could affect ANSI 74 COBOL programs:

- The keyword ALPHABET must precede alphabet-name within the alphabet-name clause of the SPECIAL-NAMES paragraph. An alphabet-name is a user-defined word in the SPECIAL-NAMES paragraph that names a character set or collating sequence.
- The relative key data item specified in the RELATIVE KEY phrase must not contain the PICTURE symbol "P."
- The ALPHABETIC class test is true for uppercase letters, lowercase letters, and the space character.
- When there is no next statement to be processed in a called program, an implicit EXIT PROGRAM is run.
- No two files in a MERGE statement can be specified in the SAME AREA or SAME SORT-MERGE AREA clause. The only files in a MERGE statement that can be specified in the SAME RECORD AREA clause are those associated with the GIVING phrase.
- Within the READ statement, the INTO phrase cannot be specified unless:

  All records associated with the file and the data item specified in the INTO phrase are group items or elementary alphanumeric items, or only one record description is subordinate to the file description entry.
- Within the RETURN statement, the INTO phrase cannot be specified unless:

  All records associated with the file and data item specified in the INTO phrase are group items or elementary alphanumeric items, or only one record description is subordinate to the sort-merge file description entry.
- File position indicator - the concept of a current record pointer has been changed to a file position indicator.
- Reserved words - new reserved words have been added.
- I/O status - new I/O status values have been added.
- Pseudo-text-1 on the COPY statement must not consist entirely of a separator comma or a separator semicolon.
- A data item appearing in the USING phrase of the Procedure Division header must not have a REDEFINES clause in its data description entry.

- If the FOOTING phrase is not specified, no end-of-page condition independent of the page overflow condition exists.
- The NO REWIND phrase cannot be specified in a CLOSE statement having the REEL/UNIT phrase.
- The CANCEL and STOP RUN statements close all open files.
- When a receiving item is a variable-length data item and contains the object of the DEPENDING ON phrase, the maximum length of the item will be used.
- Within the VARYING ... AFTER phrase of the PERFORM statement, identifier-2 is augmented before identifier-5 is set.
- Any subscripts for identifier-4 in the DIVIDE statement REMAINDER phrase are evaluated after the result of the DIVIDE operation is stored in identifier-3 of the GIVING phrase.
- The phrase ADVANCING PAGE and END-OF-PAGE must not both be in a single WRITE statement.
- The picture character-string of an alphabetic item can contain only the symbol "A." No editing is allowed for the alphabetic data category.

  Note: An alphabetic character is a letter or a space character.
- When a data item described by a PICTURE containing the character "P" is referenced, the digit positions specified by "P" are considered to contain zeros in the following operations:
  - Any operation requiring a numeric sending operand
  - A MOVE statement where the sending operand is numeric and its PICTURE character-string contains the symbol "P"
  - A MOVE statement where the sending operand is numeric edited and its PICTURE character-string contains the symbol "P" and the receiving operand is numeric or numeric edited
  - A comparison operation where both operands are numeric.
- The literal in the CURRENCY SIGN clause cannot be a figurative constant.
- If the COPY statement appears in a comment-entry, it is considered part of the comment-entry.
- The following special cases of exponentiation are defined:
  - If an expression having a zero value is raised to a negative or zero power, the size error condition exists.
  - If the evaluation of the exponentiation yields both a positive and a negative real number, the positive number is returned.
  - If no real number exists as the result of the evaluation, the size error condition exists.
- When the figurative constant ALL literal is not associated with another data item, the length of the string is the length of the literal.

Appendix F. Supporting International Languages with Double-Byte Character Sets

IBM Extension

This appendix describes only those enhancements made to the COBOL programming language for writing programs that process double-byte characters.

Specifically, this appendix describes where you can use Double-Byte Character Set (DBCS) characters in each portion of a COBOL program, and considerations for working with DBCS data in the COBOL/400 language.

There are two ways to specify DBCS characters:

- Bracketed-DBCS
- DBCS-graphic data

In general, COBOL handles bracketed-DBCS characters in the same way it handles alphanumeric characters. **Bracketed-DBCS** is a character string in which each character is represented by two bytes. The character starts with a shift-out (SO) character, and ends with a shift-in (SI) character. It is up to you to know (or have the COBOL program check) which data items contain DBCS characters, and to make sure the program receives and processes this information correctly.

You can now use DDS descriptions that define DBCS-graphic data fields with your COBOL/400 programs. **DBCS-graphic** pertains to a character string where each character is represented by two bytes. The character string does not contain shift-out or shift-in characters. You cannot use source programs containing graphic data. For information on specifying graphic data items with your COBOL/400 programs, refer to “DBCS-Graphic Fields” on page 133.

Using DBCS Characters in Literals

Types of Literals

There are two types of literals in which you can use DBCS characters: the DBCS literal and the mixed literal. A mixed literal consists of Double-Byte Character Set (DBCS) and Single-Byte Character Set (SBCS) characters.

DBCS Literals: The COBOL compiler recognizes DBCS characters in DBCS literals when you use the GRAPHIC option on the PROCESS statement.

Note: The GRAPHIC option on the PROCESS statement is not to be confused with the *GRAPHIC value in the CVTOPT parameter of the CRTCBLPGM command and the CVTGRAPHIC option on the PROCESS statement, which are used to specify double-byte graphic data from a DDS description. For more information on specifying graphic data, refer to “DBCS-Graphic Fields” on page 133.

DBCS/SBCS Literals: The COBOL compiler recognizes DBCS characters in DBCS/SBCS (mixed) literals, when you are on a DBCS system and the GRAPHIC option on the PROCESS statement is not specified.

How to Specify Literals Containing DBCS Characters

When you specify any literal that contains DBCS characters, follow the same rules that apply in specifying alphanumeric literals, as well as the following rules specific to the literal types:

How to Specify a DBCS Literal: When you specify a DBCS literal, keep in mind the following:

The format for a DBCS literal is:

"0_EK1K2$0_F$"

- A quotation mark opens and closes the literal.
- A shift-out character (0_E) immediately follows the initial quotation mark and occupies 1 byte. A **shift-out** character is a control character (hex 0E) that indicates the start of a string of double-byte characters.
- A shift-in character (0_F) immediately precedes the final quotation mark and occupies 1 byte. A **shift-in** character is a control character (hex 0F) that indicates the end of a string of double-byte characters.
- All DBCS characters appear between the shift-out and shift-in characters.
- Only DBCS characters may appear in the literal (null strings are valid).

The maximum length of a DBCS literal is 80 DBCS characters, including the shift control characters. (These counted together are equivalent in length to one DBCS character.) The shift control characters are part of the literal, and take part in all operations.

See “How to Continue DBCS Literals on a New Line” on page 339 for information on how to extend DBCS literals.

How to Specify a DBCS/SBCS Literal: When you specify a DBCS/SBCS literal, keep in mind the following:

- DBCS/SBCS literals can take many different forms. The following is only one possible example:

  "SINGLE0_EK1K2K3$0_F$BYTES"
- USAGE DISPLAY must be either explicit or implicit.
- A quotation mark opens and closes the literal.
- EBCDIC characters can appear before or after any DBCS string in the mixed literal.
- All DBCS strings appear between shift-out and shift-in characters.
- Double all SBCS quotation marks that occur within the literal. DBCS quotation marks within the literal do not require doubling.
- You can use null DBCS strings (shift-out and shift-in characters without any DBCS characters) *only* when the literal contains at least one SBCS character.

The shift-out and shift-in characters cannot be nested.

The shift control characters are part of the literal, and take part in all operations.

DBCS/SBCS literals cannot continue across lines. They are restricted to the space of AREA B on one line.

Other Considerations

Quotation Marks: Although the preceding discussion uses the term *a quotation mark* to describe the character that identifies a literal, the character actually used can vary depending upon the option specified on the CRTCBLPGM CL command, or on the PROCESS statement. If you specify the APOST option, an apostrophe (') is used. Otherwise, a quotation mark (") is used. In this appendix, *a quotation mark* refers to both an apostrophe and a quotation mark. The character that you choose does not affect the rules for specifying a literal.

Shift Characters: The shift-out and shift-in characters separate EBCDIC characters from DBCS characters. They are part of both the DBCS and the DBCS/SBCS literal. Therefore, the shift code characters participate in all operations when they appear in either DBCS or DBCS/SBCS literals.

How the COBOL Compiler Checks DBCS Characters

When the COBOL compiler finds a DBCS string, it checks the DBCS string by scanning it one DBCS character at a time.

The following conditions cause the COBOL compiler to diagnose a literal containing DBCS characters as *not valid:*

- The syntax for the literal is incorrect.
- The DBCS literal is longer than one line and does *not* follow the rules for continuing nonnumeric literals. (See “How to Continue DBCS Literals on a New Line” for more information.)
- The DBCS/SBCS literal is longer than one line.

When the COBOL compiler finds a DBCS literal that is not valid, it generates an error message, and then processes the literal as an alphanumeric literal.

For each DBCS or SBCS literal that is not valid, the compiler generates an error message and accepts or ignores the literal.

How to Continue DBCS Literals on a New Line

To continue a DBCS literal onto another line of source code, do *all* of the following:

- Place a shift-in character in either column 71 or column 72 of the line to be continued (If you put the shift-in character in column 71, the blank in column 72 is ignored)
- Place a hyphen (-) in column 7 (the continuation area) of the new line
- Place a quotation mark, then a shift-out character, and then the rest of the literal in Area B of the new line.

For example:

```
-A 1 B
  ⋮
 01  DBCS1           PIC X(12)           VALUE "0EK1K2K30F
-    "0EK4K50F".
  ⋮
```

The value of DBCS1 is "0_EK1K2K3K4K5$0_F$".

The shift-in character, quotation mark, and shift-out character used to continue a line are not counted in the length of the DBCS literal. The first shift-out and final shift-in characters are counted.

Where You Can Use DBCS Characters in a COBOL Program

In general, you can use DBCS, or DBCS/SBCS literals wherever nonnumeric literals are allowed. Literals for the following, however, cannot include double-byte characters:

- ALPHABET-NAME clause
- CURRENCY SIGN clause
- ASSIGN clause
- CLASS clause
- CALL statement
- CANCEL statement.

Note: You cannot use DBCS characters for COBOL words or names. See the *COBOL/400 Reference* for information on rules for formatting COBOL system-names, reserved words, and user-defined words such as data names and file names.

How to Write Comments

You can write comments containing DBCS characters in a COBOL program by putting an asterisk (*) or slash (/) in column seven of the program line. Either symbol causes the compiler to treat any information following column seven as documentation. The slash also causes a page eject. Because the COBOL compiler does not check the contents of comment lines, DBCS characters in comments are not detected. DBCS characters that are not valid can cause the compiler listing to print improperly.

Identification Division

You can put comment entries that contain DBCS characters in any portion of the Identification Division except the PROGRAM-ID paragraph. The program name specified in the PROGRAM-ID paragraph must be alphanumeric.

Environment Division

Configuration Section

You can use DBCS characters in comment entries only in the Configuration Section paragraph. All function-names, mnemonic-names, condition-names, and alphabet-names must be specified with alphanumeric characters. For the SOURCE-COMPUTER and the OBJECT-COMPUTER entry, use the alphanumeric computer name:

IBM-AS400

You cannot use DBCS or DBCS/SBCS literals in the Configuration Section. Instead, use alphanumeric literals to define an alphabet-name and the literal in the CURRENCY SIGN clause of the SPECIAL-NAMES paragraph. There is no DBCS alphabet. Use the EBCDIC character set instead.

Input-Output Section

Specify all data names, file names, and assignment names using alphanumeric characters. You can use DBCS characters in comments.

For indexed files, the data name in the RECORD KEY clause can refer to a DBCS or DBCS/SBCS data item within a record. The number of fields in the record, plus the number of positions occupied by the record key, together cannot be greater than 120.

Note: Each DBCS character occupies two positions, and the shift control characters each occupy one position. Ensure that both the data description of the key and the key position within the file match those specified when you created the file.

You cannot use DBCS and DBCS/SBCS data as the RELATIVE KEY in relative files.

File Control Paragraph

ASSIGN Clause: You cannot use literals containing DBCS characters in the ASSIGN clause to specify an external medium such as a printer or a database.

Data Division

File Section

For the FD (File Description) Entry, you can use DBCS or DBCS/SBCS data items or literals in the VALUE OF clause. The DATA RECORDS clause can refer to data items only. Because the COBOL/400 compiler treats both the VALUE OF clause and the DATA RECORDS clause in the File Section as documentation, neither clause has any effect when you run the program. However, the COBOL compiler checks all literals in the VALUE OF clause to make sure they are valid.

For magnetic tapes, the system can only read DBCS characters from, or write DBCS characters to, the tape in the EBCDIC format. The system cannot perform tape functions involving a tape in the ASCII format. Define the alphabet-name in the CODE-SET clause as NATIVE. Use alphanumeric characters to specify the alphabet-name.

Working-Storage Section

REDEFINES Clause: The existing rules for redefining data also apply to data that contains DBCS characters. When you determine the length of a redefining or redefined data item, remember that each DBCS character is twice as long as an alphanumeric character.

Also, ensure that redefined data items contain the shift control characters when and where necessary.

OCCURS Clause: Use this clause to define tables for storing DBCS or DBCS/SBCS data. If you specify the ASCENDING/DESCENDING KEY phrase, COBOL assumes the contents of the table are in the EBCDIC program collating sequence. The shift control characters in DBCS and DBCS/SBCS data take part in the collating sequence.

For more information about handling tables that contain DBCS characters, see “Table Handling–SEARCH Statement” on page 348.

JUSTIFIED RIGHT Clause: Use the JUSTIFIED RIGHT clause to align DBCS or DBCS/SBCS data at the rightmost position of an elementary receiving field. If the receiving field is shorter than the sending field, COBOL truncates the rightmost characters. If the receiving field is longer than the sending field, COBOL pads (fills) the unused space on the left of the receiving field with blanks.

The JUSTIFIED clause does not affect the initial setting in the VALUE clause.

VALUE Clause: You can use DBCS or DBCS/SBCS literals to specify an initial value for a data item that is not numeric, or to define values for level-88 condition-name entries.

Any shift control characters in the literal are considered part of the literal's picture string, except when used to continue a new line. When you continue a DBCS literal, the compiler does *not* include the shift-in character in column 71 or 72, or the initial quotation mark (") and shift-out character on the continued line as part of the DBCS literal. Make certain, however, that the DBCS literal does not exceed the size of the data item specified in the PICTURE clause, otherwise truncation occurs.

Note: DBCS/SBCS mixed literals cannot be continued to a new line.

When you use literals that contain DBCS characters in the VALUE clause for level-88 condition-name entries, COBOL treats the DBCS characters as alphanumeric. Therefore, follow the rules for specifying alphanumeric data, including allowing a THROUGH option. This option uses the normal EBCDIC collating sequence, but remember that shift control characters in DBCS and DBCS/SBCS data take part in the collating sequence.

PICTURE Clause: Use the PICTURE symbol X to define DBCS and DBCS/SBCS data items. Because DBCS characters are twice as long as alphanumeric, and are enclosed within shift control characters, you would define a DBCS data item containing *n* DBCS characters as

```
PICTURE X(2n+2)
```

A DBCS/SBCS data item containing *m* SBCS characters, and one string of *n* DBCS characters would be defined as

```
PICTURE X(m+2n+2)
```

You can use all edited alphanumeric PICTURE symbols for DBCS and DBCS/SBCS data items. The editing symbols have the same effect on the DBCS data in these items as they do on alphanumeric data items. Check that you have obtained the desired results.

RENAMES Clause: Use this clause to specify alternative groupings of elementary data items. The existing rules for renaming alphanumeric data items also apply to DBCS and DBCS/SBCS data items.

Procedure Division

Declaratives

An identifier in the USE FOR DEBUGGING sentence of the DECLARATIVES section can refer to a DBCS or a DBCS/SBCS data item.

You cannot use DBCS characters for file names or procedure names in the USE FOR DEBUGGING sentence.

Conditional Expressions

Because condition-names (level-88 entries) can refer to data items that contain DBCS characters, you can use the condition-name condition to test this data. (See “VALUE Clause” on page 342.) Follow the rules listed in the *COBOL/400 Reference* for using conditional variables and condition-names.

You can use DBCS or DBCS/SBCS data items or literals as the operands in a relation condition. Because COBOL treats DBCS data as alphanumeric, all comparisons occur according to the rules for alphanumeric operands. Keep the following in mind:

- The system does not recognize the mixed content.
- The system uses the shift codes in comparisons of DBCS and DBCS/SBCS data.
- The system compares the data using either the EBCDIC collating sequence, or a user-defined sequence.
- In a comparison of DBCS or DBCS/SBCS items with similar items of unequal size, the smaller item is padded on the right with EBCDIC spaces.

See “SPECIAL-NAMES Paragraph” section in the *COBOL/400 Reference* for more information.

You can use class conditions and switch status conditions as described in the *COBOL/400 Reference*.

Input/Output Statements

ACCEPT Statement: The input data received from a device by using a Format 1 ACCEPT statement can include DBCS or DBCS/SBCS data. All DBCS and DBCS/SBCS data must be identified by the proper syntax. The input data, including shift control characters, replaces the existing contents of the identifier. COBOL does not perform editing or error checking on the data.

If you use the Format 3 ACCEPT statement to get OPEN-FEEDBACK information about a file, that information includes a field showing whether the file has DBCS or DBCS/SBCS data.

Information received from the local data area by a Format 4 ACCEPT statement can include DBCS or DBCS/SBCS character strings. Information received replaces the existing contents. COBOL does not perform any editing or checking for errors. This also applies to information received from the PIP data area by a Format 5 ACCEPT statement.

Using the Format 6 ACCEPT statement, you can get the attributes of a work station display and its keyboard. For display stations that can display DBCS characters, the system sets the appropriate value in the ATTRIBUTE-DATA data item. You cannot use DBCS characters to name a device.

If you use an extended (Format 7) ACCEPT statement for field-level work station input, you must ensure that DBCS data is not split across lines. COBOL does not perform any editing or checking for errors.

DISPLAY Statement: You can specify DBCS or DBCS/SBCS data items or literals in the DISPLAY statement. You can mix the types of data. DBCS and DBCS/SBCS data, from either data items or literals, is sent as it appears to the program device or local data area that is the target named on the DISPLAY statement.

Because COBOL does not know the characteristics of the device on which data is being displayed, you must make sure that the DBCS and DBCS/SBCS data is correct. It may be necessary to specify the extended display option *NOUNDSPCHAR (or the equivalent process statement parameter option) when the program is compiled, to ensure that a workstation can handle DBCS data correctly.

Note: ALL is a valid option for mixed literals.

If you use an extended (Format 3) DISPLAY statement for field-level work station output, you must ensure that DBCS data is not split across lines.

READ Statement: You can use DBCS or DBCS/SBCS data items as the RECORD KEY for an indexed file. See “Input-Output Section” on page 341 for more information.

INTO Phrase: You can read a record into a DBCS or a DBCS/SBCS data item using the INTO phrase. This phrase causes a MOVE statement (without the CORRESPONDING option) to be performed. The compiler moves DBCS and DBCS/SBCS data in the same manner that it moves alphanumeric data. It does not make sure that this data is valid.

REWRITE Statement: Use the FROM phrase of this statement to transfer DBCS or DBCS/SBCS data from a DBCS or a DBCS/SBCS data item to an existing record. The FROM phrase causes both types of data to be moved in the same manner as the INTO phrase with the READ statement. (See “READ Statement.”)

START Statement: If you use DBCS characters in the key of an indexed file, specify a corresponding data item in the KEY phrase of the START statement.

One of the following must be true:

- The data item must be the same as the data item specified in the RECORD KEY clause of the FILE-CONTROL paragraph.
- The data item has the same first character as the record key and is not longer than the record key.

You can specify valid operators (such as EQUAL, GREATER THAN, NOT LESS THAN) in the KEY phrase. The system can follow either the EBCDIC or a user-defined collating sequence.

WRITE Statement: Use the FROM phrase of this statement to write DBCS or DBCS/SBCS data to a record. This phrase moves the data in the same manner as the REWRITE statement. (See “REWRITE Statement.”)

You must include the shift control characters when you write the data into a device file.

Data Manipulation Statements

Arithmetic Statements: Because COBOL treats DBCS characters in the same manner that it treats alphanumeric characters, do not use DBCS characters in numeric operations, nor manipulate them with arithmetic statements.

INSPECT Statement: You can use any DBCS or DBCS/SBCS data item as an operand for the INSPECT statement. The system tallies and replaces on each half of a DBCS character, including the shift control characters in these operations. Therefore, the data may not be matched properly.

You can use any combination of double-byte character and alphanumeric operands and double-byte character literals or data items. If you use the REPLACING phrase, you might cause parts of the inspected item to be replaced by alphanumeric data, or vice versa.

You cannot replace a character string with a string of a different length. Consider this when replacing alphanumeric characters with DBCS characters, or vice versa.

If you want to control the use of the INSPECT statement with items containing DBCS characters, define data items containing shift control characters. Use the shift-out and shift-in characters as BEFORE/AFTER operands in the INSPECT statement.

The following example shows how you can use the INSPECT statement to replace one DBCS character with another.

```
01  SUBJECT-ITEM                 PICTURE X(50).
01  DBCS-CHARACTERS              VALUE "0EK1K20F".
    05  SHIFT-OUT                PICTURE X.
    05  DBCS-CHARACTER-1         PICTURE XX.
    05  DBCS-CHARACTER-2         PICTURE XX.
    05  SHIFT-IN                 PICTURE X.
```

The INSPECT statement would be coded as follows:

```
INSPECT SUBJECT-ITEM
    REPLACING ALL DBCS-CHARACTER-1
              BY  DBCS-CHARACTER-2
    AFTER INITIAL SHIFT-OUT.
```

Note: Using the AFTER INITIAL SHIFT-OUT phrase helps you to avoid the risk of accidentally replacing two consecutive alphanumeric characters that have the same EBCDIC values as DBCS-CHARACTER-1 (in cases where SUBJECT-ITEM contains DBCS/SBCS data).

You can also use the INSPECT statement to determine if a data item contains DBCS characters, so that appropriate processing can occur. For example:

```
01  SUBJECT-FIELD          PICTURE X(50).
01  TALLY-FIELD            PICTURE 9(3) COMP.
01  SHIFTS                 VALUE "0E0F".
    05  SHIFT-OUT          PICTURE X.
    05  SHIFT-IN           PICTURE X.
```

In the Procedure Division you might enter the following:

```
MOVE ZERO TO TALLY-FIELD.
INSPECT SUBJECT-FIELD TALLYING TALLY-FIELD
                                FOR ALL  SHIFT-OUT.
IF TALLY-FIELD IS GREATER THAN ZERO THEN
    PERFORM DBCS-PROCESSING
ELSE
    PERFORM A-N-K-PROCESSING.
```

MOVE Statement: All DBCS characters are moved as alphanumeric character strings. The system does not convert the data or examine it.

You can move DBCS/SBCS literals to group items and alphanumeric items.

If the length of the receiving field is different from that of the sending field, COBOL does one of the following:

- Truncates characters from the sending item if it is longer than the receiving item. This operation can reduce data integrity.
- Pads the sending item with blanks if it is shorter than the receiving item.

To understand more about the effect of editing symbols in the PICTURE clause of the receiving data item, see the *COBOL/400 Reference*.

SET Statement (Condition-Name Format): When you set the condition name to TRUE on this statement, COBOL moves the literal from the VALUE clause to the associated data item. You can move a literal with DBCS characters.

STRING Statement: You can use the STRING statement to construct a data item that contains DBCS or DBCS/SBCS subfields. All data in the source data items or literals, including shift control characters, is moved to the receiving data item, one-half of a DBCS character at a time.

UNSTRING Statement: The UNSTRING statement treats DBCS data and DBCS/SBCS data the same as alphanumeric data. The UNSTRING operation is performed on one-half of a DBCS character at a time.

Data items can contain both alphanumeric and DBCS characters within the same field.

Use the DELIMITED BY phrase to locate double-byte and alphanumeric subfields within a data field. Identify the data items containing shift control characters, and use those data items as identifiers on the DELIMITED BY phrase. See the following examples for more information on how to do this. Use the POINTER variable to continue scanning through subfields of the sending field.

After the system performs the UNSTRING operation, you can check the delimiters stored by the DELIMITER IN phrases against the shift control character values to see which subfields contain DBCS and which contain alphanumeric characters.

The following example shows how you might set up fields to prepare for the unstring operation on a character string that contain DBCS/SBCS data:

```
01  SUBJECT-FIELD      PICTURE X(40)
01  FILLER.
    05  UNSTRING-TABLE OCCURS 4 TIMES.
        10  RECEIVER   PICTURE X(40).
        10  DELIMTR    PICTURE X.
        10  COUNTS     PICTURE 99 COMP.
01  SHIFTS             VALUE "0E0F".
    05  SHIFT-OUT      PICTURE X.
    05  SHIFT-IN       PICTURE X.
```

Code the UNSTRING statement as follows:

```
UNSTRING SUBJECT-FIELD  DELIMITED BY SHIFT-OUT
                                    OR SHIFT-IN
INTO RECEIVER (1) DELIMITER IN DELIMTR (1)
                   COUNT     IN COUNTS (1)
INTO RECEIVER (2) DELIMITER IN DELIMTR (2)
                   COUNT     IN COUNTS (2)
INTO RECEIVER (3) DELIMITER IN DELIMTR (3)
                   COUNT     IN COUNTS (3)
INTO RECEIVER (4) DELIMITER IN DELIMTR (4)
                   COUNT     IN COUNTS (4)
ON OVERFLOW PERFORM UNSTRING-OVERFLOW-MESSAGE.
```

This UNSTRING statement divides a character string into its alphanumeric and DBCS parts. Assuming that the data in the character string is valid, a delimiter value of shift-out indicates that the corresponding receiving field contains alphanumeric data, while a value of shift-in indicates that corresponding receiving field has DBCS data. You can check the COUNT data items to determine whether each receiving field received any characters. The following figure is an example that shows the results of the UNSTRING operation just described:

```
SUBJECT-FIELD = ABC0EK1K2K30FD0EK4K5K60F
RECEIVER (1) = ABC       DELIMTR (1) = 0E   COUNTS (1) = 3
RECEIVER (2) = K1K2K3    DELIMTR (2) = 0F   COUNTS (2) = 6
RECEIVER (3) = D         DELIMTR (3) = 0E   COUNTS (3) = 1
RECEIVER (4) = K4K5K6    DELIMTR (4) = 0F   COUNTS (4) = 6


SUBJECT-FIELD = 0EK1K2K30FABC0EK40F
RECEIVER (1) = (blanks)  DELIMTR (1) = 0E   COUNTS (1) = 0
RECEIVER (2) = K1K2K3    DELIMTR (2) = 0F   COUNTS (2) = 6
RECEIVER (3) = ABC       DELIMTR (3) = 0E   COUNTS (3) = 3
RECEIVER (4) = K4        DELIMTR (4) = 0F   COUNTS (4) = 2
```

Procedure Branching Statements

You can use either a DBCS or a DBCS/SBCS literal as the operand for the STOP statement. When you do, the system displays the literal as you entered it at your work station for interactive jobs. For batch jobs, the system displays underscores where the literal would normally appear on the system operator's message queue. The system does not edit or check the contents of the literal.

Table Handling–SEARCH Statement

You can perform a Format 1 SEARCH statement (sequential search of a table) on a table that contains DBCS or DBCS/SBCS data half a DBCS character at a time.

You can also perform a Format 2 SEARCH statement (SEARCH ALL) against a DBCS or DBCS/SBCS table as well. Order the table according to the chosen collating sequence.

Note: The shift control characters in DBCS and DBCS/SBCS data participate in the comparison.

SORT/MERGE

You cannot perform a DBCS alphabet sort using COBOL. However, you can use DBCS or DBCS/SBCS data items as keys in a SORT or MERGE statement. The sort operation orders data according to the collating sequence specified in the SORT, MERGE, or SPECIAL NAMES paragraph. The system orders any shift control characters contained in DBCS and DBCS/SBCS keys.

Use the RELEASE statement to transfer records containing DBCS characters from an input/output area to the initial phase of a sort operation. The system performs the FROM phrase with the RELEASE statement in the same way it performs the FROM phrase with the WRITE statement. (See "WRITE Statement" on page 345.)

You can also use the RETURN statement to transfer records containing DBCS characters from the final phase of a sort or merge operation to an input/output area. The system performs the INTO phrase with the RETURN statement in the same manner that it performs the INTO phrase with the READ statement. (See "READ Statement" on page 344.)

Compiler-Directing Statements

COPY Statement

You can use the COPY statement to copy source text that contains DBCS characters into a COBOL program. When you do, make sure that you specify the member name, file name, and library name using alphanumeric data, and that you specify these names according to the rules stated in the *COBOL/400 Reference*.

Use the Format 2 COPY statement to copy fields defined in the data description specifications (DDS). DBCS and DBCS/SBCS data items (the value in column 35 of the DDS form is O) are copied into a COBOL program in the PICTURE X(n) format. The compiler listing does not indicate that these fields contain DBCS characters, unless a field is a key field. In those cases, the system prints an O in the comment table for keys.

DBCS-graphic data items are copied into a COBOL program in the PICTURE X(N) format. The compiler listing indicates that these fields contain graphic data. See

“DBCS-Graphic Fields” on page 133 for a description of the DBCS-graphic data type.

You can put DBCS characters in text comments that are copied from DDS if the associated DDS field has comments.

If you specify the REPLACING phrase of the COPY statement, consider the following:

- Pseudo-text can contain any combination of DBCS and alphanumeric characters.
- You can use literals with DBCS or DBCS/SBCS content.
- Identifiers can refer to data items that contain DBCS characters.

TITLE Statement

You can use DBCS/SBCS literals as the literal in the TITLE statement.

Communications between Programs

You can specify entries for DBCS or DBCS/SBCS data items in the Linkage Section of the Data Division.

You can pass DBCS characters from one program to another program by specifying those data items in the USING phrase. You cannot use DBCS characters in the CALL statement for the program-name of the called program.

You cannot use DBCS characters in the CANCEL statement because they specify program-names.

FIPS Flagger

Enhancements to the COBOL language that let you use DBCS characters are flagged (identified) by the FIPS (Federal Information Processing Standard) flagger provided by the compiler as IBM extensions.

COBOL Program Listings

DBCS characters can appear in listings that originate from DBCS-capable source files, and that are produced on DBCS-capable systems.

DBCS characters that appear in a program listing originate from the source file, from source text generated by the COPY statement, or from COBOL compiler messages.

A listing containing DBCS characters should be output to a printer file that is capable of processing DBCS data. Listings containing DBCS characters are handled correctly if one of the following conditions is true:

- The printer file specified by the PRTFILE parameter of the CRTCBLPGM command is defined with the required attribute, using the CRTPRTF or CHGPRTF command.
- The source file is defined as capable of containing DBCS data using the IGCDTA parameter of the CRTSRCPF command. In this case, the program overrides the existing value of the attribute for the output printer file.

- The user has specified the required attribute for the output printer, using the IGCDTA parameter of the OVRPRTF command, before compiling the program.

Note: The IGCDTA parameter is only available on DBCS systems, and it cannot be defined or displayed on non-DBCS systems. You can, however, create objects with DBCS attributes on a non-DBCS system by copying them from a DBCS system. You should check for possible incompatibilities if you do this.

The compiler may use characters from your source program as substitution parameters in compiler and syntax checker messages. The system does not check or edit the substitution parameters. If you do not specify DBCS characters properly, the system may print or display parts of messages incorrectly.

End of IBM Extension

Appendix G. AS/400 File Processing Examples

This appendix contains sample programs that illustrate the fundamental programming techniques associated with each type of AS/400 file organization. These examples are intended to be used for planning purposes only, and to illustrate the input/output statements necessary for certain access methods. Other COBOL features (the use of the PERFORM statement, for example) are used only incidentally. The programs illustrated are:

- Sequential File Creation
- Sequential File Updating and Extension
- Indexed File Creation
- Indexed File Updating
- Relative File Creation
- Relative File Updating
- Relative File Retrieval.

Sequential File Creation

This program creates a sequential file of employee salary records. The input records are arranged in ascending order of employee number. The output file has the identical order. (An **output file** is a file that is opened in either the output mode or the extend mode.)

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000010 IDENTIFICATION DIVISION.
    2  000020 PROGRAM-ID.  CRTSEQ.
       000030
    3  000040 ENVIRONMENT DIVISION.
    4  000050 CONFIGURATION SECTION.
    5  000060 SOURCE-COMPUTER.   IBM-AS400.                                                          05/24/94
    6  000070 OBJECT-COMPUTER.   IBM-AS400.                                                          05/24/94
    7  000080 SPECIAL-NAMES.  CONSOLE IS TYPEWRITER.
    8  000090 INPUT-OUTPUT SECTION.
    9  000100 FILE-CONTROL.
   10  000110     SELECT INPUT-FILE ASSIGN TO DISK-FILEA
   11  000120         FILE STATUS IS INPUT-FILE-STATUS.
   12  000130     SELECT OUTPUT-FILE ASSIGN TO DISK-FILEB
   13  000140         FILE STATUS IS OUTPUT-FILE-STATUS.
   14  000150 DATA DIVISION.
   15  000160 FILE SECTION.
   16  000170 FD  INPUT-FILE LABEL RECORDS STANDARD.
   17  000180 01  INPUT-RECORD.
   18  000190     05  INPUT-EMPLOYEE-NUMBER      PICTURE 9(6).
   19  000200     05  INPUT-EMPLOYEE-NAME        PICTURE X(28).
   20  000210     05  INPUT-EMPLOYEE-CODE        PICTURE 9.
   21  000220     05  INPUT-EMPLOYEE-SALARY      PICTURE 9(6)V99.
   22  000230 FD  OUTPUT-FILE LABEL RECORDS STANDARD.
   23  000240 01  OUTPUT-RECORD.
   24  000250     05  OUTPUT-EMPLOYEE-NUMBER     PICTURE 9(6).
   25  000260     05  OUTPUT-EMPLOYEE-NAME       PICTURE X(28).
   26  000270     05  OUTPUT-EMPLOYEE-CODE       PICTURE 9.
   27  000280     05  OUTPUT-EMPLOYEE-SALARY     PICTURE 9(6)V99.
   28  000290 WORKING-STORAGE SECTION.
   29  000300 77  INPUT-FILE-STATUS              PICTURE XX.
   30  000310 77  OUTPUT-FILE-STATUS             PICTURE XX.
   31  000320 01  INPUTEND                       PICTURE X VALUE SPACE.
   32  000330     88  THE-END-OF-INPUT           VALUE "E".
   33  000340 01  DISP-RECORD.
   34  000350     05  OP-NAME                    PICTURE X(7).
   35  000360     05  FILLER                     PICTURE XX VALUE SPACE.
   36  000370     05  FILE-NAME                  PICTURE X(11).
   37  000380     05  FILLER                     PICTURE XX VALUE SPACE.
   38  000390     05  FILLER                     PICTURE X(14)
   39  000400                                    VALUE "FILE STATUS IS".
   40  000410     05  FILLER                     PICTURE XX VALUE SPACE.
   41  000420     05  SK                         PICTURE XX.
   42  000430 PROCEDURE DIVISION.
       000440 DECLARATIVES.
       000450 I-O-ERROR SECTION.
       000460           USE AFTER STANDARD ERROR PROCEDURE ON INPUT-FILE,
       000470                                                OUTPUT-FILE.
       000480 I-O-ERROR-PARA.
       000490************************************************************
       000500* DUMMY DECLARATIVES TO ENSURE CONTROL IS RETURNED TO THIS *
       000510* PROGRAM WHEN AN ERROR OCCURS DURING FILE PROCESSING.     *
       000520* ERROR HANDLING IS DONE AFTER EACH I/O STATEMENT.         *
       000530************************************************************
       000540 END DECLARATIVES.
       000550 MAIN-PROGRAM SECTION.
       000560 OPEN-FILES.
   43  000570     OPEN INPUT INPUT-FILE
       000580         OUTPUT OUTPUT-FILE.
   44  000590     IF INPUT-FILE-STATUS NOT = "00"
   45  000600         MOVE "OPEN" TO OP-NAME
   46  000610         MOVE "INPUT-FILE" TO FILE-NAME
   47  000620         MOVE INPUT-FILE-STATUS TO SK
   48  000630         PERFORM ERROR-OUT-1 THROUGH ERROR-OUT-2.
   49  000640     IF OUTPUT-FILE-STATUS NOT = "00"
   50  000650        MOVE "OPEN" TO OP-NAME
   51  000660        MOVE "OUTPUT-FILE" TO FILE-NAME
   52  000670        MOVE OUTPUT-FILE-STATUS TO SK
   53  000680        PERFORM ERROR-OUT-1 THROUGH ERROR-OUT-2.
   54  000690     PERFORM BUILD-FILE UNTIL THE-END-OF-INPUT.
       000700 CLOSE-FILES.
   55  000710        CLOSE INPUT-FILE
       000720              OUTPUT-FILE.
   56  000730        STOP RUN.
       000740 BUILD-FILE.
```

Figure 112 (Part 1 of 2). Example of a Sequential File of Employee Salary Records

```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    57  000750     READ INPUT-FILE INTO OUTPUT-RECORD
    58  000760         AT END SET THE-END-OF-INPUT TO TRUE.
    59  000770     IF INPUT-FILE-STATUS NOT = "00"
    60  000780           MOVE "WRITE" TO OP-NAME
    61  000790           MOVE "OUTPUT-FILE" TO FILE-NAME
    62  000800           MOVE OUTPUT-FILE-STATUS TO SK
    63  000810           PERFORM ERROR-OUT-1 THROUGH ERROR-OUT-2
    64  000820           GO TO CLOSE-FILES.
    65  000830       WRITE OUTPUT-RECORD.
    66  000840       IF OUTPUT-FILE-STATUS NOT = "00"
    67  000850           MOVE "WRITE" TO OP-NAME
    68  000860           MOVE "OUTPUT-FILE" TO FILE-NAME
    69  000870           MOVE OUTPUT-FILE-STATUS TO SK
    70  000880           PERFORM ERROR-OUT-1 THROUGH ERROR-OUT-2
    71  000890           GO TO CLOSE-FILES.
        000900 ERROR-OUT-1.
    72  000910           DISPLAY "FILE PROCESSING ERROR" UPON TYPEWRITER.
    73  000920           DISPLAY DISP-RECORD UPON TYPEWRITER.
    74  000930           CLOSE INPUT-FILE
        000940                 OUTPUT-FILE.
    75  000950           STOP RUN.
        000960 ERROR-OUT-2.
        000970     EXIT.
                            * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                   AS/400 COBOL Messages
  STMT
*   16  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000170
        Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
          will be performed by compiler-generated code.
*   22  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000230
        Message . . . . :   Blocking/Deblocking for file 'OUTPUT-FILE'
          will be performed by compiler-generated code.
*   43  MSGID: LBL0335  SEVERITY: 00  SEQNBR:  000540
        Message . . . . :   Empty paragraph or section precedes 'END
          DECLARATIVES' paragraph or section.
                        * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                          Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      3         3            0                0                0                 0
 Source records read . . . . . . . . :   97
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program CRTSEQ created in library XMPLIB.
                       * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 112 (Part 2 of 2). Example of a Sequential File of Employee Salary Records

Sequential File Updating and Extension

This program updates and extends the file created by the CRTSEQ program. The INPUT-FILE and the MASTER-FILE are each read. When a match is found between INPUT-EMPLOYEE-NUMBER and MST-EMPLOYEE-NUMBER, the input record replaces the original record. After the MASTER-FILE is processed, new employee records are added to the end of the file.

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000010 IDENTIFICATION DIVISION.
    2  000020 PROGRAM-ID.  UPDTSEQ.
    3  000030 ENVIRONMENT DIVISION.
    4  000040 CONFIGURATION SECTION.
    5  000050 SOURCE-COMPUTER.  IBM-AS400.                                                            05/24/94
    6  000060 OBJECT-COMPUTER.  IBM-AS400.                                                            05/24/94
    7  000070 INPUT-OUTPUT SECTION.
    8  000080 FILE-CONTROL.
    9  000090     SELECT INPUT-FILE ASSIGN TO DISK-FILES
   10  000100         FILE STATUS IS INPUT-FILE-STATUS.  A
   11  000110     SELECT MASTER-FILE ASSIGN TO DISK-MSTFILEB
   12  000120         FILE STATUS IS MASTER-FILE-STATUS.  B
       000130
   13  000140 DATA DIVISION.
   14  000150 FILE SECTION.
   15  000160 FD  INPUT-FILE LABEL RECORDS STANDARD.
   16  000170 01  INPUT-RECORD.
   17  000180     05  INPUT-EMPLOYEE-NUMBER      PICTURE 9(6).
   18  000190     05  INPUT-EMPLOYEE-NAME        PICTURE X(28).
   19  000200     05  INPUT-EMPLOYEE-CODE        PICTURE 9.
   20  000210     05  INPUT-EMPLOYEE-SALARY      PICTURE 9(6)V99.
   21  000220 FD  MASTER-FILE LABEL RECORDS STANDARD.
   22  000230 01  MASTER-RECORD.
   23  000240     05 MST-EMPLOYEE-NUMBER         PICTURE 9(6).
   24  000250     05 MST-EMPLOYEE-NAME           PICTURE X(28).
   25  000260     05 MST-EMPLOYEE-CODE           PICTURE 9.
   26  000270     05 MST-EMPLOYEE-SALARY         PICTURE 9(6)V99.
   27  000280 WORKING-STORAGE SECTION.
   28  000290 77  INPUT-FILE-STATUS              PICTURE XX.
   29  000300 77  MASTER-FILE-STATUS             PICTURE XX.
   30  000310 01  INPUTEND                       PICTURE X VALUE SPACE.
   31  000320     88 THE-END-OF-INPUT            VALUE "E".
   32  000330 01  MASTEREND                      PICTURE X VALUE SPACE.
   33  000340     88 THE-END-OF-MASTER           VALUE "E".
   34  000350 01  ERROR-INFO.
   35  000360     05 OP-NAME                     PICTURE X(12).
   36  000370     05 FILLER                      PICTURE XX VALUE SPACE.
   37  000380     05 FILE-NAME                   PICTURE X(11).
   38  000390     05 FILLER                      PICTURE XX VALUE SPACE.
   39  000400     05 FILLER                      PICTURE X(14)
   40  000410                                    VALUE "FILE STATUS IS".
   41  000420     05 FILLER                      PICTURE XX VALUE SPACE.
   42  000430     05 SK                          PICTURE XX.
   43  000440 PROCEDURE DIVISION.
       000450 DECLARATIVES.
       000460 INPUT-FILE-ERROR SECTION.
       000470      USE AFTER STANDARD ERROR PROCEDURE ON INPUT-FILE.  C
       000480 INPUT-FILE-ERROR-PARA.
   44  000490        MOVE INPUT-FILE-STATUS TO SK.
   45  000500        MOVE "INPUT-FILE" TO FILE-NAME.
   46  000510        DISPLAY "FILE PROCESSING ERROR".
   47  000520        DISPLAY ERROR-INFO.
   48  000530        DISPLAY "PROCESSING TERMINATED DUE TO I-O ERROR".
   49  000540        STOP RUN.
       000550 I-O-FILE-ERROR SECTION.
       000560     USE AFTER STANDARD ERROR PROCEDURE ON MASTER-FILE.  D
       000570 MASTER-FILE-ERROR-PARA.
   50  000580        MOVE MASTER-FILE-STATUS TO SK.
   51  000590        MOVE "MASTER-FILE" TO FILE-NAME.
   52  000600        DISPLAY "FILE PROCESSING ERROR".
   53  000610        DISPLAY ERROR-INFO.
   54  000620        DISPLAY "PROCESSING TERMINATED DUE TO I-O ERROR".
   55  000630        STOP RUN.
       000640 END DECLARATIVES.
       000650 MAIN-PROGRAM SECTION.
       000660 OPEN-FILES.
   56  000670        MOVE "OPEN" TO OP-NAME.
   57  000680        OPEN INPUT INPUT-FILE
       000690             I-O   MASTER-FILE.
       000700 PROCESSING-LOGIC.
   58  000710       PERFORM READ-INPUT-FILE.
   59  000720       PERFORM READ-MASTER-FILE.
   60  000730       PERFORM PROCESS-FILES UNTIL THE-END-OF-INPUT.
```

Figure 113 (Part 1 of 2). Example of a Sequential File Update Program

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        000740 CLOSE-FILES.
    61  000750       MOVE "CLOSE" TO OP-NAME.
    62  000760       CLOSE MASTER-FILE
        000770             INPUT-FILE.
    63  000780       STOP RUN.
        000790 READ-INPUT-FILE.
    64  000800       MOVE "READ" TO OP-NAME.
    65  000810       READ INPUT-FILE
    66  000820           AT END SET THE-END-OF-INPUT TO TRUE.
        000830 READ-MASTER-FILE.
    67  000840       MOVE "READ" TO OP-NAME.
    68  000850       READ MASTER-FILE
        000860           AT END
    69  000870              SET THE-END-OF-MASTER TO TRUE
    70  000880              MOVE "AT END CLOSE" TO OP-NAME
    71  000890              CLOSE MASTER-FILE
    72  000900              MOVE "OPEN EXTEND" TO OP-NAME
    73  000910              OPEN EXTEND MASTER-FILE.
        000920 PROCESS-FILES.
    74  000930     IF THE-END-OF-MASTER
    75  000940         WRITE MASTER-RECORD FROM INPUT-RECORD
    76  000950         PERFORM READ-INPUT-FILE
        000960     ELSE
    77  000970         IF MST-EMPLOYEE-NUMBER LESS THAN INPUT-EMPLOYEE-NUMBER
    78  000980            PERFORM READ-MASTER-FILE
        000990        ELSE
    79  001000           IF MST-EMPLOYEE-NUMBER = INPUT-EMPLOYEE-NUMBER
    80  001010              MOVE "REWRITE" TO OP-NAME
    81  001020              REWRITE MASTER-RECORD FROM INPUT-RECORD
    82  001030              PERFORM READ-INPUT-FILE
    83  001040              PERFORM READ-MASTER-FILE
        001050           ELSE
    84  001060               DISPLAY "ERROR RECORD -> ", INPUT-EMPLOYEE-NUMBER
    85  001070               PERFORM READ-INPUT-FILE.
                            * * * * *  E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                    AS/400 COBOL Messages
  STMT
*   15  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000160
        Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
          will be performed by compiler-generated code.
                        * * * * *  E N D   O F   M E S S A G E S   * * * * *
                                           Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
        1         1             0                0               0                 0
 Source records read . . . . . . . . :   107
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program UPDTSEQ created in library XMPLIB.
                       * * * * *  E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 113 (Part 2 of 2). Example of a Sequential File Update Program

The example in Figure 113 on page 354 includes:

A A FILE STATUS clause so that the program records the status of the most recent I/O request involving INPUT-FILE.

B A FILE STATUS clause so that the program records the status of the most recent I/O request involving MASTER-FILE.

C A USE procedure that is run when an I/O error occurs during the processing of INPUT-FILE.

D A USE procedure that is run when an I/O error occurs during the processing of MASTER-FILE.

File status values and USE procedures play important roles in *error handling*. For more information, see Chapter 6, “COBOL/400 Exception and Error Handling.”

Indexed File Creation

An **indexed file** is a file that records the key and the position of each record in a separate part of the file called an index.

This program creates an indexed file of summary records for bank depositors. The key within each indexed file record is INDEX-KEY (the depositor's account number); the input records are ordered in ascending sequence upon this key. Records are read from the input file and transferred to the indexed file record area. The indexed file record is then written.

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 IDENTIFICATION DIVISION.
     2  000020 PROGRAM-ID.  CRTIND.
        000030
     3  000040 ENVIRONMENT DIVISION.
     4  000050 CONFIGURATION SECTION.
     5  000060 SOURCE-COMPUTER. IBM-AS400.                                                             05/24/94
     6  000070 OBJECT-COMPUTER. IBM-AS400.                                                             05/24/94
     7  000080 INPUT-OUTPUT SECTION.
     8  000090 FILE-CONTROL.
     9  000100     SELECT INDEXED-FILE ASSIGN TO DISK-INDEXFILE
    10  000110         ORGANIZATION IS INDEXED
    11  000120         ACCESS IS SEQUENTIAL
    12  000130         RECORD KEY IS INDEX-KEY
    13  000140         FILE STATUS IS INDEXED-FILE-STATUS.
    14  000150     SELECT INPUT-FILE ASSIGN TO DISK-FILEG
    15  000160         FILE STATUS IS INPUT-FILE-STATUS.
    16  000170 DATA DIVISION.
    17  000180 FILE SECTION.
    18  000190 FD  INDEXED-FILE LABEL RECORDS STANDARD.
    19  000200 01  INDEX-RECORD.
    20  000210     05  INDEX-KEY                   PICTURE X(10).
    21  000220     05  INDEX-FLD1                  PICTURE X(10).
    22  000230     05  INDEX-NAME                  PICTURE X(20).
    23  000240     05  INDEX-BAL                   PICTURE S9(5)V99.
    24  000250 FD  INPUT-FILE LABEL RECORDS STANDARD.
    25  000260 01  INPUT-RECORD.
    26  000270     05  INPUT-KEY                   PICTURE X(10).
    27  000280     05  INPUT-NAME                  PICTURE X(20).
    28  000290     05  INPUT-BAL                   PICTURE S9(5)V99.
    29  000300 WORKING-STORAGE SECTION.
    30  000310 77  INDEXED-FILE-STATUS             PICTURE XX.
    31  000320 77  INPUT-FILE-STATUS               PICTURE XX.
    32  000330 77  OP-NAME                         PICTURE X(7).
    33  000340 01  INPUTEND                        PICTURE X VALUE SPACES.
    34  000350     88  THE-END-OF-INPUT            VALUE "E".
    35  000360 01  ERRORFLAG                       PICTURE X VALUE SPACES.
    36  000370     88  ERROR-OCCURRED              VALUE "1".
    37  000380 PROCEDURE DIVISION.
        000390 DECLARATIVES.
        000400 INPUT-ERROR SECTION.
        000410       USE AFTER STANDARD ERROR PROCEDURE ON INPUT.
        000420 INPUT-ERROR-PARA.
    38  000430     DISPLAY "UNEXPECTED ERROR ON ", OP-NAME, " FOR INPUT-FILE ".
    39  000440     DISPLAY "FILE STATUS IS ", INPUT-FILE-STATUS.
    40  000450     SET ERROR-OCCURRED TO TRUE.
        000460 OUTPUT-ERROR SECTION.
        000470       USE AFTER STANDARD ERROR PROCEDURE ON OUTPUT.
        000480 OUTPUT-ERROR-PARA.
    41  000490     DISPLAY "UNEXPECTED ERROR ON ", OP-NAME, " FOR INDEXED-FILE ".
    42  000500     DISPLAY "FILE STATUS IS ", INDEXED-FILE-STATUS.
    43  000510     SET ERROR-OCCURRED TO TRUE.
        000520 END DECLARATIVES.
        000530 MAIN-PROCESSING SECTION.
        000540 MAIN-PROCEDURE.
    44  000550     MOVE "OPEN" TO OP-NAME.
    45  000560     OPEN INPUT INPUT-FILE
        000570         OUTPUT INDEXED-FILE.
    46  000580     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
    48  000590     PERFORM READ-INPUT-FILE.
    49  000600     PERFORM LOAD-INDEXED-FILE THRU READ-INPUT-FILE
        000610                              UNTIL THE-END-OF-INPUT.
```

Figure 114 (Part 1 of 2). Example of an Indexed File Program

```
 5763CB1 V3R0M5                  AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    50  000620     MOVE "CLOSE" TO OP-NAME.
    51  000630     CLOSE INPUT-FILE
        000640           INDEXED-FILE.
    52  000650     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
    54  000660     STOP RUN.
        000670 LOAD-INDEXED-FILE.
    55  000680     MOVE INPUT-KEY TO INDEX-KEY.
    56  000690     MOVE INPUT-NAME TO INDEX-NAME.
    57  000700     MOVE INPUT-BAL TO INDEX-BAL.
    58  000710     MOVE SPACES TO INDEX-FLD1.
    59  000720     MOVE "WRITE" TO OP-NAME.
    60  000730     WRITE INDEX-RECORD
        000740           INVALID KEY
    61  000750               DISPLAY "WRITE FAILED FOR KEY ", INDEX-KEY.
    62  000760     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
        000770 READ-INPUT-FILE.
    64  000780     MOVE "READ" TO OP-NAME.
    65  000790     READ INPUT-FILE
    66  000800          AT END SET THE-END-OF-INPUT TO TRUE.
    67  000810     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
        000820 ERROR-TERMINATION.
    69  000830     DISPLAY "I-O ERROR OCCURRED - PROCESS TERMINATING".
    70  000840     STOP RUN.
                              * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                  AS/400 COBOL Messages
  STMT
*   18  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000190
        Message . . . . :   Blocking/Deblocking for file 'INDEXED-FILE'
          will be performed by compiler-generated code.
*   24  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000250
        Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
          will be performed by compiler-generated code.
                          * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                            Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      2         2            0               0               0                0
 Source records read . . . . . . . . :   84
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program CRTIND created in library XMPLIB.
                         * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 114 (Part 2 of 2). Example of an Indexed File Program

Indexed File Updating

This program updates the indexed file created in the `CRTIND` program, using dynamic access.

The input records contain the key for the record, the depositor name, and the amount of the transaction.

When the input record is read, the program tests for:

- If this is a transaction record (in which case, all fields of the record are filled)
- If this is a record requesting sequential retrieval of a specific generic class (in which case, only the `INPUT-GEN-FLD` field of the input record contains data).

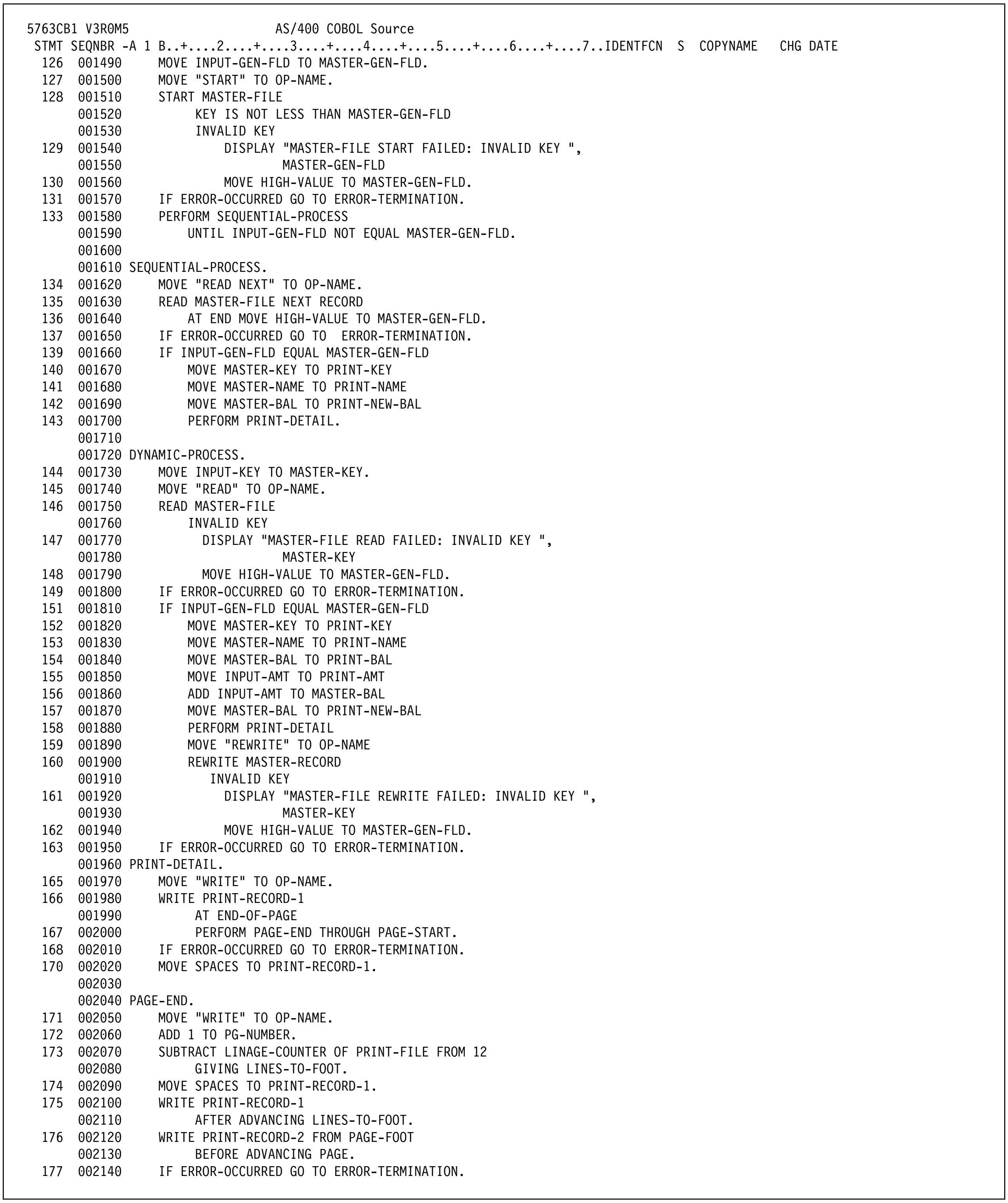
Random access is used for the updating and printing of the transaction records. Sequential access is used for the retrieval and printing of all records within one generic class.

```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 IDENTIFICATION DIVISION.
     2  000020 PROGRAM-ID.  UPDTIND.
        000030
     3  000040 ENVIRONMENT DIVISION.
     4  000050 CONFIGURATION SECTION.
     5  000060 SOURCE-COMPUTER. IBM-AS400.                                                          05/24/94
     6  000070 OBJECT-COMPUTER. IBM-AS400.                                                          05/24/94
     7  000080 INPUT-OUTPUT SECTION.
     8  000090 FILE-CONTROL.
     9  000100     SELECT MASTER-FILE ASSIGN TO DISK-INDXFILE
    10  000110         ORGANIZATION IS INDEXED
    11  000120         ACCESS IS DYNAMIC
    12  000130         RECORD KEY IS MASTER-KEY
    13  000140         FILE STATUS IS MASTER-FILE-STATUS.
    14  000150     SELECT INPUT-FILE ASSIGN TO DISK-FILEH
    15  000160         FILE STATUS IS INPUT-FILE-STATUS.
    16  000170     SELECT PRINT-FILE ASSIGN TO PRINTER-QSYSPRT
    17  000180         FILE STATUS IS PRINT-FILE-STATUS.
    18  000190 DATA DIVISION.
    19  000200 FILE SECTION.
    20  000210 FD  MASTER-FILE LABEL RECORDS STANDARD.
    21  000220 01  MASTER-RECORD.
    22  000230     05  MASTER-KEY.
    23  000240       10    MASTER-GEN-FLD   PICTURE X(5).
    24  000250       10    MASTER-DET-FLD   PICTURE X(5).
    25  000260     05  MASTER-FLD1          PICTURE X(10).
    26  000270     05  MASTER-NAME          PICTURE X(20).
    27  000280     05  MASTER-BAL           PICTURE S9(5)V99.
    28  000290 FD  INPUT-FILE LABEL RECORDS STANDARD.
    29  000300 01  INPUT-REC.
    30  000310     05  INPUT-KEY.
    31  000320       10  INPUT-GEN-FLD      PICTURE X(5).
    32  000330       10  INPUT-DET-FLD      PICTURE X(5).
    33  000340     05  INPUT-NAME           PICTURE X(20).
    34  000350     05  INPUT-AMT            PICTURE S9(5)V99.
    35  000360 FD  PRINT-FILE LABEL RECORDS OMITTED
    36  000370     LINAGE 12 LINES FOOTING AT 9.
    37  000380 01  PRINT-RECORD-1.
    38  000390     05  PRINT-KEY            PICTURE X(10).
    39  000400     05  FILLER               PICTURE X(5).
    40  000410     05  PRINT-NAME           PICTURE X(20).
    41  000420     05  FILLER               PICTURE X(5).
    42  000430     05  PRINT-BAL            PICTURE $$$,$$9.99-.
    43  000440     05  FILLER               PICTURE X(7).
    44  000450     05  PRINT-AMT            PICTURE $$$,$$9.99-.
    45  000460     05  FILLER               PICTURE X(5).
    46  000470     05  PRINT-NEW-BAL        PICTURE $$$,$$9.99-.
    47  000480 01  PRINT-RECORD-2           PICTURE X(89).
    48  000490 WORKING-STORAGE SECTION.
    49  000500 77  MASTER-FILE-STATUS       PICTURE XX.
    50  000510 77  INPUT-FILE-STATUS        PICTURE XX.
    51  000520 77  PRINT-FILE-STATUS        PICTURE XX.
    52  000530 77  LINES-TO-FOOT            PICTURE 99.
    53  000540 01  PAGE-HEAD.
    54  000550     05  FILLER               PICTURE X(38) VALUE SPACES.
    55  000560     05  FILLER               PICTURE X(13) VALUE "UPDATE REPORT".
    56  000570     05  FILLER               PICTURE X(38) VALUE SPACES.
    57  000580 01  COLUMN-HEAD.
    58  000590     05  FILLER               PICTURE X(6)  VALUE "KEY ID".
    59  000600     05  FILLER               PICTURE X(9)  VALUE SPACES.
    60  000610     05  FILLER               PICTURE X(4)  VALUE "NAME".
    61  000620     05  FILLER               PICTURE X(21) VALUE SPACES.
    62  000630     05  FILLER               PICTURE X(11) VALUE "CUR BALANCE".
    63  000640     05  FILLER               PICTURE X(6)  VALUE SPACES.
    64  000650     05  FILLER               PICTURE X(13) VALUE "UPDATE AMOUNT".
    65  000660     05  FILLER               PICTURE X(4)  VALUE SPACES.
    66  000670     05  FILLER               PICTURE X(11) VALUE "NEW BALANCE".
    67  000680     05  FILLER               PICTURE X(4)  VALUE SPACES.
    68  000690 01  PAGE-FOOT.
    69  000700     05  FILLER               PICTURE X(81)  VALUE SPACES.
    70  000710     05  FILLER               PICTURE A(6)   VALUE "PAGE  ".
    71  000720     05  PG-NUMBER            PICTURE 99     VALUE 00.
        000730
    72  000740 01  INPUTEND                 PICTURE X VALUE SPACE.
    73  000750     88  THE-END-OF-INPUT               VALUE "E".
```

Figure 115 (Part 1 of 4). Example of an Indexed File Update Program

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   74  000760 01  ERRORFLAG                PICTURE X VALUE SPACE.
   75  000770     88  ERROR-OCCURRED                 VALUE "1".
   76  000780 01  ERROR-DATA.
   77  000790     05  FILLER               PICTURE X(21)
   78  000800                                VALUE "STATEMENT FAILING IS ".
   79  000810     05  OP-NAME              PICTURE X(9).
   80  000820     05  FILLER               PICTURE X(16)
   81  000830                                VALUE "FILE STATUS IS".
   82  000840     05  STATUS-VALUE         PICTURE XX.
   83  000850 01  INPUT-MESSAGE.
   84  000860     05  FILLER               PICTURE X(30)
   85  000870         VALUE "UNEXPECTED ERROR ON INPUT-FILE" .
   86  000880 01  I-O-MESSAGE.
   87  000890     05  FILLER               PICTURE X(31)
   88  000900         VALUE "UNEXPECTED ERROR ON MASTER-FILE" .
   89  000910 01  OUTPUT-MESSAGE.
   90  000920     05  FILLER               PICTURE X(30)
   91  000930         VALUE "UNEXPECTED ERROR ON PRINT-FILE" .
   92  000940 PROCEDURE DIVISION.
       000950 DECLARATIVES.
       000960 INPUT-ERROR SECTION.
       000970       USE AFTER STANDARD ERROR PROCEDURE ON INPUT.
       000980 INPUT-ERROR-PARA.
   93  000990       DISPLAY INPUT-MESSAGE.
   94  001000       MOVE INPUT-FILE-STATUS TO STATUS-VALUE.
   95  001010       DISPLAY ERROR-DATA.
   96  001020       SET ERROR-OCCURRED TO TRUE.
       001030 I-O-ERROR SECTION.
       001040     USE AFTER STANDARD ERROR PROCEDURE ON I-O.
       001050 I-O-ERROR-PARA.
   97  001060       DISPLAY I-O-MESSAGE.
   98  001070       MOVE MASTER-FILE-STATUS TO STATUS-VALUE.
   99  001080       DISPLAY ERROR-DATA.
  100  001090       SET ERROR-OCCURRED TO TRUE.
       001100 OUTPUT-ERROR SECTION.
       001110       USE AFTER STANDARD ERROR PROCEDURE ON OUTPUT.
       001120 OUTPUT-ERROR-PARA.
  101  001130       DISPLAY OUTPUT-MESSAGE.
  102  001140       MOVE PRINT-FILE-STATUS TO STATUS-VALUE.
  103  001150       DISPLAY ERROR-DATA.
  104  001160     SET ERROR-OCCURRED TO TRUE.
       001170 END DECLARATIVES.
       001180 MAIN-PROCESSING SECTION.
       001190 MAIN-PROCEDURE.
  105  001200     MOVE "OPEN" TO OP-NAME.
  106  001210     OPEN INPUT INPUT-FILE
       001220         I-O MASTER-FILE
       001230         OUTPUT PRINT-FILE.
  107  001240     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
  109  001250     PERFORM PAGE-START.
  110  001260     PERFORM READ-INPUT-FILE.
  111  001270     PERFORM PROCESS-DATA THRU READ-INPUT-FILE
       001280                          UNTIL THE-END-OF-INPUT.
  112  001290     PERFORM PAGE-END.
  113  001300     MOVE "CLOSE" TO OP-NAME.
  114  001310     CLOSE INPUT-FILE
       001320           MASTER-FILE
       001330           PRINT-FILE.
  115  001340     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
  117  001350     STOP RUN.
       001360
       001370 PROCESS-DATA.
  118  001380     IF INPUT-DET-FLD EQUAL SPACES
  119  001390         PERFORM INIT-SEQUENTIAL-PROCESS
       001400     ELSE
  120  001410         PERFORM DYNAMIC-PROCESS.
       001420 READ-INPUT-FILE.
  121  001430     MOVE "READ" TO OP-NAME.
  122  001440     READ INPUT-FILE
  123  001450         AT END SET THE-END-OF-INPUT TO TRUE.
  124  001460     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
       001470
       001480 INIT-SEQUENTIAL-PROCESS.
```

Figure 115 (Part 2 of 4). Example of an Indexed File Update Program



```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
  126  001490     MOVE INPUT-GEN-FLD TO MASTER-GEN-FLD.
  127  001500     MOVE "START" TO OP-NAME.
  128  001510     START MASTER-FILE
       001520          KEY IS NOT LESS THAN MASTER-GEN-FLD
       001530          INVALID KEY
  129  001540              DISPLAY "MASTER-FILE START FAILED: INVALID KEY ",
       001550                      MASTER-GEN-FLD
  130  001560              MOVE HIGH-VALUE TO MASTER-GEN-FLD.
  131  001570     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
  133  001580     PERFORM SEQUENTIAL-PROCESS
       001590         UNTIL INPUT-GEN-FLD NOT EQUAL MASTER-GEN-FLD.
       001600
       001610 SEQUENTIAL-PROCESS.
  134  001620     MOVE "READ NEXT" TO OP-NAME.
  135  001630     READ MASTER-FILE NEXT RECORD
  136  001640         AT END MOVE HIGH-VALUE TO MASTER-GEN-FLD.
  137  001650     IF ERROR-OCCURRED GO TO  ERROR-TERMINATION.
  139  001660     IF INPUT-GEN-FLD EQUAL MASTER-GEN-FLD
  140  001670         MOVE MASTER-KEY TO PRINT-KEY
  141  001680         MOVE MASTER-NAME TO PRINT-NAME
  142  001690         MOVE MASTER-BAL TO PRINT-NEW-BAL
  143  001700         PERFORM PRINT-DETAIL.
       001710
       001720 DYNAMIC-PROCESS.
  144  001730     MOVE INPUT-KEY TO MASTER-KEY.
  145  001740     MOVE "READ" TO OP-NAME.
  146  001750     READ MASTER-FILE
       001760         INVALID KEY
  147  001770           DISPLAY "MASTER-FILE READ FAILED: INVALID KEY ",
       001780                      MASTER-KEY
  148  001790           MOVE HIGH-VALUE TO MASTER-GEN-FLD.
  149  001800     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
  151  001810     IF INPUT-GEN-FLD EQUAL MASTER-GEN-FLD
  152  001820         MOVE MASTER-KEY TO PRINT-KEY
  153  001830         MOVE MASTER-NAME TO PRINT-NAME
  154  001840         MOVE MASTER-BAL TO PRINT-BAL
  155  001850         MOVE INPUT-AMT TO PRINT-AMT
  156  001860         ADD INPUT-AMT TO MASTER-BAL
  157  001870         MOVE MASTER-BAL TO PRINT-NEW-BAL
  158  001880         PERFORM PRINT-DETAIL
  159  001890         MOVE "REWRITE" TO OP-NAME
  160  001900         REWRITE MASTER-RECORD
       001910            INVALID KEY
  161  001920              DISPLAY "MASTER-FILE REWRITE FAILED: INVALID KEY ",
       001930                      MASTER-KEY
  162  001940              MOVE HIGH-VALUE TO MASTER-GEN-FLD.
  163  001950     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
       001960 PRINT-DETAIL.
  165  001970     MOVE "WRITE" TO OP-NAME.
  166  001980     WRITE PRINT-RECORD-1
       001990          AT END-OF-PAGE
  167  002000          PERFORM PAGE-END THROUGH PAGE-START.
  168  002010     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
  170  002020     MOVE SPACES TO PRINT-RECORD-1.
       002030
       002040 PAGE-END.
  171  002050     MOVE "WRITE" TO OP-NAME.
  172  002060     ADD 1 TO PG-NUMBER.
  173  002070     SUBTRACT LINAGE-COUNTER OF PRINT-FILE FROM 12
       002080          GIVING LINES-TO-FOOT.
  174  002090     MOVE SPACES TO PRINT-RECORD-1.
  175  002100     WRITE PRINT-RECORD-1
       002110          AFTER ADVANCING LINES-TO-FOOT.
  176  002120     WRITE PRINT-RECORD-2 FROM PAGE-FOOT
       002130          BEFORE ADVANCING PAGE.
  177  002140     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
```

Figure 115 (Part 3 of 4). Example of an Indexed File Update Program

```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        002150 PAGE-START.
   179  002160     WRITE PRINT-RECORD-2 FROM PAGE-HEAD
        002170          AFTER ADVANCING 0 LINES.
   180  002180     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
   182  002190     MOVE SPACES TO PRINT-RECORD-2.
   183  002200     WRITE PRINT-RECORD-2 FROM COLUMN-HEAD
        002210          AFTER ADVANCING 1 LINE.
   184  002220     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
   186  002230     MOVE SPACES TO PRINT-RECORD-2.
        002240 ERROR-TERMINATION.
   187  002250     DISPLAY "PROCESS TERMINATING ABNORMALLY".
   188  002260     STOP RUN.
                              * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                    AS/400 COBOL Messages
  STMT
*   28  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000290
        Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
          will be performed by compiler-generated code.
                          * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                            Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1         1            0                0               0                0
 Source records read . . . . . . . . :   226
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program UPDTIND created in library XMPLIB.
                         * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

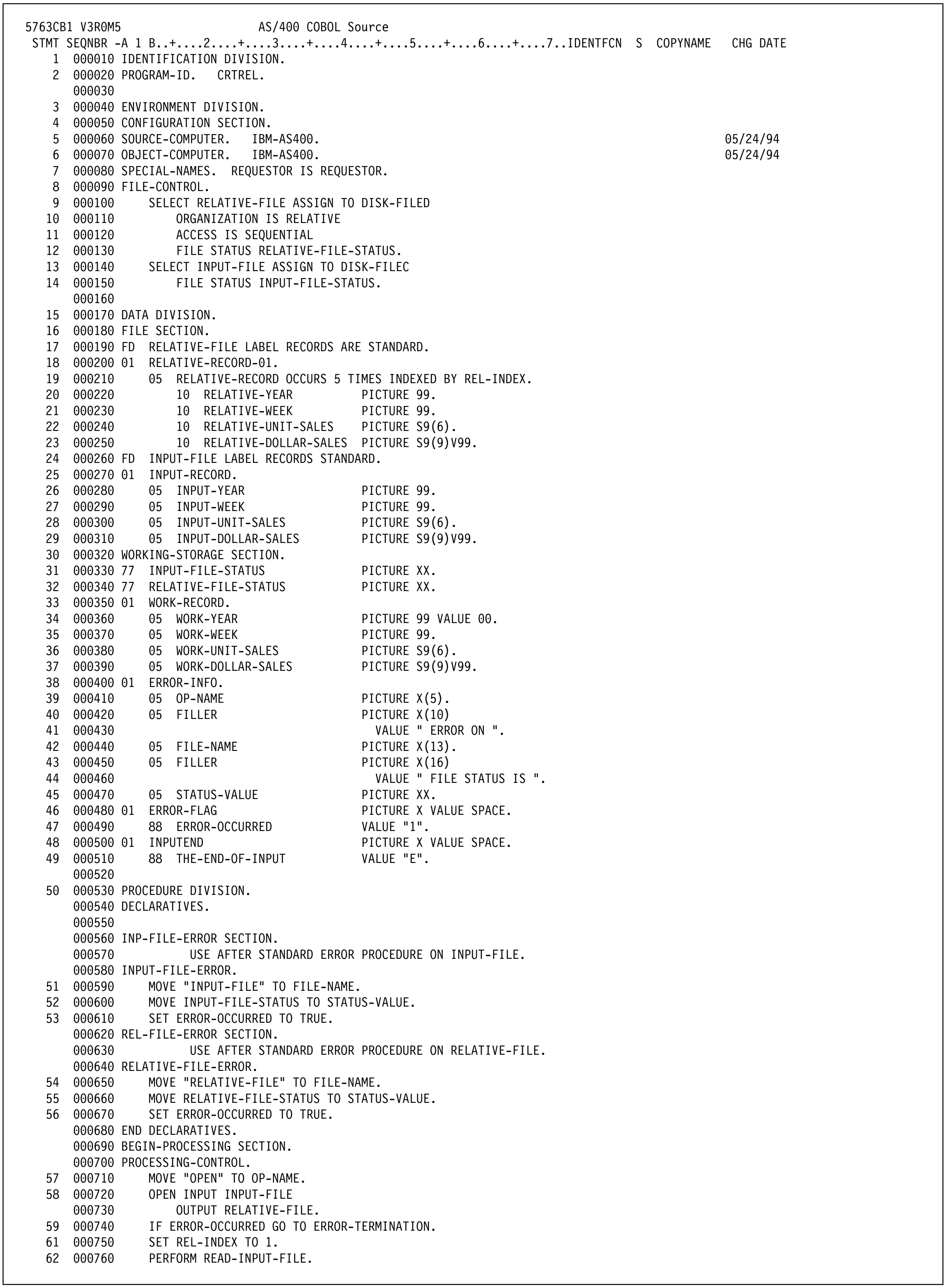
Figure 115 (Part 4 of 4). Example of an Indexed File Update Program

Relative File Creation

This program creates a relative file of summary sales records using sequential access. Each record contains a five-year summary of unit and dollar sales for one week of the year; there are 52 records within the file, each representing one week.

Each input record represents the summary sales for one week of one year. The records for the first week of the last five years (in ascending order) are the first five input records. The records for the second week of the last five years are the next five input records, and so on. Thus, five input records fill one output record.

The RELATIVE KEY for the RELATIVE-FILE is not specified because it is not required for sequential access unless the START statement is used. (For updating, however, the key is INPUT-WEEK.)



```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 IDENTIFICATION DIVISION.
     2  000020 PROGRAM-ID.   CRTREL.
        000030
     3  000040 ENVIRONMENT DIVISION.
     4  000050 CONFIGURATION SECTION.
     5  000060 SOURCE-COMPUTER.   IBM-AS400.                                                  05/24/94
     6  000070 OBJECT-COMPUTER.   IBM-AS400.                                                  05/24/94
     7  000080 SPECIAL-NAMES.  REQUESTOR IS REQUESTOR.
     8  000090 FILE-CONTROL.
     9  000100     SELECT RELATIVE-FILE ASSIGN TO DISK-FILED
    10  000110         ORGANIZATION IS RELATIVE
    11  000120         ACCESS IS SEQUENTIAL
    12  000130         FILE STATUS RELATIVE-FILE-STATUS.
    13  000140     SELECT INPUT-FILE ASSIGN TO DISK-FILEC
    14  000150         FILE STATUS INPUT-FILE-STATUS.
        000160
    15  000170 DATA DIVISION.
    16  000180 FILE SECTION.
    17  000190 FD  RELATIVE-FILE LABEL RECORDS ARE STANDARD.
    18  000200 01  RELATIVE-RECORD-01.
    19  000210     05  RELATIVE-RECORD OCCURS 5 TIMES INDEXED BY REL-INDEX.
    20  000220         10  RELATIVE-YEAR          PICTURE 99.
    21  000230         10  RELATIVE-WEEK          PICTURE 99.
    22  000240         10  RELATIVE-UNIT-SALES    PICTURE S9(6).
    23  000250         10  RELATIVE-DOLLAR-SALES  PICTURE S9(9)V99.
    24  000260 FD  INPUT-FILE LABEL RECORDS STANDARD.
    25  000270 01  INPUT-RECORD.
    26  000280     05  INPUT-YEAR                 PICTURE 99.
    27  000290     05  INPUT-WEEK                 PICTURE 99.
    28  000300     05  INPUT-UNIT-SALES           PICTURE S9(6).
    29  000310     05  INPUT-DOLLAR-SALES         PICTURE S9(9)V99.
    30  000320 WORKING-STORAGE SECTION.
    31  000330 77  INPUT-FILE-STATUS              PICTURE XX.
    32  000340 77  RELATIVE-FILE-STATUS           PICTURE XX.
    33  000350 01  WORK-RECORD.
    34  000360     05  WORK-YEAR                  PICTURE 99 VALUE 00.
    35  000370     05  WORK-WEEK                  PICTURE 99.
    36  000380     05  WORK-UNIT-SALES            PICTURE S9(6).
    37  000390     05  WORK-DOLLAR-SALES          PICTURE S9(9)V99.
    38  000400 01  ERROR-INFO.
    39  000410     05  OP-NAME                    PICTURE X(5).
    40  000420     05  FILLER                     PICTURE X(10)
    41  000430                                      VALUE " ERROR ON ".
    42  000440     05  FILE-NAME                  PICTURE X(13).
    43  000450     05  FILLER                     PICTURE X(16)
    44  000460                                      VALUE " FILE STATUS IS ".
    45  000470     05  STATUS-VALUE               PICTURE XX.
    46  000480 01  ERROR-FLAG                     PICTURE X VALUE SPACE.
    47  000490     88  ERROR-OCCURRED             VALUE "1".
    48  000500 01  INPUTEND                       PICTURE X VALUE SPACE.
    49  000510     88  THE-END-OF-INPUT           VALUE "E".
        000520
    50  000530 PROCEDURE DIVISION.
        000540 DECLARATIVES.
        000550
        000560 INP-FILE-ERROR SECTION.
        000570           USE AFTER STANDARD ERROR PROCEDURE ON INPUT-FILE.
        000580 INPUT-FILE-ERROR.
    51  000590     MOVE "INPUT-FILE" TO FILE-NAME.
    52  000600     MOVE INPUT-FILE-STATUS TO STATUS-VALUE.
    53  000610     SET ERROR-OCCURRED TO TRUE.
        000620 REL-FILE-ERROR SECTION.
        000630           USE AFTER STANDARD ERROR PROCEDURE ON RELATIVE-FILE.
        000640 RELATIVE-FILE-ERROR.
    54  000650     MOVE "RELATIVE-FILE" TO FILE-NAME.
    55  000660     MOVE RELATIVE-FILE-STATUS TO STATUS-VALUE.
    56  000670     SET ERROR-OCCURRED TO TRUE.
        000680 END DECLARATIVES.
        000690 BEGIN-PROCESSING SECTION.
        000700 PROCESSING-CONTROL.
    57  000710     MOVE "OPEN" TO OP-NAME.
    58  000720     OPEN INPUT INPUT-FILE
        000730         OUTPUT RELATIVE-FILE.
    59  000740     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
    61  000750     SET REL-INDEX TO 1.
    62  000760     PERFORM READ-INPUT-FILE.
```

Figure 116 (Part 1 of 2). Example of a Relative File Program

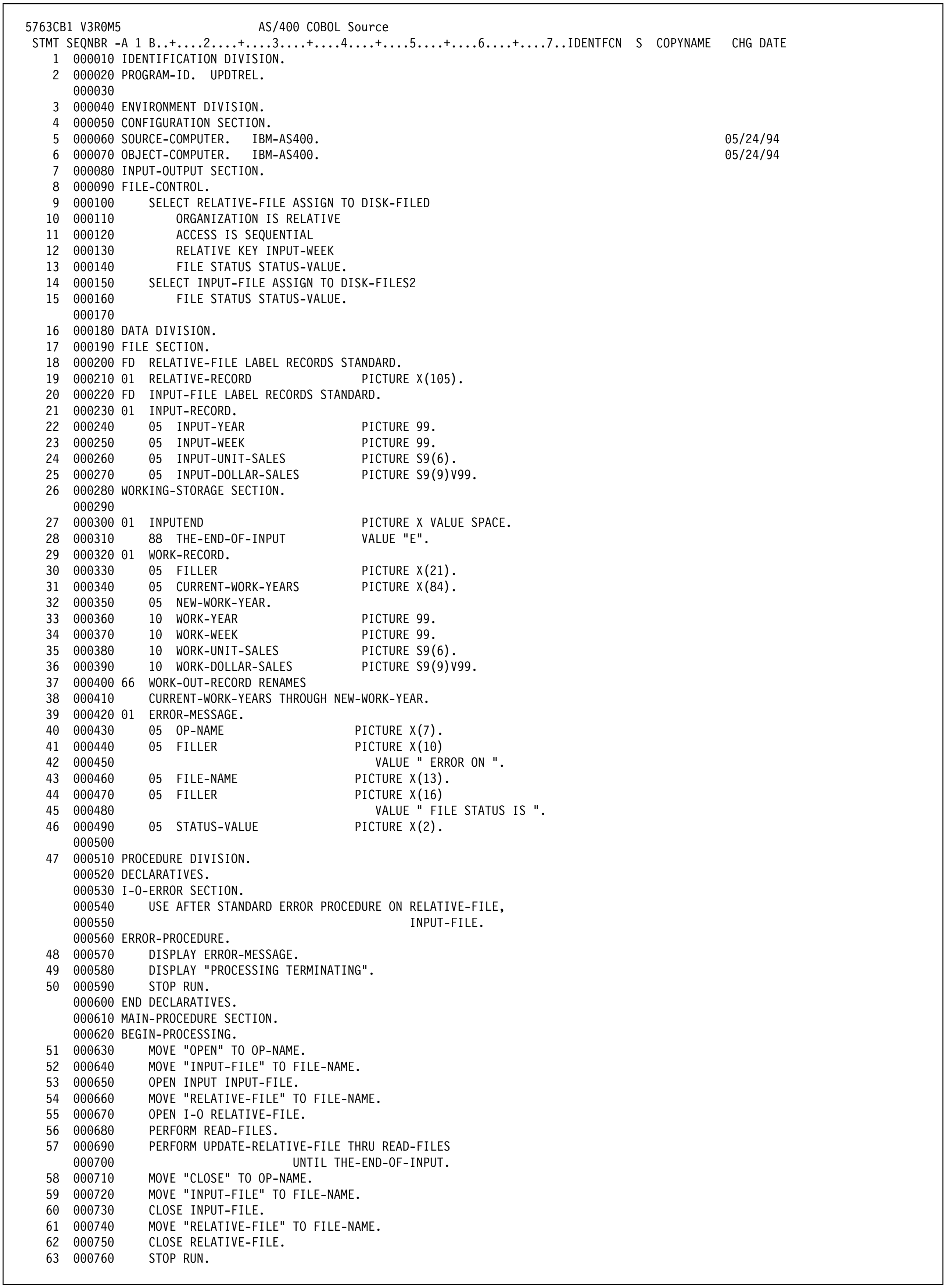
```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     63  000770     PERFORM PROCESS-DATA THRU READ-INPUT-FILE
         000780                         UNTIL THE-END-OF-INPUT.
     64  000790     CLOSE RELATIVE-FILE INPUT-FILE.
     65  000800     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
     67  000810     STOP RUN.
         000820 ERROR-TERMINATION.
     68  000830     DISPLAY ERROR-INFO UPON REQUESTOR.
     69  000840     DISPLAY "PROCESSING TERMINATED DUE TO I-O ERROR"
         000850             UPON REQUESTOR.
     70  000860     STOP RUN.
         000870 PROCESS-DATA.
     71  000880     MOVE INPUT-RECORD TO RELATIVE-RECORD (REL-INDEX).
     72  000890     IF REL-INDEX NOT = 5
     73  000900         SET REL-INDEX UP BY 1
         000910     ELSE
     74  000920         SET REL-INDEX TO 1
     75  000930         PERFORM RELATIVE-FILE-WRITE.
         000940 READ-INPUT-FILE.
     76  000950     MOVE "READ" TO OP-NAME.
     77  000960     READ INPUT-FILE
     78  000970         AT END SET THE-END-OF-INPUT TO TRUE.
     79  000980     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
         000990 RELATIVE-FILE-WRITE.
     81  001000     MOVE "WRITE" TO OP-NAME.
     82  001010     WRITE RELATIVE-RECORD-01.
     83  001020     IF ERROR-OCCURRED GO TO ERROR-TERMINATION.
                         * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                   AS/400 COBOL Messages
  STMT
*        MSGID: LBL0027  SEVERITY: 10  SEQNBR:
         Message . . . . :   I-O SECTION not found. Assumed present
*    17  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000190
         Message . . . . :   Blocking/Deblocking for file 'RELATIVE-FILE'
           will be performed by compiler-generated code.
*    24  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000260
         Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
           will be performed by compiler-generated code.
                     * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                          Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      3         2            1               0               0                0
 Source records read . . . . . . . . :   102
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   10
  LBL0901 00  Program CRTREL created in library XMPLIB.
                        * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 116 (Part 2 of 2). Example of a Relative File Program

Relative File Updating

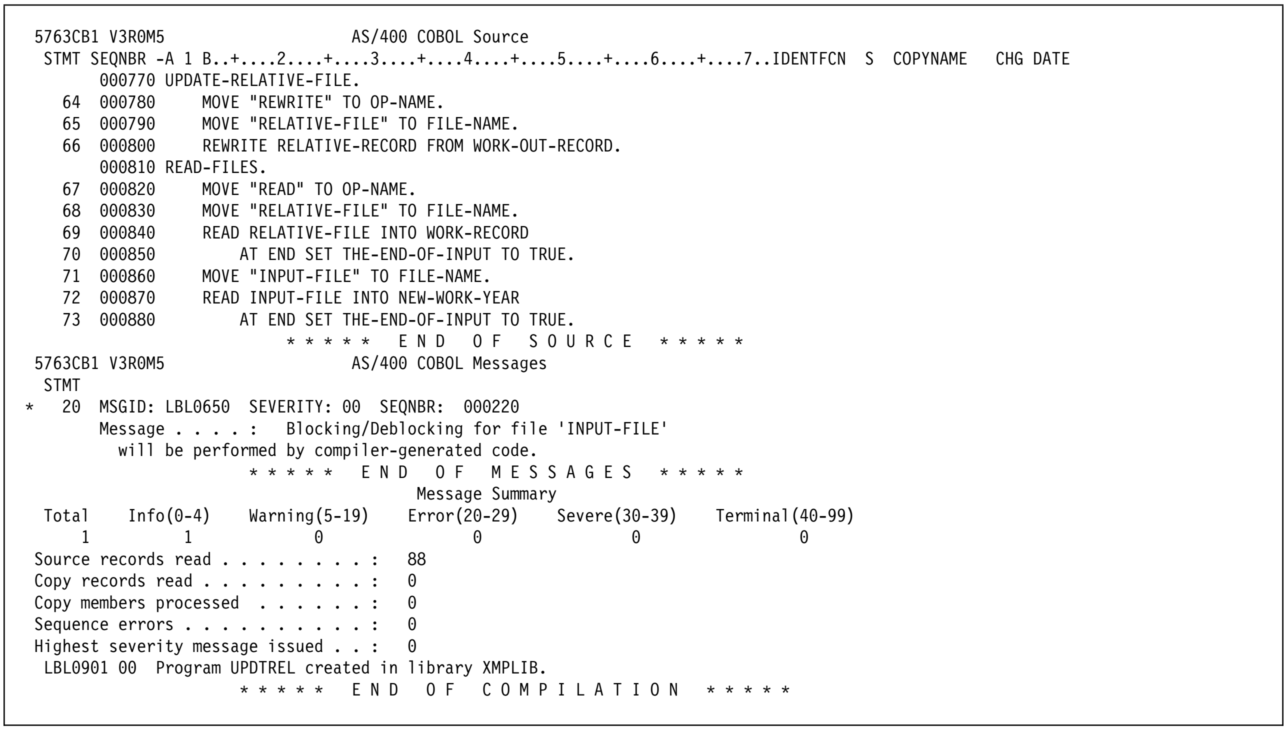
This program uses sequential access to update the file of summary sales records created in the CRTREL program. The updating program adds a record for the new year and deletes the oldest year's records from RELATIVE-FILE.

The input record represents the summary sales record for one week of the preceding year. The RELATIVE KEY for the RELATIVE-FILE is in the input record as INPUT-WEEK. The RELATIVE KEY is used to check that the record was correctly written.



```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 IDENTIFICATION DIVISION.
     2  000020 PROGRAM-ID.  UPDTREL.
        000030
     3  000040 ENVIRONMENT DIVISION.
     4  000050 CONFIGURATION SECTION.
     5  000060 SOURCE-COMPUTER.   IBM-AS400.                                                           05/24/94
     6  000070 OBJECT-COMPUTER.   IBM-AS400.                                                           05/24/94
     7  000080 INPUT-OUTPUT SECTION.
     8  000090 FILE-CONTROL.
     9  000100     SELECT RELATIVE-FILE ASSIGN TO DISK-FILED
    10  000110         ORGANIZATION IS RELATIVE
    11  000120         ACCESS IS SEQUENTIAL
    12  000130         RELATIVE KEY INPUT-WEEK
    13  000140         FILE STATUS STATUS-VALUE.
    14  000150     SELECT INPUT-FILE ASSIGN TO DISK-FILES2
    15  000160         FILE STATUS STATUS-VALUE.
        000170
    16  000180 DATA DIVISION.
    17  000190 FILE SECTION.
    18  000200 FD  RELATIVE-FILE LABEL RECORDS STANDARD.
    19  000210 01  RELATIVE-RECORD                PICTURE X(105).
    20  000220 FD  INPUT-FILE LABEL RECORDS STANDARD.
    21  000230 01  INPUT-RECORD.
    22  000240     05  INPUT-YEAR                 PICTURE 99.
    23  000250     05  INPUT-WEEK                 PICTURE 99.
    24  000260     05  INPUT-UNIT-SALES           PICTURE S9(6).
    25  000270     05  INPUT-DOLLAR-SALES         PICTURE S9(9)V99.
    26  000280 WORKING-STORAGE SECTION.
        000290
    27  000300 01  INPUTEND                       PICTURE X VALUE SPACE.
    28  000310     88  THE-END-OF-INPUT           VALUE "E".
    29  000320 01  WORK-RECORD.
    30  000330     05  FILLER                     PICTURE X(21).
    31  000340     05  CURRENT-WORK-YEARS         PICTURE X(84).
    32  000350     05  NEW-WORK-YEAR.
    33  000360     10  WORK-YEAR                  PICTURE 99.
    34  000370     10  WORK-WEEK                  PICTURE 99.
    35  000380     10  WORK-UNIT-SALES            PICTURE S9(6).
    36  000390     10  WORK-DOLLAR-SALES          PICTURE S9(9)V99.
    37  000400 66  WORK-OUT-RECORD RENAMES
    38  000410     CURRENT-WORK-YEARS THROUGH NEW-WORK-YEAR.
    39  000420 01  ERROR-MESSAGE.
    40  000430     05  OP-NAME                   PICTURE X(7).
    41  000440     05  FILLER                    PICTURE X(10)
    42  000450                                      VALUE " ERROR ON ".
    43  000460     05  FILE-NAME                 PICTURE X(13).
    44  000470     05  FILLER                    PICTURE X(16)
    45  000480                                      VALUE " FILE STATUS IS ".
    46  000490     05  STATUS-VALUE              PICTURE X(2).
        000500
    47  000510 PROCEDURE DIVISION.
        000520 DECLARATIVES.
        000530 I-O-ERROR SECTION.
        000540     USE AFTER STANDARD ERROR PROCEDURE ON RELATIVE-FILE,
        000550                                           INPUT-FILE.
        000560 ERROR-PROCEDURE.
    48  000570     DISPLAY ERROR-MESSAGE.
    49  000580     DISPLAY "PROCESSING TERMINATING".
    50  000590     STOP RUN.
        000600 END DECLARATIVES.
        000610 MAIN-PROCEDURE SECTION.
        000620 BEGIN-PROCESSING.
    51  000630     MOVE "OPEN" TO OP-NAME.
    52  000640     MOVE "INPUT-FILE" TO FILE-NAME.
    53  000650     OPEN INPUT INPUT-FILE.
    54  000660     MOVE "RELATIVE-FILE" TO FILE-NAME.
    55  000670     OPEN I-O RELATIVE-FILE.
    56  000680     PERFORM READ-FILES.
    57  000690     PERFORM UPDATE-RELATIVE-FILE THRU READ-FILES
        000700                          UNTIL THE-END-OF-INPUT.
    58  000710     MOVE "CLOSE" TO OP-NAME.
    59  000720     MOVE "INPUT-FILE" TO FILE-NAME.
    60  000730     CLOSE INPUT-FILE.
    61  000740     MOVE "RELATIVE-FILE" TO FILE-NAME.
    62  000750     CLOSE RELATIVE-FILE.
    63  000760     STOP RUN.
```

Figure 117 (Part 1 of 2). Example of a Relative File Update Program



```
 5763CB1 V3R0M5                    AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        000770 UPDATE-RELATIVE-FILE.
    64  000780     MOVE "REWRITE" TO OP-NAME.
    65  000790     MOVE "RELATIVE-FILE" TO FILE-NAME.
    66  000800     REWRITE RELATIVE-RECORD FROM WORK-OUT-RECORD.
        000810 READ-FILES.
    67  000820     MOVE "READ" TO OP-NAME.
    68  000830     MOVE "RELATIVE-FILE" TO FILE-NAME.
    69  000840     READ RELATIVE-FILE INTO WORK-RECORD
    70  000850         AT END SET THE-END-OF-INPUT TO TRUE.
    71  000860     MOVE "INPUT-FILE" TO FILE-NAME.
    72  000870     READ INPUT-FILE INTO NEW-WORK-YEAR
    73  000880         AT END SET THE-END-OF-INPUT TO TRUE.
                             * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                    AS/400 COBOL Messages
  STMT
*   20  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000220
        Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
          will be performed by compiler-generated code.
                         * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                          Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1         1             0                0               0                0
 Source records read . . . . . . . . :   88
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program UPDTREL created in library XMPLIB.
                        * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 117 (Part 2 of 2). Example of a Relative File Update Program

Relative File Retrieval

This program retrieves the summary file created by the CRTREL program, using dynamic access.

The records of the INPUT-FILE contain one required field (INPUT-WEEK), which is the RELATIVE KEY for RELATIVE-FILE, and one optional field (END-WEEK). An input record containing data in INPUT-WEEK and spaces in END-WEEK requests a printout for that one specific RELATIVE-RECORD; the record is retrieved through random access. (**Random processing** is a method of processing in which records can be read from, written to, or removed from a file in an order requested by the program that is using them.) An input record containing data in both INPUT-WEEK and END-WEEK requests a printout of all the RELATIVE-FILE records within the RELATIVE KEY range of INPUT-WEEK through END-WEEK inclusive. These records are retrieved through sequential access.

```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1 000010 IDENTIFICATION DIVISION.
    2 000020 PROGRAM-ID.  RTRVREL.
      000030
    3 000040 ENVIRONMENT DIVISION.
    4 000050 CONFIGURATION SECTION.
    5 000060 SOURCE-COMPUTER.   IBM-AS400.                                                            05/24/94
    6 000070 OBJECT-COMPUTER.   IBM-AS400.                                                            05/24/94
    7 000080 SPECIAL-NAMES.  REQUESTOR IS REQUESTOR.
    8 000090 INPUT-OUTPUT SECTION.
    9 000100 FILE-CONTROL.
   10 000110     SELECT RELATIVE-FILE ASSIGN TO DISK-FILED
   11 000120         ORGANIZATION IS RELATIVE
   12 000130         ACCESS IS DYNAMIC
   13 000140         RELATIVE KEY INPUT-WEEK
   14 000150         FILE STATUS IS RELATIVE-FILE-STATUS.
   15 000160     SELECT INPUT-FILE ASSIGN TO DISK-FILEF
   16 000170         FILE STATUS IS INPUT-FILE-STATUS.
   17 000180     SELECT PRINT-FILE ASSIGN TO PRINTER-QSYSPRT
   18 000190         FILE STATUS IS PRINT-FILE-STATUS.
      000200
   19 000210 DATA DIVISION.
   20 000220 FILE SECTION.
   21 000230 FD  RELATIVE-FILE LABEL RECORDS STANDARD.
   22 000240 01  RELATIVE-RECORD-01.
   23 000250     05  RELATIVE-RECORD OCCURS 5 TIMES INDEXED BY REL-INDEX.
   24 000260         10  RELATIVE-YEAR         PICTURE 99.
   25 000270         10  RELATIVE-WEEK         PICTURE 99.
   26 000280         10  RELATIVE-UNIT-SALES   PICTURE S9(6).
   27 000290         10  RELATIVE-DOLLAR-SALES PICTURE S9(9)V99.
   28 000300 FD  INPUT-FILE LABEL RECORDS STANDARD.
   29 000310 01  INPUT-RECORD.
   30 000320     05 INPUT-WEEK                 PICTURE 99.
   31 000330     05  END-WEEK                  PICTURE 99.
   32 000340 FD  PRINT-FILE LABEL RECORDS OMITTED.
   33 000350 01  PRINT-RECORD.
   34 000360     05 PRINT-WEEK                 PICTURE 99.
   35 000370     05 FILLER                     PICTURE X(5).
   36 000380     05 PRINT-YEAR                 PICTURE 99.
   37 000390     05 FILLER                     PICTURE X(5).
   38 000400     05 PRINT-UNIT-SALES           PICTURE ZZZ,ZZ9.
   39 000410     05 FILLER                     PICTURE X(5).
   40 000420     05 PRINT-DOLLAR-SALES         PICTURE $$$$,$$$,$$$.99.
   41 000430 WORKING-STORAGE SECTION.
   42 000440 77  RELATIVE-FILE-STATUS          PICTURE XX.
   43 000450 77  INPUT-FILE-STATUS             PICTURE XX.
   44 000460 77  PRINT-FILE-STATUS             PICTURE XX.
   45 000470 77  HIGH-WEEK                     PICTURE 99 VALUE 53.
   46 000480 77  OP-NAME                       PICTURE X(9).
   47 000490 01  INPUTEND                      PICTURE X(9).
   48 000500     88  THE-END-OF-INPUT          VALUE "E".
   49 000510 PROCEDURE DIVISION.
      000520 DECLARATIVES.
      000530 RELATIVE-FILE-ERROR SECTION.
      000540          USE AFTER STANDARD ERROR PROCEDURE ON RELATIVE-FILE.
      000550 RELATIVE-ERROR-MSG.
   50 000560     DISPLAY OP-NAME, " ERROR ON RELATIVE-FILE ".
   51 000570     DISPLAY "FILE STATUS VALUE IS ", RELATIVE-FILE-STATUS.
   52 000580     DISPLAY "PROCESSING TERMINATED ".
   53 000590     STOP RUN.
      000600 INPUT-FILE-ERROR SECTION.
      000610          USE AFTER STANDARD ERROR PROCEDURE ON INPUT-FILE.
      000620 INPUT-ERROR-MSG.
   54 000630     DISPLAY OP-NAME, " ERROR ON INPUT-FILE ".
   55 000640     DISPLAY "FILE STATUS VALUE IS ", INPUT-FILE-STATUS.
   56 000650     DISPLAY "PROCESSING TERMINATED ".
   57 000660     STOP RUN.
      000670 PRINT-FILE-ERROR SECTION.
      000680          USE AFTER STANDARD ERROR PROCEDURE ON PRINT-FILE.
      000690 PRINT-ERROR-MSG.
   58 000700     DISPLAY OP-NAME, " ERROR ON PRINT-FILE ".
   59 000710     DISPLAY "FILE STATUS VALUE IS ", PRINT-FILE-STATUS.
   60 000720     DISPLAY "PROCESSING TERMINATED ".
   61 000730     STOP RUN.
      000740 END DECLARATIVES.
```

Figure 118 (Part 1 of 2). Example of a Relative File Retrieval Program

```
 5763CB1 V3R0M5                   AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
        000750 MAIN-PROCEDURE SECTION.
        000760 MAIN-PROCESSING.
    62  000770     MOVE "OPEN" TO OP-NAME.
    63  000780     OPEN INPUT INPUT-FILE RELATIVE-FILE
        000790          OUTPUT PRINT-FILE.
    64  000800     MOVE SPACES TO PRINT-RECORD.
    65  000810     PERFORM READ-INPUT-FILE.
    66  000820     PERFORM CONTROL-PROCESS THRU READ-INPUT-FILE
        000830                          UNTIL THE-END-OF-INPUT.
    67  000840     MOVE "CLOSE" TO OP-NAME.
    68  000850     CLOSE RELATIVE-FILE
        000860          INPUT-FILE
        000870          PRINT-FILE.
    69  000880     STOP RUN.
        000890 CONTROL-PROCESS.
    70  000900     IF (END-WEEK = SPACES OR END-WEEK = 00)
    71  000910         PERFORM RANDOM-PROCESS
        000920     ELSE
    72  000930         PERFORM SEQUENTIAL-PROCESS.
        000940 READ-INPUT-FILE.
    73  000950     MOVE "READ" TO OP-NAME.
    74  000960     READ INPUT-FILE
    75  000970         AT END SET THE-END-OF-INPUT TO TRUE.
        000980 RANDOM-PROCESS.
    76  000990     MOVE "READ" TO OP-NAME.
    77  001000     READ RELATIVE-FILE
    78  001010          INVALID KEY MOVE HIGH-WEEK TO RELATIVE-WEEK(1).
    79  001020     IF RELATIVE-WEEK(1) NOT EQUAL HIGH-WEEK
    80  001030          PERFORM PRINT-SUMMARY VARYING REL-INDEX FROM 1 BY 1
        001040                               UNTIL REL-INDEX > 5.
        001050 SEQUENTIAL-PROCESS.
    81  001060     MOVE "READ" TO OP-NAME.
    82  001070     READ RELATIVE-FILE
    83  001080          INVALID KEY MOVE HIGH-WEEK TO RELATIVE-WEEK(1).
    84  001090     PERFORM READ-REL-SEQ
        001100          UNTIL RELATIVE-WEEK(1) GREATER THAN END-WEEK.
        001110
        001120 READ-REL-SEQ.
    85  001130     PERFORM PRINT-SUMMARY VARYING REL-INDEX FROM 1 BY 1
        001140                          UNTIL REL-INDEX > 5.
    86  001150     MOVE "READ NEXT" TO OP-NAME.
    87  001160     READ RELATIVE-FILE NEXT RECORD
    88  001170         AT END MOVE HIGH-WEEK TO RELATIVE-WEEK(1).
        001180 PRINT-SUMMARY.
    89  001190     MOVE RELATIVE-YEAR (REL-INDEX) TO PRINT-YEAR.
    90  001200     MOVE RELATIVE-WEEK (REL-INDEX) TO PRINT-WEEK.
    91  001210     MOVE RELATIVE-UNIT-SALES (REL-INDEX) TO PRINT-UNIT-SALES.
    92  001220     MOVE RELATIVE-DOLLAR-SALES(REL-INDEX) TO PRINT-DOLLAR-SALES.
    93  001230     MOVE "WRITE" TO OP-NAME.
    94  001240     WRITE PRINT-RECORD AFTER ADVANCING 2 LINES.
                            * * * * *   E N D   O F   S O U R C E   * * * * *
 5763CB1 V3R0M5                   AS/400 COBOL Messages
  STMT
*   28  MSGID: LBL0650  SEVERITY: 00  SEQNBR:  000300
        Message . . . . :   Blocking/Deblocking for file 'INPUT-FILE'
          will be performed by compiler-generated code.
                        * * * * *   E N D   O F   M E S S A G E S   * * * * *
                                          Message Summary
  Total    Info(0-4)    Warning(5-19)    Error(20-29)    Severe(30-39)    Terminal(40-99)
      1          1             0                0                0                 0
 Source records read . . . . . . . . :   124
 Copy records read . . . . . . . . . :   0
 Copy members processed  . . . . . . :   0
 Sequence errors . . . . . . . . . . :   0
 Highest severity message issued . . :   0
  LBL0901 00  Program RTRVREL created in library XMPLIB.
                       * * * * *   E N D   O F   C O M P I L A T I O N   * * * * *
```

Figure 118 (Part 2 of 2). Example of a Relative File Retrieval Program

Sorting and Merging Files

Figure 119 illustrates the creation of sorted files of current sales and year-to-date sales.

First, the SORT statement for current sales is executed. The input procedure for this sorting operation is SCREEN-DEPT. The records are sorted in ascending order of department, and within each department, in descending order of net sales. The output for this sort is then printed.

After the sorting operation is completed, the current sales records are merged with the year-to-date sales records. The records in this file are merged in ascending order of department number and, within each department, in ascending order of employee numbers, and, for each employee, in ascending order of months to create an updated year-to-date master file.

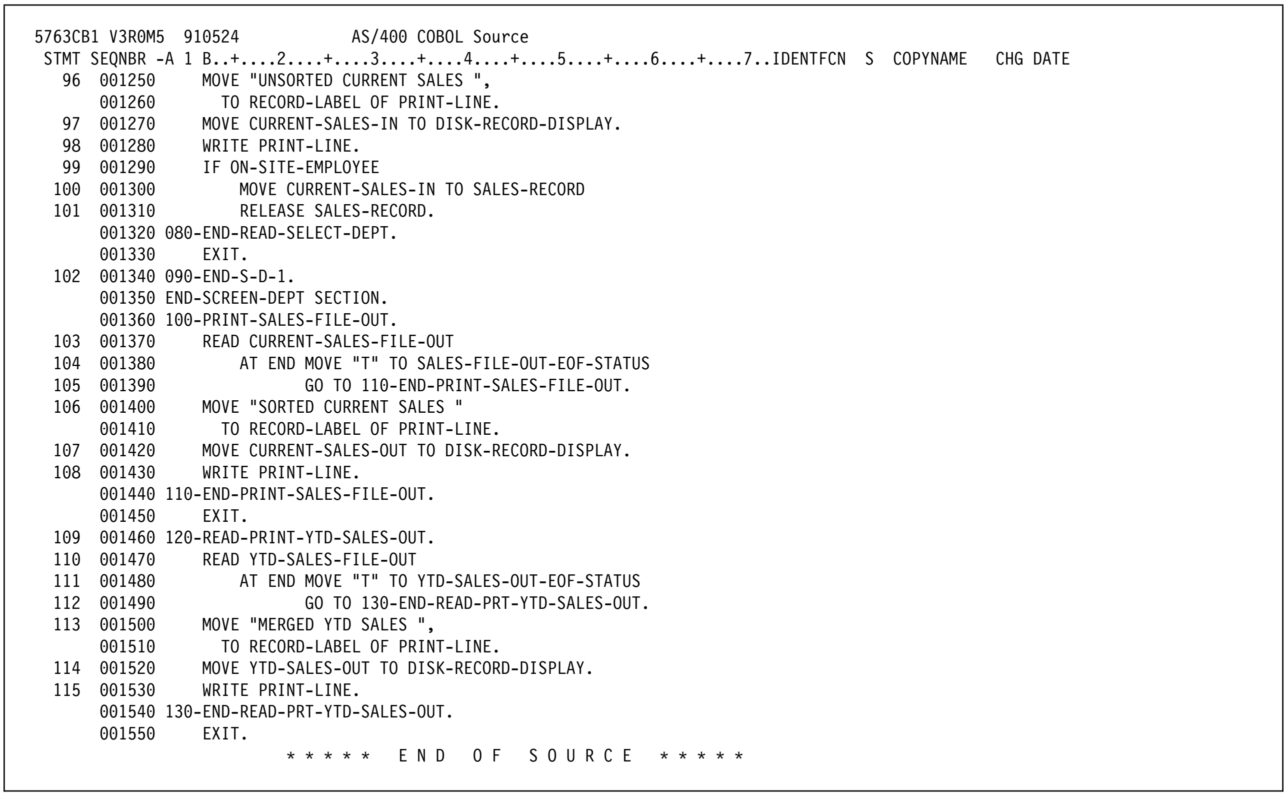
When the merging process finishes, the updated year-to-date master file is printed.

```
 5763CB1 V3R0M5  910524            AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
     1  000010 IDENTIFICATION DIVISION.
     2  000020 PROGRAM-ID.  SORTMERGE.
        000030*********************************************************
        000040* THIS IS A SORT/MERGE EXAMPLE USING AN INPUT PROCEDURE *
        000050*********************************************************
     3  000060 ENVIRONMENT DIVISION.
     4  000070 CONFIGURATION SECTION.
     5  000080 SOURCE-COMPUTER. IBM-AS400.
     6  000090 OBJECT-COMPUTER. IBM-AS400.
     7  000100 SPECIAL-NAMES.
     8  000110    REQUESTOR IS CONSOLE.
     9  000120 INPUT-OUTPUT SECTION.
    10  000130 FILE-CONTROL.
    11  000140     SELECT WORK-FILE ASSIGN TO DISK-WRK.
    12  000150     SELECT CURRENT-SALES-FILE-IN ASSIGN TO DISK-CURRIN.
    13  000160     SELECT CURRENT-SALES-FILE-OUT ASSIGN TO DISK-CURROUT.
    14  000170     SELECT YTD-SALES-FILE-IN ASSIGN TO DISK-YTDIN.
    15  000180     SELECT YTD-SALES-FILE-OUT ASSIGN TO DISK-YTDOUT.
    16  000190     SELECT PRINTER-OUT ASSIGN TO PRINTER-QPRINT.
    17  000200 DATA DIVISION.
    18  000210 FILE SECTION.
    19  000220 SD  WORK-FILE
    20  000230     DATA RECORD IS SALES-RECORD.
    21  000240 01  SALES-RECORD.
    22  000250   05 EMPL-NO                PIC 9(6).
    23  000260   05 DEPT                   PIC 9(2).
    24  000270   05 SALES                  PIC 9(7)V99.
    25  000280   05 NAME-ADDR              PIC X(61).
    26  000290   05 MONTH                  PIC X(2).
    27  000300 FD  CURRENT-SALES-FILE-IN
    28  000310     LABEL RECORDS STANDARD
    29  000320     DATA RECORD CURRENT-SALES-IN.
    30  000330 01 CURRENT-SALES-IN.
    31  000340   05 EMPL-NO                PIC 9(6).
    32  000350   05 DEPT                   PIC 9(2).
    33  000360     88 ON-SITE-EMPLOYEE    VALUES 0
    34  000370                            THRU 6, 8.
    35  000380   05 SALES                  PIC 9(7)V99.
    36  000390   05 NAME-ADDR              PIC X(61).
    37  000400   05 MONTH                  PIC X(2).
    38  000410 FD  CURRENT-SALES-FILE-OUT
    39  000420     LABEL RECORDS STANDARD
    40  000430     DATA RECORD CURRENT-SALES-OUT.
    41  000440 01 CURRENT-SALES-OUT.
    42  000450   05 EMPL-NO                PIC 9(6).
    43  000460   05 DEPT                   PIC 9(2).
    44  000470   05 SALES                  PIC 9(7)V99.
    45  000480   05 NAME-ADDR              PIC X(61).
    46  000490   05 MONTH                  PIC X(2).
```

Figure 119 (Part 1 of 3). Example of Use of SORT/MERGE

```
 5763CB1 V3R0M5  910524            AS/400 COBOL Source
  STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    47  000500 FD  YTD-SALES-FILE-IN
    48  000510     LABEL RECORDS STANDARD
    49  000520     DATA RECORD YTD-SALES-IN.
    50  000530 01 YTD-SALES-IN.
    51  000540   05 EMPL-NO                 PIC 9(6).
    52  000550   05 DEPT                    PIC 9(2).
    53  000560   05 SALES                   PIC 9(7)V99.
    54  000570   05 NAME-ADDR               PIC X(61).
    55  000580   05 MONTH                   PIC X(2).
    56  000590 FD  YTD-SALES-FILE-OUT
    57  000600     LABEL RECORDS STANDARD
    58  000610     DATA RECORD YTD-SALES-OUT.
    59  000620 01 YTD-SALES-OUT.
    60  000630   05 EMPL-NO                 PIC 9(6).
    61  000640   05 DEPT                    PIC 9(2).
    62  000650   05 SALES                   PIC 9(7)V99.
    63  000660   05 NAME-ADDR               PIC X(61).
    64  000670   05 MONTH                   PIC X(2).
    65  000680 FD  PRINTER-OUT
    66  000690     LABEL RECORDS OMITTED
    67  000700     DATA RECORD PRINT-LINE.
    68  000710 01 PRINT-LINE.
    69  000720   05 RECORD-LABEL            PIC X(25).
    70  000730   05 DISK-RECORD-DISPLAY     PIC X(80).
    71  000740 WORKING-STORAGE SECTION.
    72  000750 01 SALES-FILE-IN-EOF-STATUS  PIC X        VALUE "F".
    73  000760    88 SALES-FILE-IN-END-OF-FILE           VALUE "T".
    74  000770 01 SALES-FILE-OUT-EOF-STATUS PIC X        VALUE "F".
    75  000780    88 SALES-FILE-OUT-END-OF-FILE          VALUE "T".
    76  000790 01 YTD-SALES-OUT-EOF-STATUS  PIC X        VALUE "F".
    77  000800    88 YTD-SALES-OUT-END-OF-FILE           VALUE "T".
    78  000810 PROCEDURE DIVISION.
        000820 OPEN-PRINTER-FILE SECTION.
        000830 005-PRINTER-FILE.
    79  000840     OPEN OUTPUT PRINTER-OUT.
        000850 LIST-SORT-LIST-CURRENT-SALES SECTION.
        000860 010-LIST-SORT-CURRENT-SALES.
    80  000870     SORT WORK-FILE
        000880          ON ASCENDING KEY DEPT OF SALES-RECORD
        000890          ON DESCENDING KEY SALES OF SALES-RECORD
        000900          INPUT PROCEDURE SCREEN-DEPT
        000910          GIVING CURRENT-SALES-FILE-OUT.
        000920 020-LIST-SORTED-SALES.
    81  000930     OPEN INPUT CURRENT-SALES-FILE-OUT.
    82  000940     PERFORM 100-PRINT-SALES-FILE-OUT
        000950       THRU 110-END-PRINT-SALES-FILE-OUT
        000960         UNTIL SALES-FILE-OUT-END-OF-FILE.
    83  000970     CLOSE CURRENT-SALES-FILE-OUT.
        000980 UPDATE-YEARLY-REPORT SECTION.
        000990 040-MERGE-CURRENT-PREVIOUS.
    84  001000     MERGE WORK-FILE
        001010          ON ASCENDING KEY DEPT OF SALES-RECORD
        001020          ON ASCENDING KEY EMPL-NO OF SALES-RECORD
        001030          ON ASCENDING KEY MONTH OF SALES-RECORD
        001040          USING YTD-SALES-FILE-IN
        001050                CURRENT-SALES-FILE-IN
        001060          GIVING YTD-SALES-FILE-OUT.
        001070 040-PRINT-YTD-SALES-OUT.
    85  001080     OPEN INPUT YTD-SALES-FILE-OUT.
    86  001090     PERFORM 120-READ-PRINT-YTD-SALES-OUT
        001100         UNTIL YTD-SALES-OUT-END-OF-FILE.
    87  001110     CLOSE YTD-SALES-FILE-OUT
        001120           PRINTER-OUT.
    88  001130     STOP RUN.
        001140 SCREEN-DEPT SECTION.
        001150 060-S-D-1.
    89  001160     OPEN INPUT CURRENT-SALES-FILE-IN
    90  001170     PERFORM 070-READ-SELECT-DEPT THRU 080-END-READ-SELECT-DEPT
        001180         UNTIL SALES-FILE-IN-END-OF-FILE.
    91  001190     CLOSE CURRENT-SALES-FILE-IN.
    92  001200     GO TO 090-END-S-D-1.
        001210 070-READ-SELECT-DEPT.
    93  001220     READ CURRENT-SALES-FILE-IN
    94  001230         AT END MOVE "T" TO SALES-FILE-IN-EOF-STATUS
    95  001240                GO TO 080-END-READ-SELECT-DEPT.
```

Figure 119 (Part 2 of 3). Example of Use of SORT/MERGE



```
5763CB1 V3R0M5  910524            AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
   96  001250     MOVE "UNSORTED CURRENT SALES ",
       001260       TO RECORD-LABEL OF PRINT-LINE.
   97  001270     MOVE CURRENT-SALES-IN TO DISK-RECORD-DISPLAY.
   98  001280     WRITE PRINT-LINE.
   99  001290     IF ON-SITE-EMPLOYEE
  100  001300         MOVE CURRENT-SALES-IN TO SALES-RECORD
  101  001310         RELEASE SALES-RECORD.
       001320 080-END-READ-SELECT-DEPT.
       001330     EXIT.
  102  001340 090-END-S-D-1.
       001350 END-SCREEN-DEPT SECTION.
       001360 100-PRINT-SALES-FILE-OUT.
  103  001370     READ CURRENT-SALES-FILE-OUT
  104  001380         AT END MOVE "T" TO SALES-FILE-OUT-EOF-STATUS
  105  001390                GO TO 110-END-PRINT-SALES-FILE-OUT.
  106  001400     MOVE "SORTED CURRENT SALES "
       001410       TO RECORD-LABEL OF PRINT-LINE.
  107  001420     MOVE CURRENT-SALES-OUT TO DISK-RECORD-DISPLAY.
  108  001430     WRITE PRINT-LINE.
       001440 110-END-PRINT-SALES-FILE-OUT.
       001450     EXIT.
  109  001460 120-READ-PRINT-YTD-SALES-OUT.
  110  001470     READ YTD-SALES-FILE-OUT
  111  001480         AT END MOVE "T" TO YTD-SALES-OUT-EOF-STATUS
  112  001490                GO TO 130-END-READ-PRT-YTD-SALES-OUT.
  113  001500     MOVE "MERGED YTD SALES ",
       001510       TO RECORD-LABEL OF PRINT-LINE.
  114  001520     MOVE YTD-SALES-OUT TO DISK-RECORD-DISPLAY.
  115  001530     WRITE PRINT-LINE.
       001540 130-END-READ-PRT-YTD-SALES-OUT.
       001550     EXIT.
                           * * * * *  E N D  O F  S O U R C E  * * * * *
```

Figure 119 (Part 3 of 3). Example of Use of SORT/MERGE

Appendix H. Example of a COBOL Formatted Dump

Figure 120 on page 372 shows an example of a COBOL formatted dump. To ensure that a dump is available if something goes wrong when you try to run your program, change the INQMSGRPY parameter of the job (for instance, by using the CHGJOB command) to *RQD. When prompted, you can then specify that a dump be generated.

The following list describes the labeled areas of the figure:

A The exception for which the dump was requested and the location in the program where the exception occurred.

B The COBOL statement number of the last I-O operation that was run before the exception occurred. This information is produced only if at least one I-O operation has been processed.

C The current information for each file. This information is produced only if the program has files.

D Beginning of compiler-generated fields (included in the dump if you respond with an F option).

E I-O flags for the current file:

Bit	Meaning
1	File is open
2	File is locked
3	End of file
4	(Reserved)
5	Optional file
6	Check indexed file for duplicates at open
7	End of page
8	(Reserved).

F Previous status code.

G Beginning of Module Global Table (MGT).[3]

H Last exception code.

I Invocation number of current program.

J Qualified program name and library.

K Beginning of the Program Global Table (PGT).[4]

L Invocation number of the main COBOL program.

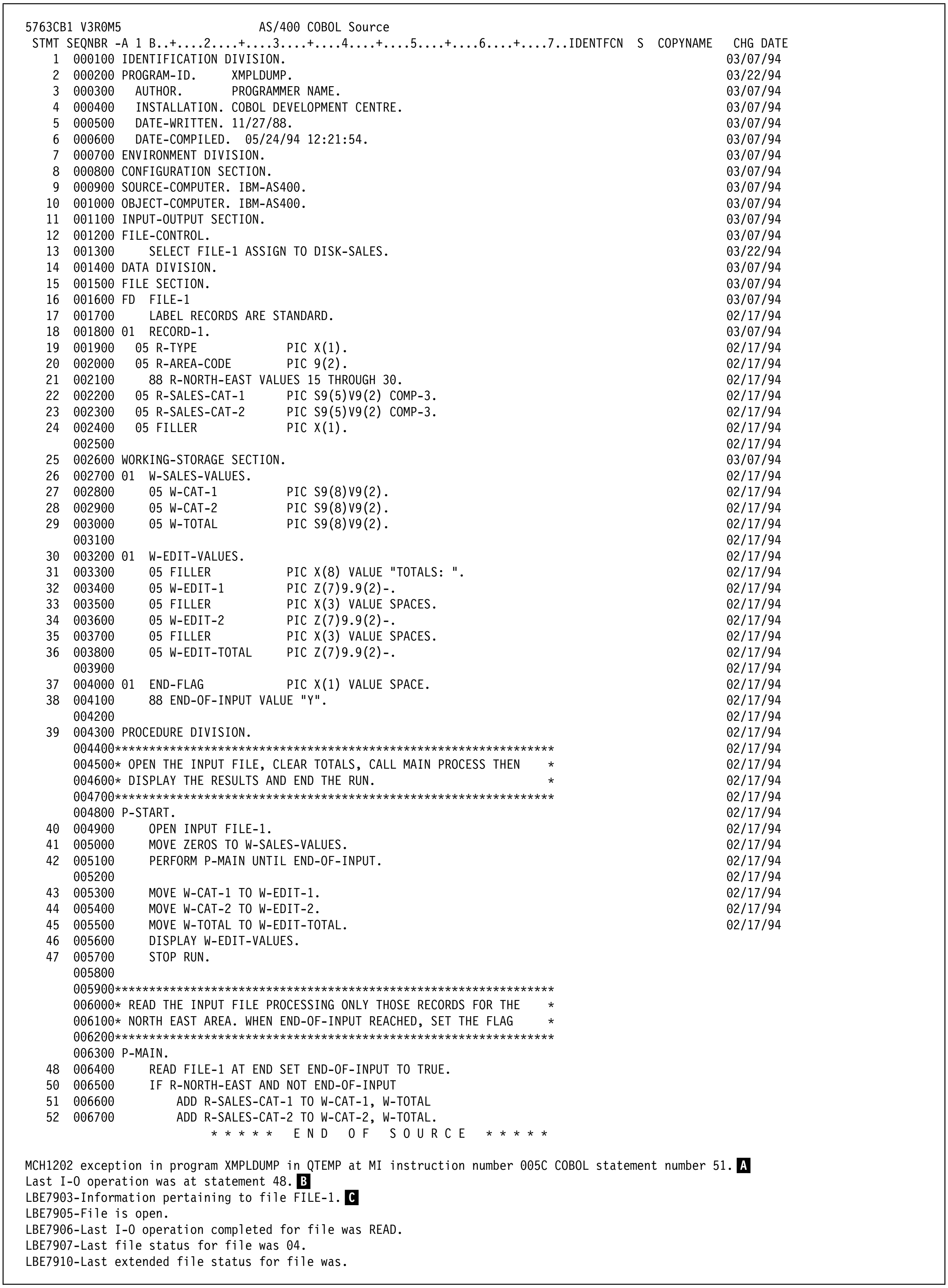
M Job date (YYMMDD).

N Beginning of user fields.

O Invalid zoned field printed in hexadecimal.

[3] The Module Global Table (MGT) defines a common area for the module. The table is used to pass information to run-time subroutines.

[4] The Program Global Table (PGT) is a communication area for the entire COBOL run unit. There is only one PGT for the run unit.



```
5763CB1 V3R0M5                    AS/400 COBOL Source
 STMT SEQNBR -A 1 B..+....2....+....3....+....4....+....5....+....6....+....7..IDENTFCN  S  COPYNAME   CHG DATE
    1  000100 IDENTIFICATION DIVISION.                                                              03/07/94
    2  000200 PROGRAM-ID.     XMPLDUMP.                                                             03/22/94
    3  000300   AUTHOR.       PROGRAMMER NAME.                                                      03/07/94
    4  000400   INSTALLATION. COBOL DEVELOPMENT CENTRE.                                             03/07/94
    5  000500   DATE-WRITTEN. 11/27/88.                                                             03/07/94
    6  000600   DATE-COMPILED.  05/24/94 12:21:54.                                                  03/07/94
    7  000700 ENVIRONMENT DIVISION.                                                                 03/07/94
    8  000800 CONFIGURATION SECTION.                                                                03/07/94
    9  000900 SOURCE-COMPUTER. IBM-AS400.                                                           03/07/94
   10  001000 OBJECT-COMPUTER. IBM-AS400.                                                           03/07/94
   11  001100 INPUT-OUTPUT SECTION.                                                                 03/07/94
   12  001200 FILE-CONTROL.                                                                         03/07/94
   13  001300     SELECT FILE-1 ASSIGN TO DISK-SALES.                                               03/22/94
   14  001400 DATA DIVISION.                                                                        03/07/94
   15  001500 FILE SECTION.                                                                         03/07/94
   16  001600 FD  FILE-1                                                                            03/07/94
   17  001700     LABEL RECORDS ARE STANDARD.                                                       02/17/94
   18  001800 01  RECORD-1.                                                                         03/07/94
   19  001900   05 R-TYPE             PIC X(1).                                                     02/17/94
   20  002000   05 R-AREA-CODE        PIC 9(2).                                                     02/17/94
   21  002100     88 R-NORTH-EAST VALUES 15 THROUGH 30.                                             02/17/94
   22  002200   05 R-SALES-CAT-1      PIC S9(5)V9(2) COMP-3.                                        02/17/94
   23  002300   05 R-SALES-CAT-2      PIC S9(5)V9(2) COMP-3.                                        02/17/94
   24  002400   05 FILLER             PIC X(1).                                                     02/17/94
       002500                                                                                       02/17/94
   25  002600 WORKING-STORAGE SECTION.                                                              03/07/94
   26  002700 01  W-SALES-VALUES.                                                                   02/17/94
   27  002800     05 W-CAT-1          PIC S9(8)V9(2).                                               02/17/94
   28  002900     05 W-CAT-2          PIC S9(8)V9(2).                                               02/17/94
   29  003000     05 W-TOTAL          PIC S9(8)V9(2).                                               02/17/94
       003100                                                                                       02/17/94
   30  003200 01  W-EDIT-VALUES.                                                                    02/17/94
   31  003300     05 FILLER           PIC X(8) VALUE "TOTALS: ".                                    02/17/94
   32  003400     05 W-EDIT-1         PIC Z(7)9.9(2)-.                                              02/17/94
   33  003500     05 FILLER           PIC X(3) VALUE SPACES.                                        02/17/94
   34  003600     05 W-EDIT-2         PIC Z(7)9.9(2)-.                                              02/17/94
   35  003700     05 FILLER           PIC X(3) VALUE SPACES.                                        02/17/94
   36  003800     05 W-EDIT-TOTAL     PIC Z(7)9.9(2)-.                                              02/17/94
       003900                                                                                       02/17/94
   37  004000 01  END-FLAG            PIC X(1) VALUE SPACE.                                         02/17/94
   38  004100     88 END-OF-INPUT VALUE "Y".                                                        02/17/94
       004200                                                                                       02/17/94
   39  004300 PROCEDURE DIVISION.                                                                   02/17/94
       004400*****************************************************************                      02/17/94
       004500* OPEN THE INPUT FILE, CLEAR TOTALS, CALL MAIN PROCESS THEN    *                       02/17/94
       004600* DISPLAY THE RESULTS AND END THE RUN.                         *                       02/17/94
       004700*****************************************************************                      02/17/94
       004800 P-START.                                                                              02/17/94
   40  004900     OPEN INPUT FILE-1.                                                                02/17/94
   41  005000     MOVE ZEROS TO W-SALES-VALUES.                                                     02/17/94
   42  005100     PERFORM P-MAIN UNTIL END-OF-INPUT.                                                02/17/94
       005200                                                                                       02/17/94
   43  005300     MOVE W-CAT-1 TO W-EDIT-1.                                                         02/17/94
   44  005400     MOVE W-CAT-2 TO W-EDIT-2.                                                         02/17/94
   45  005500     MOVE W-TOTAL TO W-EDIT-TOTAL.                                                     02/17/94
   46  005600     DISPLAY W-EDIT-VALUES.
   47  005700     STOP RUN.
       005800
       005900*****************************************************************
       006000* READ THE INPUT FILE PROCESSING ONLY THOSE RECORDS FOR THE    *
       006100* NORTH EAST AREA. WHEN END-OF-INPUT REACHED, SET THE FLAG     *
       006200*****************************************************************
       006300 P-MAIN.
   48  006400     READ FILE-1 AT END SET END-OF-INPUT TO TRUE.
   50  006500     IF R-NORTH-EAST AND NOT END-OF-INPUT
   51  006600         ADD R-SALES-CAT-1 TO W-CAT-1, W-TOTAL
   52  006700         ADD R-SALES-CAT-2 TO W-CAT-2, W-TOTAL.
                           * * * * *   E N D   O F   S O U R C E   * * * * *

MCH1202 exception in program XMPLDUMP in QTEMP at MI instruction number 005C COBOL statement number 51. A
Last I-O operation was at statement 48. B
LBE7903-Information pertaining to file FILE-1. C
LBE7905-File is open.
LBE7906-Last I-O operation completed for file was READ.
LBE7907-Last file status for file was 04.
LBE7910-Last extended file status for file was.
```

Figure 120 (Part 1 of 10). Example of a COBOL Formatted Dump

```
FORMATTED DATA DUMP FOR PROGRAM XMPLDUMP.QTEMP            13:39:08    05/24/94
NAME           OFFSET  ATTRIBUTES    VALUE D
.ADBUF         000480  POINTER(SPP)  NULL
.ADBUFVL       000B90  CHAR(68)      '                                                                    '
               000B90  VALUE IN HEX  '0000000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               000BB8    +41         '0000000000000000000000000000000000000000000000000000000000'X
.ADDEV         0004B4  CHAR(10)      '          '                    '00000000000000000000'X
.ADENV         000493  CHAR(1)       'I'
.ADFILE        0004C0  POINTER(SPP)  NULL
.ADFUNC        000490  CHAR(1)       ' '                               '00'X
.ADLN          000494  BINARY(2)     0
.ADMID         000496  BINARY(2)     0
.ADPGM         00049B  CHAR(10)      'XMPLDUMP  '
.ADRLN         000498  BINARY(2)     0
.ADRTN         000470  POINTER(IP)   NULL
.ADRTYP        00049A  CHAR(1)       ' '                               '00'X
.ADTOD         0004A5  CHAR(15)      '               '               '000000000000000000000000000000'X
.ADTYP         000491  BINARY(2)     0
.BINSUB        000558  BINARY(4)     0
.BIN2          00055C  BINARY(2)     0
.BPCA          0004B0  CHAR(32767)   '          A        T            D01   <HHH               D12   <HHH               D15   <H'
               00050A    +91         'HH                D15   <HHH               D22   <HHH               D99   <HHH                '
               000564    +181        '  D01   <HHH               D23   <HHH               D25   <HHH                 '
               0004B0  VALUE IN HEX  '80000000000000000003DC19EB7000A40000100A30019000E4040404040404040C4F0F14444444C88'X
               0004D8    +41         '88888C40404000010000000100000000040C4F1F24444444C8888888C4040400001000000002000000'X
               000500    +81         '0040C4F1F54444444C8888888C404040000100000003000000000040C4F1F54444444C8888888C4040'X
               000528    +121        '40000100000000400000000040C4F2F24444444C8888888C40404000010000000500000000040C4F9F9'X
               000550    +161        '4444444C8888888C40404000010000000600000000040C4F0F14444444C8888888C40404000010000'X
               000578    +201        '00070000000000040C4F2F34444444C8888888C40404000010000000800000000040C4F2F54444444C88'X
               0005A0    +241        '88888C4040400001000000009000000000'X
.BPCACTR       0004C0  BINARY(2)     1
.BPCAFB        0004C6  BINARY(2)     14
.BPCAMXR       0004C2  BINARY(2)     163
.BPCARCD       0004B0  POINTER(SPP)  SPACE OFFSET    1632     '00000660'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.BPCARIO       0004C4  BINARY(2)     25
.BP01CA        0004B0  CHAR(32767)   '          A        T            D01   <HHH               D12   <HHH               D15   <H'
               00050A    +91         'HH                D15   <HHH               D22   <HHH               D99   <HHH                '
               000564    +181        '  D01   <HHH               D23   <HHH               D25   <HHH                 '
               0004B0  VALUE IN HEX  '80000000000000000003DC19EB7000A40000100A30019000E4040404040404040C4F0F14444444C88'X
               0004D8    +41         '88888C40404000010000000100000000040C4F1F24444444C8888888C4040400001000000002000000'X
               000500    +81         '0040C4F1F54444444C8888888C404040000100000003000000000040C4F1F54444444C8888888C4040'X
               000528    +121        '40000100000000400000000040C4F2F24444444C8888888C40404000010000000500000000040C4F9F9'X
               000550    +161        '4444444C8888888C40404000010000000600000000040C4F0F14444444C8888888C40404000010000'X
               000578    +201        '00070000000000040C4F2F34444444C8888888C40404000010000000800000000040C4F2F54444444C88'X
               0005A0    +241        '88888C4040400001000000009000000000'X
.BP01CTR       0004C0  BINARY(2)     1
.BP01FB        0004C6  BINARY(2)     14
.BP01MXR       0004C2  BINARY(2)     163
.BP01RCD       0004B0  POINTER(SPP)  SPACE OFFSET    1632     '00000660'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.BP01RIO       0004C4  BINARY(2)     25
.BSTRING               NOT ADDRESSABLE
.BUFFER                NOT ADDRESSABLE
.BUFPTR        000770  POINTER(SPP)  NULL
.CALERP        000580  POINTER(SPP)  SPACE OFFSET    1376     '00000560'X
                                     OBJECT    PSSA
.CALLOWR       000C70  CHAR(27)      ' ETAOINSHRDLUCMFWYPVBGKQJXZ'   '4085A381968995A288998493A4839486A6A897A58287929891A7A9'X
.CALPHAB       000C20  CHAR(53)      ' ETAOINSHRDLUCMFWYPVBGKQJXZETAOINSHRDLUCMFWYPVBGKQJXZ'
               000C20  VALUE IN HEX  '40C5E3C1D6C9D5E2C8D9C4D3E4C3D4C6E6E8D7E5C2C7D2D8D1E7E985A381968995A288998493A483'X
               000C48    +41         '9486A6A897A58287929891A7A9'X
.CALUPPR       000C55  CHAR(27)      ' ETAOINSHRDLUCMFWYPVBGKQJXZ'
.CIMBSGN       000BDA  CHAR(60)      '0123456789 JKLMNOPQR  STUVWXYZ           ABCDEFGHI  STUVWXYZ'
               000BDA  VALUE IN HEX  'F0F1F2F3F4F5F6F7F8F9D0D1D2D3D4D5D6D7D8D9A0A1A2A3A4A5A6A7A8A9B0B1B2B3B4B5B6B7B8B9'X
               000C02    +41         'C0C1C2C3C4C5C6C7C8C9E0E1E2E3E4E5E6E7E8E9'X
.CNUMERC       000C16  CHAR(10)      '0123456789'
.CPADCHR       000C8B  CHAR(1)       ' '
.CRCLEAR       000D00  POINTER(SYP)  OBJECT    QLRCLEAR
                                     CONTEXT   QSYS
.CSEPSGN       000BD8  CHAR(2)       '+-'
.DBUGRTN       000450  POINTER(IP)   NULL
.DEVPTR        000730  POINTER(SPP)  SPACE OFFSET    324     '00000144'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.DISPPOS       000CB0  BINARY(2)     0
.DISPPTR       000CA0  POINTER(SPP)  NULL
.DLINENO       000552  CHAR(6)       '      '                         '000000000000'X
.DMCACIN       000870  BINARY(2)     121
.DMCACQR       000872  BINARY(2)     66
```

Figure 120 (Part 2 of 10). Example of a COBOL Formatted Dump

```
.DMCBLKR       0003BD  CHAR(1)       '*'
.DMCCPCL       000178  BINARY(2)     13
.DMCCPOP       00017A  BINARY(2)     17
.DMCDBOF       000020  BINARY(4)     704
.DMCDDS        0002C0  CHAR(298)     '                                           R              A    0          A    0          '
               00031A    +91         ' TY                                                                                       '
               000374    +181        '                                                3                CPF     *  '
               0002C0  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000008000000000008000'X
               0002E8    +41         '001000990F0004B08000000000000000000003DC19EB70006F080000000000000000003DC19EB70006F0'X
               000310    +81         '4800000000000000000000A3E800001100000000000000000000000000000000000000000000000019'X
               000338    +121        '0000000E000000000000000000000000000000000000000000000000000000000000000000000000'X
               000360    +161        '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               000388    +201        '00000000000000000000000000000000000000000000000000000000F30000010000000000000000'X
               0003B0    +241        '00FF000000C3D7C600000000005CE000'X
.DMCDELT       000166  BINARY(2)     69
.DMCDROP       000874  BINARY(2)     71
.DMCFDEL       0003E9  CHAR(1)       ' '                             '00'X
.DMCFEOD       000168  BINARY(2)     111
.DMCFRCE       00016A  BINARY(2)     69
.DMCGET        000158  BINARY(2)     770
.DMCGETD       00015A  BINARY(2)     14
.DMCGETK       00015C  BINARY(2)     69
.DMCLINK       0007A5  BINARY(2)     0
.DMCODP        000000  CHAR(32767)   'E      M   M           F                                                  A               '
               00005A    +91         '                                A                                                      DBSA'
               0000B4    +181        'LES     COBOLEX                             SALESFILE                      A'
               000000  VALUE IN HEX  '85000002000014D4000014D4000000B000000140000001C6000002800000000000000002C000000000'X
               000028    +41         '00000000000014000000000000000000000000000000000000000000000000000003DC19EB7000DFF'X
               000050    +81         '000000000000000000000000000000800000000000000000003DC00036000AE08000000000000000'X
               000078    +121        '003DC19EB700189B0000000000000000000000000000000019000000000000000000000C00000000'X
               0000A0    +161        '0C0000000000000000004B0000000000C4C2E2C1D3C5E24040404040C3D6C2F3F8C5E74040400000'X
               0000C8    +201        '0000000000000000000000000000000000000000000E0000E2C1D3C5E2C6C9D3C540000010040000'X
               0000F0    +241        '0000000000000000000000000000011C1'X
.DMCOFFS       000010  BINARY(4)     320
.DMCPTGT       000162  BINARY(2)     69
.DMCPUT        000160  BINARY(2)     69
.DMCPUTD       00015E  BINARY(2)     69
.DMCRLSE       000170  BINARY(2)     69
.DMCRSTD       00016E  BINARY(2)     69
.DMCSPDD       00016C  BINARY(2)     69
.DMCSPTB       00017C  BINARY(2)     0
.DMCTBLE       00017E  BINARY(2)     1
.DMCUPD        000164  BINARY(2)     69
.DMPBDMJ               NOT ADDRESSABLE
.DMPBDSE               NOT ADDRESSABLE
.DMPCDFO       0001C6  BINARY(2)     144
.DMPCDFP       000790  POINTER(SPP)  NULL
.DMPDBFB               NOT ADDRESSABLE
.DMPDBFL       000190  CHAR(1)       ' '                             '00'X
.DMPDENT       000144  CHAR(130)     DIMENSION(250)
               000144    (1)         'DATABASE                             ?                                                    '
               00019E    +91         '                                        '
               000144  VALUE IN HEX  'C4C1E3C1C2C1E2C54040000000000000000000000302000E004500450045004500450045006F0045'X
               00016C    +41         '0045004500450BFD00450045000D00110000000100000000000000000000000000000000000000000'X
               000194    +81         2 LINES OF ZEROES SUPPRESSED
               0001C6    (2)         '                    SALESFILE                                                             '
               000220    +91         '                                        '
               0001C6  VALUE IN HEX  '00900000000000000001000000000000000000001E2C1D3C5E2C6C9D3C5000000000000000000000'X
               0001EE    +41         '00000000000E00000000000000000000000000000000000000000000000000000000000000000000'X
               000216    +81         '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00023E    +121        '00000000000000110000'X
               000248    (3)         '                                                                                   R      '
               0002A2    +91         '         R    AA                        '
               000248  VALUE IN HEX  '00000000000000000000000000000000002200000000000000000001000048000040000000000000'X
               000270    +41         '00000001000000110000000000000000000000020030000000000000000030000000000000000000'X
               000298    +81         '001000990E000DFF00000000000000180010009900B000B108181000000000000000000000000000000'X
               0002C0    +121        '00000000000000000000'X
               0002CA    (4)         '                                 R              A    0          A    0           TY       '
               000324    +91         '                                        '
               0002CA  VALUE IN HEX  '00000000000000000000000000000000000000000000800000000000800000 1000990F0004B08000'X
               0002F2    +41         '000000000000003DC19EB70006F080000000000000000003DC19EB70006F048000000000000000000'X
               00031A    +81         '00A3E800001100000000000000000000000000000000000000000000000190000000E000000000000'X
               000342    +121        '00000000000000000000'X
               00034C    (5)         '                                                                                        3 '
               0003A6    +91         '               CPF     *       T        '
               00034C  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               000374    +41         '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00039C    +81         '0000000000000000F3000001000000000000000000FF000000C3D7C600000000005CE0000000003C'X
```

Figure 120 (Part 3 of 10). Example of a COBOL Formatted Dump

```
               0003C4    +121        '00A30000000000000000'X
               0003CE    (6)         '                                                                                          '
               000428    +91         '                        SALESFILE  2A248'
               0003CE  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000010000'X
               0003F6    +41         '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00041E    +81         '000000000000000000000011000000000000000000000000000000000E000000000001E2C1D3C5E2C6'X
               000446    +121        'C9D3C54000F2C1F2F4F8'X
               000450    (7)         '33FF03CF                                                        U      &                  '
               0004AA    +91         '                A        T            D0'
               000450  VALUE IN HEX  'F3F3C6C6F0F3C3C600000000000E000100000001000000000000000000000000000000000000000000'X
               000478    +41         '0000000000000000000000000000000000000000000000A4000000000000500000000000000000'X
               0004A0    +81         '00000000000000000000000000000000800000000000000003DC19EB7000A40000100A30019000E'X
               0004C8    +121        '4040404040404040C4F0'X
               0004D2    (8)         '1   <HHH               D12   <HHH               D15   <HHH               D15   <HHH       '
               00052C    +91         '        D22   <HHH               D99   <'
               0004D2  VALUE IN HEX  'F14444444C8888888C404040000100000000100000000040C4F1F24444444C8888888C404040000100'X
               0004FA    +41         '0000020000000040C4F1F54444444C8888888C40404000010000000300000000040C4F1F54444444C'X
               000522    +81         '8888888C404040000100000004000000000040C4F2F24444444C8888888C4040400001000000050000'X
               00054A    +121        '000040C4F9F94444444C'X
               000554    (9)         'HHH               D01   <HHH               D23   <HHH               D25   <HHH            '
               0005AE    +91         '   D88   <HHH               D99   <HHH '
               000554  VALUE IN HEX  '8888888C404040000100000006000000000040C4F0F14444444C8888888C4040400001000000070000'X
               00057C    +41         '000040C4F2F34444444C8888888C404040000100000008000000000040C4F2F54444444C8888888C40'X
               0005A4    +81         '4040000100000009000000000040C4F8F84444444C8888888C4040400001000000A0000000040C4F9'X
               0005CC    +121        'F94444444C8888888C40'X
               0005D6    (10)        '             D22   <HHH               D01   <HHH               D66   <HHH               D2'
               000630    +91         '2   <HHH               D77   <HHH       '
               0005D6  VALUE IN HEX  '404000010000000B0000000040C4F2F24444444C8888888C4040400001000000C0000000040C4F0'X
               0005FE    +41         'F14444444C8888888C4040400001000000D0000000040C4F6F64444444C8888888C404040000100'X
               000626    +81         '00000E0000000040C4F2F24444444C8888888C4040400001000000F0000000040C4F7F74444444C'X
               00064E    +121        '8888888C404040000100'X
               000658    (11)        '        H2500000000  <          '
               000658  VALUE IN HEX  '0000100000000040C8F2F5F0F0F0F0F0F0F0F040404C000100000001100000000404040404040404040'X
               000680    +41         '40404040404040404040404040404040404040404040404040404040404040404040404040404040'X
               0006A8    +81         '40404040404040404040404040404040404040404040404040404040404040404040404040404040'X
               0006D0    +121        '40404040404040404040'X
               00140E    (12-38)     ' '
               001490    (39)        '                                                                                          '
               0014EA    +91         '                                        '
               001490  VALUE IN HEX  '40404040404040404040404040404040404040404040404040404040404040404040404040404040'X
               0014B8    +41         '40404040404040404040404040404040404040404040404040400000000000000000000000000000'X
               0014E0    +81         2 LINES OF ZEROES SUPPRESSED
                                     CANNOT DUMP - SPACE ADDRESSING OR BOUNDARY ALIGNMENT EXCEPTION
.DMPDEVN       0001E6  CHAR(10)      '          '                    '00000000000000000000'X
.DMPDIOF               NOT ADDRESSABLE
.DMPDRN                NOT ADDRESSABLE
.DMPDSEK               NOT ADDRESSABLE
.DMPDVNM       000144  CHAR(10)      'DATABASE  '
.DMPENT        000144  CHAR(130)     'DATABASE                             ?                                                    '
               00019E    +91         '                                        '
               000144  VALUE IN HEX  'C4C1E3C1C2C1E2C540400000000000000000000000302000E0045004500450045004500045006F0045'X
               00016C    +41         '0045004500450BFD00450045000D00110000000100000000000000000000000000000000000000000'X
               000194    +81         2 LINES OF ZEROES SUPPRESSED
.DMPFBAC       0000B0  CHAR(32767)   'DBSALES     COBOLEX                             SALESFILE                      AR NU      '
               00010A    +91         '&               T                                         DATABASE                        '
               000164    +181        '     ?                                                                      '
               0000B0  VALUE IN HEX  'C4C2E2C1D3C5E240404040C3D6C2F3F8C5E740404000000000000000000000000000000000000000'X
               0000D8    +41         '00000000000E0000E2C1D3C5E2C6C9D3C54000001004000000000000000000000000000000000011C1'X
               000100    +81         'D900D5A40000000000000500000000000000000000000000000000000A300000019000003E00000000000'X
               000128    +121        '000000000000000100000001020000000000000000000000000010001C4C1E3C1C2C1E2C540400000'X
               000150    +161        '000000000000000000302000E0045004500450045004500045006F004500450045004500450BFD00450045'X
               000178    +201        '000D0011000000010000000000000000000000000000000000000000000000000000000000000000'X
               0001A0    +241        '00000000000000000000000000000000'X
.DMPFBAT       0000FF  CHAR(2)       'AR'
.DMPFBCL       0000F9  BINARY(2)     0
.DMPFBCT       008038  BINARY(2)     CANNOT DUMP - SPACE ADDRESSING OR BOUNDARY ALIGNMENT EXCEPTION
.DMPFBDC       0000F2  BINARY(2)     0
.DMPFBDE       00803C  CHAR(50)      DIMENSION(32)
                                     CANNOT DUMP - SPACE ADDRESSING OR BOUNDARY ALIGNMENT EXCEPTION
.DMPFBDU       000101  CHAR(1)       ' '                             '00'X
.DMPFBFN       0000B2  CHAR(10)      'SALES     '
.DMPFBH1               NOT ADDRESSABLE
.DMPFBH2               NOT ADDRESSABLE
.DMPFBIB       0000EA  BINARY(4)     4100
.DMPFBLN       0000BC  CHAR(10)      'COBOLEX   '
.DMPFBLO       000117  BINARY(2)     0
.DMPFBLP       000740  POINTER(SPP)  NULL
.DMPFBLS               NOT ADDRESSABLE
```

Figure 120 (Part 4 of 10). Example of a COBOL Formatted Dump

```
.DMPFBL1       0000DC  BINARY(2)     14
.DMPFBL2       0000DE  BINARY(2)     0
.DMPFBMF       000123  CHAR(1)       ' '                            '00'X
.DMPFBMN       0000E0  CHAR(10)      'SALESFILE '
.DMPFBND       00803A  BINARY(2)     CANNOT DUMP - SPACE ADDRESSING OR BOUNDARY ALIGNMENT EXCEPTION
.DMPFBOB       0000EE  BINARY(4)     0
.DMPFBOF       00010D  CHAR(10)      '          '                   '00000000000000000000'X
.DMPFBOL       0000F4  CHAR(3)       '   '                          '000000'X
.DMPFBPO       00011F  BINARY(4)     992
.DMPFBQN       000124  CHAR(10)      '          '                   '00000000000000000000'X
.DMPFBRC       0000FB  BINARY(4)     17
.DMPFBRW       0000F7  BINARY(2)     0
.DMPFBSC       000102  CHAR(1)       'N'
.DMPFBSF       0000C6  CHAR(10)      '          '                   '00000000000000000000'X
.DMPFBSL       0000D0  CHAR(10)      '          '                   '00000000000000000000'X
.DMPFBSN       0000DA  BINARY(2)     0
.DMPFBTY       0000B0  CHAR(2)       'DB'
.DMPFBUF       000103  CHAR(10)      'U      &  '                   'A4000000000000500000'X
.DMPFBVL               NOT ADDRESSABLE
.DMPIOFB       0001C6  CHAR(32767)   '                    SALESFILE                                                             '
               000220    +91         '                                                                                          '
               00027A    +181        '                                 R               R   AA                     '
               0001C6  VALUE IN HEX  '00900000000000000001000000000000000000001E2C1D3C5E2C6C9D3C54000000000000000000000'X
               0001EE    +41         '00000000000E00000000000000000000000000000000000000000000000000000000000000000000'X
               000216    +81         '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00023E    +121        '00000000000000110000000000000000000000000000000000000022000000000000000000010000'X
               000266    +161        '04800004000000000000000000010000001100000000000000000000000200300000000000000000'X
               00028E    +201        '30000000000000000000001000990E000DFF0000000000000018001000990B000B10818100000000'X
               0002B6    +241        '00000000000000000000000000000000'X
.DMPIOFS       0001C6  CHAR(144)     '                    SALESFILE                                                             '
               000220    +91         '                                                      '
               0001C6  VALUE IN HEX  '00900000000000000001000000000000000000001E2C1D3C5E2C6C9D3C54000000000000000000000'X
               0001EE    +41         '00000000000E00000000000000000000000000000000000000000000000000000000000000000000'X
               000216    +81         '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00023E    +121        '000000000000001100000000000000000000000000000000'X
.DMPKYLN               NOT ADDRESSABLE
.DMPNDEV       000142  BINARY(2)     1
.DMPOFBS       0000B0  CHAR(17126)   DIMENSION(2)
                                     CANNOT DUMP - SPACE ADDRESSING OR BOUNDARY ALIGNMENT EXCEPTION
.DMPRCD                NOT ADDRESSABLE
.DMPRCDN               NOT ADDRESSABLE
.DMPRDUP               NOT ADDRESSABLE
.DMPRFMT       0001DA  CHAR(10)      'SALESFILE '
.DMPRRN                NOT ADDRESSABLE
.DMPSRC                NOT ADDRESSABLE
.EXCODE        000D30  CHAR(1)       ' '                            '00'X
.EXMSGID       000D35  CHAR(4)       '    '                         '00000000'X
.EXPARMS       000D30  CHAR(12)      '            '                 '000000000000000000000000'X
.EXPTR         000D40  POINTER(SPP)  SPACE OFFSET    3376     '00000D30'X
                                     OBJECT    PSSA
.FCLPP         0006DF  CHAR(3)       '   '                          '000000'X
.FCLSTC        0006DC  CHAR(12)      '            '                 '000000000000000000000000'X
.FCLSTC#       0006D0  CHAR(12)      '   PU       '                 '0D0003D7E4400600020001FF'X
.FCLSTP        0006FF  CHAR(21)      '                     '        '000000000000000000000000000000000000000000'X
.FCLSTP#       0006EA  CHAR(21)      '                     '        '09000200000A000200000B000200000C00020000FF'X
.FCPARM        0005B0  CHAR(22)      '                      '
.FCPARMP       0005D0  POINTER(SPP)  SPACE OFFSET    1456     '000005B0'X
                                     OBJECT    PSSA
.FCPTR         0005A0  POINTER(SYP)  OBJECT    QLREXHAN
                                     CONTEXT   QSYS
.FIB           0008A0  CHAR(32767)   'FILE-1                              0400                                                  '
               0008FA    +91         '                                                               A                          '
               000954    +181        '                                                                            '
               0008A0  VALUE IN HEX  'C6C9D3C560F14040404040404040404040404040404040404040404040008003000001F0F4F0F0'X
               0008C8    +41         '000400000000000000000000000000000000404040404040404040404000000000100010001000C00'X
               0008F0    +81         '800000000000000000003DC00036000AE0000000000000000000000000000000000000000000000000'X
               000918    +121        '00000000000000000000000000000000000000000000000080000000000000000003DC19EB7000890'X
               000940    +161        '40404040404040404040000100000000000000000000000000000000000000000000000000000000'X
               000968    +201        2 LINES OF ZEROES SUPPRESSED
.FIB#OPT       00062C  CHAR(8)       '        '                     '0000000000000000'X
.FIB#OP1               NOT ADDRESSABLE
.FIBACC        0008E9  BINARY(2)     1
.FIBACQ        0006E8  BINARY(2)     0
.FIBACTL       0006C0  CHAR(8)       '        '                     '16000400000000FF'X
.FIBALT        0008BE  CHAR(1)       ' '                            '00'X
.FIBCA         000955  CHAR(22)      '                      '       '00000000000000000000000000000000000000000000'X
.FIBCFMT       000961  CHAR(10)      '          '                   '00000000000000000000'X
.FIBCFS        0008C4  CHAR(2)       '04'
```

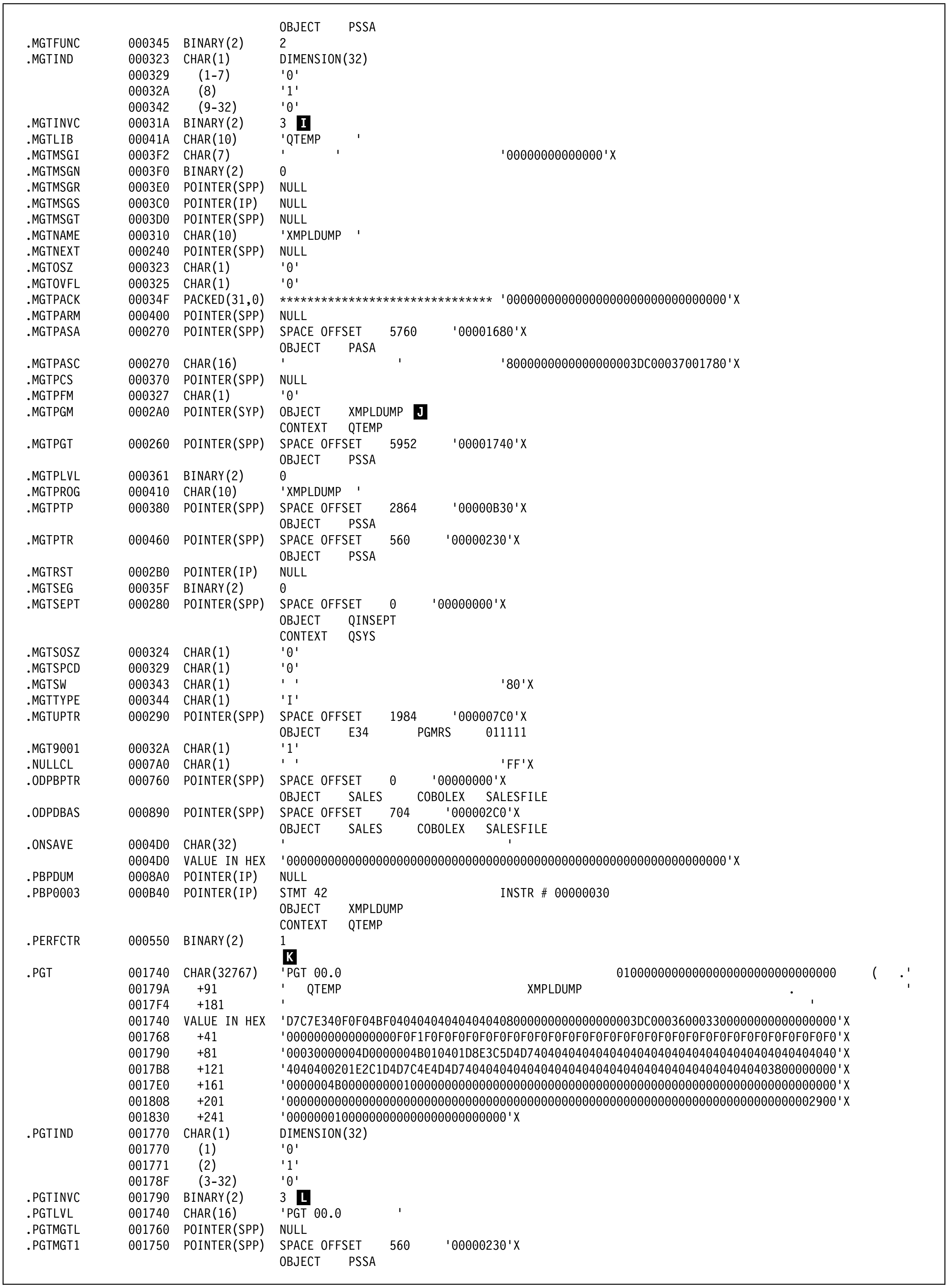
Figure 120 (Part 5 of 10). Example of a COBOL Formatted Dump

```
.FIBCFS1       0008C4  CHAR(1)       '0'
.FIBCFS2       00094C  CHAR(4)       '    '                          '00000000'X
.FIBCHAN       000920  POINTER(SPP)  NULL
.FIBCKID       000955  ZONED(2,0)    **                              '0000'X
.FIBCOP        0008C0  CHAR(4)       '    '                          '03000001'X
.FIBCRP        0008E4  CHAR(1)       ' '                             '00'X
.FIBCTID       000957  CHAR(10)      '          '                    '00000000000000000000'X
.FIBCTL        000750  POINTER(SPP)  NULL
.FIBCUR        0008C0  CHAR(6)       '    04'                        '03000001F0F4'X
.FIBCURK       000634  CHAR(123)     '                                                                                           '
               00068E    +91         '                                '
               000634  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00065C    +41         3 LINES OF ZEROES SUPPRESSED
.FIBDEVC       0008E5  BINARY(2)     0
.FIBDEVI       00094A  BINARY(2)     1
.FIBDEVN       000940  CHAR(10)      '          '
.FIBFLGS       0008BF  CHAR(1)       ' '                             '80'X  E
.FIBFMT        0008DA  CHAR(10)      '          '
.FIBFN         0008A0  CHAR(30)      'FILE-1                        '
.FIBK#LN       00062D  BINARY(2)     0
.FIBK#R#       00062F  BINARY(4)     0
.FIBK#RK       000631  BINARY(2)     0
.FIBK#TP       00062C  CHAR(1)       ' '                             '00'X
.FIBKCGK       000600  CHAR(8)       '        '                      '0800040000000009'X
.FIBKCGR       000608  CHAR(8)       '        '                      '02000400000000FF'X
.FIBKCPD       000610  CHAR(8)       '        '                      '04000400000000FF'X
.FIBKCTL       000618  BINARY(2)     0
.FIBKDLN       000628  BINARY(2)     2
.FIBKDM#       00062A  BINARY(2)     0
.FIBKDTP       000627  CHAR(1)       ' '                             '0F'X
.FIBKEY        0008CA  BINARY(4)     0
.FIBKFLN       00061B  BINARY(2)     10
.FIBKFMT       00061D  CHAR(10)      '          '
.FIBKFTP       00061A  CHAR(1)       ' '                             '01'X
.FIBKKEY       000636  CHAR(121)     '                                                                                           '
               000690    +91         '                              '
               000636  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00065E    +41         3 LINES OF ZEROES SUPPRESSED
.FIBKKLN       000634  BINARY(2)     0
.FIBKKTP       000633  CHAR(1)       ' '                             '00'X
.FIBKLEN       0008CE  BINARY(2)     0
.FIBKSTC       00062C  CHAR(1)       ' '                             '00'X
.FIBKSTE       000631  CHAR(1)       ' '                             '00'X
.FIBKSTL       00062D  BINARY(2)     0
.FIBKSTT       00062F  BINARY(2)     0
.FIBLBO        0008D0  BINARY(2)     0
.FIBLFT        0008CC  BINARY(2)     0
.FIBLIN        0008CA  BINARY(2)     0
.FIBLINE       0008D2  BINARY(2)     0
.FIBLTO        0008CE  BINARY(2)     0
.FIBMBRN       0009D6  CHAR(10)      'SALESFILE '
.FIBOFMT       0009CC  CHAR(10)      '          '                    '00000000000000000000'X
.FIBOFS        0008C6  CHAR(2)       '00'  F
.FIBOFS1       0008C6  CHAR(1)       '0'
.FIBOKEY       000953  CHAR(121)     '                                                                                           '
               0009AD    +91         '                              '
               000953  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               00097B    +41         3 LINES OF ZEROES SUPPRESSED
.FIBOKLN       000951  BINARY(2)     0
.FIBOLDK       000951  CHAR(123)     '                                                                                           '
               0009AB    +91         '                                '
               000951  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               000979    +41         3 LINES OF ZEROES SUPPRESSED
.FIBOP         0007A1  CHAR(4)       '    '                          '03000001'X
.FIBOP1        0007A1  CHAR(1)       ' '                             '03'X
.FIBOP2        0007A2  CHAR(1)       ' '                             '00'X
.FIBOP3        0007A3  CHAR(1)       ' '                             '00'X
.FIBOP4        0007A4  CHAR(1)       ' '                             '01'X
.FIBORG        0008E7  BINARY(2)     1
.FIBORRN       000951  BINARY(4)     0
.FIBOTP        0008EB  BINARY(2)     1
.FIBPTR        0003B0  POINTER(SPP)  SPACE OFFSET    2208     '000008A0'X
                                     OBJECT    PSSA
.FIBP1         000930  POINTER(SPP)  SPACE OFFSET    1200     '000004B0'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.FIBRECS       0008ED  BINARY(2)     12
.FIBREL                NOT ADDRESSABLE
.FIBRLPT       0006B0  POINTER(SPP)  NULL
```

Figure 120 (Part 6 of 10). Example of a COBOL Formatted Dump

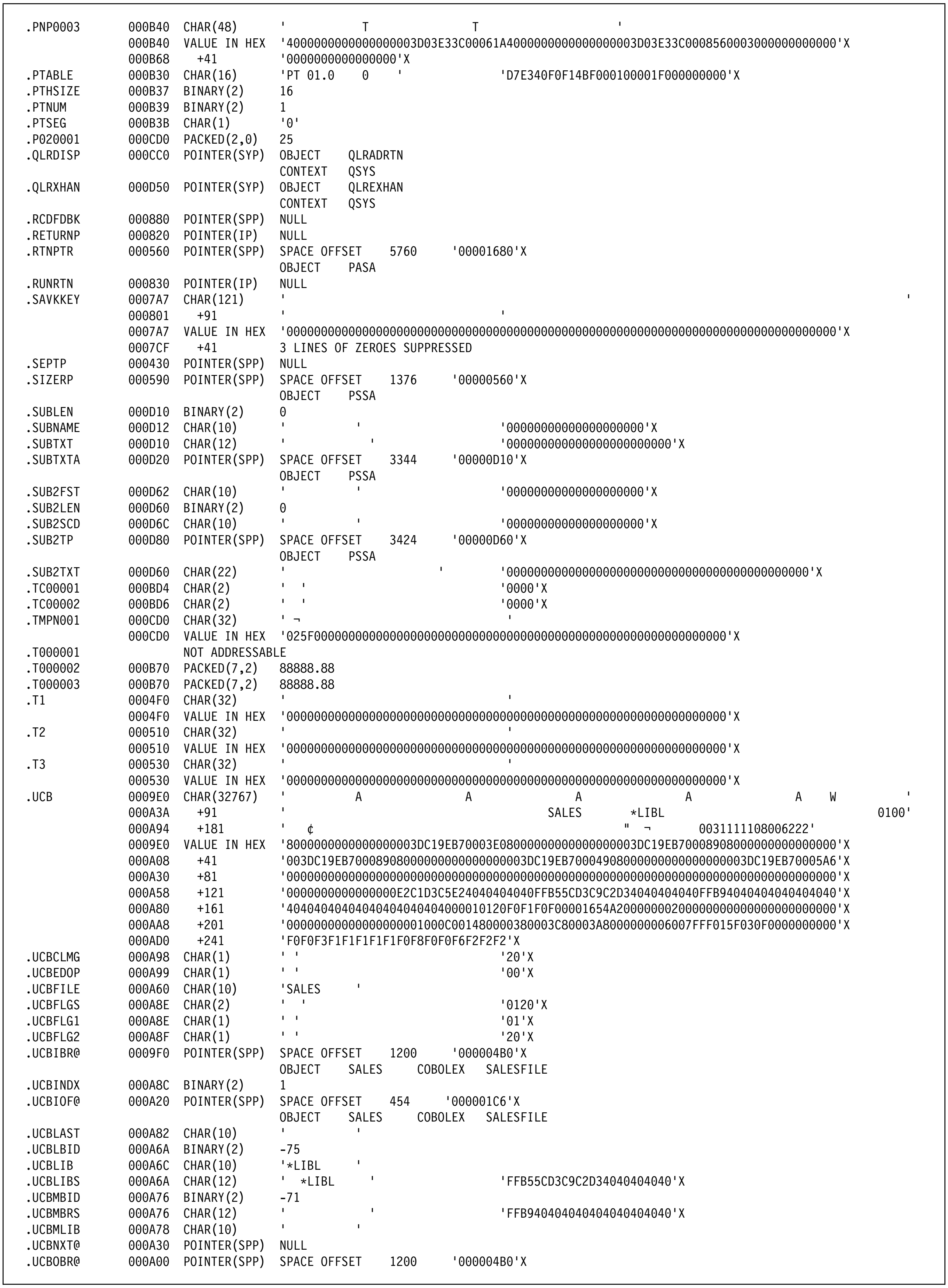
```
  .FIBROLC               NOT ADDRESSABLE
  .FIBROLE               NOT ADDRESSABLE
  .FIBROLL               NOT ADDRESSABLE
  .FIBRSL                NOT ADDRESSABLE
  .FIBRVAL               NOT ADDRESSABLE
  .FIBSPC        0008CA  CHAR(14)      '              '                '0000000000000000000000000000'X
  .FIBTAPE       0006C8  CHAR(8)       '        '                      '11000400000000FF'X
  .FIBTLEN       0006CB  BINARY(4)     0
  .FIBUBTO       000900  POINTER(IP)   NULL
  .FIBUFCB       0008F0  POINTER(SPP)  SPACE OFFSET    2528     '000009E0'X
                                       OBJECT    PSSA
  .FIBURTN       000910  POINTER(SPP)  NULL
  .FIBUSAV       0005F0  POINTER(IP)   NULL
  .FIBUSE#       0008D8  BINARY(2)     0
  .FIBVERB       0008C8  BINARY(2)     4
  .FSKA          00070C  BINARY(2)     0
  .FSKB          000702  BINARY(2)     0
  .FSPA          000711  BINARY(2)     0
  .FSPB          000707  BINARY(2)     0
  .FSTKS         0006E5  BINARY(2)     0
  .FWTRCD        0006C3  BINARY(4)     0
  .F01ACC        0008E9  BINARY(2)     1
  .F01ALTS       0008BE  CHAR(1)       ' '                             '00'X
  .F01CFS2       00094C  CHAR(4)       '    '                          '00000000'X
  .F01CHAN       000920  POINTER(SPP)  NULL
  .F01COP        0008C0  CHAR(4)       '    '                          '03000001'X
  .F01CRP        0008E4  CHAR(1)       ' '                             '00'X
  .F01CUR        0008C0  CHAR(6)       '    04'                        '03000001F0F4'X
  .F01DEVC       0008E5  BINARY(2)     0
  .F01DEVI       00094A  BINARY(2)     1
  .F01DEVN       000940  CHAR(10)      '          '
  .F01FLGS       0008BF  CHAR(1)       ' '                             '80'X
  .F01FMT        0008DA  CHAR(10)      '          '
  .F01FN         0008A0  CHAR(30)      'FILE-1                        '
  .F01MBRN       0009D6  CHAR(10)      'SALESFILE '
  .F01OFMT       0009CC  CHAR(10)      '          '                    '00000000000000000000'X
  .F01OFS        0008C6  CHAR(2)       '00'
  .F01OKLN       000951  BINARY(2)     0
  .F01OLDK       000953  CHAR(121)     '                                                                                           '
                 0009AD    +91         '                              '
                 000953  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
                 00097B    +41         3 LINES OF ZEROES SUPPRESSED
  .F01ORG        0008E7  BINARY(2)     1
  .F01OTP        0008EB  BINARY(2)     1
  .F01P1         000930  POINTER(SPP)  SPACE OFFSET    1200     '000004B0'X
                                       OBJECT    SALES     COBOLEX   SALESFILE
  .F01RECS       0008ED  BINARY(2)     12
  .F01SPC        0008CA  CHAR(14)      '              '                '0000000000000000000000000000'X
  .F01UBTO       000900  POINTER(IP)   NULL
  .F01UFCB       0008F0  POINTER(SPP)  SPACE OFFSET    2528     '000009E0'X
                                       OBJECT    PSSA
  .F01URTN       000910  POINTER(SPP)  NULL
  .F01USE#       0008D8  BINARY(2)     0
  .F01VERB       0008C8  CHAR(2)       '  '                            '0004'X
  .IOCPTR        000860  POINTER(SPP)  SPACE OFFSET    1952     '000007A0'X
                                       OBJECT    PSSA
  .IOEPTR        000840  POINTER(SYP)  OBJECT    QDBGETM
                                       CONTEXT   QSYS
  .IOFDBEX       000780  POINTER(SPP)  NULL
  .IOOPTR        000850  POINTER(SPP)  SPACE OFFSET    2240     '000008C0'X
                                       OBJECT    PSSA
  .IORTN         0003A0  POINTER(IP)   STMT 48                         INSTR # 0000004F
                                       OBJECT    XMPLDUMP
                                       CONTEXT   QTEMP
  .IP00001       000C90  POINTER(IP)   STMT 52                         INSTR # 00000065
                                       OBJECT    XMPLDUMP
                                       CONTEXT   QTEMP
  .MAINRTN       000440  POINTER(SYP)  OBJECT    QLRMAIN
                                       CONTEXT   QSYS
  .MGT           000230  CHAR(16)      'COBOL MGT 00.0LR'  G
  .MGTBIN8       000347  CHAR(8)       '        '                      '0000000000000000'X
  .MGTB81        000347  BINARY(4)     0
  .MGTCNTR       0002C0  BINARY(4)     DIMENSION(20)
                 00030C    (40-20)     0
  .MGTCPGM       000390  POINTER(SYP)  NULL
  .MGTDBUG       000328  CHAR(1)       '0'
  .MGTEXCP       00031C  CHAR(7)       '       '  H
  .MGTFIB        000250  POINTER(SPP)  SPACE OFFSET    2208     '000008A0'X
```

Figure 120 (Part 7 of 10). Example of a COBOL Formatted Dump



```
                                       OBJECT    PSSA
  .MGTFUNC       000345  BINARY(2)     2
  .MGTIND        000323  CHAR(1)       DIMENSION(32)
                 000329    (1-7)       '0'
                 00032A    (8)         '1'
                 000342    (9-32)      '0'
  .MGTINVC       00031A  BINARY(2)     3 I
  .MGTLIB        00041A  CHAR(10)      'QTEMP     '
  .MGTMSGI       0003F2  CHAR(7)       '       '                       '00000000000000'X
  .MGTMSGN       0003F0  BINARY(2)     0
  .MGTMSGR       0003E0  POINTER(SPP)  NULL
  .MGTMSGS       0003C0  POINTER(IP)   NULL
  .MGTMSGT       0003D0  POINTER(SPP)  NULL
  .MGTNAME       000310  CHAR(10)      'XMPLDUMP  '
  .MGTNEXT       000240  POINTER(SPP)  NULL
  .MGTOSZ        000323  CHAR(1)       '0'
  .MGTOVFL       000325  CHAR(1)       '0'
  .MGTPACK       00034F  PACKED(31,0)  ******************************* '00000000000000000000000000000000'X
  .MGTPARM       000400  POINTER(SPP)  NULL
  .MGTPASA       000270  POINTER(SPP)  SPACE OFFSET    5760     '00001680'X
                                       OBJECT    PASA
  .MGTPASC       000270  CHAR(16)      '                '              '80000000000000000003DC00037001780'X
  .MGTPCS        000370  POINTER(SPP)  NULL
  .MGTPFM        000327  CHAR(1)       '0'
  .MGTPGM        0002A0  POINTER(SYP)  OBJECT    XMPLDUMP J
                                       CONTEXT   QTEMP
  .MGTPGT        000260  POINTER(SPP)  SPACE OFFSET    5952     '00001740'X
                                       OBJECT    PSSA
  .MGTPLVL       000361  BINARY(2)     0
  .MGTPROG       000410  CHAR(10)      'XMPLDUMP  '
  .MGTPTP        000380  POINTER(SPP)  SPACE OFFSET    2864     '00000B30'X
                                       OBJECT    PSSA
  .MGTPTR        000460  POINTER(SPP)  SPACE OFFSET    560     '00000230'X
                                       OBJECT    PSSA
  .MGTRST        0002B0  POINTER(IP)   NULL
  .MGTSEG        00035F  BINARY(2)     0
  .MGTSEPT       000280  POINTER(SPP)  SPACE OFFSET    0     '00000000'X
                                       OBJECT    QINSEPT
                                       CONTEXT   QSYS
  .MGTSOSZ       000324  CHAR(1)       '0'
  .MGTSPCD       000329  CHAR(1)       '0'
  .MGTSW         000343  CHAR(1)       ' '                             '80'X
  .MGTTYPE       000344  CHAR(1)       'I'
  .MGTUPTR       000290  POINTER(SPP)  SPACE OFFSET    1984     '000007C0'X
                                       OBJECT    E34       PGMRS     011111
  .MGT9001       00032A  CHAR(1)       '1'
  .NULLCL        0007A0  CHAR(1)       ' '                             'FF'X
  .ODPBPTR       000760  POINTER(SPP)  SPACE OFFSET    0     '00000000'X
                                       OBJECT    SALES     COBOLEX   SALESFILE
  .ODPDBAS       000890  POINTER(SPP)  SPACE OFFSET    704     '000002C0'X
                                       OBJECT    SALES     COBOLEX   SALESFILE
  .ONSAVE        0004D0  CHAR(32)      '                                '
                 0004D0  VALUE IN HEX  '0000000000000000000000000000000000000000000000000000000000000000'X
  .PBPDUM        0008A0  POINTER(IP)   NULL
  .PBP0003       000B40  POINTER(IP)   STMT 42                         INSTR # 00000030
                                       OBJECT    XMPLDUMP
                                       CONTEXT   QTEMP
  .PERFCTR       000550  BINARY(2)     1
                                        K
  .PGT           001740  CHAR(32767)   'PGT 00.0                                        01000000000000000000000000000000     (   .'
                 00179A    +91         '   QTEMP                           XMPLDUMP                              .                '
                 0017F4    +181        '                                                                            '
                 001740  VALUE IN HEX  'D7C7E340F0F04BF04040404040404040800000000000000003DC000360003300000000000000000'X
                 001768    +41         '0000000000000000F0F1F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0F0'X
                 001790    +81         '00030000004D0000004B010401D8E3C5D4D740404040404040404040404040404040404040404040'X
                 0017B8    +121        '4040400201E2C1D4D7C4E4D4D740404040404040404040404040404040404040404040403800000000'X
                 0017E0    +161        '0000004B00000000010000000000000000000000000000000000000000000000000000000000000'X
                 001808    +201        '00000000000000000000000000000000000000000000000000000000000000000000000000002900'X
                 001830    +241        '00000001000000000000000000000000'X
  .PGTIND        001770  CHAR(1)       DIMENSION(32)
                 001770    (1)         '0'
                 001771    (2)         '1'
                 00178F    (3-32)      '0'
  .PGTINVC       001790  BINARY(2)     3 L
  .PGTLVL        001740  CHAR(16)      'PGT 00.0        '
  .PGTMGTL       001760  POINTER(SPP)  NULL
  .PGTMGT1       001750  POINTER(SPP)  SPACE OFFSET    560     '00000230'X
                                       OBJECT    PSSA
```

Figure 120 (Part 8 of 10). Example of a COBOL Formatted Dump



```
.PNP0003       000B40  CHAR(48)      '           T               T                    '
               000B40  VALUE IN HEX  '40000000000000000003D03E33C00061A4000000000000000003D03E33C0008560003000000000000'X
               000B68    +41         '0000000000000000'X
.PTABLE        000B30  CHAR(16)      'PT 01.0    0    '              'D7E340F0F14BF000100001F000000000'X
.PTHSIZE       000B37  BINARY(2)     16
.PTNUM         000B39  BINARY(2)     1
.PTSEG         000B3B  CHAR(1)       '0'
.P020001       000CD0  PACKED(2,0)   25
.QLRDISP       000CC0  POINTER(SYP)  OBJECT    QLRADRTN
                                     CONTEXT   QSYS
.QLRXHAN       000D50  POINTER(SYP)  OBJECT    QLREXHAN
                                     CONTEXT   QSYS
.RCDFDBK       000880  POINTER(SPP)  NULL
.RETURNP       000820  POINTER(IP)   NULL
.RTNPTR        000560  POINTER(SPP)  SPACE OFFSET    5760     '00001680'X
                                     OBJECT    PASA
.RUNRTN        000830  POINTER(IP)   NULL
.SAVKKEY       0007A7  CHAR(121)     '                                                                                          '
               000801    +91         '                               '
               0007A7  VALUE IN HEX  '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               0007CF    +41         3 LINES OF ZEROES SUPPRESSED
.SEPTP         000430  POINTER(SPP)  NULL
.SIZERP        000590  POINTER(SPP)  SPACE OFFSET    1376     '00000560'X
                                     OBJECT    PSSA
.SUBLEN        000D10  BINARY(2)     0
.SUBNAME       000D12  CHAR(10)      '          '                    '00000000000000000000'X
.SUBTXT        000D10  CHAR(12)      '            '                  '000000000000000000000000'X
.SUBTXTA       000D20  POINTER(SPP)  SPACE OFFSET    3344     '00000D10'X
                                     OBJECT    PSSA
.SUB2FST       000D62  CHAR(10)      '          '                    '00000000000000000000'X
.SUB2LEN       000D60  BINARY(2)     0
.SUB2SCD       000D6C  CHAR(10)      '          '                    '00000000000000000000'X
.SUB2TP        000D80  POINTER(SPP)  SPACE OFFSET    3424     '00000D60'X
                                     OBJECT    PSSA
.SUB2TXT       000D60  CHAR(22)      '                      '        '00000000000000000000000000000000000000000000'X
.TC00001       000BD4  CHAR(2)       '  '                            '0000'X
.TC00002       000BD6  CHAR(2)       '  '                            '0000'X
.TMPN001       000CD0  CHAR(32)      ' ¬                              '
               000CD0  VALUE IN HEX  '025F000000000000000000000000000000000000000000000000000000000000'X
.T000001               NOT ADDRESSABLE
.T000002       000B70  PACKED(7,2)   88888.88
.T000003       000B70  PACKED(7,2)   88888.88
.T1            0004F0  CHAR(32)      '                                '
               0004F0  VALUE IN HEX  '0000000000000000000000000000000000000000000000000000000000000000'X
.T2            000510  CHAR(32)      '                                '
               000510  VALUE IN HEX  '0000000000000000000000000000000000000000000000000000000000000000'X
.T3            000530  CHAR(32)      '                                '
               000530  VALUE IN HEX  '0000000000000000000000000000000000000000000000000000000000000000'X
.UCB           0009E0  CHAR(32767)   '          A               A               A               A               A    W          '
               000A3A    +91         '                                      SALES       *LIBL                               0100'
               000A94    +181        '   ¢                                             "  ¬    0031111108006222'
               0009E0  VALUE IN HEX  '8000000000000000003DC19EB70003E08000000000000000003DC19EB70008908000000000000000'X
               000A08    +41         '003DC19EB70008908000000000000000003DC19EB70004908000000000000000003DC19EB70005A6'X
               000A30    +81         '00000000000000000000000000000000000000000000000000000000000000000000000000000000'X
               000A58    +121        '0000000000000000E2C1D3C5E24040404040FFB55CD3C9C2D34040404040FFB94040404040404040'X
               000A80    +161        '40404040404040404040404000010120F0F1F0F00001654A20000000200000000000000000000000'X
               000AA8    +201        '00000000000000000001000C001480000380003C80003A8000000006007FFF015F030F0000000000'X
               000AD0    +241        'F0F0F3F1F1F1F1F1F0F8F0F0F6F2F2F2'X
.UCBCLMG       000A98  CHAR(1)       ' '                             '20'X
.UCBEDOP       000A99  CHAR(1)       ' '                             '00'X
.UCBFILE       000A60  CHAR(10)      'SALES     '
.UCBFLGS       000A8E  CHAR(2)       '  '                            '0120'X
.UCBFLG1       000A8E  CHAR(1)       ' '                             '01'X
.UCBFLG2       000A8F  CHAR(1)       ' '                             '20'X
.UCBIBR@       0009F0  POINTER(SPP)  SPACE OFFSET    1200     '000004B0'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.UCBINDX       000A8C  BINARY(2)     1
.UCBIOF@       000A20  POINTER(SPP)  SPACE OFFSET    454     '000001C6'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.UCBLAST       000A82  CHAR(10)      '          '
.UCBLBID       000A6A  BINARY(2)     -75
.UCBLIB        000A6C  CHAR(10)      '*LIBL     '
.UCBLIBS       000A6A  CHAR(12)      '  *LIBL     '                  'FFB55CD3C9C2D34040404040'X
.UCBMBID       000A76  BINARY(2)     -71
.UCBMBRS       000A76  CHAR(12)      '            '                  'FFB940404040404040404040'X
.UCBMLIB       000A78  CHAR(10)      '          '
.UCBNXT@       000A30  POINTER(SPP)  NULL
.UCBOBR@       000A00  POINTER(SPP)  SPACE OFFSET    1200     '000004B0'X
```

Figure 120 (Part 9 of 10). Example of a COBOL Formatted Dump

```
                                     OBJECT    SALES     COBOLEX   SALESFILE
.UCBODP@       0009E0  POINTER(SPP)  SPACE OFFSET    0     '00000000'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.UCBOPF@       000A10  POINTER(SPP)  SPACE OFFSET    176     '000000B0'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.UCBPARM       000AB0  BINARY(2)     1
.UCBRLEN       000AB2  BINARY(2)     12
.UCBRLVR       000A90  CHAR(4)       '0100'
.UCBSEP@       000A40  POINTER(SPP)  NULL
.UFCBPTR       000720  POINTER(SPP)  SPACE OFFSET    2528     '000009E0'X
                                     OBJECT    PSSA
.UFLGSAV       000CF0  CHAR(2)       '  '                            '0000'X
.USERTN        0005E0  POINTER(IP)   NULL
.USEWRK@       000D90  POINTER(SPP)  NULL
.U01CLMG       000A98  CHAR(1)       ' '                             '20'X
.U01FLGS       000A8E  CHAR(2)       '  '                            '0120'X
.U01IBF@       0009F0  POINTER(SPP)  SPACE OFFSET    1200     '000004B0'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.U01OBF@       000A00  POINTER(SPP)  SPACE OFFSET    1200     '000004B0'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.U01SEQO       000ABF  CHAR(1)       ' '                             '80'X
.U01UFCB       0009E0  POINTER(SPP)  SPACE OFFSET    0     '00000000'X
                                     OBJECT    SALES     COBOLEX   SALESFILE
.VALT001       000B70  CHAR(32)      'HHH                             '
               000B70  VALUE IN HEX  '8888888F00000000000000000000000000000000000000000000000000000000'X
.V005622       000662  CHAR(1)       '5'
.WCBCNLS       0007D0  CHAR(1)       '0'
.WCBJDAT       0007D1  CHAR(7)       '0890623'  M
.WCBLURC       0007C0  BINARY(2)     2
.WCBPINF       0007C2  BINARY(2)     0
.WCBSWTC       0007D8  CHAR(8)       '00000000'
.WCBUDTA       0007C0  CHAR(32767)   '                0089062300000000                                                          '
               00081A    +91         2 LINES OF BLANKS SUPPRESSED
               0007C0  VALUE IN HEX  '00020000000000000000000000000000F0F0F8F9F0F6F2F3F0F0F0F0F0F0F0F00000000000000000'X
               0007E8    +41         6 LINES OF ZEROES SUPPRESSED
.WCBURC        0007CE  CHAR(2)       '  '                            '0000'X
.WCBU0         0007D8  CHAR(1)       '0'
.WCBU1         0007D9  CHAR(1)       '0'
.WCBU2         0007DA  CHAR(1)       '0'
.WCBU3         0007DB  CHAR(1)       '0'
.WCBU4         0007DC  CHAR(1)       '0'
.WCBU5         0007DD  CHAR(1)       '0'
.WCBU6         0007DE  CHAR(1)       '0'
.WCBU7         0007DF  CHAR(1)       '0'
END-FLAG       000B28  CHAR(1)       ' '   N
END-OF-INPUT   000B29  CHAR(1)       'Y'
FILE-1         000660  CHAR(12)      'H2500000000 '
FILLER         00066B  CHAR(1)       ' '
FILLER         000B13  CHAR(3)       '   '
FILLER         000B04  CHAR(3)       '   '
FILLER         000AF0  CHAR(8)       'TOTALS: '
R-AREA-CODE    000661  ZONED(2,0)    25
R-NORTH-EAST   000AC9  PACKED(2,0)   30
R-NORTH-EAST   000AC7  PACKED(2,0)   15
R-SALES-CAT-1  000663  PACKED(7,2)
                     **INVALID DATA  'F0F0F0F0'X  O
R-SALES-CAT-2  000667  PACKED(7,2)
                     **INVALID DATA  'F0F0F0F0'X
R-TYPE         000660  CHAR(1)       'H'
RECORD-1       000660  CHAR(12)      'H2500000000 '
W-CAT-1        000AD0  ZONED(10,2)   311111.08
W-CAT-2        000ADA  ZONED(10,2)   622222.16
W-EDIT-TOTAL   000B16  CHAR(12)      '            '
W-EDIT-VALUES  000AF0  CHAR(50)      'TOTALS:                                           '
W-EDIT-1       000AF8  CHAR(12)      '            '
W-EDIT-2       000B07  CHAR(12)      '            '
W-SALES-VALUES 000AD0  CHAR(30)      '003111110800622222160093333324'
W-TOTAL        000AE4  ZONED(10,2)   933333.24
STATIC STORAGE FOR PROGRAM XMPLDUMP.QTEMP        BEGINS AT OFFSET 000230 IN THE PROGRAM STATIC STORAGE AREA (PSSA)
AUTOMATIC STORAGE FOR PROGRAM XMPLDUMP.QTEMP        BEGINS AT OFFSET 0016C0 IN THE PROGRAM AUTOMATIC STORAGE AREA (PASA)
```

Figure 120 (Part 10 of 10). Example of a COBOL Formatted Dump

Bibliography

For additional information about topics related to COBOL/400 programming on the AS/400 system, refer to the following IBM AS/400 publications:

- *Communications: Management Guide, SC41-0024*
  Short title: *Communications Management Guide*
- *Device Configuration Guide, SC41-8106*
  Short title: *Device Configuration Guide*
- *Software Installation*, SC41-3120
  Short title: *Software Installation*
- *System Programmer's Interface Reference, SC41-8223*
  Short title: *System Programmer's Interface Reference*
- *Database Guide, SC41-9659*
  Short title: *DDS Reference*
- *Data Description Specifications Coding Form, SX41-9891*
  Short title: *DDS Coding Form*
- *Communications: Intersystem Communications Function Programmer's Guide, SC41-9590*
  Short title: *ICF Programmer's Guide*
- *System Operation*, SC41-3203
  Short title: *System Operation*
- *Basic Security Guide, SC41-0047* and *Security Reference, SC41-8083*
  Short titles: *Basic Security Guide* and *Security Reference*
- *Distributed Data Management Guide, SC41-9600*
  Short title: *DDM Guide*
- *Database Guide, SC41-9659*
  Short title: *Database Guide*
- *Utilities: Interactive Data Definition Utility User's Guide, SC41-9657*
  Short title: *IDDU User's Guide*
- *System Programmer's Interface Reference, SC41-8223*
  Short title: *System Programmer's Interface Reference*
- *CICS/400 Application Programming Guide*, SC33-0822
  Short title: CICS/400 Application Programming Guide
- *Communications: Remote Work Station Guide, SC41-0002*
  Short title: *Remote Work Station Guide*
- *Advanced Backup and Recovery Guide, SC41-8079*
  Short title: *Advanced Backup and Recovery Guide*
- *Programming: Control Language Programmer's Guide, SC41-8077*
  Short title: *CL Programmer's Guide*
- *New User's Guide, SC41-8211*
  Short title: *New User's Guide*
- *Programming: Control Language Reference, SC41-0030*
  Short title: *CL Reference*
- *Publications Guide, GC41-9678*
  Short title: *Publications Guide*
- *Programming: Work Management Guide, SC41-8078*
  Short title: *Work Management Guide*
- *Systems Application Architecture* Structured Query Language/400 Reference, SC41-9608*
  Short title: *SQL/400* Reference*
- *Data Management Guide, SC41-9658*
  Short title: *Data Management Guide*
- *COBOL/400 Reference*, SC09-1813
  Short title: *COBOL/400 Reference*
- *American National Standard Programming Language COBOL, ANSI X3.23-1985, ISO 1989-1985*
  Short title: *American National Standard Programming Language COBOL, ANSI X3.23-1985, ISO 1989-1985*

For information about Common Programming Interface (CPI) COBOL, refer to the following publication:

- *Systems Application Architecture Common Programming Interface COBOL Reference*, SC26-4354.

Glossary of Abbreviations

Abbreviation	Meaning	Explanation
Appl Dev Tools	Application Development Tools	Consisting of programs for the AS/400 system, such as the Screen Design Aid (SDA) and the Source Entry Utility (SEU).
ANSI	American National Standards Institute	An organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States.
ASCII	American National Standard Code for Information Interchange	The code developed by American National Standards Institute for information exchange among data processing systems, data communications systems, and associated equipment. The ASCII character set consists of 8-bit characters, consisting of 7-bit control characters and symbolic characters, plus one parity-check bit.

Abbreviation	Meaning	Explanation
CICS	Customer Information Control Service	An IBM licensed program that enables transactions entered at remote work stations to be processed concurrently by user-written application programs. The licensed program includes functions for building, using, and maintaining databases, and for communicating with CICS on other operating systems.
CL	Control Language	The set of all commands with which a user requests system functions.

Abbreviation	Meaning	Explanation
DBCS	Double-Byte Character Set	A set of characters in which each character is represented by 2 bytes. Languages such as Japanese, Chinese, and Korean, which contain more symbols than can be represented by 256 code points, require double-byte character sets. Because each character requires 2 bytes, the typing, displaying, and printing of DBCS characters requires hardware and programs that support DBCS. Four double-byte character sets are supported by the system: Japanese, Korean, Simplified Chinese, and Traditional Chinese. Contrast with single-byte character set.

Abbreviation	Meaning	Explanation
DDM	Distributed Data Management	A function of the operating system that allows an application program or user on one system to use data files stored on remote systems. The systems must be connected by a communications network, and the remote systems must also be using DDM.
DDS	Data Description Specifications	A description of the user's database or device files that is entered into the system in a fixed form. The description is then used to create files.
EBCDIC	Extended Binary-Coded Decimal Interchange Code.	A coded character set consisting of 256 eight-bit characters.
FIPS	Federal Information Processing Standard	An official standard to improve the utilization and management of computers and data processing in business.

Abbreviation	Meaning	Explanation
ICF	Intersystem Communications Function	A function of the operating system that allows a program to communicate interactively with another program or system.
I/O	Input/Output	Data provided to the computer or data resulting from computer processing.
LVLCHK	Level Checking	A function that compares the record format-level identifiers of a file to be opened with the file description that is part of a compiled program to determine if the record format for the file changed since the program was compiled.

Abbreviation	Meaning	Explanation
ODT	Object Definition Table	A table built at compile time by the system to keep track of objects declared in the program. The program objects in the table include variables, constants, labels, operand lists and exception descriptions. The table resides in the compiled program object.
OS/400	Operating System/400	The AS/400 operating system.
SDA	Screen Design Aid	A function of the AS/400 Application Development Tools licensed program that helps the user design, create, and maintain displays and menus.
SEU	Source Entry Utility	A function of the AS/400 Application Development Tools licensed program that is used to create and change source members.
SQL/400	Structured Query Language/400	An IBM licensed program supporting the relational database that is used to put information into a database and to get and organize selected information from a database.
UPSI	User Program Status Indicator switch	An external program switch that performs the functions of a hardware switch. Eight switches are provided: UPSI 0 - 7.

Note: The abbreviations for OS/400 commands do not appear here. Refer to the *CL Reference* for OS/400 commands and their usage.

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