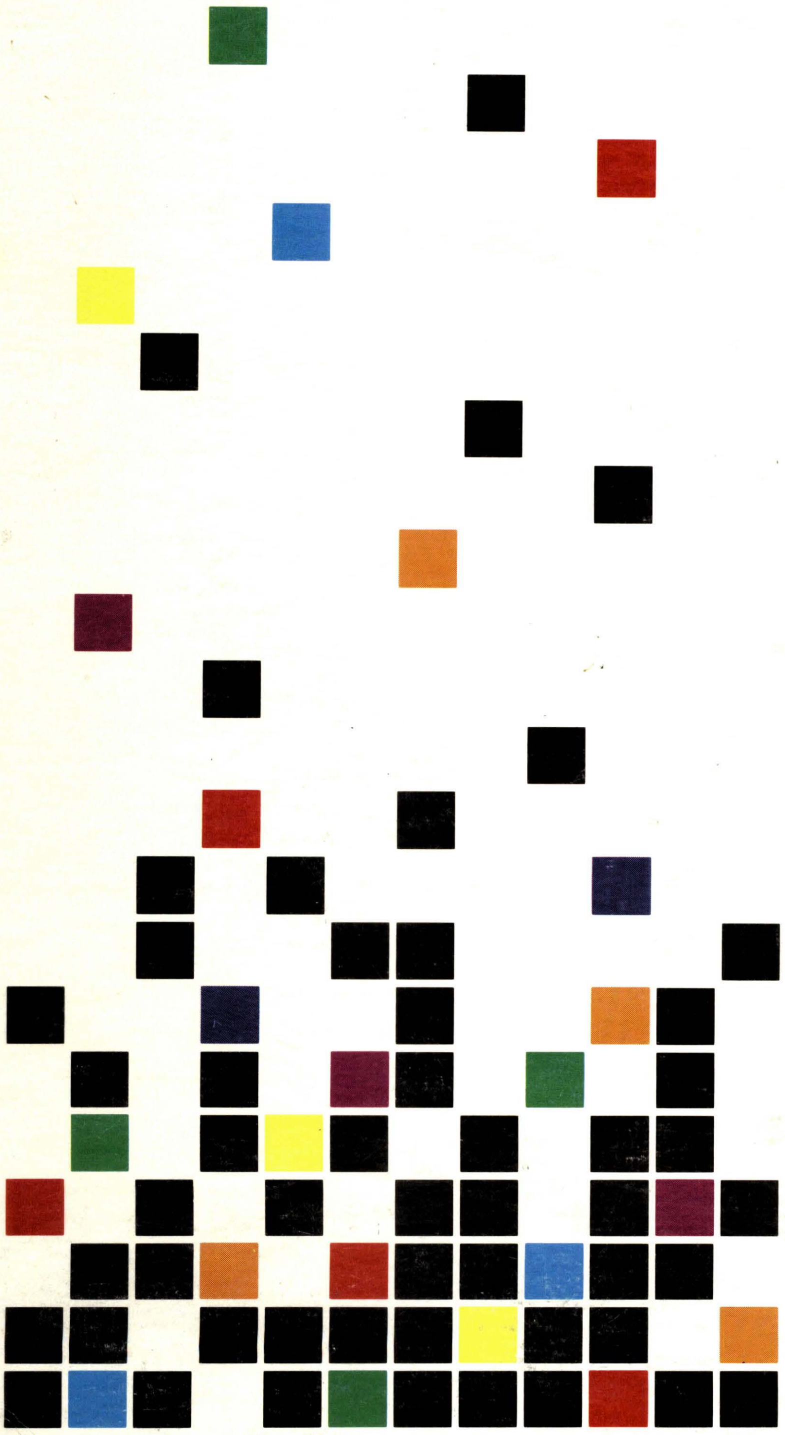
CICS

Customer Information Control System

Version 1 Release 6

Application Programming Primer

Volume I



Main Instructional Text

IBM

CICS

Customer Information Control System

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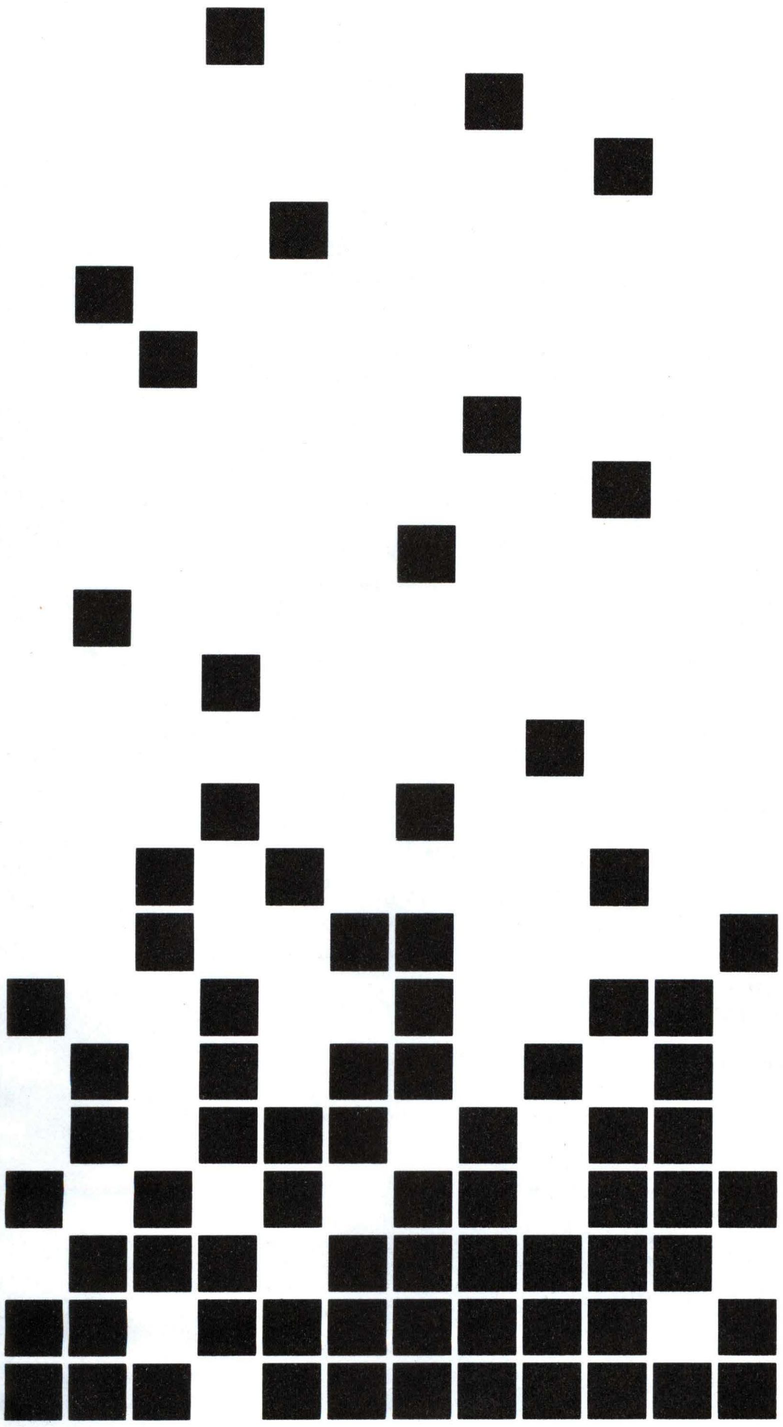
Application

Programming Primer

Volume I

Program Numbers

5740-XX1 (CICS/OS/VS)
5746-XX3 (CICS/DOS/VS)



Main

Instructional

Text

IBM

First Edition (October 1984)

This edition of the CICS Primer applies to Version 1 Release 6 (Version 1.6) of the IBM program product Customer Information Control System/Virtual Storage, program number 5746-XX3 (CICS/DOS/VS), and program number 5740-XX1 (CICS/OS/VS).

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Preface

With a little effort from you, this Primer can teach you how to write CICS application programs, using the command-level CICS interface and the COBOL programming language. We assume you're an application programmer, bringing to CICS your existing knowledge of COBOL gained in a batch programming environment. However, experience of other (non-CICS) online systems, and of other high-level programming languages (such as PL/I), will be helpful.

It will also be helpful (but not vital) if you can read the *CICS/VS General Information* manual for the current release of CICS.

This Primer has two simple aims. We want to tell you just enough for you to be able to design, code, test, and run your first CICS application program. And we want to point you to the various books in the CICS library that will fill in the gaps because, in a book this size, we won't be able to tell you **all** about CICS.

We'll be talking about, and basing our examples on, a CICS system that offers only a subset of the full CICS facilities. This will make things easier for you because it means we won't have to keep referring you to other books in the CICS library while you're learning. These other books are listed in "Bibliography" on page 317.

The CICS system we've chosen is as complete and self-sufficient as we can make it. It will give you a sound framework for your first application programs, and offer a logical starting point for more advanced work.

How to Use This Book

Read through it at your own pace until you reach Part 4. At that point, you meet the COBOL source code for our example application. We've printed it separately for easier reference. Our intention is to make the code available in machine-readable form for you to translate and compile for your own system.

Study the code. Run the application. Think how you would improve it (this might not be as difficult as you imagine!). Make your changes and try them out. Remember: "I read, and I remember; I do, and I understand."

The Structure of this Book

There are five main instructional parts, and some reference material in appendixes at the back of the book.

"Part 1. Setting the Scene" introduces CICS, and tries to answer the question "What's different about CICS?" (compared to, say, a batch system).

"Part 2. Application Design" deals with application design from various angles: the user interface, the design of the data, the splitting of the processing steps into sensible transactions, the exercise of control and communication between transactions, and so on.

"Part 3. Application Programming" tells you how to write the COBOL programs that will implement the CICS example file inquiry and update application. These programs form a realistic (non-trivial) working system.

"Part 4. The COBOL Code of our Example Application" is printed separately. It contains the source code in full, along with detailed step-by-step notes of how the code works.

"Part 5. Testing and Diagnosis" covers running, testing, and debugging application programs. It shows you a complete debugging session using the powerful facilities of the Execution Diagnostic Facility, EDF. (The bug is one we deliberately added, in case you're wondering...)

It also shows you how to work through a transaction dump of the same problem, arriving at the same conclusion.

Appendix A, "Getting the Application Into Your CICS System" tells you how to install and bring up a CICS system sufficient for your first application.

Appendix B, "Additional CICS Facilities and Your Reference Manual (the APRM)" tells you about the various features of CICS that we've not been able to cover in a book this size. It also introduces you to the CICS book you'll need when you start writing your own programs: the *CICS/VS Application Programmer's Reference Manual (Command Level)*, SC33-0077.

Finally, there's a **glossary** and an **index**.

Just before Part 1, you'll find a questionnaire in which we invite you to tell us what you think about this book. We always welcome feedback on our books (praise or criticism) and would be grateful for **your** comments.

A Note on Installing your CICS System

Before you can test your application, you need a CICS system on which to run it. We've put all the necessary information about installing a CICS/DOS/VS system into Appendix A, "Getting the Application Into Your CICS System" on page 269.

We suggest you refer to this appendix or, if you have access to a friendly system programmer, get his or her help right now. By following the step-by-step instructions you should end up with a working CICS system on which you can install and run your first application program.

Product Names

Throughout the book we've used the simple, commonly used, abbreviations for the names of IBM program products. If you want to know exactly what these abbreviations mean, refer to the glossary at the back of the book.

Computer Systems

CICS runs on a wide range of IBM computer systems. Most of the information in this book applies to all these systems. However, where we need to make an assumption about the computer system that you are using, we assume a relatively small, single-processor system, controlled by the VSE operating system, and including all the facilities available with SIPO and VSE/SP.

Terminals

Terminals are the interface between a CICS system and its users. You can use many different types of terminal, depending on the functions that you need to perform. However, the general-purpose terminals of the IBM 3270 Information Display System are very widely used. For this reason, we'll be assuming 3270 terminals are used for the example application in this book.

Contents

Figures

Questionnaire **Application Programming Primer**

(CICS/VS Version 1 Release 6)

To help us produce books that meet your needs, please fill in this questionnaire. It would help us if you provide your name and address in case we need to clarify any of the points you raise. Please understand that IBM may use or distribute whatever information you supply in any way it believes appropriate without incurring any obligation to you.

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well organized	1	2	3	4	5	badly organized
easy to understand	1	2	3	4	5	incomprehensible
adequately illustrated	1	2	3	4	5	inadequately illustrated
has enough examples	1	2	3	4	5	has too few examples
And the book as a whole? excellent	1	2	3	4	5	poor

2. Which topics does the book handle well?

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____

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Questionnaire

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Part 1. Setting the Scene

This Part of the Primer:

- Describes the ideas behind CICS
- Explains some of the CICS terminology
- Describes a typical online application program

Chapter 1-1. Introduction to CICS

What is CICS?

CICS (Customer Information Control System) is a general-purpose data communication system that can support a network of many hundreds of terminals. You may find it helpful to think of CICS as an operating system within your own operating system (although this definition might offend purists). In these terms, CICS is a specialized operating system whose job is to provide an environment for the execution of your online application programs, including interfaces to files and data base products. See Figure 1.

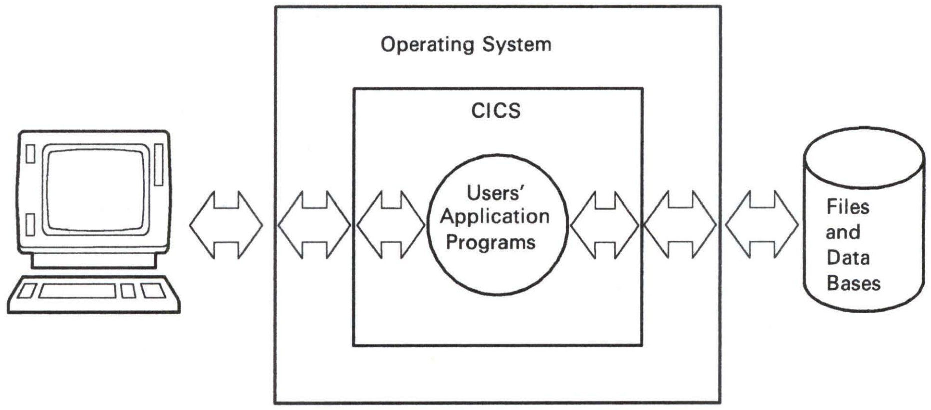


Figure 1. The CICS Online Environment

The total system is known as a **data-base/data-communication system**, but this is such a mouthful that we usually shorten it to **DB/DC system**.

Your host operating system, of course, is still the final interface with the computer; CICS is "merely" another interface, this time with the operating system itself.

Operating systems are designed to make the best use of the computer's various resources. CICS helps out by separating a particular kind of application program (namely, online applications) from others in the system, and handling these programs itself.

Why You May Need an Online System

If you're the sort of person we've imagined as a typical reader, until now you've written programs that (typically) read a file, process individual data records, update a carried-forward version of the file, and produce some type of printed output. These files usually go offline when your program has finished with them, and the file data thus becomes inaccessible for inquiry purposes. Furthermore, the records in the files are only as up-to-date as the most recent program run, and don't reflect any intervening activity.

Nowadays, this often isn't good enough. Your users want immediate responses to their information processing needs. The overnight turnaround associated with traditional systems is no longer adequate: accurate, up-to-date information is needed within seconds. To achieve this you need an online information processing system, using terminals that can give direct access to data held in either data sets or data bases. In other words, you need a DB/DC system.

Developing a DB/DC system can be a major undertaking, particularly if you choose to write all your own control programs for handling terminals and files, and provide your own job-scheduling mechanisms. However, CICS can make it very much easier by supplying all the basic components needed to handle your data communications. This allows you to concentrate on developing application programs to meet your organization's business needs. You don't need to concern yourself with the details of data transmission, buffer handling, or the properties of individual terminal devices.

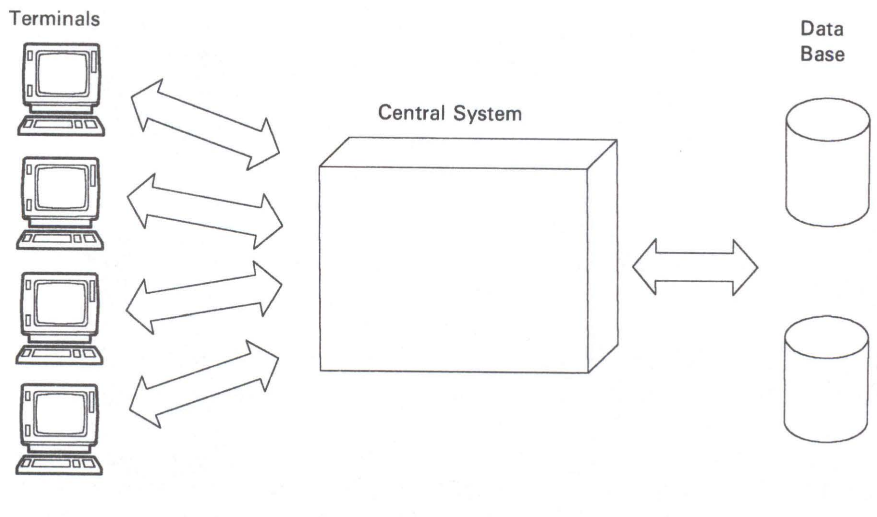


Figure 2. A DB/DC System

Why Have CICS?

The online end users within a network can make all sorts of demands on many different sets of data. The things they want to do individually are usually short. Often they are interrelated and share the same programs and data. Furthermore, the response times they get should be as short as possible. For all these reasons, the users' transactions are done more efficiently within a single operating system job, rather than as separate jobs.

If all the transactions are to be handled within the same job, a controller is needed to look after them, in much the same way that an operating system is needed within a computer to control the jobs. CICS carries out this controlling function within a DB/DC job.

CICS provides the communications control and service functions necessary for users to create their own, customized DB/DC system. This cuts down the total amount of programming needed. You can customize CICS to the needs of practically any online application, and it can support networks consisting of a wide variety of terminals and subsystems.

For most of the time, the users will be unaware of CICS and, indeed, unaware of the existence of other applications. They will spend their time using the online application programs that you've designed for their particular transactions.

Because CICS **is** a general-purpose product, the view your users get of it will depend far more on the configuration of your system and the application programs you provide, than on any features of CICS.

What Does CICS Do?

CICS controls online DB/DC application programs. But what does this mean? In fact, it means that CICS is a program that does a lot of work on your behalf. CICS handles interactions between terminal users and your application programs. An interaction may consist of one or more requests from, and responses to, a terminal user in the course of a single job by that user.

CICS provides:

- The functions required by application programs for communication with remote and local terminals and subsystems
- Control of concurrently running programs serving many online users
- Facilities for accessing data bases and files, in conjunction with the various IBM data base products and data access methods that are available

- The ability to communicate with other CICS systems and data base systems, both in the same computer and in connected computer systems.

We've left things as open as possible to allow our customers to produce the system **they** need. It's up to your systems and applications designers (which could mean you, of course) to choose what they want from the various CICS facilities, and to build whatever kind of user interface that best suits the end users. So, although you still have to provide the application programs that the end users actually run, CICS makes it much easier. Your programs gain access to the CICS facilities they need by straightforward, high-level, commands.

CICS Application Programs

Online application programs have certain features and needs in common. Typically, they:

- Serve many online users, apparently simultaneously
- Require common access to the same data sets and data bases
- Try to give each end user a timely response to each interaction
- Involve telecommunications access to remote terminals.

The host operating system is in overall charge of the computer and manages resources in whatever way you set up. But the very versatility of a general-purpose operating system means that it often cannot give online programs the sort of priority treatment they need. Instead, CICS may be given "privileged" treatment on behalf of all the online programs that run under it.

To make the best use of the time and system resources that the operating system gives to CICS, CICS takes on itself some of the aspects of an operating system. For example, CICS allows more than one of its programs (tasks) to be in an active state at the same time. But CICS doesn't duplicate all of the services provided by the operating system. Whenever appropriate, CICS goes straight to the operating system to provide what its tasks ask for.

Couldn't I Do All This Myself?

Yes, of course, but why reinvent the wheel?

CICS is a large, mature piece of software that has evolved in parallel with the growth of online terminal networks and the movement toward distributed processing. It supports a wide range of hardware and software (for details, have a look at the *CICS General Information* manual). Many thousands of data-processing installations around the world have made CICS the basis of their data communication systems.

Can CICS Serve Very Large Systems and Very Small Systems Properly?

Yes. CICS is designed in a modular fashion, and we supply it as a set of programs that you can combine rather like building blocks. If you don't need certain CICS functions, you simply leave out those parts of CICS when installing your system. Or perhaps, more typically, you might install everything, but only **use** what you need.

To start with, though, you'll be putting together your first application on the subset CICS system that we've chosen for this Primer.

How Does a CICS-Based Application Differ from a Batch Application?

As we hinted in the preface, we expect you to have a batch programming background. That being so, you don't need us to tell you what batch programming is all about. However, we **do** want to tell you how a CICS-based application differs from a batch application.

Basic Differences

Not **everything** is different, of course. But here are some basic differences for you to think about:

- In a batch program, you often define all the required input/output and work areas within the program. In CICS, these areas are outside the program. They are allocated by CICS, as needed, from a dynamic storage area within the CICS partition or region. This lets CICS economize on main storage, and use the same copy of a program to do work for several users at once.

- A batch program reads its own input data, whereas CICS reads the data on behalf of the CICS application programs. A particular CICS application program need not even be loaded into the computer before its first input message arrives.

- A batch program issues its input/output instructions directly to the operating system. CICS application programs always issue such instructions to CICS, and CICS handles the interface to the operating system.

- Recovering when things go wrong is more interesting (as we'll see).

Recovering When Things Go Wrong

The final major difference between a batch system and an online system comes up when things go wrong.

Obviously, all data processing systems need to be able to survive faults and errors such as the loss of power supply, processor failures, program errors, data set failures, and (in online systems) communication errors. Procedures are required to recover from such faults or to restart the system if a fault has stopped it.

Recovery and restart design is inevitably more complex for an online system than for a batch system:

- For **batch** processing, input data is prepared before processing begins. The data is then supplied to the batch process in one orderly sequence, which is controlled and predictable.

- For **online** processing, input data isn't prepared beforehand, but is entered as needed while the application is running. Furthermore, the input data can come from many different users working concurrently. In other words, input data does not arrive in a predictable sequence.

If a failure occurs:

- With a batch program, you can repeat the processing, or continue it from the point of failure. This is because the processing sequence is **predictable** (it is based entirely on the predefined input data), and because the input data is still available.

- With an online application, you cannot simply rerun the application or continue from the point of failure because the state of the process is unknown. And even if it were known, you couldn't expect the terminal users to reenter a day's work.

So, online application programs need a system that provides special mechanisms for recovery and restart. In broad terms, these mechanisms ensure that each resource associated with an interrupted online application is returned to a known state so that processing can be restarted safely. As you work through this book, you'll see how CICS can help you get over your recovery and restart problems.

Perhaps the most striking difference is how a small, simple application program can be loaded into the computer and promptly be used, by hundreds of people throughout a terminal network. Not only that, but the same application program could be in use by all these people at the same time. And yet these online application programs aren't necessarily more difficult to write and get working than the programs you've been used to up to now.

Two Vital Terms

Next, we want to introduce two important words in the CICS vocabulary: "transaction" and "task." You'll constantly see these so it's good to know what they mean right from the start.

A **transaction** is a piece of processing initiated by a single request, usually from an end user at a terminal. A single transaction will consist of one or more application programs that, when run, will carry out the processing needed.

In other words, "transaction" means in CICS what it does in everyday English: a single event or item of business between two parties. In batch processing, transactions of one type are grouped together and processed in a batch (all the updates to the personnel file in one job, a list of all the overdue accounts in another, and so on). In an online system, in contrast, transactions aren't sorted by type, but instead are done individually as they arrive (an update to a personnel record here, a customer order entered there, a billing inquiry next, and so on).

Having given you this straightforward definition, we'll immediately complicate things a bit by admitting that the word "transaction" is used to mean both a single event (as we just described) and a class of similar events. Thus we speak of adding Mary Smith to the Payroll File with a (single) "add" transaction, but we also speak of the "add" transaction meaning all additions to that particular file.

Things are further complicated by the fact that one sometimes describes what the user sees as a single transaction (the addition to a file, perhaps) as several transactions to CICS. We get to this nicety in "Chapter 2-7. A Basic Decision: Conversational or Pseudoconversational" on page 77. Until we get there, you should use the definition of transaction we've given above; you'll be able to tell from context whether we mean a transaction type or a single bit of processing.

Now, what about a **task?**

Users tell CICS what **type** of transaction they want to do next by using a transaction identifier. By convention, this is the first "word" in the input for a new transaction, and is from one to four characters long, although this source of the identifier is sometimes overridden by programming.

CICS looks up the transaction identifier in one of its internal tables, the Program Control Table, where it finds out which program to invoke first to do the work requested. It creates a **task** to do the work, and transfers control to the indicated program. So a task is a single execution of some type of transaction, and means the same thing as "transaction" when that word is used in its single event sense.

A task can read from and write to the terminal that started it, read and write files, start other tasks, and do many other things. All these services are controlled by and requested through CICS commands in your application programs. CICS manages many tasks concurrently. Only one task can actually be executing at any one instant. However, when the task requests a service which involves a wait, such as file input/output, CICS uses the wait time of the first task to execute a second; so, to the users, it looks as if many tasks are being executed at the same time.

Starting a Transaction

Normally, end users wishing to begin an online session will first identify themselves to CICS by signing-on. Signing-on to CICS gives users the authority to invoke certain transactions. Once signed-on, they invoke the particular application (transaction) they intend to use. They can do so by typing the **transaction identification code** at the start of their initial request. But, if your designers decide otherwise, it's just as easy to set up a particular program function (PF) key to invoke a transaction with a single keystroke or, indeed, for a given terminal always to invoke a particular transaction.

Application programs are stored in a library on a direct access storage device (DASD) attached to the processor. They can be loaded when the system is started, or simply loaded as required. If a program is in storage and isn't being used, CICS can release the space for other purposes. When the program is next needed, CICS loads a fresh copy of it from the library.

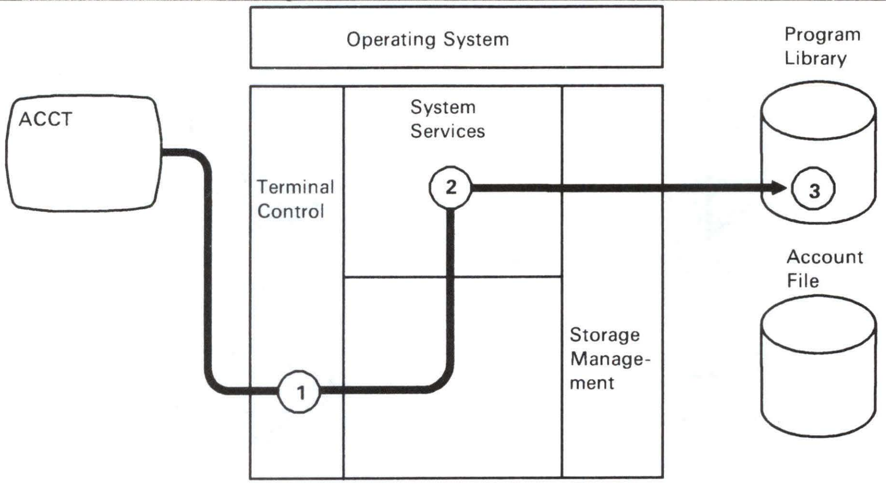
Inside CICS

In the time it takes to process one transaction, the system may receive messages from several terminals. For each message, CICS loads the application program (if it isn't already loaded), and starts a task to execute it. Thus multiple CICS tasks can be running concurrently.

CICS maintains a separate thread of control for each task. When, for example, one task is waiting to read a disk file, or to get a response from a terminal, CICS is able to give control to another task. Tasks are managed by the CICS **task control** program; the management of multiple tasks is called **multitasking**.

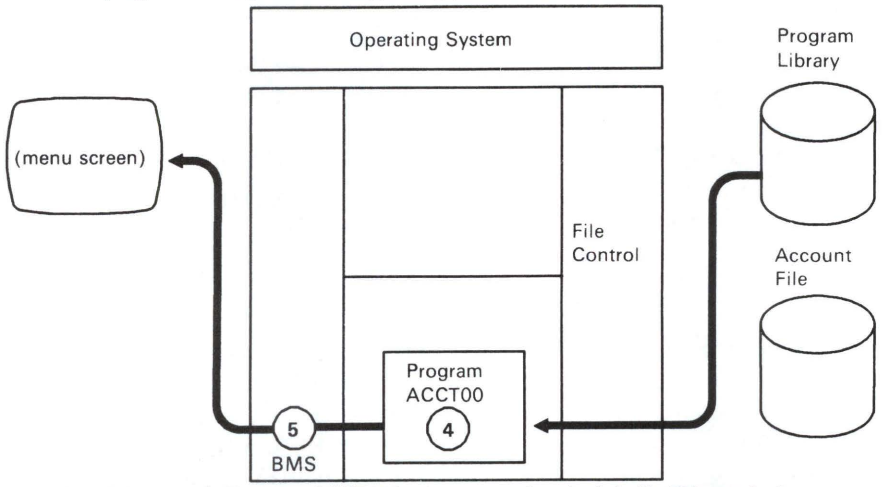
CICS manages both multitasking and requests from the tasks themselves for services (of the operating system or of CICS itself). This allows CICS processing to continue while a task is waiting for the operating system to complete a request on its behalf. Each transaction that is being managed by CICS is given control of the processor when that transaction has the highest priority of those that are ready to run.

While it runs, your application program requests various CICS facilities to handle message transmissions between it and the terminal, and to handle any necessary file accesses. When the application is complete, CICS returns the terminal to a standby state. Figure 3 should help you understand what goes on.



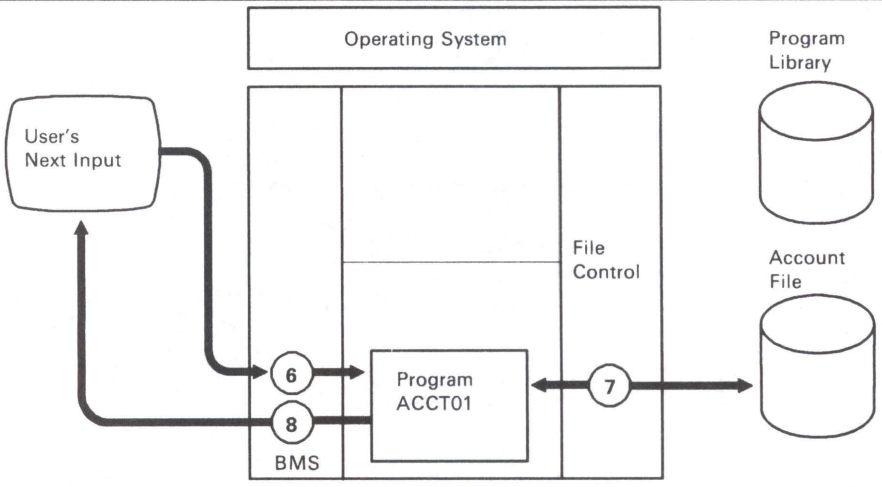
The flow of control during a transaction (code ACCT) is shown by the sequence of numbers 1 to 8 on the panels. Don't take this transaction too seriously; we're only using it to show some of the stages that can be involved. The meanings of these eight stages are as follows:

1. **Terminal control** accepts characters ACCT, typed at the terminal, and puts them in working storage.
2. **System services** interpret the transaction code ACCT as a call for an application program called ACCT00. If the terminal operator has authority to invoke this program it is either found already in storage or loaded from....
3. **The program library** into working storage, where....



4. A task is created. Program **ACCT00** is given control on its behalf. This particular program invokes....
5. **Basic mapping support (BMS)** and terminal control to send a menu to the terminal, allowing the user to specify precisely what information is needed.

Figure 3 (Part 1 of 2). The Flow of Control During a Transaction



6. **BMS** and terminal control also handle the user's next input, returning it to ACCT01 (the program designated by ACCT00 to handle the next response from the terminal) which then invokes....

7. **File control** to read the appropriate file for the information the terminal user has requested. Finally, ACCT01 invokes....

8. **BMS** and terminal control to format the retrieved data and present it on the terminal.

Figure 3 (Part 2 of 2). The Flow of Control During a Transaction

The transaction continues to run until it reaches a place in the program at which it's waiting for some activity (such as a disk access) to end. At this point, CICS allocates the processor to the next task that can run. Only when there's no work to do on behalf of any CICS task does CICS pass control back to the operating system to allow batch work to run. This allows CICS to maintain the priority of online working over batch work in other address spaces or partitions.

In this way, CICS controls the overall flow of your online system.

Besides doing all the transaction processing, CICS also supports the bookkeeping side of the system, by accumulating performance statistics and monitoring the resources used. This gives you the information that enables user departments in an organization to be charged accordingly. It also allows you to find out which parts of CICS are being heavily or lightly used. This will help your systems people change the CICS set-up when you wish to tune your system to improve its performance.

How Does CICS Help You Set Up an Online System?

After your system has been designed, the programming effort to turn the specification into a working reality is normally divided between two groups: the people who install and maintain the system, and those who write the application programs it will use. (We don't want to rule out the possibility of all this work being done by one heroic person.) CICS offers a variety of helpful features for both groups. Concentrating on the application programming side, CICS aids include:

- A **choice of programming language**. You can write your application programs in COBOL, PL/I, RPGII (VSE only), or assembler language.
- A **command-level programming interface** with CICS. You need know little about how CICS works. You request data or communication with terminals by issuing CICS commands that resemble those of the programming language you are using. A **command language translator** preprocesses the application source code, translating CICS commands into the appropriate language statements. It also provides useful diagnostics.
- An **execution diagnostic facility (EDF)**, for testing command-level application programs interactively.

How Do You Use CICS?

Now that you have some idea of what CICS is and how it fits into your computer system, we can explain how you use it.

We're going to do so by showing you the stages in designing and implementing a reasonably typical and useful application: a file inquiry and update system. This example starts in the next chapter.

To get the best out of your CICS system (or, for that matter, any system) you should design the system around its applications. However, for our purposes, we'll assume that you've been through this process for other applications, and simply wish to extend your present system by adding this online file inquiry and update application.

In reality, if your proposed new application programs were very different from your existing ones, your systems programmers might have to tailor your CICS system to provide the necessary functions, typically by picking different sets of system parameters for different occasions. This could mean **initializing** the system again, to include IBM-supplied programs to help you do what you want. If your needs are very unusual, they might have to **customize** some parts of your CICS system, adding code of their own, before initializing the system.

The programs that we develop and describe in this book are all supported by a simple CICS system, so you can forget about initialization or customization for the time being.

Part 2. Application Design

This Part of the Primer:

- Explains how to design your first CICS application programs
- Defines the problem
- Describes 3270 Information System data streams
- Deals with designing the data
- Talks about establishing the user interface
- Examines special features of the CICS environment
- Defines the example application programs involved, and their interactions

THE CICS EXAMPLE APPLICATION - A DEPARTMENT STORE

The Current Situation

A department store with credit customers maintains a master file of its customers' accounts. The record for each customer contains the customer's name, address, telephone number, charge limit, current balance, account activity, payment history, and so on. At present, a set of batch processing programs updates this file (and some related ones) twice a week with the necessary charge and payment information. The records are also printed periodically, to help in answering questions both from customers and from within the Accounting and Customer Service Departments. However, this listing is too large to be printed often, and so it is usually out-of-date.

Online Access to Information

The store would like to be able to access a customer's record online, to have absolutely current information. In addition, the Accounting Department wants to be able to update these customer records online, for convenience and currency. A facility to add new records, delete records and change addresses and other information not related to billing is therefore required, as well as the inquiry function.

Each customer has a unique account number, which is the key to the existing master file. The users in the Accounting Department will presumably access records by this number, because it is always available when they are processing work or researching questions.

Access by Name

However, the Customer Service Department wants to be able to access the file by customer name. When customers make an inquiry, they don't usually know their account numbers, but they normally do manage to remember their names! If they want to charge items but don't have their charge cards with them, a clerk will call Customer Service, verify the existence and payment status of the account, and get the account number for the charge slip.

Logging and Printing Changes

Finally, the people in the Accounting Department have asked us to make quite sure that all changes to the file are logged, with a hard-copy report. They seem to be rather nervous about subjecting their master file to online updating, but assure us that they will feel more confident having a printed record of all changes made. They are also concerned about the security aspects of this first venture into online file updating, and want to be able to trace changes to specific records. Later, they will probably agree to direct this log to tape, printing it only when necessary, but for the moment they need it in hard-copy form.

Chapter 2-1. The CICS Example Application - A Department Store

This chapter explains, by means of an example, how to set about designing a CICS application. The text you've just been reading (in the boxes opposite) describes what the application will do.

The outline specification for our example is a simple one. It shows design issues and programming requirements that arise in nearly every application. The CICS services required by this application are a subset of the full range available; however, this subset consists of those functions that most straightforward applications need to use. Let's relate the department store's needs to some general points about CICS application programs. A CICS application usually consists of three main parts:

- The data to be processed
- The transactions to be performed on that data
- The interface with the user.

You can see these parts in the specifications just described for the example. The customer information in the account file is the data to be processed; the online operations (display a record, add a record, and so on) are the transactions to be performed on that data; and the terminals, formatted screens, and operating procedures are the interface with the user. Let's see how each of these parts could be designed.

It is important to note before starting, and it will certainly be clear in what follows, that each of these three parts bears on the others. You cannot design one without reference to the other two.

Moreover, design is an iterative process. Decisions about the user interface affect transaction definition, which in turn causes a slight change in specifications, and the whole cycle begins again. These adjustments are normal and should be expected in any design process.

However, you must freeze the design at some point or you may never complete the job.

Defining the Problem

The first step in the design process is to specify broadly what the application will do. In our case, the need for the application came from two user departments, and the first functions they requested are:

- Display of customer account record, given an account number
- Addition of new account records
- Modification of existing account records (by account number)
- Deletion of account records (by account number)
- Hard-copy listing of changes to the account file
- Ability to access records by name.

The Account File Records

The detailed design of our programs is going to be influenced by the established form of the existing customer data, of course. And the account file is very much at the center of this application. Its records are shown in Figure 4.

The fields marked as Type "A" are the ones that are to be maintained by the online program. Those marked "B" are updated by the batch billing and payment cycle and need only to be displayed in the online system.

Requirements Imposed by the Environment

Besides the users' requirements, we're going to assume that certain others are imposed by the environment in which this application will run. These are:

- The terminals available are IBM 3270 system displays and printers. The screens display 24 lines, each of 80 characters (the IBM 3278 Display Station model 2, for example), with corresponding printers.
- Some of the people who will use the application will do so infrequently. Consequently, the application should be as self-documenting as possible, and users should not need to memorize very much to use it comfortably. On the other hand, help to casual users should not result in slow or annoying interactions for frequent users. Some hard-copy documentation on how to use the system will be provided, but we hope users will only rarely need to look at it. The goal is to keep everything nice and simple for all users.

FIELD	LENGTH	OCCURS	TOTAL	TYPE
Account Number (Key)	5	1	5	A
Surname	18	1	18	A
First Name	12	1	12	A
Middle initial	1	1	1	A
Title (Jr, Sr, and so on)	4	1	4	A
Telephone number	10	1	10	A
Address line	24	3	72	A
Other charge name	32	4	128	A
Cards issued	1	1	1	A
Date issued	6	1	6	A
Reason issued	1	1	1	A
Card code	1	1	1	A
Approver (initials)	3	1	3	A
Special codes	1	3	3	A
Account status	2	1	2	B
Charge limit	8	1	8	B
Payment history:	(36)	3	108	B
-Balance	8			
-Bill date	6			
-Bill amount	8			
-Date paid	6			
-Amount paid	8			

Figure 4. Account File Record Format

- The integrity of the account file must be maintained. This means that it must be protected from inconsistent or lost data, whether resulting from a failure in the application or CICS or the operating system. It also must be protected from total loss, such as a disk head crash or other catastrophe.

- The existing account file is a VSAM key-sequenced data set containing about 10 000 records of 383 characters each, including the 5-digit account number key.

Refining and Developing the Specifications

The next step in defining the problem is to verify the first program specifications with whoever made the original requests. You should be especially alert for information or functions that no-one requested but that nevertheless may actually be required when real work is attempted. Otherwise the users will make the same discoveries right after you complete your programming effort, and you'll be faced with making changes when it may prove difficult, rather than now when it is easy.

It is always useful to talk to the actual users of an application, to find out how they do their work and how they view the functions you intend to provide. Supervisors can provide other insights. It is very important to repeat this verification step as the design process moves along from a broad outline toward more and more detailed specifications.

Estimating the Number of Transactions

Now is also the time to find out how often the system will be expected to cope with the transactions of each type, what sort of response times will be expected, what times of the day the application will have to be available, and so on. This will allow you to design programs that are efficient for the bulk of the work, and it will help you in determining system and operational requirements.

For the example application, let's assume that our inquiries produced the following information:

- There will be about 10 additions, 50 modifications, 5 deletions, and 200 inquiries (by account number) per day in the Accounting Department.
- The people in Accounting are unable to estimate the number of inquiries that they would make by name, but they sound intrigued with the possibility, and therefore may be expected to make some use of this facility.
- Accounting would find it very useful to be able to get a printed copy of a customer account record, besides being able to display it on the screen. (This is a new requirement, not in the original specification. We should consider providing it.)
- Customer Service makes nearly 1000 inquiries per day against account records, ninety percent of them by name. For most of these, the only items used from the complete account record are the name and address (to verify that it is the *right* record), and the credit status and limit.

Note: In assessing estimates of transaction frequency, we need to account for a fact of life. That is, if we make it much easier to do something, such as an inquiry, users will almost certainly do it more often than they used to do. Indeed, the eventual transaction rates experienced with online systems are almost always higher than can be predicted from the current workload - often a reliable indication of their success.

Summary

We've now identified some of the first steps when starting to design an application. You should:

- Broadly set down the application functions based on user needs
- Identify the individual data elements involved in the processing.
- Consider any external environmental factors and restrictions

- Verify your initial specifications with the users
- Estimate the expected load on the system from the various new functions that your application will provide.

When you've done this, you can then go on to design the transactions and processing programs that you'll need. So, let's continue now with some application design considerations.

Designing the Transactions: Preliminaries

Earlier in this chapter, we described the functions needed in our example. Let's now see how we might define transactions to perform these functions. One obvious approach is to make each function a separate transaction. The transaction to display an account record, then, would work something like this:

- Find out from the terminal user which record is to be displayed.
- Read that record from the file.
- Display the information from that record at the terminal.

That seems straightforward. How about the add transaction?

- Get the data for the new record as keyed in by the user at the terminal.
- Write this data to the file.

Even simpler. However, there are a few things we've not taken into account.

First of all, we're not dealing with the familiar batch devices of card reader and line printer here. The 3270-system terminals are radically different in their characteristics from such batch devices. They are different, too, from line- or record-oriented devices such as Teletypes[1] and IBM 2741s.

Second, there are human beings operating the terminals, and their happiness and efficiency must be a major design goal in *any* application.

Third, we have to deal with the implications of processing in an online environment, where our goals and constraints may be quite different from those that govern a batch program.

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1 "Teletype" is a trademark of the Teletype Corporation.

Finally, we've not provided for any exceptional conditions. For example, what if the record to be displayed isn't in the file? Or if the one to be added *is* in the file? You probably know that in a batch program about 80 percent of the effort and the code is devoted to handling errors, even though this code is executed rarely. In online programs, all these same problems have to be thought about and resolved, and there are also some new potential problems.

What Next?

Before we continue trying to design our transactions, let's learn a little more about the 3270 systems that our users will be using to communicate with the transactions. After all, one of the first things to be considered is the user interface: how will the terminal operators communicate with this application, and how will it give them the information they need?

We can then go on to find out more about a much wider range of issues: what makes users happy ("human factors"), the design of data, programming for a CICS environment, and so on.

But first, 3270s. If you are already familiar with 3270 terminals and the 3270 data stream, you can skip ahead to "Chapter 2-3. Designing the User Interface" on page 33.

Chapter 2-2. 3270 Terminals

Remember, you're free to skip this chapter if you know about IBM 3270 terminals already.

The 3270 Information Display System is a family of display and printer terminals. Different 3270 device types and models differ in screen sizes, printer speeds, features (like color and special symbol sets) and manner of attachment to the processor, but they all use essentially the same data format.

You need to know a little about this format to make the best use of 3270-system devices, and to understand the **Basic Mapping Support** (BMS) services that CICS provides for communicating with these devices. That's the purpose of this chapter.

Let's talk about the IBM 3278 Display Station Model 2, which has a display screen and a keyboard. This device is used for both input and output, and in both cases the screen (or rather a buffer that represents it) is the crucial medium of exchange between the terminal and the processor. The purpose of the keyboard is to modify the screen, in preparation for input, and to signal when that input is ready to be sent to the processor.

When your application program writes to a 3278, the processor sends a stream of data in the special format used by 3270 devices. Most of the data in the stream is the text that is to be displayed on the screen; the rest of it is control information that defines where the text should go on the screen, whether it can be overtyped from the keyboard later, and so on.

The printers that correspond to the 3278 can use this same data stream, so a stream built for a display device can be used equally well for a printer.

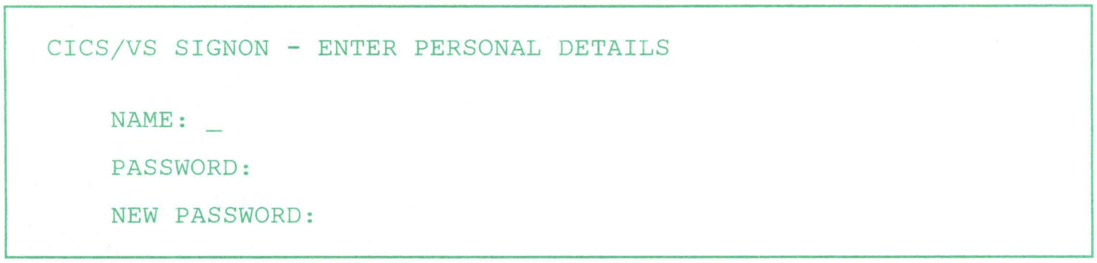
3270 Field Structure

The screen of the 3278 Model 2 can display up to 1920 characters, in 24 rows and 80 columns. That is, the face of the screen is logically divided into an array of positions, 24 deep and 80 wide, each capable of displaying one character, with enough space around it to separate it from the next character.

Each of these 1920 character positions is individually addressable. This means that your COBOL application program can send data to any position on the screen, without having to space it out with space characters to get it into the right location. Your program does not, however, give an address for each character you want displayed. Instead, within your program, you divide your display output into **fields**.

A field on the 3278 screen is a consecutive set of character positions, all having the same display characteristics (high intensity, normal intensity, protected, not protected, and so on). Normally, you use a 3270 field in exactly the same way as a field in a file record or an output report: to contain one item of data.

To show you how this works, Figure 5 shows the screen that the CICS system uses for the standard sign-on transaction:



```
CICS/VS SIGNON - ENTER PERSONAL DETAILS

    NAME: _

    PASSWORD:

    NEW PASSWORD:
```

Figure 5. The CICS Sign-On Screen

There are ten fields on this screen although, as shown, only four of the fields are displaying character data. The first one is at row 1, column 1 (position 1,1), and it contains the data "CICS/VS SIGNON - ENTER PERSONAL DETAILS". The field is specified as having the display characteristics of **protected** (meaning that the terminal operator cannot type over that area of the screen) and **bright** (high intensity, in this case just for emphasis). The second field is at position (4,5) and contains the data "NAME:". This is also protected and displayed at high intensity. (The underscore after "NAME:" is the cursor and marks the position into which the next character entered from the keyboard will go.) Both of these fields have been used for output only, to convey something to the user. For the second field, it was to show what should be typed into the third field, which is located immediately after the second field at position (4,11).

This third field is different because we intend the user to key something into it which will become input the next time the terminal transmits. So it isn't protected. It is set for normal intensity, and, even though you cannot see this by looking at the screen, it is 20 positions long. This is the permitted length of the name field in the CICS **Sign-On Table**, with which the contents of this field will later be compared.

At the end of this field is another field, known as a **stopper field**. (You can't see this one, either.) Its only function is to stop the user from keying more than 20 characters into the name field. The reason for this is that the beginning, but not the end, of each field is flagged in the buffer which represents the screen. The end of a field is one position before the beginning of the next field. There is no data in this "stopper" field; the important thing is that it is protected. Whenever you try to key into a protected field on the screen, you are prevented from doing so, and the keyboard locks. Users who try to key more than 20 characters into the name field, therefore, run into this protected field, and are made aware of the error by the locking of the keyboard.

The next three fields are two lines down, at positions (6,5), (6,15) and (6,24). They are rather like the three fields on the earlier line. The first of them contains the data "PASSWORD:" and is protected. The second is the field into which the user is supposed to enter the password. It is unprotected, and has another attribute that may at first seem curious. It is **dark** or **nondisplay**. This means that the data in the field does not show on the screen (whether the user puts it there or the program does), even though it is very much there. Nondisplay is used for this field because passwords are supposed to be secret, and this way no one passing by while the user is signing-on will see the password. The third field is again a stopper field to stop the user from keying in more than eight characters of password information.

The remaining three fields are two lines down again, at positions (8,5), (8,19), and (8,28) and they are also parallel in function to the three on the previous line: label, input field, and stopper field.

3270 Output Data Stream

Now let's consider how this information is formatted for transmission from the processor to the 3278. Figure 6 shows the data stream.

```
Control information affecting the whole transmission, such
as whether to unlock the keyboard or not, where to place
the cursor, and so on.

First      ENCODED SCREEN ADDRESS showing where
field:     the next field goes on the screen (row 1,
           column 1)

           CONTROL INFORMATION to show that a
           field is about to begin

           CONTROL INFORMATION to describe display
           attributes of field: high intensity, protected

           DATA to be displayed: "CICS/VS SIGNON -
           ENTER PERSONAL DETAILS"
```

Figure 6 (Part 1 of 2). A 3270 Output Data Stream

Second field:	ENCODED SCREEN ADDRESS showing where the next field goes on the screen (row 4, column 5)
	CONTROL INFORMATION to show that a field is about to begin
	CONTROL INFORMATION to describe display attributes of field: high intensity, protected
	DATA to be displayed "NAME:"
Third Field:	CONTROL INFORMATION to show that a field is about to begin
	CONTROL INFORMATION to describe display attributes of field: normal intensity, unprotected
Fourth Field:	ENCODED SCREEN ADDRESS showing where the next field goes on the screen (row 4, column 32)
	CONTROL INFORMATION to show that a field is about to begin
	CONTROL INFORMATION to describe display attributes of field: protected (stopper)
Fifth Field:	ENCODED SCREEN ADDRESS showing where the next field goes on the screen (row 6, column 5)
	CONTROL INFORMATION to show that a field is about to begin
	CONTROL INFORMATION to describe display attributes of field: high intensity, protected
	DATA to be displayed: "PASSWORD:"
...And so on for the remaining fields.	

Figure 6 (Part 2 of 2). A 3270 Output Data Stream

There are several things to note about this data stream:

- For the first and second fields, a screen address appears in the data stream, whereas for the next field it does not. This is because no new address needs to be provided when one field immediately follows another. Addresses for these fields could be included, but they would increase the length of the transmission. It is important to keep transmissions as short as possible when dealing with terminals that may be connected by telephone lines.

- Similarly, data is included for the first two fields but not for the next two. Again, if there is no data, it isn't necessary to include anything in the data stream. This also reduces the length of the transmission.

- We've shown the various fields for the screen being transmitted in the order they appear on the screen. This is customary and natural, but it isn't required by the device, which will accept fields in any order.

- The most striking feature of the data stream is its variable length and format, which depend on the presence or absence of data, adjacency or nonadjacency of fields, and so on. This would be very cumbersome to produce in a COBOL program, to say the least. Moreover, every time you moved something about on the screen, you would have to change the program that produced the data stream.

Don't panic! "Saved by BMS" on page 31 shows us the light at the end of this particular tunnel.

3270 Attribute Bytes

One more point about this output data stream. If you followed the screen positions used in the example carefully, you may have noticed that each field seems to be one position too long. If the 20-position name field begins at (4,11), why doesn't the stopper field start at (4,31) instead of (4,32)? This is because the display attributes to which we've referred (protected, bright, and so on) actually occupy one screen position for each field. That is, if we start a 20-character field at position (4,11), the **attribute byte** (as it is called) for the field is located at (4,11) and the actual data goes from (4,12) through (4,31). The attribute byte looks like a space on the screen, and is itself protected (whether or not the field to which it applies is protected), so that the user cannot key into it and change the field identity.

As noted earlier, the attribute byte controls how data is shown on the screen. The choices are:

- High intensity
- Normal intensity
- Dark (nondisplay).

The attribute byte also governs what can be done to the field from the keyboard. Here the choices are:

- Unprotected: The user may key anything into the field.

- Numeric: The user may key only digits, decimal points, and minus signs into the field.

- Protected: The user may not key into the field.

- Autoskip: The user may not key into the field and, furthermore, the cursor will automatically skip over the field if the previous field is filled.

Autoskip is usually used for stopper fields if the information in the previous field is of fixed length and always fills the field. That way, the user can key continuously, and doesn't have to use the cursor advance key after filling a field to get to the next one.

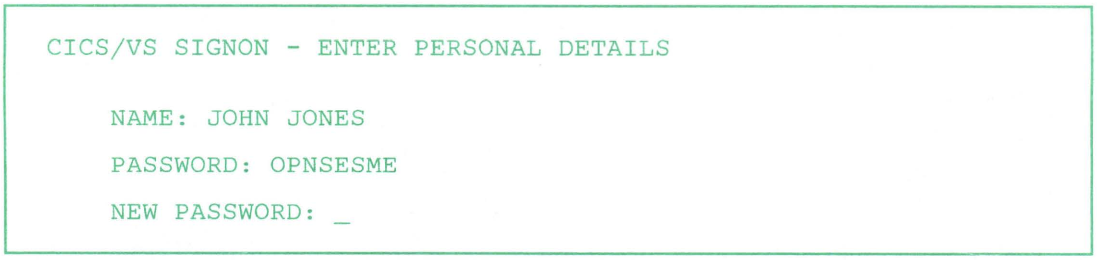
After variable-length data, however, like the name field in the sign-on screen, it is customary to make the stopper a protected field, instead. If you specify autoskip, and the user keys too much, the excess goes into the next unprotected field, and the user may not be aware of this. Where there are fields for both fixed-length and variable-length data, some programmers like to use only protected stoppers, so that the user consistently has to use the cursor advance key to get to the next field, whether or not the current field is full. Others prefer to use both kinds on the same screen.

The attribute byte also carries one more piece of information. This is the **modified data tag**. It has to do with input, however, and so we'll explain it later. (If you can't wait, you'll find more details on page 29 and in "The BMS Macros" on page 111.)

Note: Not all combinations of attributes are permitted, but all the useful ones are. We should also point out now that displays with additional features, like color and special symbols, have more complex attribute combinations to express the additional possibilities. However, the logic for formatting the data stream with these extended attributes is essentially the same.

3270 Input Data Stream

Now that we've described what output to a 3278 looks like, what does the input look like? There are several different possible formats, and the one used depends both on the type of read command used and on certain other circumstances. Figure 7 shows our sign-on screen after John Jones has been busy at it.



```
CICS/VS SIGNON - ENTER PERSONAL DETAILS

     NAME: JOHN JONES

     PASSWORD: OPNSESME

     NEW PASSWORD: _
```

Figure 7. The Sign-On Screen in Use

We're showing you the password here but, remember, you wouldn't normally see it because it's held in a nondisplay field.

What is of interest to us is what CICS gets when it reads a screen like this one. Figure 8 on page 29 shows us what comes back after the user presses the **ENTER** key.

```
Control information affecting the whole transmission, such
as which key caused the input to be sent (ENTER, PFx),
where the cursor is, and so on

First     ENCODED SCREEN ADDRESS showing where
field:    the field was on the screen (here Row 4,
          Column 11).

          CONTENTS of the field: "JOHN JONES" (10
          characters, not the full 20 allowed).

Second    ENCODED SCREEN ADDRESS showing where
field:    the field was on the screen (here Row 6,
          Column 15).

          CONTENTS of the field: "OPNSESME"
```

Figure 8. A 3270 Input Data Stream

Points to note about this transmission are:

- Practically nothing came back. All the fields used for titles and labels have been omitted from the transmission, and even the "new password" field, which the user did not fill in, is missing. This is because only *changed* fields are transmitted back on the kind of read used here by CICS. The reason the hardware works this way is, again, to minimize the length of the transmission.

  How does the 3278 know what to send? When a user keys into a field, a bit in the attribute byte is turned on. This is the modified data tag, or "MDT." You can also turn this bit on when you write to the screen, so that the field is returned whether or not the user keys into it. This provides a handy method for storing information on the screen between transactions, but we'll explain that later, in "Communication Between Transactions" on page 89.

- The second thing to note is that only the significant portion of a changed field is sent; the unused portion on the right-hand side of the field is not. This is because the 3270 does not send empty positions on the screen. Empty positions are called **nulls**, and have a character encoding of hexadecimal (hex) 00 ("LOW-VALUE" in COBOL). If you ask for the screen to be erased (as you'll often want to) before your data stream is written to it, the screen is set to nulls. Nulls aren't the same as spaces, even though they look the same on the screen. Spaces have a hexadecimal representation of 40 and are transmitted; thus the space between "JOHN" and "JONES" comes in, but the unused part of the field after "JONES" does not. This is, once again, to minimize the length of the data transmission.

The result of all these length-reduction measures is another data stream of extremely variable format. This time the position of the data coming back depends not only on the content of what was sent but also on what the operator did, presenting a considerable challenge to decode.

We mentioned earlier that there were several different formats used for transmission to the processor, depending on the type of read used and other circumstances.

One of the other circumstances is the type of key the operator used to send the input. A number of keys cause the 3278 to send input to the processor at the earliest opportunity (these keys include CLEAR and ENTER, the program access (PA) keys, and the program function (PF) keys). Of these, the CLEAR key and the PA keys send only the identity of the key itself, without sending any of the data on the screen. If the operator uses one of these so-called "short-read" keys, the data stream shown in Figure 8 ends right after the initial control information. This causes a special situation which you'll have to deal with in any program which tries to read a formatted screen.

Unformatted 3270 Data

As well as transmitting a short data stream to the processor, the CLEAR key also erases the screen. The entire screen is set to null values, and there are no fields. You may prefer to think of the screen as just one big field, but it is a field without attributes. The user can key into this field and send it to the processor. In fact, if you think about it, almost every new transaction is going to start this way. The user presses CLEAR to erase the leftovers from the previous operation, and then keys in something to identify the next request and transmits it with the ENTER key. What does this look like coming in to the processor?

Data that comes in from a screen that was not formatted into fields by a previous write is called, very logically, **unformatted** data. The data stream looks like the one in Figure 8 on page 29 except that no address is provided (the data is assumed to start at the first position on the screen), and there is only one field. The field consists of every character that isn't a null - that is, every character that the user keyed - regardless of where it is on the screen, and in the order it appears on the screen).

Unformatted data is handled in CICS with a slightly different set of commands from formatted data. Unformatted data is actually simpler than formatted data (and you can write it as well as receive it), but it isn't nearly as useful. So we'll only cover formatted data in this Primer, and point you to where you can find out how to use unformatted screens if you should want to.

Saved by BMS

We said earlier that you do not have to deal directly with this data format in your CICS program. The feature of CICS that spares you this complexity is called Basic Mapping Support (BMS). BMS does several things for you:

- It allows you to deal with data in a fixed format, providing a data structure for you to copy into your program in which the input fields (the name, password, and new password in the example we showed) are always in the same place and of the same (maximum) length.

- It allows you to deal with data by name. In this instance we might have called the three fields where we expected input NAME, PSWD, and NEWPSWD. (We would do this when we first defined the screen.) Then we could refer to these variables by name in our program, without any concern for where they are on the screen.

- It allows you to define all the constant data for the screen (titles, field labels, and so on) separately from your program, so that you don't have to clutter your code with a great many statements like

```
MOVE 'CICS/VS SIGNON - ENTER PERSONAL DETAILS' TO ....
```

- It saves you from having to know about the details of the 3270 data stream.

With these facilities, you can change the arrangement of the screen, the words in the titles, and so on without any changes to your program - a very important advantage.

"What BMS Does" on page 109 tells you more about BMS and explains how to use it.

Now, let's go on and look at what we'll have to consider when designing the user interface.

Chapter 2-3. Designing the User Interface

We know broadly what we want our application to do:

- Display customer account records, given their account numbers
- Add new account records
- Modify existing account records
- Delete account records
- Print a list of the changes made to the account file
- Print a single copy of a customer account record
- Access records by name.

We also now know something about how the 3270 data stream works and how CICS starts transactions. So we can start thinking about how our application might look to the user.

A First Approach

One approach is to review the transactions which the user wants to do, and think about what the user should see while performing each one.

The Display Transaction

If we take the simplest one as a starting point, displaying a record in the file, then we need to decide:

1. How the user enters a request.

2. How we show the user the requested record.

3. What to do if the user makes a mistake.

The user need enter only a very little information to request the display of a record: just the transaction type (display, in this case) and something to identify the record to be displayed. The output, on the other hand, is quite extensive, consisting of all the fields in the account record.

We can therefore imagine that a user wanting to display a record might switch on the terminal, sign-on to the system, clear the screen, and enter something like:

```
DISP12345
```

"DISP" here is the transaction identifier that CICS needs to decide which transaction the user wants to perform, and "12345" is the number of the account to be displayed.

If the requested record can be found in the Account File, the application program should respond with a screen showing the data in the record.

To make the screen as easy as possible to understand, we should label each field to show what it means. Figure 9 shows a possible screen format.

```
ACCOUNT FILE: RECORD DISPLAY

ACCOUNT NO: 12345       SURNAME:   MOUNCE
                        FIRST:     DAVID           MI: C  TITLE:
TELEPHONE: 7512483960   ADDRESS:   79 WISTFUL VISTA
                                   PLEASANTVILLE, NY 10549

OTHERS WHO MAY CHARGE:
CHRISTA MOUNCE (WIFE)              PETER MOUNCE (SON)

NO. CARDS ISSUED: 2     DATE ISSUED: 04/01/84      REASON: L
CARD CODE: C            APPROVED BY: CES           SPECIAL CODES: A J

ACCOUNT STATUS: OK      CHARGE LIMIT:   2000.00

HISTORY:   BALANCE      BILLED        AMOUNT       PAID          AMOUNT
              0.00      04/25/84      101.37       05/04/84      101.37
              0.00      05/25/84       42.50       06/08/84       42.50
            321.97      06/25/84      321.97

PRESS "CLEAR" OR "ENTER" WHEN FINISHED
```

Figure 9. A Typical Display Screen Format

If the request wasn't correct, we have to write back some sort of message explaining exactly what's wrong. Very little can go wrong here with the display transaction (unlike the add transaction, where all sorts of things can happen!). The user can make a format error in specifying the record, or name a non-existent record and thus try to display something that isn't there.

Note that it is CICS that has to deal with errors in the transaction type. If the user gets the "DISP" part wrong, CICS won't know what transaction to start up, and will so inform the user. So, if the user enters something other than "DISP", but something that happens to match a valid transaction identifier, CICS will happily start up the "wrong" transaction. Beware! (The "cure" the user generally tries in such a situation is usually to press the CLEAR key and try again.)

Other, "higher level" error possibilities include:

- The user may not be authorized for access
- The account file may not be online
- There may be a physical error while accessing a record from the file.

However, in the absence of these "high level" problems, as we said, very little can go wrong here.

The Print Transaction

We can make the print transaction very similar to the display transaction. The only functional difference will be that the output will go to a printer instead of the screen. And if we intend to use more than one printer, we'll probably want to let the user tell us which one, which means another item of input (and, we must admit, more opportunity for error).

The Add Transaction

When it comes to adding a new record to the file - an add transaction - we must still think about the same three things as for the display transaction. Unlike the display situation, however, the input required is very extensive. We could let users enter the request and the particulars for an add at the same time, but this would make things rather difficult for them, besides being a poor use of the 3270. With that many fields to enter, we definitely want users to enter the input into formatted screens, with labels to show where and how to enter the data.

So users will have to make two entries to do an add. The first one will display the formatted screen, and the second will contain the input for the addition. The output screen for the first stage of the add will be the skeleton into which the user is to enter the data. No output is actually *required* from the second stage of the add, but good human factors suggest that we consider telling the user that the transaction was successful.

Also, unlike the display transaction, there are plenty of opportunities for errors on an add. The record to be added might already exist on the file, or some of the fields entered might be missing or incorrect or inconsistent with each other. We don't want to make our users start all over again if they get one or two items wrong, so we'll have to think of a way for them to fix any bad fields without rekeying the good ones.

Maybe an add transaction could go like this. The user would enter something like "ADD 12345" and the transaction would do one of two things. Either it would respond with an error message that the record to be added already existed (far better to tell the user now, instead of after all the data for the record has been keyed in). Or it would display a skeleton screen for the user to fill in.

Now users entering records are probably reading from a form of some sort while they do the data entry. It's very helpful to them if you make the screen look as much like their original data form as possible. If, for example, the original customer account application form was as shown in Figure 10 on page 37, then Figure 11 on page 38 shows the sort of skeleton screen that we'd want. (The underscores simply show where the input fields are; they wouldn't appear on the screen.)

Notice there are some bits and pieces on the form that we haven't transferred to the data entry screen. For example, the addresses of the other account users, the meanings of the four "Reason" codes, the format of the date, and the customer's signature.

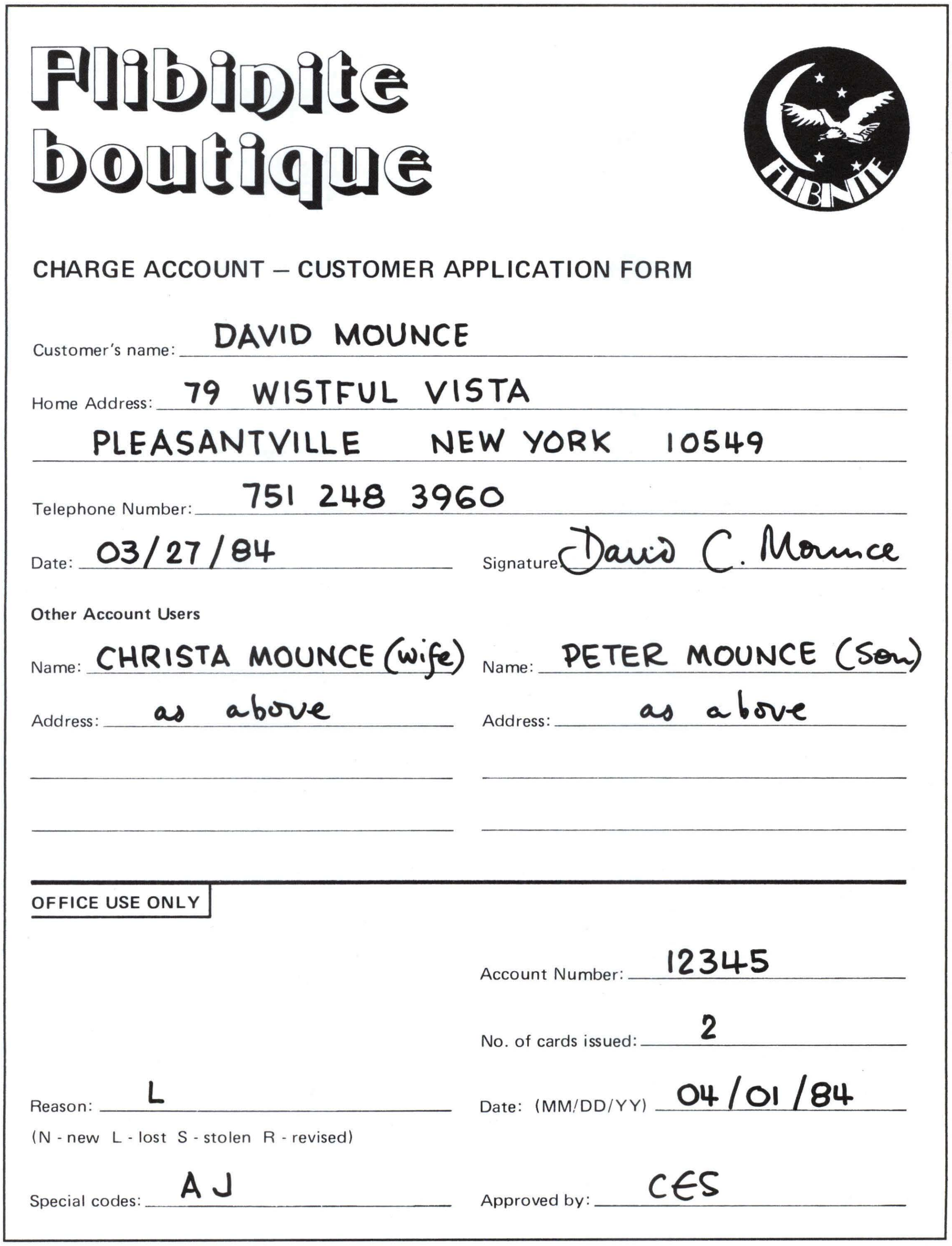
While it's generally true that a well-designed form will translate painlessly into a data entry screen, never miss the chance to re-think aspects of the data entry task from the terminal operator's point of view. Also remember that if the operator's receiving information during a telephone conversation, the original form may be largely irrelevant to that particular situation.

After the user had filled in this screen, the transaction would check the input fields for reasonable and consistent values. If one or more of them were unacceptable, it could redisplay the user's input with the fields in error highlighted, and with a message added that the highlighted fields were either wrong or inconsistent with each other. The user could then fix the errors, and this input-edit-redisplay cycle could be repeated until the input was right. Then the transaction would send a message to the terminal saying that the record had been added to the file.

Strictly speaking, the transaction needn't *confirm* that the addition was successful. However, many users don't entirely trust computers, and a wary user might develop the habit of doing a display transaction after each add, just to make sure the add worked. This would waste a lot of user and computer time, and can easily be avoided by having a confirmation message.

The Modify Transaction

A modification could be almost like an add, except that instead of a skeleton screen being displayed, the information in the record would be displayed instead. The user would show the changes by typing over the old information on the screen.



Flibinite boutique

CHARGE ACCOUNT – CUSTOMER APPLICATION FORM

Customer's name: DAVID MOUNCE

Home Address: 79 WISTFUL VISTA

PLEASANTVILLE NEW YORK 10549

Telephone Number: 751 248 3960

Date: 03/27/84 Signature: David C. Mounce

Other Account Users

Name: CHRISTA MOUNCE (wife)	Name: PETER MOUNCE (Son)
Address: as above	Address: as above

OFFICE USE ONLY

Account Number: 12345

No. of cards issued: 2

Reason: L

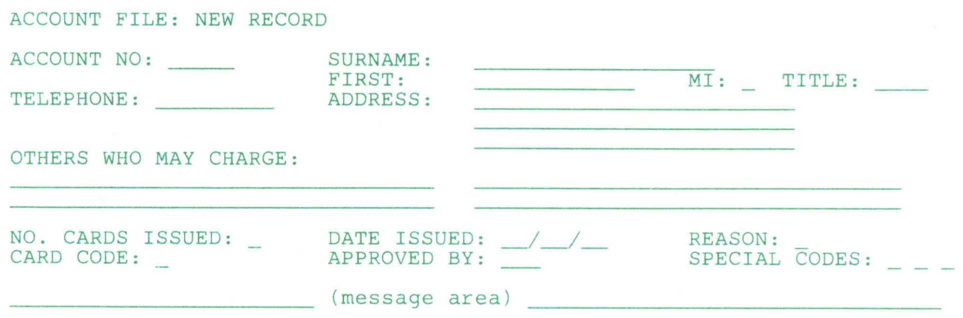
(N - new L - lost S - stolen R - revised)

Date: (MM/DD/YY) 04/01/84

Special codes: A J

Approved by: CES

Figure 10. The Original Customer Account Application Form



```
ACCOUNT FILE: NEW RECORD

ACCOUNT NO: _____        SURNAME:   __________________
                         FIRST:     ____________   MI: _  TITLE: ____
TELEPHONE: _________     ADDRESS:   ________________________
                                    ________________________
                                    ________________________
OTHERS WHO MAY CHARGE:
________________________________    ________________________________
________________________________    ________________________________

NO. CARDS ISSUED: _      DATE ISSUED: __/__/__     REASON: _
CARD CODE: _             APPROVED BY: ___          SPECIAL CODES: _ _ _

_______________________ (message area) _______________________________
```

Figure 11. A Corresponding Skeleton Screen

The Delete Transaction

The deletion could be a very simple matter. We could let the user enter "DELE12345", and then simply delete account number 12345, and send back a message that we had done so. It turns out that this isn't a good idea, however. Users could easily make a mistake in keying the account number, and would be very distressed when they realized that they had removed the wrong record and had to get it put back again. Worse than that, they might not notice at all!

Generally, when you're about to perform something as potentially irrevocable as a deletion in an online system, it's a good idea to confirm that the user really wants to go ahead with it.

Therefore, we probably want a deletion to be handled like a special case of a modification. Users will enter the account number to be deleted; we'll show them the record they are about to delete; and instead of keying in changes as they would for a modification, they will enter something to confirm that the record on the screen is really the one they want to delete. Only then will we delete it and say that we've done so.

Of course, we must give the user some way to say "no, I didn't mean it," that is, to cancel the transaction, and escape the deletion. Come to think of it, we'll have to do that in all these update transactions. If a user starts to add a record and then can't complete the entry for some reason (perhaps some required information is missing), then the user must be able to cancel the request without corrupting the files with a half-completed addition, modification, or whatever.

A User-Friendly Approach

Using a Menu Screen

Before going on to the other transactions, let's look at an alternative approach to this growing list of transaction identifiers. It's called the **menu** technique, and it's become increasingly popular as a user interface.

It works like this. For any application, users need to remember just one transaction identifier. When they want to do any transaction in that application (in our case, add, display, print, and so on) they enter just the one transaction identifier. In response, the screen displays a menu of things that the users can do in this application. The menu has formatted fields for the data items that are required on input. It also shows instructions in case users don't remember exactly what to do.

The chief advantage of this technique is that the user has to remember almost nothing, a big help to the "infrequent" users that we need to address in our example application.

There are some other benefits as well: you can diagnose errors in the request input in the same convenient way that we described for the "add" screen, so that the user gets a good explanation of the problem and has to do a minimum of rekeying to correct the errors. Also, when you complete a transaction such as an add, you can combine your confirmation message with this menu screen. This way the user knows that the previous entry was successful, and is all ready to enter the next request.

The menu for this application might look like the one here (Figure 12). Again, the input fields are underscored in the figure to show their position, but the underscores wouldn't appear on the actual screen:

```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                      ONLY SURNAME
                                                                  REQUIRED. EITHER
      SURNAME: ____________     FIRST NAME: _______               MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                  PRINTER REQUIRED
      REQUEST TYPE: _    ACCOUNT: _____    PRINTER: ____          ONLY FOR PRINT
                                                                  REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD      X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"             -OR-    PRESS "CLEAR" TO EXIT

   ___________________(message area)______________________
```

Figure 12. A Typical Menu Screen

Almost the only disadvantage to this menu technique is that a user has to go through one extra screen for the *first* transaction of a session, and one extra step (clearing the screen in this case) to escape. The only time this is a serious matter is when users need to mix transactions from different *applications* constantly. This isn't the case in our example, and we do have infrequent users to think about, so we'll use the menu approach.

So here's how, say, a modify transaction will work:

1. The user keys in the four-character transaction identifier to get started.

2. The menu screen is displayed in response.

3. The user enters "M" for the request type, keys in an account number, and presses ENTER.

If there's a problem, the user will see the same screen with the fields in error highlighted and a message at the bottom saying what's wrong.

Otherwise, the response will be a display of the record to be modified, ready for the user to change. The user will change the fields to be modified, and then press ENTER to send the screen back. If there are errors in the changes, the transaction will send back the input with the errors highlighted and a message if necessary. If (when) the user gets it right, the transaction will update the file, and send back the menu screen, with a message at the bottom saying that the modification just requested was completed successfully. The user will then enter the next request, or clear the screen to quit our application.

Printing the Log

We've not yet dealt with the printing of the log of changes to the account file. The log will be printed only occasionally, perhaps once a day, and this will be done by a supervisor in the Accounting Department. We probably don't want to include it in our menu, because it will only confuse the other users, who may not even know what a log is. So we'll have a separate transaction identifier for this one function.

The main output, of course, will be the printed log. We should also send a confirmation to the input terminal, however, in case the printer isn't in the immediate area or is busy with another task at the time of the request.

Name Inquiry

Finally, we must think a little more about the name inquiry transaction.

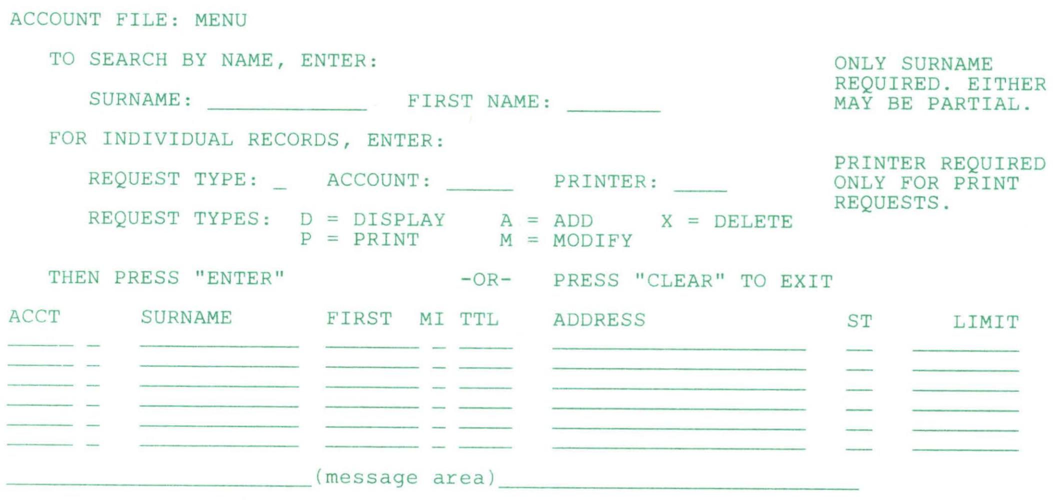
In view of the structure of the rest of the application, it would be very convenient if we could just fetch a single record from the file on the basis of a name instead of an account number. Unfortunately, this won't usually be possible, because names are a notorious problem. They cannot be depended on to be unique, they vary enormously in format and length, and spelling is a great challenge. That, in fact, is exactly why we assign an account number to each customer and use it as the file key, instead of using the one identifier that is most natural (and that the customer is least likely to forget).

It isn't usually possible to guarantee a unique response to a request that specifies a name, because we can't depend on that name being unique (and the user may even have misspelled it). What we want to do, then, is to give the users who need this facility some way to get to the right account number by entering a name. Suppose that our response to such a request is a list of customer names, in alphabetical order, starting with the first one that matches the requested name, up to the capacity of the screen.

In fact, since the user may be uncertain of the spelling, we'll treat the name entered as a generic or partial name, and show all the names that start in the way specified. So, if the user enters "Adams," the response will begin with the Adamses and continue with the Adamsons. But if the name were one that had several common spellings, such as "Reid" (also often "Reade"), then the user could enter just "Re" and get both forms. We can treat the first name similarly. The user could enter the first name (or initial) if known, to limit the number of responses, but we won't make this mandatory.

In our example, remember, we learned from our user survey that the Customer Service people are going to be the heaviest users. Most of their transactions will be inquiries by name. Moreover, most of these inquiries involve just three items besides the name: address, account status, and charge limit. So, when a user inquires by name, it makes sense to display these items along with the name and account number. That way these users will usually see all the data they want on the first response, without having to ask for the detailed display of one particular record.

Sometimes, of course, they will want to see the whole record, and the Accounting Department will want this facility as well. So we must provide some easy way to get from the summary display to the other transactions that the users might want to do, once they have the account number. Suppose we use the remaining lines on the menu screen to display the results of a name search when one is requested. After a search, the users can then enter the request directly, without changing screens, on the menu to which they are accustomed. Figure 13 shows how the expanded menu screen might look:



```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                    ONLY SURNAME
                                                                REQUIRED. EITHER
      SURNAME: ____________   FIRST NAME: _______               MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                PRINTER REQUIRED
      REQUEST TYPE: _   ACCOUNT: _____   PRINTER: ____          ONLY FOR PRINT
                                                                REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD      X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"             -OR-    PRESS "CLEAR" TO EXIT

ACCT      SURNAME       FIRST   MI TTL    ADDRESS                ST      LIMIT
_____ _   ____________  _______ _  ____   ___________________    __    ________
_____ _   ____________  _______ _  ____   ___________________    __    ________
_____ _   ____________  _______ _  ____   ___________________    __    ________
_____ _   ____________  _______ _  ____   ___________________    __    ________
_____ _   ____________  _______ _  ____   ___________________    __    ________
_____ _   ____________  _______ _  ____   ___________________    __    ________

_______________________(message area)___________________________
```

Figure 13. An Expanded Menu Screen

Some Interface Design Principles

In reaching our current idea of how our user interface will look, we've based most of our decisions on what is easiest for the user. Indeed, that should be the cardinal rule. Human time has become so much more valuable than computer time that it is worth a lot of effort and coding to make the user as productive as possible.

It isn't always obvious how to do this to best advantage, and what is best for one user may not be best for another. This applies especially to occasional users of an application. In fact, the style of conversation between users and computers has changed significantly as people have learned more about the "human factors" aspect of online systems.

The advent of sophisticated terminals, like those in the 3270 system, has also had an enormous effect in this area, as it became practical to deal with users in ways not possible with earlier devices. The whole idea of using a menu, for example, came much later than the original release of CICS, and depends explicitly on the characteristics of the 3270 for success.

Though there are no hard-and-fast rules, and though there can be many good designs for the user interface, there are five guidelines that we can safely propose:

1. Make screens easy to understand

- Keep to the rules used in forms design: Try to give the screen layout an uncluttered appearance and, to the extent possible, a columnar structure, so that the reader's eye moves easily from one item to the next and doesn't have to jump long distances.
- Put a title on the screen, so that users know where they are in the current transaction.
- Be consistent from screen to screen. If you put the title on the top center of one screen, put it there on all the screens. If you put the messages at the bottom of one screen, put them there on all the screens.
- If the user will be reading from a form for input to a screen, make the screen look as much as possible like the form. Put the fields in the same order, and use the same placement as far as possible.
- Likewise, if a screen is used to display information that the user is accustomed to seeing printed on a form, make the screen resemble the form as nearly as possible.

2. Cut down what the user must remember

- If there are more than a few fields to be filled in, use a formatted screen with labels and instructions.
- Where possible, put instructions on the screen to show what the user can do next.
- Use consistent procedures, both within and across application programs. For example, if the CLEAR key is used to cancel in one transaction, use it that way in all transactions.

3. Protect users from themselves

If a user is about to do something that's hard to undo, such as a file deletion, get the user to confirm that it's the right deletion.

4. Save the user's time and patience

- Minimize the number of characters that have to be keyed.
- Make the user change screens as little as possible.
- Make it as easy as possible to correct errors. There are many ways to do this. In our application, for example, we stick to the following:
  - We redisplay the user's input in the same screen as the one in which it was entered.
  - We diagnose all the errors at once (to the extent possible).
  - We highlight fields that have errors.
  - If the user misses any required fields, we fill them with asterisks and highlight them.
  - We place the cursor under the start of the first field in error.
  - We display an explanatory message if the error may not be obvious.
- Place the cursor where the user will probably want to key first.
- Minimize the number of times that the users have to skip over fields.

5. Reassure users

- Give a positive confirmation that a requested action has been done successfully.
- When you know a particular response time is likely to be longer than usual (because of the operation being performed) consider sending an intermediate display.

Chapter 2-4. Coming to Grips with the Data

Having decided what you want to do, you can now determine what data will be required to do it and how to organize that data.

The Account File

In this application, we know that we need access to all the fields that make up records in the existing account file, because this is the data that we intend to maintain and display. We need direct access to these records by account number for several of the required operations (display, add, and so on). Happily, this file exists in a form directly usable by CICS (a VSAM key-sequenced data set (KSDS), with the exact key that we need). This isn't pure luck or coincidence. The account number is the natural key for this file, and a VSAM key-sequenced data set is a good choice for a mixture of sequential and direct processing, such as probably occurs now in the batch programs that use this file. Figure 14 shows the record format for this file.

FIELD	LENGTH	OCCURS	TOTAL
Account Number (Key)	5	1	5
Surname	18	1	18
First Name	12	1	12
Middle initial	1	1	1
Title (Jr, Sr, and so on)	4	1	4
Telephone number	10	1	10
Address line	24	3	72
Other charge name	32	4	128
Cards issued	1	1	1
Date issued	6	1	6
Reason issued	1	1	1
Card code	1	1	1
Approver (initials)	3	1	3
Special codes	1	3	3
Account status	2	1	2
Charge limit	8	1	8
Payment history:	(36)	3	108
-Balance	8		
-Bill date	6		
-Bill amount	8		
-Date paid	6		
-Amount paid	8		

Access by Name

As well as accessing the account file records by account number, we need to access them by a second key - the customer name. There are many ways of achieving an alternative path into a file. For example, VSAM provides a facility called an **alternate index**, which can be used in CICS.

In addition, CICS/DOS/VS supports two data base systems: the relational Structured Query Language/Data System (SQL/DS) and the hierarchical Data Language/1 (DL/1). Similarly, CICS/OS/VS supports the DATABASE 2 relational product, and IMS/DB DL/1. These systems provide powerful cross-indexing facilities, and they have many other features that reduce the coding required in user applications. They support complex data structures, provide increased function, and simplify the maintenance of file integrity. If you have data that you need to access by more than just a few different key fields, or if you have data that does not arrange itself into neat units like the account records in this application, you should evaluate seriously the use of a data base system.

However, all these data base products are beyond the scope of this Primer. For our application we'll use a simple technique, frequently used and quite appropriate to an application of this size. We'll build a small separate file, in name sequence order, to use as an index into the account file.

This is probably going to offer us better performance for sequential browsing of customer names than, say, an alternate VSAM index.

Choosing the File Organization

For the initial read, we'll need direct access to the index file when we process an inquiry by name. After that, we'll read sequentially until we have enough names to fill one screen. So VSAM key-sequenced organization[2] is appropriate to this file as well as to the account file. ("Other File Services" on page 164 lists the other file access methods supported in CICS. VSAM KSDS is widely applicable, however, and is the only one covered in this book.)

Name Index Records

What do we need in our name index records? We need the surname, clearly, and the first name. We need the account number, for access to the main file and to ensure a unique key. This is all we really need. However, since we're maintaining our own index file, we've the option of putting more than pointers into it. Let's see what else we can usefully put into the name index file.

[2] File organization, of course, isn't generally chosen by an application programmer, but by the application designer.

In our application, we could produce the display shown in Figure 13 on page 42 in two different ways:

- Read the name from the name index record and, for each name, use the account number in the index to access the account file. This can get us the address, the account status, and the charge limit.

- Repeat the address, the account status, and the charge limit fields within the name index file. We'd then only need to access the name index file (and not the account file) to get these items.

In the second case, the index records would be a little larger as a result, and we'd have two copies of some fields (a potential source of trouble in large file-based systems). On the other hand, we could avoid one read for every name in the response to a name inquiry.

This latter point turns out to be important. In VSAM, one read brings a whole **control interval** (CI) of data into virtual storage. CICS passes to your program only the particular logical record that your program asked for, but on your next program read, CICS can return your record directly, without another VSAM read, if the record is in the same control interval. When you are reading in key sequence, the probability of the record being in the same control interval is very high. In our example, we'll be going through the name index records in name order, and the records are small, so we can expect there to be only one physical read for several logical reads.

However, if we needed to access the account file once for each of these reads, there would probably be a physical read to that file for every logical read to the index file, as we wouldn't be reading the account file in sequential (customer number) order.

In deciding which method to choose, we must weigh the cost of the many additional reads against file space and against the possible complications of keeping the two files synchronized. Changes that will have to be made to the batch billing and payment system need to be evaluated as well. If searching by name were an infrequent request, or if any of these other factors had a large cost associated, we might choose the first method. However, for our example we'll assume that this isn't so and, since inquiry by name will be by far the most frequent transaction, we'll include these fields in the index.

Figure 15 on page 50 shows a reasonable layout for the name index record:

```
FIELD                    LENGTH (in bytes)

    Surname                   12    These two fields form
    Account Number             5    the key.
    First name                 7
    Middle Initial             1
    Title                      4
    Street Address            24
    Account Status             2
    Charge Limit               8
```

Figure 15. The Name Index Record Format

The first two fields together form the key. It will be unique because account numbers are unique, and it will allow us to search by surname, using a partial key of variable length. Notice that we chose field lengths for the surname and first name that were shorter than the corresponding fields in the account file. We also included only one line of the address. This keeps our index records reasonably small and lets us display a name index record on a single line of the screen. We can afford to do this because our purpose is to help the user in recognizing the right name, not to account for all the possibilities that can occur in names and addresses.

Choosing a Control Interval (CI) Size

One of the issues in designing VSAM files is choosing control interval sizes for the data and the index. The choice depends partly on the fit of records into the CI, but it also depends on whether the data will be accessed directly or sequentially. In our example, the account file will always be accessed directly. That is, there is little or no chance of reading account records in account number order. So a large data control interval will hurt rather than help us. It will mean larger buffers (more demand for virtual storage), and more data will be transferred than can be used (the larger the interval, the more records transferred in one read). Therefore a small data CI is appropriate for this file.

In contrast, the name index file will be read sequentially more often than directly. The first read in a name inquiry will of course be random, but after that we'll tend to read several records in sequence. Therefore it will be helpful to get many logical records in a single physical read, and so we'll choose a large data CI size for the name index.

All these physical reads are done by CICS using VSAM. Your program is concerned only with logical reads, which are completely unaffected by CI size. So you don't **have** to think about these factors. However, a good application designer will try to take all such factors into consideration.

While learning, you can certainly put off the choice of the "best" CI size until your program is working. After all, you can change the CI sizes of your files without changing your application code or your CICS tables, and you may wish to do this later if trying to tune your system for faster response.

Recovery Requirements

One of the first requirements for the example application was to maintain the integrity of the account file. We'll see in "Chapter 2-7. A Basic Decision: Conversational or Pseudoconversational" on page 77 how CICS prevents the loss of integrity associated with partially completed transactions, and we'll use this feature to keep the two files (the name index file and the account file) properly synchronized. However, we must also protect the account file from disasters such as a head crash.

In a batch environment, you can keep an extra copy of an important file, or keep enough information to recreate it (by keeping back versions, for instance, with the inputs to the update runs). In an online environment, this isn't so easily done. You cannot copy the file after every update. Nor can you afford to lose all the updates since the last time you copied the file. These updates were entered at terminals by many different users, who may not remember what stage they had reached when you last secured the file, who may not have ready access to the input documents any longer, and who will certainly be very cross if they have to rekey a large number of transactions.

CICS solves this problem by using a variation on the batch technique. If you have a file that must be protected, you ask CICS to **journal** the updates. CICS then keeps a copy of every change made to the file on a tape or disk. It logs these changes on the system log, which is journal number one. If you lose a file, you go back to the most recent copy of it and recreate it from that. Then you run a program that applies the changes recorded on all the journals created since that copy was made.

In our example application, the account file is clearly a file that must be protected in this way. In contrast, the index file does not require these precautions. We do have to protect its integrity from partially completed transactions, just as we do the account file. However, we can always recreate the index file from the account file with a very simple batch program (see "Compiling and Link-Editing the Index File Program" on page 272) so it isn't necessary to journal the changes to it, nor even to make periodic security copies.

Chapter 2-5. Designing the Transactions: More Detail

We've now looked at several principles that we need to bear in mind when working on application programs for online transactions. Next, let's have a closer look at what we have to do to accomplish the functions that make up our example. Some people just write out, in English, the transaction flow. Others prefer flowcharts. You'll find both in this chapter.

Now that we've decided to give the user a "menu" screen, we'll start by displaying this menu and analyzing the request entered on it. After that we'll describe the requirements according to the type of request (add, display, and so on).

Request Analysis

1. Display the menu screen, (as shown in Figure 12 on page 39).

2. Wait for the user to enter a request.

3. Analyze the request, which may be:

   a. To leave the application entirely.

   b. To add, modify, delete, display, or print a record.

   c. To search on a name.

   d. None of the above.

4. Process according to the type of request.

   - In case a above, simply return control to CICS.

   - In cases b and c, process as described on later pages.

   - If the request cannot be deciphered (case d), send an error message to the user. Then go back to step 2 to wait for the user to correct the input. (When it arrives, repeat the processing from step 3 above.)

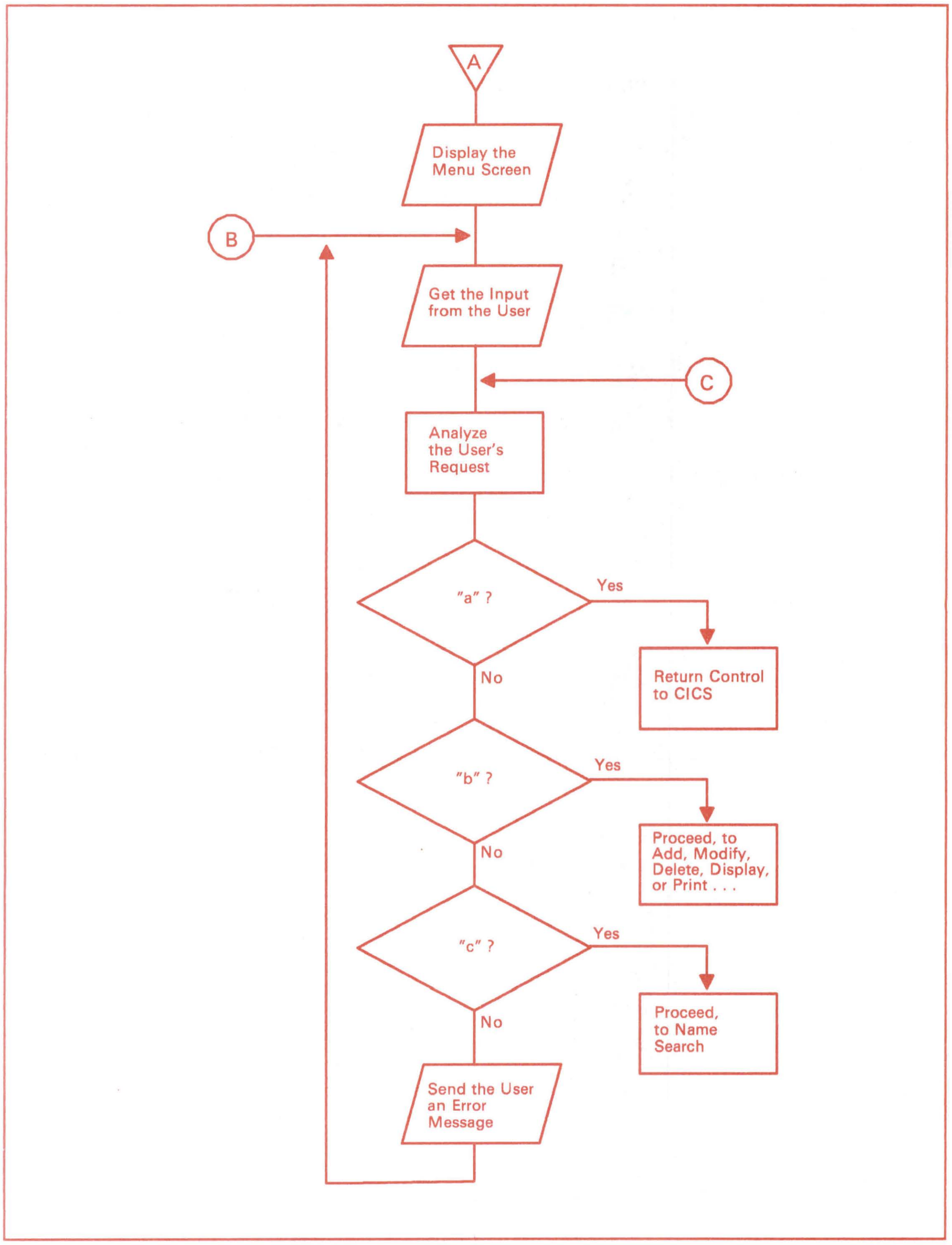

A
Display the Menu Screen
B
Get the Input from the User
C
Analyze the User's Request
"a" ?
Yes
No
Return Control to CICS
"b" ?
Yes
No
Proceed, to Add, Modify, Delete, Display, or Print . . .
"c" ?
Yes
No
Proceed, to Name Search
Send the User an Error Message

Figure 16. Request Analysis

Add Processing

1. Check the customer account number that was entered along with the request. It must be present, and:

   a. Numeric
   b. In the proper range (we'll assume the Accounting Department restricts numbers to the range from 10 000 to 79 999)
   c. Not already used (that is, not already in the file).

   If any of these conditions isn't met, send a message to the user saying what is wrong. Then go back to step 2 of "Request Analysis" to wait for the corrected input. When it arrives, processing will resume at step 3 of that process, so that the user has a full range of choices at this point. That is, the user can correct the add request, change to a different type of request, or quit the application entirely.

2. If the account number is acceptable, send a skeleton screen (see Figure 11 on page 38) back to the terminal so that the user can fill in the fields for the new record.

3. Wait for the user to enter the data (or to signal a desire to quit by using the CLEAR key).

4. See whether the user wants to continue this operation. (He or she might have had trouble entering this particular record or had a change of mind.) If the user doesn't want to go on, display the menu screen again with a message like "previous request cancelled" and go to step 2 of "Request Analysis" to wait for the next request to come in.

5. Otherwise, check the fields read from the filled-in data entry screen for reasonableness and consistency. If there are errors, send a message back to the terminal saying what the errors are, and go back to step 3 to wait for the next input.

6. If no errors are detected in the input, update the files:

   a. Write an image of the new record to the change log.
   b. Build a new account record using the information from the input screen, and add this record to the file.
   c. Build the corresponding name index record and add this to the name index file.

7. Redisplay the menu screen, with a message to say what has just been done, and resume at step 2 of "Request Analysis."

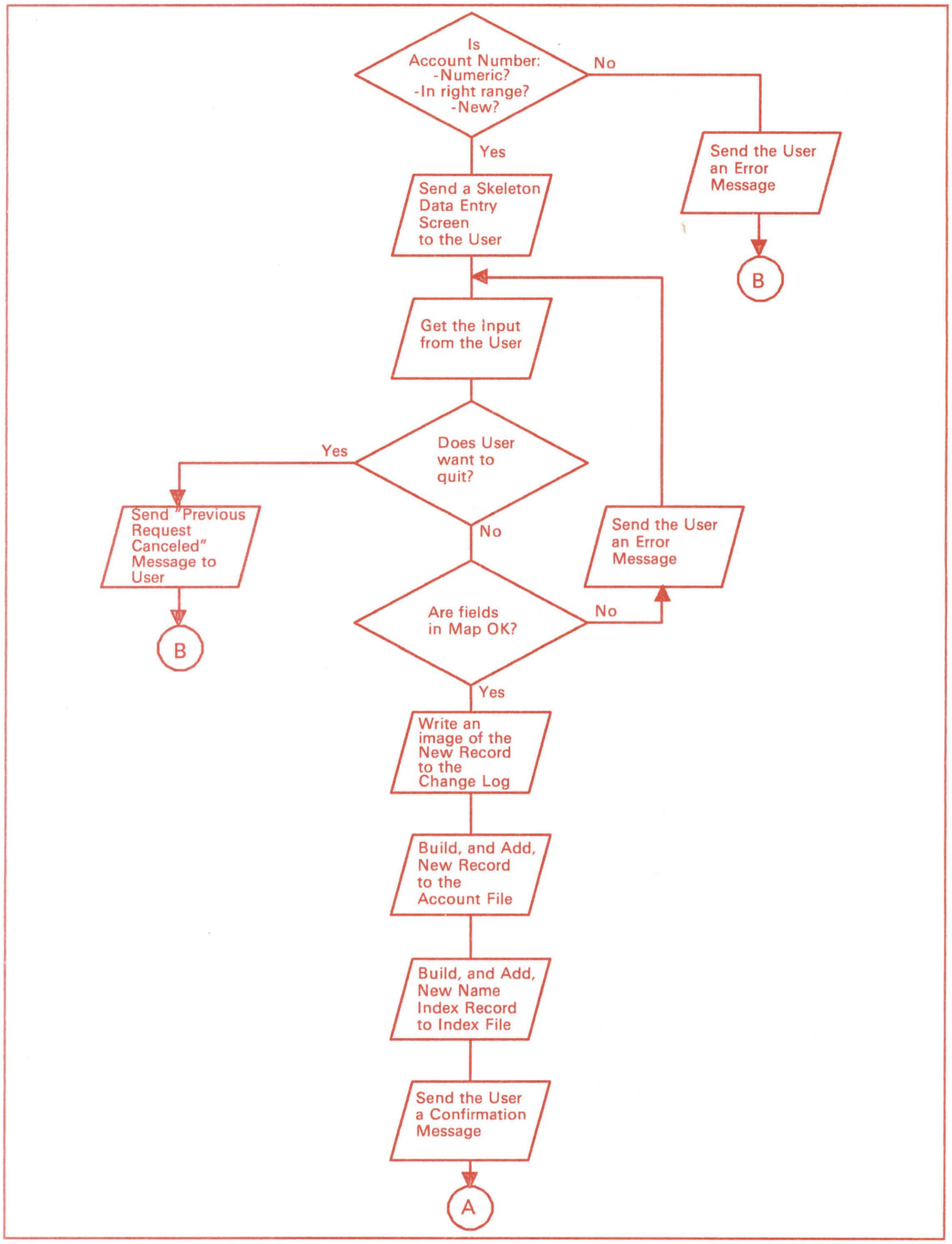

Is Account Number: -Numeric? -In right range? -New?
No
Yes
Send the User an Error Message
B
Send a Skeleton Data Entry Screen to the User
Get the Input from the User
Does User want to quit?
Yes
Send "Previous Request Canceled" Message to User
B
No
Send the User an Error Message
Are fields in Map OK?
No
Yes
Write an image of the New Record to the Change Log
Build, and Add, New Record to the Account File
Build, and Add, New Name Index Record to Index File
Send the User a Confirmation Message
A

Figure 17. Add Processing

Modify Processing

1. Check the account number that is entered along with the request. It must be present, and:

   a. Numeric
   b. In the proper range (10 000 to 79 999)
   c. Already on file.

   Just as in the add processing, if any of these conditions isn't met, send a message to the user saying what is wrong, and then go to step 2 of "Request Analysis" to await corrected (new) input.

2. Build a display of the current contents of the record from the information on file, and send it to the user's screen.

3. Wait for the user to enter the changes (or to indicate, with the CLEAR key, a desire to abandon the transaction).

4. If the user doesn't want to continue, send a fresh menu screen with a message acknowledging the cancellation and then go to step 2 of "Request Analysis" to wait for the next request.

5. Build a new version of the record by applying the changes entered on the screen to the old version of the record.

6. Check all items in the new record for reasonableness and consistency with each other. If there are errors, send the input screen back to the terminal with all the errors noted. Also, if there are no differences between the new record and the old one, send a message noting this (the user may have made an error and should be notified). Treat this situation just like an error in a data item. Return to step 3 to await corrected input.

7. If there are no errors in the input, update the files:

   a. Write a record of the changes (that is, images of the old and new records, plus an indication of the changed areas) to the change log.
   b. Replace the old record in the file with the new version.
   c. If the changes affected the corresponding index record, replace that record, too, with a revised version.

8. Redisplay the menu screen, with a message to say what has just been done, and resume at step 2 of "Request Analysis."

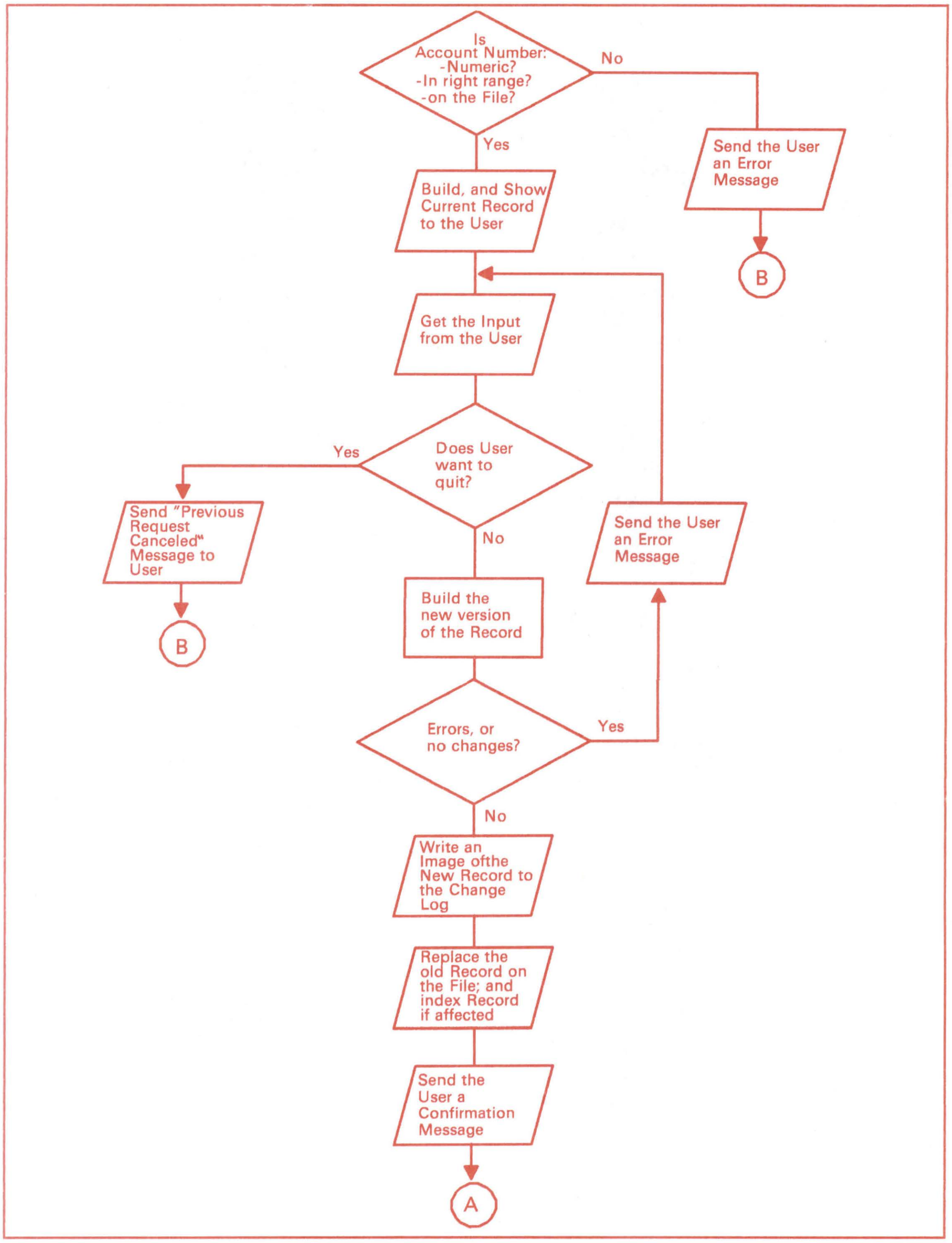

Is
Account Number:
-Numeric?
-In right range?
-on the File?
No
Send the User an Error Message
B
Yes
Build, and Show Current Record to the User
Get the Input from the User
Does User want to quit?
Yes
Send "Previous Request Canceled" Message to User
B
No
Build the new version of the Record
Errors, or no changes?
Yes
Send the User an Error Message
No
Write an Image ofthe New Record to the Change Log
Replace the old Record on the File; and index Record if affected
Send the User a Confirmation Message
A

Figure 18. Modify Processing

Delete Processing

1. Check the account number entered with the request; the requirements and the error processing are the same as for "Modify Processing" on page 58.

2. Build a display of the contents of the record from the information in the account file and send this to the terminal.

3. Wait for the user to confirm or cancel the delete request.

4. See if the user has decided to cancel the delete request. If so, proceed as in step 4 of "Add Processing" on page 56.

5. If the user has not cancelled, see whether he or she has confirmed the delete request. If not, send a message asking the user either to confirm or cancel, and go back to step 3.

6. If the delete request is confirmed, update the files:

   a. Write an image of the deleted record to the change log.

   b. Delete the record from the account file.

   c. Delete the corresponding name index record from that file.

7. Redisplay the menu screen, with a message to say what has just been done, and go back to step 2 of "Request Analysis" on page 54 to wait for the next request.

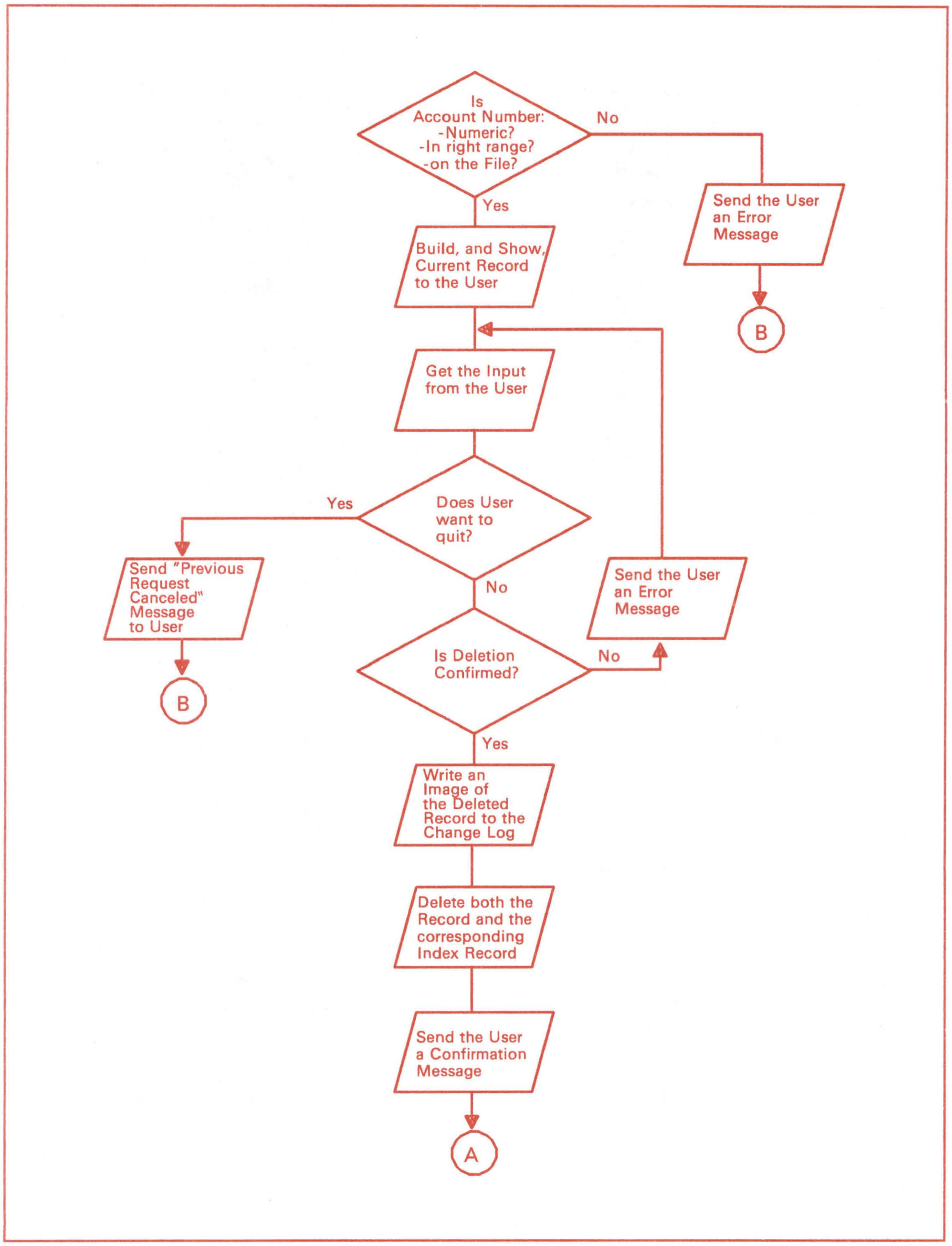

Is Account Number: -Numeric? -In right range? -on the File?
No
Send the User an Error Message
B
Yes
Build, and Show, Current Record to the User
Get the Input from the User
Does User want to quit?
Yes
Send "Previous Request Canceled" Message to User
B
No
Is Deletion Confirmed?
No
Send the User an Error Message
Yes
Write an Image of the Deleted Record to the Change Log
Delete both the Record and the corresponding Index Record
Send the User a Confirmation Message
A

Figure 19. Delete Processing

Display Processing

1. Check the account number entered with the request; the requirements and the error processing are the same as for "Modify Processing" on page 58.

2. Build a display of the contents of the record from the information in the account file, and send it to the screen.

3. Wait for the next input from the terminal (indicating that the user has finished looking at the display), and then go back to step 1 of "Request Analysis" on page 54.

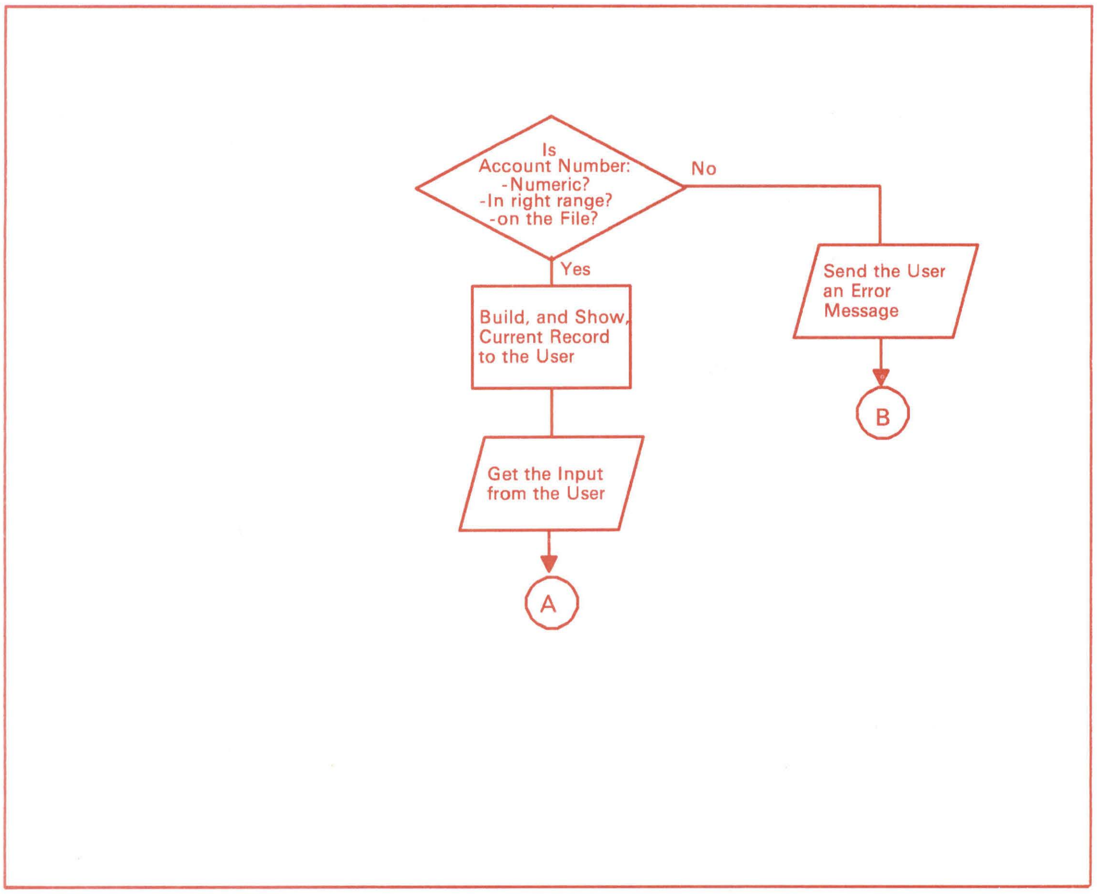

Is
Account Number:
-Numeric?
-In right range?
-on the File?
No
Yes
Build, and Show, Current Record to the User
Send the User an Error Message
Get the Input from the User
A
B

Figure 20. Display Processing

Print Processing

1. Check the account number entered with the request; the requirements are the same as for a "modify" request. Also check the name of the printer entered with the request. It must be present and must correspond to the name of a real printer known to CICS. If either input item is in error, send an appropriate message to the terminal and return to step 2 of "Request Analysis" on page 54 to await corrected input.

2. Build a display image of the contents of the record from the information in the account file, (printers understand the same data streams that displays do).

3. Send this image to the indicated printer.

4. Send a message to the terminal, saying that the print request has been processed; then go back to step 2 of "Request Analysis" on page 54 to await the next request.

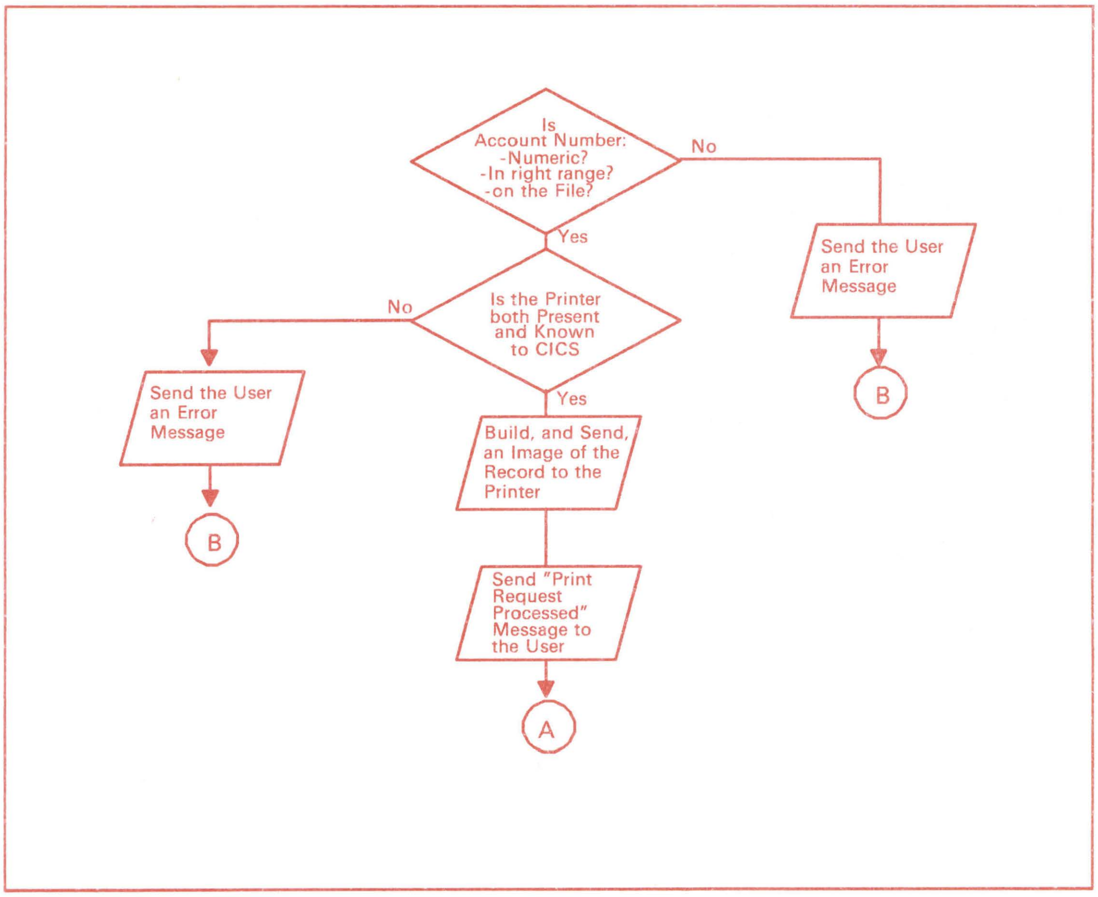

Is Account Number: -Numeric? -In right range? -on the File?
No
Yes
Send the User an Error Message
B
Is the Printer both Present and Known to CICS
No
Yes
Send the User an Error Message
B
Build, and Send, an Image of the Record to the Printer
Send "Print Request Processed" Message to the User
A

Figure 21. Print Processing

Name Inquiry Processing

1. Check the name search input:

   - The surname must be present and alphabetic
   - The first name must be alphabetic, if present.

   If either condition isn't met, send an error message to the terminal and go back to step 2 of "Request Analysis" on page 54 to wait for corrected input or another request.

2. If the names are correct, find the first index file record that has a surname that matches the (full or partial) surname specified in the input, or which is just higher in the alphabet than the input surname.

3. Build the search output part of the display, one line at a time.

   a. Read the next record in the index file.

   b. See if this record meets the input criteria for the given name. If it does, build an output line from it.

   Repeat this step (building one line at a time, remember) until the surname read from the file is higher in the alphabet than any that would match the input surname, or the end of the file is reached, or all the output lines have been used.

4. Send the completed output to the screen.

5. Wait for the user's next request.

6. If the next input shows that the user wants to continue the search, go back to step 2, using as a starting point the last record read in producing the previous display.

7. If the user doesn't want to continue, go to step 3 of "Request Analysis" on page 54 to find out what he or she wants to do instead.

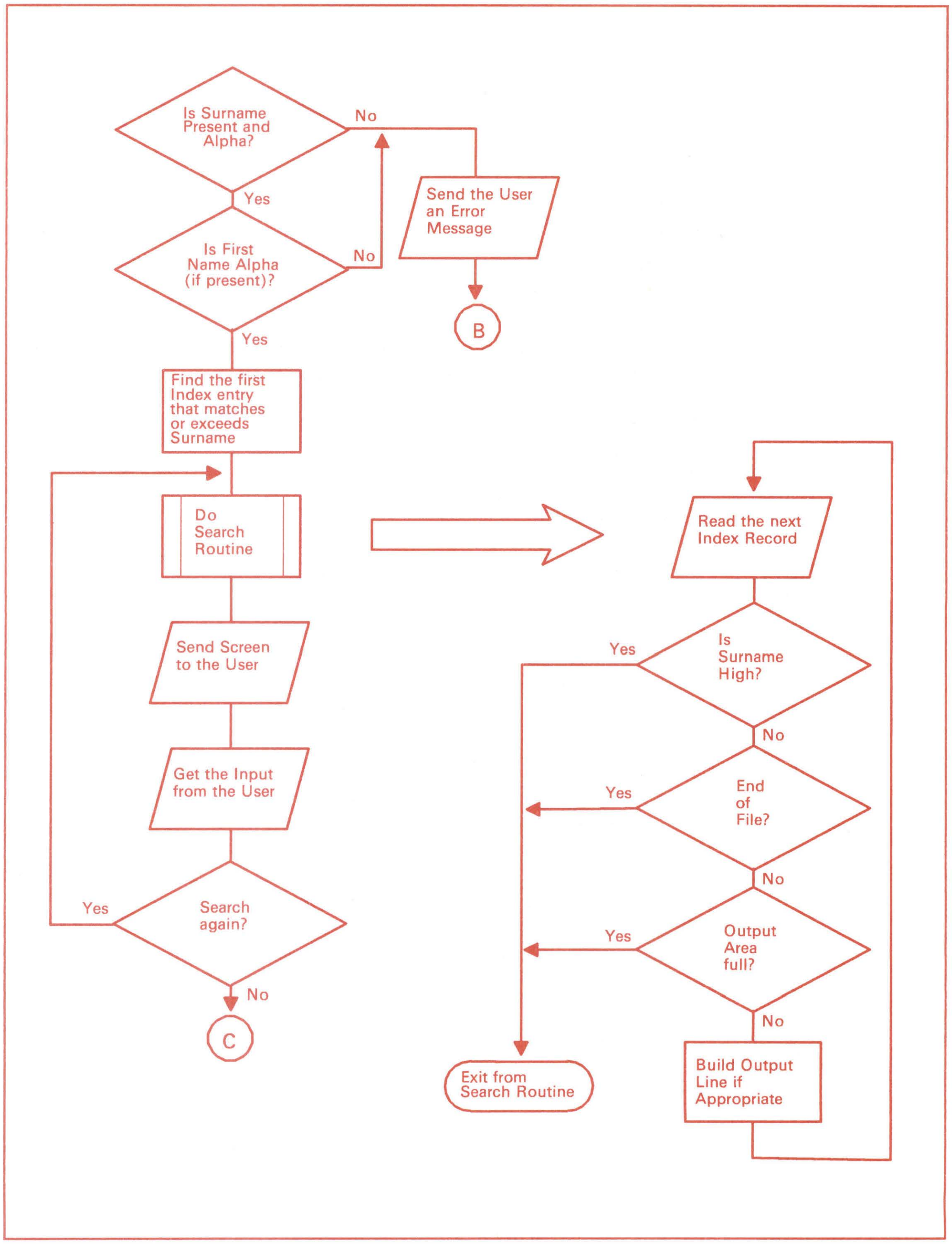

Is Surname Present and Alpha?
No
Yes
Send the User an Error Message
B
Is First Name Alpha (if present)?
No
Yes
Find the first Index entry that matches or exceeds Surname
Do Search Routine
Send Screen to the User
Get the Input from the User
Search again?
Yes
No
C
Read the next Index Record
Is Surname High?
Yes
No
End of File?
Yes
No
Output Area full?
Yes
No
Build Output Line if Appropriate
Exit from Search Routine

Figure 22. Name Inquiry Processing

Printing the Log

1. Read the first (next) record from the log.

2. Write the information read to the log printer.

3. Repeat steps 1 and 2 until there are no more records on the log.

4. Delete the log records once they have been printed.

You'll find more information about this log in "Program ACCT03: Requests for Printing" on page 99. (We mention this now because the concept of the log and its printing has given some readers minor problems when reviewing earlier drafts of this Primer.)

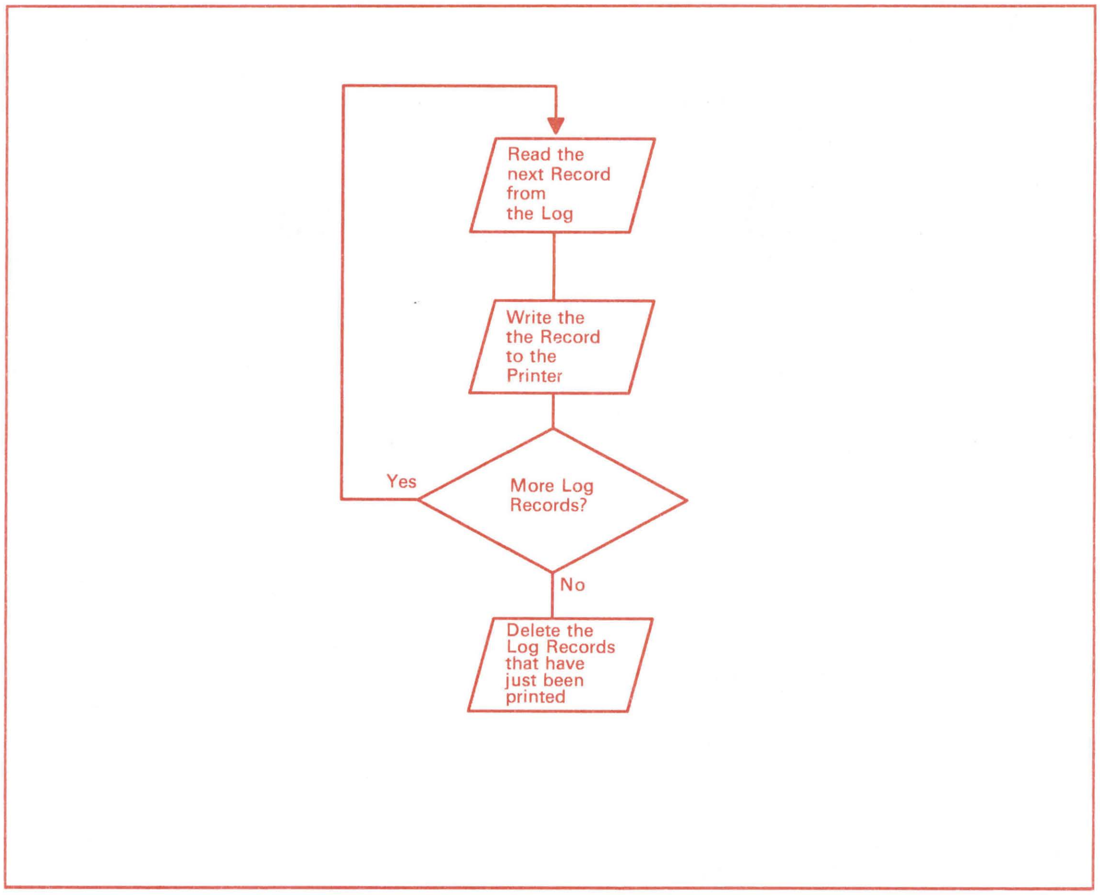

Read the next Record from the Log
Write the the Record to the Printer
More Log Records?
Yes
No
Delete the Log Records that have just been printed

Figure 23. Printing the Log

Summary

We've now seen the requirements for the various functions our users can perform at (or, in the case of printing, from) their terminals.

The next thing we need to do is to consider how to break up these functions into CICS transactions, and what factors affect program design in a CICS environment.

Chapter 2-6. Programming for a CICS Environment

The overall design goals in an online environment are the same as those in a batch environment: to provide as much service (do as much useful work) as possible while using as little resource as possible.

Deciding what services to provide is, as we noted in "Defining the Problem" on page 18, the first step in the design. It takes a little experience and experimentation in online programming to know what additional services you can provide at reasonable cost, beyond simply replacing batch services with equivalent online services.

In our example, for instance, we decided initially to replace the function of the old printed account listing with the ability to display individual records on the screen. Originally, we had no plans to allow users to print individual records, even though it seemed an obvious feature to provide, once a user pointed out how useful it would be. This kind of interaction with potential users is invaluable in arriving at a design that is good from the user's point of view. It should be repeated often in the design cycle, as your insight into the application and the programming requirements develops.

Resources

After deciding what to do, what resources do we have to conserve while providing this function? Some of them are the traditional ones that are common to both batch programming and online programming:

- Processor storage
- Processor time
- Auxiliary storage space and transmission capacity to it.

Others are new, and require some new considerations in design. They are:

- User time and good humor
- One-user-at-a-time resources, such as terminals, file records, scratch-pad areas, and so on
- Line transmission capacity.

Let's take these individually and develop some guidelines for designing and programming CICS applications from them. Remember, there's bound to be conflict from time to time when trying to save one resource at the "cost" of another. The appropriate compromises will vary from one program to the next.

"Traditional" Resources

Processor Storage

The first resource to consider is processor storage. Your applications use up storage in two ways. First, there are the CICS control blocks associated with any transaction being processed, and second, there is the program or programs being executed to accomplish the transaction. The programs, in turn, take up space both for executable code and for working-storage areas. In an online system, the storage needs for these purposes constantly come and go. They exist only for at most the duration of a transaction, and so in assessing storage needs, we have to consider not only how much, but for how long. The trade-off between space and time is complex, but at a minimum we can say:

Processor Storage Guidelines (1)

Keep programs short.

Keep Working-Storage short.

Keep programs short in duration of use.

How transactions use storage over time is taken up again in "Chapter 2-7. A Basic Decision: Conversational or Pseudoconversational" on page 77.

We should also note that CICS/VS is a virtual storage system, and the good coding practices observed in batch programming for a virtual storage environment apply equally well to CICS. These include:

Processor Storage Guidelines (2)

Keep GOTOs to a minimum.

Place subroutines near the code that PERFORMs them.

Avoid long searches for data.

Some Remarks About PERFORM: Having mentioned subroutines, let's stay with them for a few moments. COBOL programmers learning CICS often ask about the pros and cons of using PERFORMs in CICS.

First of all, using PERFORM to execute a COBOL subroutine is very much more efficient than the CICS overheads associated with a CICS command to link to, or transfer control to, another program. However, repeating the subroutine in each of your COBOL transactions is going to cost you more storage. That is, if you're using PERFORM for repeated code, you're trading space against (possible) paging.

Like earlier COBOL compilers, the new VS COBOL II compiler (OS/VS only) allows a COBOL program to use CALLs to external routines, but now the called routines can issue CICS commands. This avoids the CICS overheads, but it does mean link-editing the routines with every calling program.

We've some more to say in the next part of the Primer (in "The COBOL CALL Statement" on page 179).

Secondly, the matter also arises in COBOL loop situations. You see, COBOL doesn't let you put the PERFORM which controls the loop physically adjacent to the actual code of the loop, unless you cheat and use a GOTO rather unnaturally. PERFORMs are ok for loops, but always keep the code you PERFORM as near as you can to the controlling PERFORM statement, to minimize the risk of the two things being in separate pages of storage.

Finally, the question of a PERFORM also crops up with regard to code that isn't a true "subroutine" in the old-fashioned sense, and code which the programmer never really considered breaking off as a separate (sub)routine.

This kind of PERFORM comes from some of the structured programming rules, where you PERFORM blocks of code (often physically distant in the program, with attendant paging implications) for reasons of neatness, readability, maintainability, and so on. The response time impact of flipping through a lot of pages is of course much more critical in a real-time environment than in batch, because you have to compete with all those other terminal users instead of just a few other jobs.

Our "PERFORM" Guidelines

Use PERFORMs to help structure your code (but watch out for increased paging).

Keep PERFORMed code as close as possible to the PERFORM statement.

Use PERFORM for long code, or code used in a great many places.

Processor Time

In general, we need to conserve processor time in CICS in the same way as in a batch program. The major factor is exactly the same: calls for operating system services take much longer, relatively speaking, than straight application code. This is true whether you are coding in CICS, where a call takes the form of a CICS command, or in batch COBOL, where a call is implicit in your input-output statements (OPEN, READ, WRITE and so on). So, avoiding unnecessary commands in a CICS design will reduce processor time much more than fine tuning your COBOL code, just as avoiding a single input/output operation in a regular program will make up for many MOVEs and GOTOs.

It is never desirable to do long calculations (matrix inversion and such) in an online program. This is because any online program is sharing the processor with many other programs (or occurrences of the same program) servicing users who each think they have the full attention of the "computer." Fortunately, such long calculations are rarely needed in online programs.

Processor Time Guidelines

Avoid unnecessary CICS commands.

Avoid excessively long calculations.

Auxiliary Storage

Disk space and transfer capacity are minimized in an online system in the same way as in a batch system. What differs is the following. In a batch system, the system programmer arranges data sets on disk according to what *jobs* might run concurrently. In an online system, however, the system programmer arranges data sets according to what *transactions* might execute concurrently. The same techniques are used for tuning: statistics on device and channel utilization in combination with knowledge of the applications.

Resources Specific to Working Online

This brings us to the new considerations.

User Time and Good Humor

We've already discussed (in "Some Interface Design Principles" on page 43) how user time and aggravation can be minimized. You'll find our guidelines there.

One-User-at-a-Time Resources

The next candidates for conservation are a whole class of resources that can be used by only one user (one transaction) at a time. A file record is a perfect example of this type of resource. As we've noted several times, we do **not** want two transactions updating the same record at the same time. CICS provides the enqueue mechanisms to prevent conflicts between transactions over such resources. What you have to remember in designing a transaction is that when one user has access to such a resource, everyone else who wants it will have to wait. Therefore:

Exclusive-Use Resource Guideline

Minimize the duration of transactions that require exclusive use of resources.

We'll say some more about these resources in later chapters.

Line Transmission Capacity

The last new element on our list is line transmission capacity. In an online system with terminals located a long way from the processor, the signals between them are generally (although not invariably) carried over the public voice telephone network. Compared to most of the elements of a computing system, telephone lines are very slow indeed. Transmission time, especially over a congested line, may be a major component of the total response time. Therefore:

Line Transmission Guideline

Avoid sending unnecessary data to and from screens.

For the most part, CICS does this for you automatically, using the 3270 hardware features explained in "Chapter 2-2. 3270 Terminals" on page 23. Sometimes, however, you can help as well. For example, if you were writing a data entry application program in which the operator repeatedly filled in the same screen, you would not need to rewrite the constant information on the screen (the titles and field labels) after the first display. It would be well worth your while to add a little extra program logic, to distinguish between the screen for the first entry and that for subsequent entries, and thereby reduce line traffic by not resending data that is already on the screen.

Chapter 2-7. A Basic Decision: Conversational or Pseudoconversational

Now that we've established guidelines for design, let's return to the problem of defining the transactions that make up the example application. In "Chapter 2-5. Designing the Transactions: More Detail" on page 53, we described the processing required for the various transaction types that the user sees: add, modify, display, and so on. If we were to define our CICS transactions along these functional lines, we can foresee several problems:

- There is much repetitive code, which suggests that we should at least use common programs for some of the transactions, if not combine some transactions.
- Every transaction involves a wait for the user to enter data, and the update transactions contain two such waits. This means that these transactions will be running for a relatively long time, which is a violation of the guideline to keep program duration short.
- The modify and delete transactions will be holding on to a one-user-at-a-time resource during one of the waits, contradicting the guideline to minimize the duration of transactions that use such resources.

Let's put aside the first problem for a moment, and look at the other two, which bring up an important issue in CICS design.

Take, for example, the modify transaction. If we were to program it as outlined earlier, the sequence of major events would be as shown in Figure 24:

```
1. Display menu screen.
2. Wait for response.
3. Receive menu screen (which is presumed to contain a correct
   modify request).
4. Read the subject record from the account file.
5. Display the record in formatted form.
6. Wait for the user to enter changes.
7. Receive the changes.
8. Write changes to the printed log.
9. Update the account and index files accordingly.
10. Redisplay the menu screen.
```

Figure 24. The Conversational Sequence of the Modify Transaction

Conversational Transactions

In CICS, this is called a **conversational transaction**, because the program(s) being executed enter into a conversation with the user. A **nonconversational transaction**, by contrast, processes one input (which was read by CICS and which was what started the task), responds, and ends (disappears). It never pauses to read a second input from the terminal, so there is no real conversation.

There are important differences between the two types: for example, duration. Because the time required for a response from a terminal user is much longer than the time required for the computer to process the input, conversational transactions last that much longer than nonconversational transactions. This means, in turn, that conversational transactions use storage and other resources much more heavily than nonconversational ones, because they hold on to their resources for so long. Whenever one of these resources is critical, you have a compelling reason for using nonconversational transactions if possible.

Pseudoconversational Transactions

This motivation brought about a technique in CICS called **pseudoconversational** processing, in which a series of nonconversational transactions gives the appearance (to the user) of a single conversational transaction. In the case we were just looking at, the pseudoconversational structure is shown in Figure 25:

```
TRANSACTION          OPERATIONS

First          1.   Display menu screen.

Second         3.   Receive menu screen.
               4.   Read the subject record from the account file.
               5.   Display the record in formatted form.

Third          7.   Receive the changes.
               8.   Write changes to the printed log.
               9.   Update the account and index files accordingly.
               10.  Redisplay the menu screen.
```

Figure 25. The Pseudoconversational Structure

Notice that steps 2 and 6 of the conversational version have disappeared. No transaction exists during these waits for input; CICS takes care of reading the input when the user gets around to sending it.

A word about "transactions". If we seem to be using the word in two different ways, well...yes we are. We defined the word earlier in the way that the user sees a transaction: a single item of business, such as an add, a display operation, and so on.

This is a correct use of the word. However, what the user sees as a transaction isn't necessarily what CICS sees.

To CICS, a transaction is a task that begins (usually on request from a terminal), exists for long enough to do the required work, and then disappears. It may last milliseconds or it may last hours. As we've just explained, you can use either one or several CICS transactions to do what the user regards as a single transaction. We're still deciding what we should define to CICS as transactions to accomplish the user transactions in our example problem. At the moment, the pseudoconversational approach seems promising; it will use shorter programs, which are desirable in CICS, and although there may be more of them, the programming does not look any more complicated.

There is a second important issue in this choice of techniques, however. It brings up a characteristic of the conversational transaction that can be both a significant advantage and a serious disadvantage. This characteristic is the length of the transaction, and it affects both file integrity and the ownership of resources that other transactions may need.

Maintaining File Integrity

We said earlier (in "Recovery Requirements" on page 51) that CICS has facilities for maintaining the integrity of files and other resources that are important enough to protect. CICS does two things:

1. It makes sure that transactions are either executed completely or not at all. For example, if a transaction has to update two related files and, after updating the first, finds it cannot do the second, then CICS undoes (**backs out**) the first update. We'll make use of this feature in our example application. If the application changes the account file and then discovers that someone has closed the index file by the time it goes to make the corresponding change there, CICS automatically removes the update to the account file.

2. It makes sure that protected resources (records in protected files, protected scratchpad areas, and so on) are updated by only one transaction at a time, and that any transaction updating such a resource finishes completely before a second transaction gets access to that resource.

Let's reexamine the conversational v. pseudoconversational issue in view of this new information. We've been insisting that we do not want two users to update the same record at once. If we use a single conversational transaction for our modify, CICS will prevent this from happening (that's good). When we issue the read (for update) in this sequence, CICS will prevent any other task from writing this record. If a second task comes along and requests the same record, for update, CICS will suspend that task until the first one is finished.

However, the program being executed in this second transaction won't be notified that it is going to get suspended, and so the user won't know why the request is taking longer than usual (that's bad).

To be honest, it's a little more complicated than that...

Both CICS and VSAM get involved in protecting the file from concurrent updates. VSAM's mechanism is based on the control interval, and has this effect: while one transaction is updating a record, no other transaction can update any record *in the same control interval.* Furthermore, other transactions may not even be able to *read* a record in the same CI as the one being updated.[3] Moreover, the wait experienced by the second transaction may be substantial; it will last as long as it takes the first user to enter the modifications on the screen. If he or she should leave the terminal before finishing, or go through a lot of error cycles getting the input correct, the wait may be very long indeed.

Double Updating...

If we choose the pseudoconversational technique, this waiting problem disappears, but so does the protection. In this case, the second transaction in the pseudoconversational sequence could issue the same "read" as in the conversational form. But as soon as this transaction ends, CICS releases the record, long before the update process is complete. A second user can come along and request the same record. Then you have two users making changes on the basis of the same "old" copy of the record. Changes made by the first user will go into the file, but then changes from the second user will go into the file right over the first user's, and the first set of changes will be lost (that's very bad).

Now clearly, in our application, we can separate off the first part of our user transaction (the first transaction in the pseudoconversational sequence) because we're not yet dealing with any protected resources. Nothing is done in this step that a later failure would have to undo. But what about the rest of it? We seem to be between two unfortunate alternatives. If we use a conversational approach, there will be greater use of storage and, worse, occasional unexplained waits. If we use a pseudoconversational approach, we may compromise file integrity.

There is no easy way to get around the unexplained waits of the conversational approach, but there **are** ways to get around the integrity problem, with a little extra coding.

[3] Whether a second transaction can read a record in the same control interval depends on whether the file is using local shared resource (LSR) or nonshared resource (NSR). For NSR only, a second task can perform a simple read (but not a read-for-update) on a record in the same control interval.

For example, suppose that as soon as a user asked to update an account number, we made a note in a scratchpad area. (CICS provides scratchpad facilities for keeping track of things *between* transactions.) We can leave the number there until the update is entirely completed and then erase it. In our example, this means that we write a scratchpad record in the second transaction, and erase it in the third. Before we start any update request, we can check to see if the number is in use. If it is, we can tell the user this and ask him or her to resubmit the request later. Furthermore, we can let the user **display** the record even if it is in use.

This isn't quite all, however. Because CICS ensures that transactions are either done completely or not at all, we have to make sure that all our protected resources get updated in what CICS regards as a single transaction to ensure file integrity. In the conversational case, this takes care of itself, as there is only one transaction. In the pseudoconversational case, the files are all updated in the third transaction (good), but the scratchpad is updated in two different transactions (not so good). If the second transaction is completed successfully, but something happens to the third, the scratchpad record is written but not erased. Our files would be okay, which is the main thing, but we'd be unable to update the record involved until we could somehow reset the scratchpad.

... and How To Avoid It

We'll get around this by designing a slightly more sophisticated scratchpad mechanism. We can, for instance, put a limit on the time for which a transaction can "own" an account number. Then an accident in the third transaction or thoughtless behavior by a user (going to lunch in the middle of a modification) will not cause an account record to become unusable for more than a short period of time. All this involves extra coding and complications, however. Is it worth it?

In this example, it really isn't obvious whether conversational or pseudoconversational is the better choice (after the menu phase, in which being pseudoconversational is definitely better). The choice really comes down to how many of these transactions we might expect at once. If there were a great many, the storage burden of a conversational transaction alone might cause us to choose pseudoconversational. If there were only a modest number, then we would have to consider how often a user would experience the unexplained wait if we chose conversational. If nearly all the activity consisted of displaying and printing, with only an occasional update, then the conversational approach might still be the correct choice.

We'll assume here, however, that there are enough transactions with enough updates to justify choosing the pseudoconversational approach, and we'll program our own mechanism for avoiding concurrent updates.

Double updating is one of those problems that a program designer can tackle in a variety of ways. We've chosen a scratchpad (partly because it's a reasonable method, and partly because it's going to allow us to show you how to use a CICS facility called temporary storage). A drawback of our scratchpad, however, is that **all** future (and, as yet, unknown) transactions that update the account file will have to refer to this scratchpad. We'll mention an alternative solution in "The Need for Scratchpad and Queuing Facilities" on page 165.

Chapter 2-8. Arranging the Processing into Transactions and Programs

We've now reached the point where we can start to arrange the processing described earlier into transactions and programs. Remember, a CICS transaction uses one or several programs to do its work. When a transaction is invoked, CICS looks in one of its tables, the Program Control Table (the **PCT**), to determine which program should be executed *first* to accomplish that transaction. However, that program may invoke any number of other programs. Several transactions may use the same program or programs, in the same order or in a different order.

Let's first look at the transactions we'll need, and then we can assess what programs we'll require. Because we're going to use the pseudoconversational approach, we need transactions that take an input from the screen, process it, and write back either the final result or an intermediate result in preparation for the next transaction.

Defining the Transactions

Displaying the Menu

The first thing we need is a very simple transaction that will accept a request to get started: that is, one that will put the menu up on the screen.

Analyzing the User's Response

Once the menu is on the screen, we need a transaction to analyze and respond to the input request that comes in after the user has completed fields on the menu screen. Going back to "Chapter 2-5. Designing the Transactions: More Detail" on page 53, we see that this transaction must do the following steps:

Steps 3 - 4 of "Request Analysis" on page 54

Steps 1 - 2 of "Add Processing" on page 56

Steps 1 - 2 of "Modify Processing" on page 58

Steps 1 - 2 of "Delete Processing" on page 60

Steps 1 - 2 of "Display Processing" on page 62

Steps 1 - 4 of "Name Inquiry Processing" on page 66

All steps of "Print Processing" on page 64.

Remember that we don't have to do all this processing with a single program. We'll decide on the programs we need later, after we've laid out the transactions.

Adding a New Record

The next transaction that we need is one to do steps 4 through 7 of "Add Processing" on page 56. We'll use this transaction if the request in the previous transaction was to add an account record.

Handling Updates and Other Requests

Similarly, we'll need four other transactions to do, respectively, the steps shown below:

Steps 4 - 8 of "Modify Processing" on page 58

Steps 4 - 7 of "Delete Processing" on page 60

Steps 6 - 7 of "Name Inquiry Processing" on page 66

All steps of "Printing the Log" on page 68.

We might use a separate transaction for each of these requirements, or we might combine some of them. We won't make that decision for the time being.

Defining the Programs

Let's look at the programs that we're going to need in support of these transactions, because that will help us to decide how many different transaction types we need.

Displaying the Menu - ACCT00

Let's go back to the first transaction, the one that puts up the menu screen, and give it a name so that we can refer to it easily. We'll need a four-character transaction identifier to define it to CICS anyway, so let's call it, say, ACCT. This is what the terminal user will key in to see the menu screen for this application. Now ACCT needs a program that will display the menu screen. This program is so simple that perhaps it should be combined with some other program, but for clarity we'll keep it separate. Let's call this program ACCT00.

Analyzing the User's Response - ACCT01

The next transaction is the one that processes the menu input. Let's also give it a name, say, AC01. It's a good idea to use some sort of naming convention for both your transactions and programs. You should be able to tell which application they belong to just by their names. There's a temptation when writing your first application to use names like MENU, ADD, and UPDT. These turn out to be unfortunate choices when you get around to doing your *second* application, however, and so names that identify the application are generally better.

ACCT is the only transaction identifier the general user will have to remember, so we'll start the others with AC for ease of recognition, and just number them from there. Similarly, the programs will start with ACCT and be numbered.

But back to transactions. Let's look at the processing that AC01 has to do, so that we can visualize the programs required. Looking back at the list of requirements, one approach would be to write a separate program for each item on the list. The first program (the one that did the initial request analysis) would transfer control to one of the others, depending on the type of request. However, if we look at the content of Steps 1 and 2 of "Add Processing," "Display Processing," "Modify Processing," "Delete Processing", and "Print Processing," we find that they are very similar. They start with the same data and access the same file record, so we probably want to combine these into a single program. So we can cut down our original list for this transaction to:

Steps 3 - 4 of "Request Analysis" on page 54

Steps 1 - 2 for add, modify, delete, display, print

Steps 1 - 4 for "Name Inquiry Processing" on page 66

Steps 3 - 4 for "Print Processing" on page 64.

None of these is a very long piece of code, so it will probably be most convenient to put them in the same program. For the moment we'll call this program ACCT01. However, it may turn out later that it's better to break out one or more of these segments of code into additional programs. Program and transaction structures often become clearer when you start to code, and you may find that you can come up with a better structure than your original one once you start. Don't worry if everything isn't obvious at first; it takes practice.

Handling Updates (Including Additions) - ACCT02

For the transactions that follow transaction AC01 and finish the processing for adds, modifies, and so on, we again might consider a separate program for each type of function. Once more, however, it's obvious that the processing for adds, modifies and deletes is very similar. Most of the steps, in fact, are identical. So, let's combine these into a single program, and call it ACCT02. Then we can use a single transaction for all three processes. We could use different transactions, all using the same program, but it would be pointless in this case. Let's assign the identifier AC02 to the transaction that gets executed when the user has filled in an update screen (add, modify or delete).

We still need a transaction that will do the remaining steps of "Name Inquiry Processing" on page 66. But this code will be almost identical to an initial name search request, so we can probably include it in program ACCT01.

Summary

To summarize, thus far we've defined three transactions, and three programs in support of them, as shown in Figure 26:

IDENTIFIER	TRANSACTION	PROGRAMS USED
ACCT	Displays menu.	ACCT00
AC01	Analyzes requests; Processes name search, display and print requests;* Does first part of update requests	ACCT01
AC02	Completes update requests	ACCT02

* Almost, as we'll see later

Figure 26. The Three Transactions and Three Programs

The only thing left is the printing of the log. Or is it? In fact, in addition to printing, we haven't yet thought much about the business of telling the user at the terminal about any error conditions that may arise. So before we consider the log, we shall digress to discuss three considerations that will bear on our definition of transactions and programs.

These are:

- Communication between transactions
- Error handling
- The relationship between transactions and terminals.

These bear directly on how we'll handle the last two application functions.

Chapter 2-9. Three Remaining Considerations

Communication Between Transactions

You may have noticed when we were explaining pseudoconversational processing that there seemed to be some gaps in control and communication.

When one transaction of a pseudoconversational sequence has been completed, doesn't this task disappear when control goes back to CICS? And if so, how can we make sure that the transaction we intend to follow this one is actually the one that gets executed? And how will the next transaction know what this one was doing? In the case where transaction AC02 is supposed to follow AC01, for example, doesn't AC02 need to know what kind of an update has been requested and *which* record was being updated?

Yes, CICS does indeed effectively erase all the storage associated with a transaction when it ends, and it often erases the program as well. However, before it passes out of existence, the departing transaction is allowed to pass data forward to be used by the next transaction initiated *from the same terminal*, whenever that transaction arrives. It is also allowed to dictate *what* that next transaction is to be. You can see that this is a very useful - indeed, vital - facility for pseudoconversational programming. It's what allows us to ensure that transaction AC01 always follows ACCT, that AC02 follows AC01 when we're updating, and so on. It's called, not surprisingly, the "next transaction identifier" feature. We'll shorten this to "next transid."

The main way one transaction passes data forward to the next is by using the COMMAREA (for **communication area**). The same facility is available to pass data between programs within a transaction. We'll see how to use it for both purposes in Part 3.

There are other facilities for storing data between transactions as well. One of these is a CICS facility known as **Temporary Storage**, which can be used as a sort of application scratchpad. This facility will do nicely for keeping track of the account numbers being updated. We'll see how to use it in Part 3.

A less obvious place to store data between transactions is the screen itself. You may recall from our discussion of the 3270 data stream (see "Chapter 2-2. 3270 Terminals" on page 23) that the modified data tag governs whether or not a field on the screen is transmitted back to the processor. One way to ensure that an item of data gets from one transaction to another, then, is simply to store it on the screen, with the modified data tag on and the field protected, so that the user cannot change it. You can even prevent users from seeing the data (if that might confuse them), by using the dark attribute.

This method isn't appropriate to large amounts of data, of course, because we don't want to send *much* extra data over a communications link.

Handling Errors and Exceptional Conditions

Before we get down to specifying our programs, we need to discuss the topic of errors. Errors in online programs are indeed a topic in their own right and we'll take them up individually as we discuss the CICS commands in Part 3. However, we need to state some guidelines here before we start to specify our programs.

We can divide the errors that can occur in a CICS transaction into five categories:

1. **Conditions that aren't normal from CICS's point of view but that are expected in the program.**

   There's an example in transaction AC01, when we test to be sure the record to be added isn't already there and get the "not found" response.

   Errors in this category should be handled by explicit logic in the program.

2. **Conditions caused by user errors and input data errors.**

   We'd have an error of this kind in our example application if a user tried to add an account number that already existed, or used the wrong key to send the data on the screen.

   Errors in this category should also be handled by explicit logic in your program. Ideally, no errors of either of these types should be allowed to stop the program, or do anything else to upset the user.

3. **Conditions caused by omissions or errors in the application code.**

   These may result in the immediate failure of the transaction (ABEND) or simply in a condition that we believed "could not happen" according to our program logic. In our example application, a "duplicate record" response in AC02, on adding a record to the account file, would represent this kind of error. We don't expect it, because we've already tested in transaction AC01 to ensure that no record with the same key is in the file.

   For errors in this category, you'll want to terminate your transaction abnormally, in case CICS doesn't do it for you first. The resulting dump should enable you to find out why the condition occurred, and we'll give you more guidance on this in

Part 5. One of the main goals of the debugging process should be to get rid of this type of error.

4. **Errors caused by mismatches between applications and CICS tables, generation parameters, and JCL.**

   An example is when CICS responds "no such file exists" to your read or write request. When you are first debugging an application, these problems are almost invariably your fault. (This may sound harsh, but we're afraid it's true.) Perhaps the entry got left out of the File Control Table, or you spelled a name differently in the table from the program, or asked for the wrong set of services in selecting CICS modules.

   These conditions sometimes occur after the system has been put into use, as well. In this stage they are usually the result of changes to a CICS table, or services parameters, or JCL, usually related to some other application.

   This category needs the same treatment as the third while you are debugging. Once the program is in actual use, however, something more is needed when one of these conditions arises. You must give users an intelligible message that they or their supervisors can relay to the operations staff, to help in identifying and correcting the problem. For example, if a machine room operator has closed a file for some reason and forgotten to reopen it, you want a message that says that the problem is caused by a closed file (and *which* closed file, of course). Moreover, you should program for these eventualities right away, as this part of the program will need debugging just as well as the rest.

5. **Errors related to hardware or other system conditions beyond the control of an application program.**

   The classic example of this is an "input/output error" while accessing a file.

   As far as the application programs are concerned, this category needs the same treatment as the fourth. Systems or operations personnel will still have to analyze the problem and fix it. The only differences are that they probably didn't cause it directly, and it may take much more effort to put right.

The need to produce an appropriate message when an error in one of these last two categories occurs (or when one in category 3 slips through the debugging) will mean an additional program in our example application.

A "Catchall" Error Program - ACCT04

Since there are CICS commands in every program, we'll need this message logic in each. Rather than repeat the code in each, we'll put it in a separate program (ACCT04). This will not only avoid repetition, but will remove a long section of rarely-used code from the mainline programs. (The code itself isn't long, but the error message tables are.)

Transactions and Terminals

There's one additional complication to think about in defining our transactions for this application program. This is the relationship between transactions and terminals in CICS. As we explained earlier, most CICS transactions (tasks) are invoked when CICS receives unsolicited input from a terminal. On receiving such input, CICS creates a task to process it. Which type of task is determined from the transaction identifier at the start of the input or the next transid that was set by the previous transaction at this terminal.

The task and the terminal that invoked it have a special relationship in CICS: the task essentially "owns" the terminal for its duration; it can write to it and read from it directly, and no other task can do so during this time. Conversely, the task owns *only* this terminal and cannot read from or write to any other terminal directly (another task might own that terminal at the time, and a sudden message from a second task might disrupt the owning task hopelessly).

You may be asking at this point "how can transaction AC01 in the example do all the steps of print processing?" as we proposed earlier, since step 3 of "Print Processing" on page 64 (send this image to the indicated printer) seems to violate this restriction. The answer is that it can't. The same task cannot own the display terminal from which the input was received and a printer terminal.

A Printer Program - ACCT03

What we do to get around this restriction is to have transaction AC01 do the other steps of the print processing and then create a second transaction (task), which *does* own the necessary printer terminal, to do step 3. CICS provides a command called START expressly for this purpose, as we'll see in Part 3. So we must add another transaction to our list, namely the one that does step 3 of "Print Processing" on page 64. Let's call it AC03. We'll also need a program to go with it, albeit a very short one; this we'll call ACCT03.

Now clearly the same problem will arise with printing the log. The input that invokes this transaction is clearly not going to come from the terminal required to execute it (printers not being strong on input) and so again we'll need two

ID	TRANSACTION	PROGRAMS USED
ACCT	Displays menu	ACCT00
AC01	Analyzes requests; processes name search and display requests fully; does first part of update and print requests	ACCT01/04*
AC02	Completes update requests	ACCT02/04*
AC03	Completes print requests	ACCT03/04*
ACLG	Invokes AC05	ACCT03/04*
AC05	Prints the log	ACCT03/04*

* Note: ACCT04 is used only if an error occurs.

Figure 27. The Six Transactions and Five Programs

transactions. One will accept the request from an input terminal and start a second, which will have the necessary printer at its disposal.

Let's call this first transaction ACLG and the second AC05. (We're reverting to a transaction identifier that's easier to remember, because the supervisor will have to remember it.)

We'll also need a program for each of these transactions. We could define a separate one for each, but the code required for these functions turns out to be so short, in fact, that we'll include it in the little program we defined for transaction AC03, and use a single program for three different functions.

Figure 27 shows the program structure we've now arrived at. The five programs in support of these six transactions are examined one last time in "Chapter 2-10. Defining the Programs - A Final Look" on page 95. You can either read this chapter to consolidate your ideas about the programs, or move straight on to the next part of the Primer: "Part 3. Application Programming" on page 103.

Chapter 2-10. Defining the Programs - A Final Look

We've now defined five programs in support of six transactions. In this chapter, we'll describe briefly what each program does. This material repeats that in "Chapter 2-5. Designing the Transactions: More Detail" on page 53, but it's arranged somewhat differently. Feel free to move on to "Part 3. Application Programming" on page 103 if you already feel comfortable with the program structure that we've defined.

Program ACCT00: Menu Display

This program is the first one executed when transaction ACCT is entered. It displays the menu screen, which prompts the operator for request input, and then ends (it returns control to CICS). In returning, it specifies that transaction AC01 is to be executed when the next input is received from this terminal, which means that program ACCT01 will be invoked to process the input from the menu. The processing steps are:

1. Display the menu on the screen.

2. Go back to CICS, setting the next transid to AC01.

Program ACCT01: Initial Request Processing

This program analyzes requests that are entered through the menu screen (all requests except those for printing the log). It processes name search and record display requests completely, does update requests up to the point where the user has to enter more information, and does print requests except for the step that requires access to a printer terminal. It's the first program invoked when transaction AC01 is executed. The main steps in the program are:

1. Find out what the user wants to do. This involves looking at the input, both the actual data and the attention identifier (the key used to send the data). The possibilities are:

    a. A request to leave the application (indicated by use of the CLEAR key). Here control is returned to CICS, without any next transid.

   b. A request to cancel the previous (partially completed) request and start again with a menu screen. This means sending a new menu screen and then returning control to CICS with the next transid set to AC01 (so that this same program will process the input from that menu when it arrives).

   c. A request to continue a name search that produced more matching records than would fit on a single screen (indicated by the user pressing the PA2 key to move on from the current (full) screen, and view more records on the next). In this event, processing resumes at step 5, using search control information that was saved in the COMMAREA when this transaction was last executed for this terminal.

   d. A corrected request or a completely new request.

2. For a new request, get the input and examine the contents. The first decision is whether the user wants a name search or one of the other functions.

3. If the user entered a name, check it for reasonableness. If there's an error, write the appropriate error information to the screen and return control to CICS. Once again, set the next transid to AC01, so that this same program will get invoked to process the corrected input.

4. If the names are correct, build the control information we need to do the search, namely:

   - An index file key that is equal to or just before the input in alphabetical sequence, so that we know where in the file to start reading,

   - A limiting value for that key to tell us when we've read too far (alphabetically) in the file, and

   - A range of alphabetical values for the given name, so that we can exclude records which do not meet that criterion, if any was specified.

5. Point to the first eligible record in the index file and begin reading sequentially. For each record read, check to see if the given name is within the required range. If it is, build an output line for the screen from the information in the record and then go on reading. If not, skip the record and go on reading. Continue this process until the surname in the file exceeds the one we're looking for, or the end of the file is reached, or there is no more room on the screen.

6. When this happens, send the results back to the user. If we ran out of space on the screen, add a message saying that there are more names and that they can be seen by using the PA2 key. Then return control to CICS, again setting the next transid to AC01. If there are more matching names, save the search control information in COMMAREA as well.

7. If the request was other than a name search (display, print, add, modify, delete, or even an error), check the request type, account number and printer name (if applicable) for correctness. Checking the account number involves reading the account file. We check to make sure the record isn't there for an add request but that it *is* there for all the other request types. If any of the checks fail, or if the request itself is unrecognizable, write the appropriate error information back to the screen and return to CICS, once again with the next transid set to AC01.

8. If the request is an update (add, modify or delete), read the scratchpad to ensure that no other terminal is currently updating the same account number. If one is, treat the situation as an error in the account number and proceed as in the previous step. Otherwise, write the necessary scratchpad record to reserve the number for this terminal.

9. Build a screen image to send to the user (or the printer). For add requests, this will simply be a skeleton screen, with only the account number filled in. For the others, however, it will involve moving the information from the account file record (read in step 7) into the detail screen. Also, the title, message area and certain other items in the screen need to be customized to the particular type of request.

10. For all requests except print requests, send this screen back to the input terminal. Then return to CICS. The next transid for display requests will be ACCT, as the next thing the user will want after looking at the record is a fresh menu screen. For the update requests, the next transaction should be AC02.

11. For print requests, ask CICS to start another task (AC03) with the required printer as its terminal. Pass the screen image built in step 9 as data to that task. Then add a message to the menu currently on the screen saying that the printing has been scheduled, and return to CICS. Set the next transid to AC01, as the menu is still on the screen and therefore the next input should be processed by this same program.

Program ACCT02: Update Processing

ACCT02 is the first program invoked by transaction AC02. It completes update transactions, using the information supplied by the user on the detail screen. The main steps are as follows:

1. Make sure that the user wants to complete the update request. (It is important in a situation like this to allow users some means of escape, in case they change their mind about a file update they started or in case they simply don't have the right information to complete it. This application observes the convention that using the CLEAR key at any time means that the user wants to cancel the current operation.)

If the user wants to quit, release control of the account number, send a fresh menu screen with a message that the previous request has been canceled, and return to CICS. Set the next transid to AC01, since the next input to be processed will come in on that menu screen.

2. Otherwise, get the input. If the request is to add a record, build a new record from the information on the screen. If the request is a modification, read the old record and build a new record by merging it with the changes entered on the screen.

3. Check the input for correctness. For delete requests, the only requirement is that the user confirm the deletion with a "Y" in the "verify" field. For add and modify requests, all the fields entered must meet their respective edit requirements. If there are any errors, send the appropriate error information to the screen. Then return control to CICS with the next transid set to AC02, so that this same program processes the corrected input.

4. Read the scratchpad to make sure that the input terminal still has control of the account number it is trying to update. (In other words, check that the scratchpad has neither been erased nor altered. Check back to " ... and How To Avoid It" on page 81, if you need reminding about the scratchpad.)

   If not, treat the situation in the same way as an input error (see step 3 above), but with a different error message, of course.

5. Otherwise, write the update information to the log of changes. For additions, this will be an image of the new record. For modifications, it will be both the old and the new versions, and for deletions, it will be the record being deleted.

6. Do the actual updates. For adds, this means adding the new record to the account file and the corresponding index record to the index file. For deletes, it means removing a record from each file. For modifications, it means rewriting the record in the account file. The corresponding index record may have to be rewritten as well, depending on which fields in the account record changed. If the surname changed, for example, the old index record must be deleted and a new one added, because the key will have changed. (The first 12 characters of the surname, together with the account number, form the key, remember.)

7. Release ownership of the account number by erasing it from the scratchpad.

8. Send a fresh menu screen to the input terminal, with a message saying that the requested update has been completed. Then return control to CICS with the next transid set to AC01.

Program ACCT03: Requests for Printing

ACCT03 does three independent jobs, all related to printed output (as opposed to display output). When it is invoked by transaction AC03, it completes the request for printed output of a record in the account file. Transaction AC01 processed the initial stages of the print request, checking the input, reading the record to be printed, and building the detail screen from the information in the file record. It then requested that transaction AC03 be started with the required printer as its terminal. The processing in AC03 is:

1. Retrieve the screen image prepared and saved for this purpose in transaction AC01.

2. Send this screen to the terminal owned by this transaction (the printer named by the user in the print request).

3. Return control to CICS. Don't set any next transid because there's no need to do so for terminals that never send unsolicited input. Also, we don't know what transaction should be executed next at this printer.

Transactions ACLG and AC05 together process a user request to print the log of changes to the account file. The user invokes transaction ACLG directly, by entering this identifier at a display terminal. When invoked by ACLG, the program simply requests CICS to start transaction AC05, with the hardcopy printer as its terminal. ACLG then sends a message to the user saying that the printing has been scheduled, and returns control to CICS. No next transid is set, because we're not controlling the flow of transactions at the input terminal, as we do when input requests are entered through the menu screen.

We'll format our log as follows:

- **For additions**, we'll print the new record, using the same format that we use on the screen (the "detail" map).

- **For modifications**, we'll print both the old version of the record and the new one, again using the map format. In the message area of the old record we'll note the areas that were changed (name, address, etc.), to make it easy for the supervisor to check.

- **For deletions**, we'll print the old record.

- **For all types**:

  1. We'll note the contents of the screen in the title line of the map: NEW RECORD for additions, BEFORE CHANGE and AFTER CHANGE for the two images printed on a modification, and DELETION on a delete.

2. We'll show the time and date of the update and the name of the terminal at which it was entered. We'll put this information in the message area (for modifications, it will be in the "new" record image).

As a result of executing transaction ACLG, CICS starts AC05 as soon as the requested printer is available. When invoked in this way, the program reads through the data set containing the hard-copy log sequentially, transferring each entry to the printer. After the last item is printed, it deletes the log. Then it returns control to CICS. Again, no next transid is set, because there's no need to do so for terminals that never send unsolicited input.

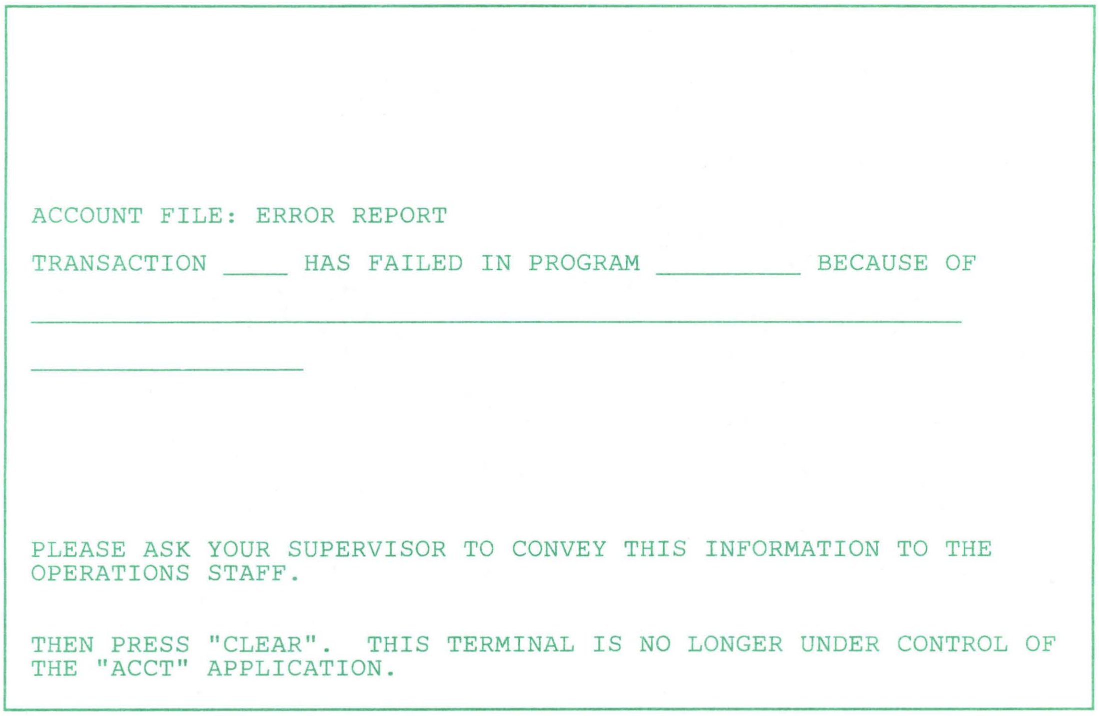
Program ACCT04: Error Processing

This program is a general-purpose error routine. It isn't invoked directly by any transaction, but instead receives control from programs ACCT01, ACCT02, and ACCT03 when they meet a condition from which they cannot recover. (Program ACCT00 is so simple that no such situation arises.)

The program sends a screen to the terminal user (see Figure 28) with a text description of the problem and a request to report it. The text is based on the CICS command that failed and the particular error that occurred on it. The name of the transaction and the program (and if applicable, the file) involved are also shown. The command, error type, and program name are passed to ACCT04 from the program which transferred control to it; we get the other items from the CICS **Exec Interface Block** (EIB). The EIB is a CICS control block associated with a task, containing information accessible to the application program. We'll look at it in more detail in "The EXEC Interface Block (EIB)" on page 143.

After writing the screen, the program terminates itself abnormally (it **abends**), so that any updates to recoverable resources done in the half-completed transaction get **backed out**.

You'll see ACCT04 in action in "A Session With EDF" on page 219.



```
ACCOUNT FILE: ERROR REPORT

TRANSACTION ____ HAS FAILED IN PROGRAM _________ BECAUSE OF

___________________________________________________________

_________________




PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORMATION TO THE
OPERATIONS STAFF.

THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGER UNDER CONTROL OF
THE "ACCT" APPLICATION.
```

Figure 28. The Transaction Error Screen

Part 3. Application Programming

This Part of the Primer:

- Describes CICS COBOL application programs
- Examines the features of Basic Mapping Support (BMS)
- Deals with reading and writing files
- Explains a scratchpad mechanism that uses temporary storage
- Covers communication and control between application and tasks
- Explains how to use CICS services such as START and RETRIEVE
- Covers errors and error recovery

Chapter 3-1. Writing CICS Programs in COBOL

In this chapter we'll begin by explaining the basic differences between batch and CICS programs. In later chapters, we'll describe, by function, the services that CICS provides: first terminal services, then file services, and so on.

To show you how to use these services, we'll be coding parts of our example application as we go. In "Part 4. The COBOL Code of our Example Application" (which is printed separately), we list the programs in their entirety, with a step-by-step description of what the code does.

Appendix A, "Getting the Application Into Your CICS System" on page 269, shows you how to prepare these programs for execution under CICS.

What's Different About CICS Programs?

Well, not **so** much **is** different. Here, for instance, are the steps a typical batch program goes through:

A Typical Batch Program

1. Initialize for the whole run (set all the counters to zero and open up the files).
2. Initialize for the next input.
3. Read it.
4. Process it.
5. Write the related outputs.
6. Repeat Steps 2 - 5 until you run out of input.
7. Finish (add up the counters, print any summary results and close the files).

A typical CICS transaction is very similar, but it includes only steps 2 through 5. That is, it's like the core of a batch program, where a single input is processed. CICS takes care of opening and closing the files for you. The reports and summaries associated with batch jobs can often be dispensed with in an online environment, or they may be produced periodically by a different transaction or even by a batch job.

The other big differences are: -

- You request "operating system" services, such as file input/output, by issuing a CICS command instead of using the corresponding language facility (READ, WRITE, and so on).
- You aren't allowed to use the language facilities for which CICS has provided substitutes.
- You cannot use language features and compiler options that need operating system services during execution. The SORT and TRACE facilities are examples.

How To Invoke CICS Services

When you come to the point where you require a system service, such as reading a record from a file, you include a CICS command in your code. Commands look like this:

```
EXEC CICS function option option ... END-EXEC
```

The "function" is the thing you want to do. Reading a file is READ, writing to a terminal is SEND, and so on.

An "option" is some specification that's associated with the function. Options are expressed as keywords, some of which need a value in parentheses after the keyword. For example, the options for the READ command include DATASET, RIDFLD, UPDATE, and others. DATASET tells CICS which file you want to read, and is always followed by a value indicating or pointing to the file name.

RIDFLD (record identification field, that is, the key) tells CICS which record and likewise needs a value. The UPDATE option, on the other hand, simply means that you intend to change the record (thereby invoking the CICS protections we discussed earlier) and doesn't take any value. So, to read, with intent to modify, a record from a file known to CICS as ACCTFIL, using a key that we've stored in Working-Storage at ACCTC, we'd issue a command that looks like this:

```
EXEC CICS READ DATASET('ACCTFIL') RIDFLD(ACCTC)
          UPDATE   ...   END-EXEC
```

When you specify a value, you may either use a literal, as we did for DATASET above, or you may point to a data area in your program where the value you want is stored, as we did for RIDFLD above. In other words, we might have written:

```
    MOVE 'ACCTFIL' TO DSNAME
    EXEC CICS READ DATASET(DSNAME) RIDFLD(ACCTC)
              UPDATE   ...   END-EXEC
```

instead of our earlier command. If you use a literal, follow the usual COBOL rules and put it in quotes unless it's a number. In other types of commands, these values may be paragraph names in your program, telling CICS where to go if a certain type of exceptional condition arises. Don't use quotes around paragraph names.

You may be curious about what the COBOL compiler does with what is (to it) a strange-looking English-like statement like the one above. The answer? The compiler doesn't see that statement. Processing of a CICS program for execution begins with a translation step. The translator converts your commands into true COBOL, in the form of CALL statements. You then compile and link edit this in the normal way. The generated CALL statements never contain periods, by the way, unless you include one explicitly after the END-EXEC. This means you can use CICS commands within IF statements (by leaving the period out of the command), or you can end a sentence with the command (by including the period).

Restrictions in CICS COBOL

1. The biggest difference between batch and CICS COBOL programs is that you don't define your files in a CICS program. Instead, they are defined in a CICS table, the File Control Table, which we cover in "Chapter 3-4. Handling Files" on page 151. So:

   - You cannot use the entries in the Environment Division and the Data Division that are normally associated with files. In particular, the entire File Section is omitted from the Data Division. Put the record formats that usually appear there in either the Working-Storage or Linkage Sections.

   - You cannot use the COBOL READ, WRITE, OPEN, and CLOSE statements.

2. You cannot use compiler features that require the use of operating system facilities. For example:

   - Special features of the COBOL compilers, namely:

     ACCEPT DISPLAY EXHIBIT INSPECT * REPORT WRITER
     SEGMENTATION SORT TRACE UNSTRING *

     * VS COBOL II permits these features under CICS/OS/VS

- Features that require an operating system GETMAIN (the most common of which is CURRENT-DATE).

- Certain compiler options:

  ```
  COUNT   ENDJOB   FLOW   DYNAM   STOP   RUN
  SYMDUMP   STATE   SYST    TEST
  ```

3. Your program must be what CICS calls "quasi-reentrant." Technically, this means your program must not modify itself between calls for CICS services. For this purpose, in command-level CICS, your WORKING-STORAGE section is *not* considered part of the program (neither is anything in the LINKAGE section). Consequently, you rarely have a chance to break the "quasi-reentrant" rule.

4. There are significant differences between VS COBOL II and other levels of the COBOL language. For example, unless you are using VS COBOL II, the following restriction is in force:

   - When separate COBOL programs are link edited together, only the first may invoke CICS services.

These are the major restrictions, and the only ones you are likely to encounter using the commands described in this Primer. The *CICS/VS Application Programmer's Reference Manual (Command Level)* contains further information on this subject. We'll often cite this manual in this part of the Primer. Since it has such a long name, we'll refer to it by its common nickname: "the APRM."

Another useful book is the *VS COBOL II for CICS/OS/VS Users*, SC33-0203.

Chapter 3-2. Defining Screens With Basic Mapping Support (BMS)

Let's now plunge in and try to code our example application. If we start at the beginning of the first program we specified (ACCT00), the first thing we need is to write a formatted screen to the input terminal. This requires the use of CICS terminal input/output services. In particular, we'll need to use Basic Mapping Support (BMS).

First, some background. CICS supports a wide variety of terminals, from teletypewriters to subsystems such as intelligent cluster controllers, under a variety of communications access methods. In this Primer, however, we cover only the most common CICS terminals, those of the IBM 3270 system. Specifically the 3277 and 3278 display devices (with a screen size of 24 lines and 80 columns) and the associated printer terminals: 3284, 3286, 3287 and 3289.

We don't use features that depend on a particular terminal access method, and we only cover formatted output. Nor do we cover many of the formatted services; instead we concentrate on the basic things you need to get an ordinary application going. After we've explained these fundamentals, we'll tell you what else you can do when you're feeling adventurous, and where to look for guidance on how to do it.

What BMS Does

As you read through this chapter (and the next) you may start to feel a bit overwhelmed by all the detail you'll be learning about BMS. So let's get a couple of things straight right from the word "go". BMS simplifies your programming job, keeping your code largely independent of any changes in your network of terminals and of any changes in the terminal types. And after you've written your first few maps, you'll find they aren't so bad!

Before we start to look at the BMS commands, we need to explain in a little more detail what BMS does for you. It's probably easiest to define what BMS does by examining the menu screen we need. You can see what it looks like in Figure 29 on page 110.

To help us in this discussion, we've added row and column numbers to the figure and underlined the fields that would otherwise not show unless filled in with data. We've also marked the position of the attribute byte for the "stopper" fields with a vertical bar (|) and for other fields with a plus sign (+). These markers won't show up on the screen we're building; it will look just as it did in Figure 13 on page 42.

```
              1         2         3         4         5         6         7         8
Col: 12345678901234567890123456789012345678901234567890123456789012345678901234567890
Row:
 1   +ACCOUNT FILE: MENU
 2
 3      +TO SEARCH BY NAME, ENTER:                                 +ONLY SURNAME
 4                                                                 +REQUIRED. EITHER
 5         +SURNAME:+____________+  FIRST NAME:+_______|           +MAY BE PARTIAL.
 6
 7      +FOR INDIVIDUAL RECORDS, ENTER:
 8                                                                 +PRINTER REQUIRED
 9         +REQUEST TYPE:+_+  ACCOUNT:+_____+  PRINTER:+____+       ONLY FOR PRINT
10                                                                 +REQUESTS.
11         +REQUEST TYPES:  D = DISPLAY    A = ADD     X = DELETE
12                         +P = PRINT      M = MODIFY
13
14      +THEN PRESS "ENTER"            +-OR-   PRESS "CLEAR" TO EXIT
15
16   +ACCT    SURNAME       FIRST   MI  TTL    ADDRESS                   ST     LIMIT
17   +_____   ____________  _______  _  ____   ________________________  __   _______
18   +_____   ____________  _______  _  ____   ________________________  __   _______
19   +_____   ____________  _______  _  ____   ________________________  __   _______
20   +_____   ____________  _______  _  ____   ________________________  __   _______
21   +_____   ____________  _______  _  ____   ________________________  __   _______
22   +_____   ____________  _______  _  ____   ________________________  __   _______
23
24   +____________________________(msg area)__________________________
```

Figure 29. A Detailed Look at the Menu Screen

You define this screen with **BMS macros**, which are a form of assembler language. When you've defined the whole map, you put some job control language (JCL) around it and assemble it. You assemble it twice, in fact. One of the assemblies produces the **physical map**. This gets stored in one of the execution-time libraries, just like a program, and CICS uses it when it executes a program using this particular screen.

The physical map contains the information BMS needs to:

- Build the screen, with all the titles and labels in their proper places and all the proper attributes for the various fields
- Merge the variable data *from* your program in the proper places on the screen when the screen is sent to the terminal.
- Extract the variable data *for* your program when the screen is read.

The information is in an encoded form comprehensible only to BMS, but fortunately we never need to examine this ourselves.

The other assembly produces a COBOL structure which we call the **symbolic description map** or DSECT (an assembly language term for this type of data structure, standing for dummy control section). This structure defines all of the variable fields (the ones you might read or write in your program), so that you can refer to them by name. The data structure gets placed in a library along with similar COPY structures like file record layouts, and you simply copy it into your program.

The BMS Macros

To show you how this works, let's go ahead and define the menu map. We'll explain the three map-definition macros as we go. Don't be put off by the syntax; it's really quite simple when you get used to it. We'll go from the inside out, starting with the individual fields.

The DFHMDF Macro: Generate BMS Field Definition

For each field on the screen, you need one DFHMDF macro, which looks like this:

```
fldname DFHMDF POS=(line,column),LENGTH=number,
               INITIAL='text',OCCURS=number,
               ATTRB=(attr1,attr2,....)
```

(You need a continuation character - any character except a space - in col. 72 of each line except the last.)

The items in this macro have the following meanings:

fldname

This is the name of the field, as you'll use it in your program (or almost so, as we'll explain). Name every field that you intend to read or write in your program, but don't name any field that's constant ("ACCOUNT FILE: MENU..." and other labels, or the stopper fields in this screen). The name must begin with a letter, contain only letters and numbers, and be no more than seven characters long.

DFHMDF

This is the macro identifier, which must be present. It shows that you are defining a field.

POS=(line,column)

This is the position on the screen where the field should appear. (In fact, it's the position relative to the beginning of the map. For the purposes of this Primer, however, screen and map position are the same.) Remember that a field starts with its attribute byte, so if you code POS=(1,1), the attribute byte for that field is on line 1 in column 1, and the actual data starts in column 2. For the type of maps in this Primer, you need this parameter for every field.

LENGTH=number
This is the length of the field, *not* counting the attribute byte. You'll have to specify length for the type of maps in this Primer.

INITIAL='text'
This is the character data for an output field. It's how we specify labels and titles for the screen and keep them independent of the program. For the first field in the menu screen, for example, we'll code

```
INITIAL='ACCOUNT FILE:  MENU'
```

ATTRB=(attr1,attr2,...)
These are the attributes of the field, and there are four different characteristics you can specify. The first is the display intensity of the field, and your choices are:

NORM
Normal display intensity.

BRT
Bright (highlighted) intensity.

DRK
Dark (not displayed).

The second characteristic governs what the user can do at the keyboard. Here your choices are:

ASKIP
The field cannot be keyed into, and the cursor will skip over it if the user fills the preceding field.

PROT
The field cannot be keyed into, but the cursor will not skip over it if the user fills the preceding field.

UNPROT
The field can be keyed into.

NUM
The field can be keyed into, but only numbers, decimal points and minus signs are allowed, if you have the NUM LOCK feature.

The third characteristic governs the modified data tag that we discussed in "3270 Input Data Stream" on page 28:

FSET

Turns on the modified data tag. This causes the field to be sent on the subsequent read whether or not the user keys into it. If you don't specify this, the field is sent only if the user changes it.

The fourth characteristic that you can specify as part of the "attributes" has nothing to do with the attribute byte on the screen. It gives you a way of specifying that you want the cursor to be in this field. To do so, code:

IC

Places the cursor under the first position of the field. Since there is only one cursor, you should specify "IC" for only one field. If you specify it for more than one, the last one specified will be the one used.

You don't need the ATTRB parameter. If you omit it, the field will be ASKIP and NORM, with no FSET and no IC specified. If you specify either the protection or the intensity characteristics, however, it will be clearer if you specify both, because the specification of one can change the default for the other.

OCCURS = number

This parameter gives you a way to specify several fields at once, provided they all have the same characteristics and are adjacent. If you specify a field of length 10 at position (4,1) that is ASKIP and NORM with OCCURS = 3, you'll get three fields of length 10, autoskip and normal intensity, at positions (4,1), (4,12), and (4,23). This is an exception to the "one DFHMDF macro for every field" rule we gave you earlier.

Now we can define the fields in our menu map. We'll "do" the fields in order. Although this is no longer required in CICS, it's a good idea for clarity. Figure 30 shows the DFHMDF macros for the menu map.

```
Col     Col    Col                                              Col -->
1       9      16                                                72

*       MENU MAP.
ACCTMNU DFHMDI SIZE=(24,80),CTRL=(PRINT,FREEKB)
        DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=18,                 X
               INITIAL='ACCOUNT FILE: MENU'
        DFHMDF POS=(3,4),ATTRB=(ASKIP,NORM),LENGTH=25,                 X
               INITIAL='TO SEARCH BY NAME, ENTER:'
        DFHMDF POS=(3,63),ATTRB=(ASKIP,NORM),LENGTH=12,                X
               INITIAL='ONLY SURNAME'
```

Figure 30 (Part 1 of 2). The DFHMDF Macros for the Menu Map

```
Col     Col    Col                                       Col -->
1       9      16                                         72

        DFHMDF POS=(4,63),ATTRB=(ASKIP,NORM),LENGTH=16,                 X
               INITIAL='REQUIRED. EITHER'
        DFHMDF POS=(5,7),ATTRB=(ASKIP,BRT),LENGTH=8,                    X
               INITIAL='SURNAME:'
SNAMEM  DFHMDF POS=(5,16),ATTRB=(UNPROT,NORM,IC),LENGTH=12
        DFHMDF POS=(5,29),ATTRB=(PROT,BRT),LENGTH=13,                   X
               INITIAL='  FIRST NAME:'
FNAMEM  DFHMDF POS=(5,43),ATTRB=(UNPROT,NORM),LENGTH=7
        DFHMDF POS=(5,51),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(5,63),ATTRB=(ASKIP,NORM),LENGTH=15,                 X
               INITIAL='MAY BE PARTIAL.'
        DFHMDF POS=(7,4),ATTRB=(ASKIP,NORM),LENGTH=30,                  X
               INITIAL='FOR INDIVIDUAL RECORDS, ENTER:'
        DFHMDF POS=(8,63),ATTRB=(ASKIP,NORM),LENGTH=16,                 X
               INITIAL='PRINTER REQUIRED'
        DFHMDF POS=(9,7),ATTRB=(ASKIP,BRT),LENGTH=13,                   X
               INITIAL='REQUEST TYPE:'
REQM    DFHMDF POS=(9,21),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF POS=(9,23),ATTRB=(ASKIP,BRT),LENGTH=10,                  X
               INITIAL='  ACCOUNT: '
ACCTM   DFHMDF POS=(9,34),ATTRB=(NUM,NORM),LENGTH=5
        DFHMDF POS=(9,40),ATTRB=(ASKIP,BRT),LENGTH=10,                  X
               INITIAL='  PRINTER:'
PRTRM   DFHMDF POS=(9,51),ATTRB=(UNPROT,NORM),LENGTH=4
        DFHMDF POS=(9,56),ATTRB=(ASKIP,NORM),LENGTH=21,                 X
               INITIAL='       ONLY FOR PRINT'
        DFHMDF POS=(10,63),ATTRB=(ASKIP,NORM),LENGTH=9,                 X
               INITIAL='REQUESTS.'
        DFHMDF POS=(11,7),ATTRB=(ASKIP,NORM),LENGTH=53,                 X
               INITIAL='REQUEST TYPES:  D = DISPLAY    A = ADD     X = X
               DELETE'
        DFHMDF POS=(12,23),ATTRB=(ASKIP,NORM),LENGTH=25,                X
               INITIAL='P = PRINT      M = MODIFY'
        DFHMDF POS=(14,4),ATTRB=(ASKIP,NORM),LENGTH=18,                 X
               INITIAL='THEN PRESS "ENTER"'
        DFHMDF POS=(14,35),ATTRB=(ASKIP,NORM),LENGTH=28,                X
               INITIAL='-OR-   PRESS "CLEAR" TO EXIT'
SUMTTLM DFHMDF POS=(16,1),ATTRB=(ASKIP,DRK),LENGTH=79,                  X
               INITIAL='ACCT    SURNAME       FIRST   MI  TTL   ADDRESSX
                                  ST      LIMIT'
SUMLNM  DFHMDF POS=(17,1),ATTRB=(ASKIP,NORM),LENGTH=79,OCCURS=6
MSGM    DFHMDF POS=(24,1),ATTRB=(ASKIP,BRT),LENGTH=60
```

Figure 30 (Part 2 of 2). The DFHMDF Macros for the Menu Map

The DFHMDI Macro: Generate BMS Map Definition

Now that we've sorted out the middle of the map (all the fields) we need to wrap some control information around it. To start any map, you need a different kind of macro:

```
mapname DFHMDI SIZE=(line,column),
               CTRL=(ctrl1,ctrl2,...)
```

The items in this macro are:

mapname
: This is the map's name, which you'll use when you issue a CICS command to read or write the map. It's required. Like a field name, it must start with a letter, contain only letters and numbers, and be no more than seven characters long.

DFHMDI
: This is the macro identifier, also required. It shows that you're starting a new map.

SIZE=(line,column)
: This parameter gives the size of the map. You need it for the type of maps we're using. BMS allows you to build a screen using several maps, and this parameter becomes important when you are doing that. In this Primer, however, we'll keep to the simpler situation where there's only one map per screen. In this case, there's no point in using a size other than the screen capacity (that is, SIZE=(24,80) for a 3276, 3277, 3278, or 3279 Model 2).

CTRL=(ctrl1,ctrl2,...)
: This parameter shows the screen and keyboard control information that you want sent along with a map. You can specify any combination of the following:

  PRINT
  : Specify this for any map that might be sent to a printer terminal.

    Since it costs nothing to add this (and it can cause a lot of grief if you accidentally omit it when you *do* need it), we always try to remember to specify it.

  FREEKB
  : This means "free the keyboard."

    The keyboard locks automatically as soon as the user sends any input to the processor, and it stays locked until some transaction unlocks it, or the user presses the RESET key. So you'll almost always want to specify FREEKB when you send a screen to the terminal, to save the user from having to press RESET before making the next entry.

  ALARM
  : This parameter sounds the audible alarm at the terminal (if the terminal has this feature; otherwise it does nothing). You might want to use this when displaying an error map, for example. We chose not to.

The DFHMDI macro we need to start our menu map, which we'll call "ACCTMNU", is shown in Figure 31:

```
ACCTMNU DFHMDI SIZE=(24,80),CTRL=(PRINT,FREEKB)
```

Figure 31. The DFHMDI Macro for the Menu Map

The DFHMSD Macro: Generate BMS Map Set Definition

You can put several maps together into a **map set** and assemble them all together. In fact, all maps (even a single map) must form a map set. For efficiency reasons, it's a good idea to put related maps that are generally used in the same transactions in the same map set. All the maps in a map set get assembled together, and they're loaded together at execution time as well.

When you've defined all the maps for a set, you put another macro in front of all the others to define the map set. This is the DFHMSD macro:

```
setname DFHMSD TYPE=type,MODE=mode,LANG=COBOL,
               STORAGE=AUTO,TIOAPFX=YES,
               CTRL=(ctrl1,ctrl2,...)
```

The items in this macro have the following meanings:

setname
This is the name of the map set. You'll use it when you issue a CICS command to read or write one of the maps in the set. It's required. Like a field name, it must start with a letter, consist of only letters and numbers, and be no more then seven characters long.

Because this name goes into the PPT, make sure your system programmer (or whoever maintains the CICS tables) knows what the name is, and that neither of you changes it without telling the other. It's the load module name (OS) or phase (DOS).

DFHMSD
This is the macro identifier, also required. It shows that you're starting a map set.

TYPE=type
TYPE governs whether the assembly produces the physical map or the symbolic description (DSECT). As we pointed out in "What BMS Does" on page 109, you do your assembly twice, once with TYPE=MAP specified and once with TYPE=DSECT specified. The TYPE parameter is required.

Alternatively, for DOS, you can specify TYPE=&SYSPARM and specify in the SYSPARM option on assembly whether you want MAP or DSECT. The two jobs differ only in their JCL - there's no change to the map source. See "Symbolic Description Maps (DSECT Structures)" on page 127.

MODE = mode
This shows whether the maps are used only for input (MODE = IN), only for output (MODE = OUT), or for both (MODE = INOUT).

LANG = COBOL
This decides the language of the DSECT structure, for copying into the application program. For the examples in this Primer, the language will always be COBOL. However, you can program in PL/I as well (in which case you would code LANG = PLI), or in assembler (LANG = ASM), or on a DOS system in RPG (LANG = RPG).

STORAGE = AUTO
For a COBOL program, this operand causes the DSECT structures for different maps in a map set *not* to overlay each other. If you omit it, storage for each successive map in a map set redefines that for the first map. If you don't use these maps at the same time, you should omit STORAGE = AUTO to cut down the size of your Working-Storage. However, when several maps are in the same map set, they're most likely to be used at the same time, and then you should specify STORAGE = AUTO. This is the case in the example application, where we use the menu and other maps in the same transaction.

CTRL = (ctrl1,ctrl2,...)
This parameter has the same meaning as in the DFHMDI macro. Control specifications in the DFHMSD macro apply to all the maps in the set; those on the DFHMDI macro apply only to that particular map, so you can use the DFHMDI options to override, temporarily, those of the DFHMSD macro.

TIOAPFX = YES
Always use this parameter in command-level programs, such as the ones we're writing in this Primer. See the paragraph beginning The first 12 characters in the DSECT ("FILLER") on page 129.

Since all the maps in the example application are used together in one transaction or another, we'll put them all into a single map set, and call it "ACCTSET." The DFHMSD macro we need, then, is:

```
ACCTSET DFHMSD TYPE=MAP,MODE=INOUT,LANG=COBOL,
               STORAGE=AUTO,TIOAPFX=YES
```

The only thing now missing from our map definition is the control information to show where the map set ends. This is very simple: It's another macro, DFHMSD TYPE = FINAL, followed by the assembler END statement:

```
         DFHMSD TYPE=FINAL
         END
```

Rules on Macro Formats

When you write assembler language (which is what you **are** doing when using these macros) you have to observe some syntax rules. Here's a simple set of format rules that works. This is *by no means* the only acceptable format.

- Start the map set, map, or field name (if any) in column 1.
- Put the macro name (DFHMDF, DFHMDI, or DFHMSD) in columns 9 through 14 (END goes in 9 through 11).
- Start your parameters in column 16. You can put them in any order you like.
- Separate the parameters by one comma (no spaces), but do not put a comma after the last one.
- If you cannot get everything into 71 columns, stop after the comma that follows the last parameter that fits on the line, and resume in column 16 of the next line.
- The INITIAL parameter is an exception to the rule just stated, because the text portion may be very long. Be sure you can get the word "INITIAL", the equal sign, the first quote mark, and at least one character of text in by column 71. If you can't, start a new line in column 16, as you would with any other parameter. Once you've started the INITIAL parameter, continue across as many lines as you need, using all the columns from 16 to 71. After the last character of your text, put a final quote mark.
- Where you have more than one line for a single macro (because of initial values or any other parameters), put an "X" (or any character except a space) in column 72 of *all lines except the last*. This continuation character is very important. It's easy to forget, but this upsets the assembler.
- Always surround initial values by single quote marks. If you need a single quote *within* your text, use two successive single quotes, and the assembler will know you want just one. Similarly with a single "&" character. For example:

```
        INITIAL='MRS. O''LEARY''S COW && BULL'
```

- If you want to put a comment into your map, use a separate line. Put an asterisk (*) in column 1, and use any part of columns 2 through 71 for your text. Do not go beyond 71.

Map Definitions for the Example

Defining the Account Detail Map

Now that we've all the information we need for building maps, and now that we've done the menu map, let's define the other maps and the map set we need for our example application. Figure 32 shows the map for displaying the detail in an account record. It's used for displaying and printing the record, and for additions, modifications, and deletions. As you can see, the attribute bytes are marked, and we've added line and column numbers as before.

```
              1         2         3         4         5         6         7
Col: 1234567890123456789012345678901234567890123456789012345678901234567890123
Row:
 1   +ACCOUNT FILE:+RECORD DISPLAY
 2
 3   +ACCOUNT NO:+_____      +SURNAME:  +__________________|
 4                           +FIRST:    +____________+   MI:+_+ TITLE:+____|
 5   +TELEPHONE:+__________  +ADDRESS:  +________________________|
 6                                      +________________________|
 7                                      +________________________|
 8   +OTHERS WHO MAY CHARGE:
 9   +________________________________| +________________________________|
10   +________________________________| +________________________________|
11
12   +NO. CARDS ISSUED:+_+    DATE ISSUED:+__+__+__+     REASON:+_|
13   +CARD CODE:+_|          +APPROVED BY:+___|         +SPECIAL CODES:+_+_+_|
14
15   +ACCOUNT STATUS:+__+     CHARGE LIMIT:+_________|
16
17   +HISTORY:   BALANCE      BILLED        AMOUNT       PAID          AMOUNT
18            +_________      __/__/__    ________       __/__/__    ________
19            +_________      __/__/__    ________       __/__/__    ________
20            +_________      __/__/__    ________       __/__/__    ________
21
22   +_______________________ (message area) _____________________
```

Figure 32. The Account Detail Map

Figure 33 shows the map definition for this screen; after the code there are notes on some of the macros.

```
Col     Col    Col                                               Col -->
1       9      16                                                 72

*       DETAIL MAP.
ACCTDTL DFHMDI SIZE=(24,80),CTRL=(FREEKB,PRINT)
        DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=13,                  X
               INITIAL='ACCOUNT FILE: '
TITLED  DFHMDF POS=(1,15),ATTRB=(ASKIP,NORM),LENGTH=14, ** NOTE 1 **    X
               INITIAL='RECORD DISPLAY'                 ** NOTE 2 **
        DFHMDF POS=(3,1),ATTRB=(ASKIP,NORM),LENGTH=11,                  X
               INITIAL='ACCOUNT NO:'
ACCTD   DFHMDF POS=(3,13),ATTRB=(ASKIP,NORM),LENGTH=5
        DFHMDF POS=(3,25),ATTRB=(ASKIP,NORM),LENGTH=9 ,                 X
               INITIAL='SURNAME:  '                     ** NOTE 3 **
SNAMED  DFHMDF POS=(3,36),ATTRB=(UNPROT,NORM,IC),       ** NOTE 4 **    X
               LENGTH=18
        DFHMDF POS=(3,55),ATTRB=(PROT,NORM),LENGTH=1    ** NOTE 5 **
        DFHMDF POS=(4,25),ATTRB=(ASKIP,NORM),LENGTH=10,                 X
               INITIAL='FIRST:    '
FNAMED  DFHMDF POS=(4,36),ATTRB=(UNPROT,NORM),LENGTH=12
        DFHMDF POS=(4,49),ATTRB=(PROT,NORM),LENGTH=6,   ** NOTE 6 **    X
               INITIAL='   MI:'
MID     DFHMDF POS=(4,56),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF POS=(4,58),ATTRB=(ASKIP,NORM),LENGTH=7,                  X
               INITIAL=' TITLE:'
TTLD    DFHMDF POS=(4,66),ATTRB=(UNPROT,NORM),LENGTH=4
        DFHMDF POS=(4,71),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(5,1),ATTRB=(ASKIP,NORM),LENGTH=10,                  X
               INITIAL='TELEPHONE:'
TELD    DFHMDF POS=(5,12),ATTRB=(NUM,NORM),LENGTH=10
        DFHMDF POS=(5,23),ATTRB=(ASKIP,NORM),LENGTH=12,                 X
               INITIAL='  ADDRESS:  '
ADDR1D  DFHMDF POS=(5,36),ATTRB=(UNPROT,NORM),LENGTH=24
        DFHMDF POS=(5,61),ATTRB=(PROT,NORM),LENGTH=1
ADDR2D  DFHMDF POS=(6,36),ATTRB=(UNPROT,NORM),LENGTH=24
        DFHMDF POS=(6,61),ATTRB=(PROT,NORM),LENGTH=1
ADDR3D  DFHMDF POS=(7,36),ATTRB=(UNPROT,NORM),LENGTH=24
        DFHMDF POS=(7,61),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(8,1),ATTRB=(ASKIP,NORM),LENGTH=22,                  X
               INITIAL='OTHERS WHO MAY CHARGE:'
AUTH1D  DFHMDF POS=(9,1),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(9,34),ATTRB=(PROT,NORM),LENGTH=1
AUTH2D  DFHMDF POS=(9,36),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(9,69),ATTRB=(PROT,NORM),LENGTH=1
AUTH3D  DFHMDF POS=(10,1),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(10,34),ATTRB=(PROT,NORM),LENGTH=1
AUTH4D  DFHMDF POS=(10,36),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(10,69),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(12,1),ATTRB=(ASKIP,NORM),LENGTH=17,                 X
               INITIAL='NO. CARDS ISSUED:'
CARDSD  DFHMDF POS=(12,19),ATTRB=(NUM,NORM),LENGTH=1
        DFHMDF POS=(12,21),ATTRB=(ASKIP,NORM),LENGTH=16,                X
               INITIAL='     DATE ISSUED:'
IMOD    DFHMDF POS=(12,38),ATTRB=(UNPROT,NORM),LENGTH=2 ** NOTE 7 **
IDAYD   DFHMDF POS=(12,41),ATTRB=(UNPROT,NORM),LENGTH=2
```

Figure 33 (Part 1 of 2). The Account Detail Map Definition

```
Col     Col     Col                                                     Col -->
1       9       16                                                       72

IYRD    DFHMDF  POS=(12,44),ATTRB=(UNPROT,NORM),LENGTH=2
        DFHMDF  POS=(12,47),ATTRB=(ASKIP,NORM),LENGTH=12,                      X
                INITIAL='      REASON:'
RSND    DFHMDF  POS=(12,60),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF  POS=(12,62),ATTRB=(ASKIP,NORM),LENGTH=1
        DFHMDF  POS=(13,1),ATTRB=(ASKIP,NORM),LENGTH=10,                       X
                INITIAL='CARD CODE:'
CCODED  DFHMDF  POS=(13,12),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF  POS=(13,14),ATTRB=(ASKIP,NORM),LENGTH=1
        DFHMDF  POS=(13,25),ATTRB=(ASKIP,NORM),LENGTH=12,                      X
                INITIAL='APPROVED BY:'
APPRD   DFHMDF  POS=(13,38),ATTRB=(UNPROT,NORM),LENGTH=3
        DFHMDF  POS=(13,42),ATTRB=(ASKIP,NORM),LENGTH=1
        DFHMDF  POS=(13,52),ATTRB=(ASKIP,NORM),LENGTH=14,                      X
                INITIAL='SPECIAL CODES:'
SCODE1D DFHMDF  POS=(13,67),ATTRB=(UNPROT,NORM),LENGTH=1
SCODE2D DFHMDF  POS=(13,69),ATTRB=(UNPROT,NORM),LENGTH=1
SCODE3D DFHMDF  POS=(13,71),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF  POS=(13,73),ATTRB=(ASKIP,NORM),LENGTH=1
STATTLD DFHMDF  POS=(15,1),ATTRB=(ASKIP,NORM),LENGTH=15,                       X
                INITIAL='ACCOUNT STATUS:'
STATD   DFHMDF  POS=(15,17),ATTRB=(ASKIP,NORM),LENGTH=2
LIMTTLD DFHMDF  POS=(15,20),ATTRB=(ASKIP,NORM),LENGTH=18,                      X
                INITIAL='      CHARGE LIMIT:'
LIMITD  DFHMDF  POS=(15,39),ATTRB=(ASKIP,NORM),LENGTH=8
HISTTLD DFHMDF  POS=(17,1),ATTRB=(ASKIP,NORM),LENGTH=71,  ** NOTE 8 **     X
                INITIAL='HISTORY:   BALANCE      BILLED         AMOUNT     X
                    PAID          AMOUNT'                 ** NOTE 9 **
HIST1D  DFHMDF  POS=(18,11),ATTRB=(ASKIP,NORM),LENGTH=61  ** NOTE 10 **
HIST2D  DFHMDF  POS=(19,11),ATTRB=(ASKIP,NORM),LENGTH=61
HIST3D  DFHMDF  POS=(20,11),ATTRB=(ASKIP,NORM),LENGTH=61
MSGD    DFHMDF  POS=(22,1),ATTRB=(ASKIP,BRT),LENGTH=60
VFYD    DFHMDF  POS=(22,62),ATTRB=(ASKIP,NORM),LENGTH=1   ** NOTE 11 **
```

Figure 33 (Part 2 of 2). The Account Detail Map Definition

Notes on the Detail Map

The **** NOTE n **** comments are *not* part of the code.

1. We've put a suffix on each of the labels to tell us which map the field is from; in this map the suffix is D, for detail. We did the same thing in the menu (M) - see Figure 30 on page 113 - and will do so in subsequent maps. Thus the account number is ACCTM in the menu map and ACCTD in the detail map. This is simply for clarity and to avoid having to use COBOL qualifiers to distinguish between fields with the same name. We could just as easily have used a prefix instead of a suffix; neither is a BMS requirement.

2. In this field, we've specified the value for the most common situation: record displays. This initial value is not a constant, as it is in the fields without labels, but a default. The field will be set to a different value by the program for adds, modifies, and other uses of the screen.

Notice that it has a label, so that the program has access to it.

3. Where you have a data field following a constant field, and there are three or fewer space characters between the end of the constant and the attribute byte for the data field, it's a good idea to fill out the constant to meet the data field. This allows BMS to omit the address for the data field (since it is adjacent to the previous field).

   You cut down the length of the transmitted datastream this way, although the definition works perfectly well without this nicety, of course.

   This field could have a length of 8 and an initial value of 'SURNAME:'; the appearance of the map would be exactly the same.

4. This is the first field into which the user is to enter data, under ordinary circumstances, and so we've specified that the cursor should be here. This is a default specification; the program can and often will override it.

5. We've defined this stopper field as protected, rather than autoskip, because the preceding field is of variable length.

   As we said earlier, this choice warns users who try to key too many characters for the field, because the keyboard locks as soon as they get to the protected field.

6. We've combined a stopper field with the label field following it here. Since any field that begins right after the input field can act as a stopper, we've simply lengthened the field following the input field (the label "MI" here) with *leading* spaces, to combine our stopper and label in one field.

   Generally, if there are fewer than four characters between the end of one field and the start of another, and they are constant (unlabeled) fields with the same attributes, it's better to combine them. The resulting data stream is shorter, and there's less BMS code.

7. You don't need a stopper field for an input field if another input field follows immediately.

8. These title fields are supposed to appear on all the displays except the skeleton screen for adding new records. It's easiest to put them in the map, therefore, and simply knock them out (not allow them to appear) for an add operation.

   We'll do this by setting the attribute byte to "nondisplay" in that one case. To enable the program to access the attribute bytes, we have to put labels on the fields.

9. This field is an example of a long INITIAL value parameter, for which two lines are required.

10. These are composite fields. If we wanted, we could define each of the "history" lines on the bottom of the screen as seven different fields, one for each item of data, and we'd do this if data was being entered on this line. However, since it's only being displayed, we don't need the attribute and cursor control that separate fields would provide.

    It's easier to treat these seven items as a composite field, formatting the line within the program. If you look back at Figure 30 on page 113, you'll notice that we used the same technique for the name search output in the menu map.

11. This field is used only for deletions, so the default value for the attribute byte will be autoskip. That way the user won't even be aware of the field when using the map for other transactions. For deletions, the program will change the attribute byte to be unprotected.

Defining the Error Map

Next is the error map, to produce the screen shown in Figure 28 on page 101. Figure 34 shows the error screen map, with row and column numbers added.

```
              1         2         3         4         5         6         7
Col: 1234567890123456789012345678901234567890123456789012345678901234567890123
Row:
 1
 2
 3
 4   +ACCOUNT FILE: ERROR REPORT
 5
 6   +TRANSACTION +____+ HAS FAILED IN PROGRAM +________+  BECAUSE OF
 7
 8   +_________________________________________________
 9
10   __________________________________________________
11
12   +PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORMATION TO THE
13   +OPERATIONS STAFF.
14
15   +THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGER UNDER CONTROL OF
16   +THE "ACCT" APPLICATION.
```

Figure 34. The Error Screen Map

When CICS abends our transaction, the ABEND message appears towards the foot of this screen. It normally appears at the current cursor position, although your system programmer can override this. (See Figure 60 on page 222 for an example.)

Figure 35 shows the macro definition we need to produce this error screen.

```
Col     Col     Col                                                     Col -->
1       9       16                                                       72

*       ERROR MAP.
ACCTERR DFHMDI SIZE=(24,80),CTRL=FREEKB
        DFHMDF POS=(4,1),ATTRB=(ASKIP,NORM),LENGTH=26,                         X
               INITIAL='ACCOUNT FILE: ERROR REPORT'
        DFHMDF POS=(6,1),ATTRB=(ASKIP,NORM),LENGTH=12,                         X
               INITIAL='TRANSACTION '
TRANE   DFHMDF POS=(6,14),ATTRB=(ASKIP,BRT),LENGTH=4
        DFHMDF POS=(6,19),ATTRB=(ASKIP,NORM),LENGTH=23,                        X
               INITIAL=' HAS FAILED IN PROGRAM '
PGME    DFHMDF POS=(6,43),ATTRB=(ASKIP,BRT),LENGTH=8
        DFHMDF POS=(6,52),ATTRB=(ASKIP,NORM),LENGTH=11,                        X
               INITIAL=' BECAUSE OF'
RSNE    DFHMDF POS=(8,1),ATTRB=(ASKIP,BRT),LENGTH=60
FILEE   DFHMDF POS=(10,1),ATTRB=(ASKIP,BRT),LENGTH=22
        DFHMDF POS=(12,1),ATTRB=(ASKIP,NORM),LENGTH=60,                        X
               INITIAL='PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORX
               MATION TO THE'
        DFHMDF POS=(13,1),ATTRB=(ASKIP,NORM),LENGTH=17,                        X
               INITIAL='OPERATIONS STAFF.'
        DFHMDF POS=(15,1),ATTRB=(ASKIP,NORM),LENGTH=64,                        X
               INITIAL='THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGERX
                UNDER CONTROL OF'
        DFHMDF POS=(16,1),ATTRB=(ASKIP,NORM),LENGTH=23,                        X
               INITIAL='THE "ACCT" APPLICATION.'
```

Figure 35. The Error Screen Map Definition

Defining the Message Map

Finally, there's the message map, which has just a single field, in which to send a message to the user.

We need this map in program ACCT03, to confirm (at the input terminal) that a request to print the log of changes to the account file has been processed. In other words, it's for the response to an ACLG (log print) transaction entered by the supervisor. Figure 36 shows the definition:

```
Col     Col     Col                                                     Col -->
1       9       16                                                       72

*       MESSAGE MAP.
ACCTMSG DFHMDI SIZE=(24,80),CTRL=FREEKB
MSG     DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=79
```

Figure 36. The Message Map Definition

After we've executed

```
MOVE 'PRINTING OF LOG HAS BEEN SCHEDULED' TO MSGO.
```

we send this message back to the requesting terminal, confirming that the requested work has been scheduled. Unlike all the other types of requests that make up this application, a request to print the log isn't entered through the menu screen. So it isn't appropriate to use the message area of the menu screen, which is why we need our separate message map to send this message. As you can see, ACCTMSG is simply a one-line map consisting of an area for a message.

The Map Set

If we put together the four maps that we've now defined (the menu map, detail map, error map, and message map), Figure 37 shows the result.

```
ACCTSET DFHMSD TYPE=MAP,MODE=INOUT,LANG=COBOL,
               STORAGE=AUTO,TIOAPFX=YES
*       MENU MAP.
ACCTMNU DFHMDI SIZE=(24,80),CTRL=(PRINT,FREEKB)
        DFHMDF ... (all macros for the menu map)
*
*       DETAIL MAP.
ACCTDTL DFHMDI SIZE=(24,80),CTRL=(FREEKB,PRINT)
        DFHMDF ... (all macros for the detail map)
*
*       ERROR MAP.
ACCTERR DFHMDI SIZE=(24,80),CTRL=FREEKB
        DFHMDF ... (all macros for the error map)
*
*       MESSAGE MAP.
ACCTMSG DFHMDI SIZE=(24,80),CTRL=FREEKB
MSG     DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=79
        DFHMSD TYPE=FINAL
        END
```

Figure 37. All Four Maps

Summary

Item	Comments
fldname	Use only on fields your program will access
mapname	1-7 characters, starting alpha, no special characters
setname	As mapname. Co-ordinate setname with the PPT entry
POS	Gives position of attribute byte, not first data character
LENGTH	Does not include attribute byte.

Optional Exercise

For those of you with a terminal, the CICS COBOL sample programs, and a running CICS system.

You can use the CICS command interpreter CECI (not covered in this Primer) to see what a map looks like on the screen:

```
CECI SEND MAP ('XDFHCMA') MAPONLY
```

This will display the operator instructions menu that is supplied with CICS Version 1 Release 6 as part of its own sample transaction set. (You'll find the same map in the COBOL sample programs appendix of the APRM.) Don't worry about trying to decipher the map now, though - wait until you've read the next chapter.

Alternatively, you can get a rough idea of how the application behaves by skimming through the EDF screens shown in "A Session With EDF" on page 219.

Chapter 3-3. Using BMS: More Detail

Symbolic Description Maps (DSECT Structures)

As we said earlier, assembling the macros with TYPE=MAP specified in the DFHMSD macro produces the physical map that CICS uses at execution time. After you've done this assembly, you do it all over again, this time specifying TYPE=DSECT. This second assembly produces the **symbolic description map**, a COBOL structure that you copy into your program. It's stored in the copybook library specified in the JCL, and its name in that library is the map set name specified in the DFHMSD macro.

This structure is a set of data definitions for all the display fields on the screen, plus information about those fields. It allows your program to refer to these display data fields by name and to manipulate the way in which they are displayed, without worrying about their size or position on the screen.

Copying the Map DSECT into a Program

To copy the DSECT structures for the maps in a map set into a program, you write a COPY statement like this:

```
                    COPY setname.
```

Here, setname is the name of the map set. This COPY statement usually appears in Working-Storage, although later you may find reasons to put it in the Linkage Section. We'll cover only the Working-Storage situation. To get the symbolic descriptions for our maps in a program, we'll write:

```
                    COPY ACCTSET.
```

Figure 38 shows you the first few lines of what is copied into your program as a result of this COPY statement. The part shown is generated by the first map in the set, the menu map. It's followed by similar structures for the other maps. We've not shown all of them here because they're very long and very similar in form. They're all in "The Result of the SYSPARM=DSECT Assembly" on page 280.

```
01  ACCTMNUI.
    02  FILLER                  PIC X(12).
    02  SNAMEML                 PIC S9(4) COMP.
    02  SNAMEMF                 PIC X.
    02  FILLER REDEFINES SNAMEMF.
        03  SNAMEMA             PIC X.
    02  SNAMEMI                 PIC X(12).
    02  FNAMEML                 PIC S9(4) COMP.
    02  FNAMEMF                 PIC X.
    02  FILLER REDEFINES FNAMEMF.
        03  FNAMEMA             PIC X.
    02  FNAMEMI                 PIC X(7).
    02  REQML                   PIC S9(4) COMP.
    02  REQMF                   PIC X.
    02  FILLER REDEFINES REQMF.
        03  REQMA               PIC X.
    02  REQMI                   PIC X.
    02  ACCTML                  PIC S9(4) COMP.
    02  ACCTMF                  PIC X.
    02  FILLER REDEFINES ACCTMF.
        03  ACCTMA              PIC X.
    02  ACCTMI                  PIC X(5).
    02  PRTRML                  PIC S9(4) COMP.
    02  PRTRMF                  PIC X.
    02  FILLER REDEFINES PRTRMF.
        .
        .
        .
```

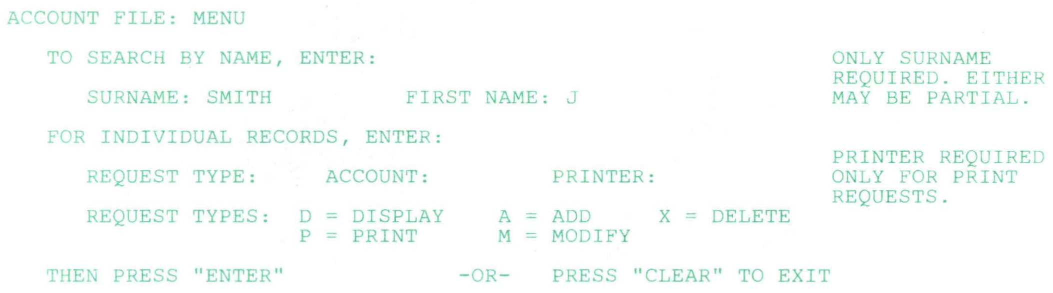
Figure 38. Copying the Menu Map into Your Program

Because we asked for a map to be used for both input and output (by coding MODE=INOUT in the DFHMSD macro), the resulting structure has two parts. The first part corresponds to the input screen, and is always labelled (at the 01 level) with the map name, suffixed by the letter I (for "input"). The second part corresponds to the output screen, and is labeled with the map name followed by the letter O. The output map always redefines the input map. If we'd specified MODE=IN, only the input part would have been generated, and similarly, MODE=OUT would've produced only the output part.

The Generated Subfields

We gave names to eight field definitions in the menu map: SNAMEM, FNAMEM, REQM, ACCTM, PRTRM, SUMTTLM, SUMLNM and MSGM. (One of these, SUMLNM, has an "OCCURS" clause causing it to define six different fields, but we'll get to that shortly.) Notice that for each of these map fields, five data subfields are generated. Each subfield has a name consisting of the field name in the map and a one-letter suffix. (We're using "subfields" to distinguish them from the single "map" field from which they originate.)

We can explain the contents of the subfields better by using a specific set of data. Suppose someone has filled in the menu screen, as shown in Figure 39 on page 129:



```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                                  ONLY SURNAME
                                                                              REQUIRED. EITHER
      SURNAME: SMITH            FIRST NAME: J                                 MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                              PRINTER REQUIRED
      REQUEST TYPE:     ACCOUNT:           PRINTER:                           ONLY FOR PRINT
                                                                              REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD      X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"             -OR-    PRESS "CLEAR" TO EXIT
```

Figure 39. The Menu Screen at Work

Ultimately, BMS puts the user's data into our program's Working-Storage, along with some control information. Look at Figure 38 as you study what follows.

The first 12 characters in the DSECT ("FILLER") are there because we said TIOAPFX=YES when we defined the map set. They're reserved for CICS control information, and are of no concern to the application program.

The first suffix is L, which stands for "length." SNAMEML is the number of characters that the user keyed into the SNAMEM field (or, if the program put some data there and turned on the modified data tag, the length of that data). In the example shown above, SNAMEML will be 5 (the length of "SMITH"), FNAMEML will be 1, and REQML, ACCTML and all the others will be zero.

The second suffix is F (meaning "flag"), and this subfield tells you whether or not the user changed the corresponding field on the screen *by erasing it* (setting it to nulls with the ERASE EOF key). Such a subfield of course always has a length (L subfield) of zero; the flag allows you to tell whether it was written on the screen that way or whether the user erased something that was there. A flag value of hex 80 indicates that the field was changed by erasing; otherwise the flag value is hex 00 (nulls, or "LOW-VALUE" in COBOL). In the filled-in menu screen, all the flag fields will contain hex 00, because there was no field sent which could be erased.

Pressing ERASE EOF causes the flag to be set *even if the field was empty to start with*, and whether or not you type in some data before changing your mind and erasing the field.

The flag value becomes important in connection with modifications, as we'll see later.

The other suffix is I, for "input." This is the actual content of the field on the screen, provided that the modified data tag is on for the field. The tag will be on if the user changed the field or if it was sent with the FSET attribute specified. If the tag isn't on, the program doesn't read what's on the screen, and the I subfield will contain nulls.

The I subfield is defined as a character string of the length you specify in the map. Because the SNAMEM field in the menu map has a length of 12, the SNAMEMI subfield is given a PICTURE value of "X(12)" in the symbolic map description. (BMS provides a parameter called "PICIN" that you can use in the DFHMDF macro for a field that changes the picture generated, however, if you wish to do so.)

If the user doesn't fill in the whole field, as in the case of the two name fields here, BMS pads out the field to its maximum length. If a field has the NUM attribute, it's filled on the left with leading (decimal) zeros; otherwise it's filled on the right with spaces. In this screen, then, SNAMEMI would equal "SMITH   ", and FNAMEMI would be "J   " - the unkeyed part of each field being filled with spaces.

The remaining two data fields for a map field concern output rather than input, even though one of them appears in the "input" part of an INOUT map. This is the one suffixed by A (for "attribute"). When you're sending a map, and you want a field to have a different set of attributes than you specified in the map, you can override the map specification by setting this field. For example, suppose the user had typed SM1TH instead of SMITH. We'd want to bounce the menu screen straight back to the user with the surname field highlighted, to show our displeasure at finding the numeric character "1" there. To do so, we'd simply need to move the character that represented the attributes we wanted to SNAMEMA.

The character we need to do this is the one actually used in the 3270 output data stream. These character representations are quite hard to remember, so CICS provides you with a library member containing most of the useful combinations, defined with meaningful names. To get access to it, you simply put the statement:

```
                    COPY DFHBMSCA
```

in your Working-Storage. This generates a list of definitions like the one shown in Figure 40 on page 131:

```
01  DFHBMSCA.
    02  DFHBMPEM     PICTURE X    VALUE IS ' '.
    02  DFHBMPNL     PICTURE X    VALUE IS ' '.
    02  DFHBMASK     PICTURE X    VALUE IS '0'.
    02  DFHBMUNP     PICTURE X    VALUE IS ' '.
    02  DFHBMUNN     PICTURE X    VALUE IS '&'.
    02  DFHBMPRO     PICTURE X    VALUE IS '-'.
    02  DFHBMBRY     PICTURE X    VALUE IS 'H'.
    02  DFHBMDAR     PICTURE X    VALUE IS '<'.
    02  DFHBMFSE     PICTURE X    VALUE IS 'A'.
    02  DFHBMPRF     PICTURE X    VALUE IS '/'.
        . . .
```

Figure 40. Attribute Values for the IBM 3270 Data Stream

The values which appear to be spaces are not; they are bit combinations that do not represent a printed character, although they are all valid EBCDIC characters. The definitions generated (that apply to this Primer) are shown in Figure 41.

VARIABLE	PROTECTION	INTENSITY	MODIFIED DATA TAG
DFHBMUNP	Unprotected	Normal	Off
DFHBMUNN	Numeric	Normal	Off
DFHBMPRO	Protected	Normal	Off
DFHBMASK	Autoskip	Normal	Off
DFHBMBRY	Unprotected	Bright	Off
DFHPROTI	Protected	Bright	Off
DFHBMASB	Autoskip	Bright	Off
DFHBMDAR	Unprotected	Non-display	Off
DFHPROTN	Protected	Non-display	Off
DFHBMFSE	Unprotected	Normal	On
DFHUNNUM	Numeric	Normal	On
DFHBMPRF	Protected	Normal	On
DFHBMASF	Autoskip	Normal	On
DFHUNIMD	Unprotected	Bright	On
DFHUNINT	Numeric	Bright	On
DFHUNNOD	Unprotected	Non-display	On
DFHUNNON	Numeric	Non-display	On

Figure 41. Attribute Values Used in this Primer

Referring back to our example, to highlight the surname we:

```
MOVE DFHBMBRY TO SNAMEMA
```

before sending the map back to the terminal. We're using DFHBMBRY, rather than one of the other "bright" variables because, unlike some other high-intensity values, DFHBMBRY leaves the field unprotected, so the user will be able to rekey the name properly. It also sets the modified data tag off (a choice we'll discuss later).

The last of the five data subfields for a map field is named with a suffix of O (for "output"). It's the data that you want displayed in the map field when you send it. Like the input subfield, the output subfield defaults to a character string of the length specified in the map; you can specify some other PICTURE by using the PICOUT parameter in the DFHMDF macro that defines the field. PICOUT and PICIN are both described with the DFHMDF macro in the APRM.

Fields Defined With the OCCURS= Parameter

The only field on the screen that has generated a slightly different structure from what we've just described is the SUMLNM field, and this is because we've said it OCCURS six times.

Have another look at the DSECT. This time, you'll need to look at the full version, starting on page 280 in Appendix A.

For the SUMLNM field there's another level to the COBOL structure, a group named SUMLNMD, with an OCCURS value of 6. This group contains the SUMLNML, SUMLNMF, and SUMLNMI fields, which represent the length, flag value, and input for SUMLNM, just as you'd expect. The attribute field appears in the output section, where an extra group level is also introduced. This one's called "DFHMS1" (an arbitrarily generated name); it, too, OCCURS six times and contains the SUMLNMA and SUMLNMO fields. So you refer to the attribute value of the fourth occurrence of this field as "SUMLNMA(4)", the input for the second occurrence as "SUMLNMI(2)", and so on.

Some Things to Keep in Mind About These DSECTs

- Because of the way the input and output parts of the map structure overlay each other, the "-I" and the "-O" subfields for a given map field always redefine each other. That is, SNAMEMI and SNAMEMO occupy the same storage, FNAMEMI and FNAMEMO do also, and so on. This turns out to be convenient in coding.

- The attribute and flag subfields occupy the same space (REQMF overlays REQMA, ACCTMF overlays ACCTMA, and so on). You don't have to worry about removing these flags when you're sending output, however. Since the two input flag values (hex 80 and hex 00) don't represent acceptable output attribute byte values, BMS can distinguish on output between a leftover flag and a new attribute.

- When you write a map, you don't have to put anything in the length field. BMS knows how long the field is from the information in the physical map. The only time you use the length field for an output field is to set the cursor position, a matter we'll explain shortly.

Sending a Map to a Terminal

Now that we've defined our maps, we can think about writing them to the terminal.

The terminal to which we'll write, of course, is the one that sent the input and thereby invoked the transaction. This is the only terminal to which a transaction can write directly, as mentioned in "Transactions and Terminals" on page 92.

The SEND MAP Command

The SEND MAP command writes formatted output to a terminal. It looks like this:

```
EXEC CICS SEND MAP(mapname) MAPSET(setname)
    option option ... END-EXEC
```

mapname
is the name of the map you want to send. It's required. Put it in quotes if it's a literal.

setname
is the name of the map set that contains the mapname. Put the name in quotes if it's a literal. The map set name is needed unless it's the same as the map name. Code it for documentation purposes, anyway.

option
There are a number of options that you can specify; they affect what's sent and how it is sent. Except where noted, you can use any combination of them. The possibilities are:

MAPONLY
means that no data from your program is to be merged into the map; only the information in the map is transmitted. In our example application, we'll use this option when we send the menu map the first time, because we'll have no information to put into it.

DATAONLY
is the logical opposite of MAPONLY. You use it to modify the variable data in a display that's already been created. Only the data from your program is sent to the screen. The constants in the map aren't sent; so you can use this option only *after* you've sent the same map without using the DATAONLY option. We'll see an example when we send the results of a name search to the terminal in program ACCT01.

ERASE

causes the entire screen to be erased before what you're sending is shown.

ERASEAUP

(erase all unprotected fields) in contrast to ERASE, causes just the unprotected fields on the screen (those with either the UNPROT or NUM attribute) to be erased before your output is placed on the screen. It's most often used in preparing to read new data from a map that's already on the screen. Don't use it at the same time as ERASE; ERASE makes ERASEAUP meaningless.

FRSET

(flag reset) turns off the modified data tag in the attribute bytes for all the fields on the screen before what you're sending is placed there. (Once set on, whether by the user or the program, a modified data tag stays on until turned off explicitly, even over several transmissions of the screen. It can be turned off by the program sending a new attribute byte, an FRSET option, or an ERASE, or an ERASEAUP, or by the user pressing the CLEAR key.) Like ERASEAUP, the FRSET option is most often used in preparing to read new data from a map already on the screen. It can also reduce the amount of data re-sent on an error cycle, as we'll explain in coding our example.

CURSOR

can be used in two ways to position the cursor. If you specify a value after CURSOR, it's the relative position on the screen where the cursor is to be put. Express this position as a single number, such as CURSOR(81) for line 2, column 2 (counting starts at zero and goes across the lines, which on an IBM 3270-system display Model 2 are 80 characters wide). Why column 2? Because the attribute byte goes in column 1, and we want the cursor to appear under the first character of data.

Some people prefer to put the attribute at the end of the previous line (for example, POS=(1,80)) to let the data in the field start in screen column 1.

Alternatively, you can specify CURSOR without a value, and use the length subfields in the output map to show which field is to get the cursor. See "Positioning the Cursor" on page 138. In general we recommend you to position the cursor in this second manner, rather than the first, so that changes in the map layout don't lead to changes in the program. Both kinds of CURSOR specification override the cursor placement specified in the map.

ALARM
means the same thing in the SEND command as it does in the DFHMSD and DFHMDI macros for the map: it causes the audible alarm to be sounded. The alarm will sound if you specify ALARM in either the map definition or the SEND command.

FREEKB
likewise means the same thing as it does in the map definition: the keyboard is unlocked if you specify FREEKB in either the map or the SEND command.

PRINT
allows the output of a SEND command to be printed on a printer, just as it does in the map definition. It is in force if specified in either the map or the command.

FORMFEED
causes the printer to restore the paper to the top of the next page before the output is printed. This specification has no effect on maps sent to a display, to printers without the features which allow sensing the top of the form, or to printers for which the "formfeed" feature is not specified in the CICS Terminal Control Table.

Using SEND MAP in the Example Program

The first time we need to send a map to a terminal occurs in program ACCT00, where we display the menu screen. The command we need is:

```
EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET')
     ERASE MAPONLY END-EXEC.
```

This is a very simple situation. Because we don't have any variable data to put in the map, we can use the MAPONLY option, and we don't have to worry about preparing variable data for merging with the physical map.

If we were sending some data to the screen with the map, we could not use MAPONLY, and CICS would expect the data to be used for filling in the map to be in a structure whose name is the map name (as specified in the MAP option) suffixed with the letter O. So, when we issue the command:

```
EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET')
     END-EXEC.
```

CICS expects the data for the map to be in a structure within the program (of exactly the sort generated by the DSECT assembly) named "ACCTMNUO." This structure is usually in your Working-Storage Section, but it might be in a Linkage area instead. (There's an option on the SEND MAP command that lets you specify a data structure other than the one assumed by CICS. We won't cover it here, but you can read about it in the APRM under "Sending Data to a Display.")

Let's look at the more common situation in which we're merging program data into the map. In program ACCT01, we're supposed to build a detail display map for one record and send it to the screen. Since the contents of the screen vary somewhat with the type of request, and we're using the same screen for all types, this will entail the following:

1. Putting the appropriate title on the map (add, modify, or whatever it happens to be).

2. Moving the data from the file record to the symbolic map (except for adds).

3. Adjusting the attribute bytes. The input fields must be protected in a display or delete operation; the "verify" field must be unprotected for deletes, and the titles at the bottom of the screen must be made nondisplay for adds.

4. Putting the appropriate user instructions (about what to do next) into the message area.

5. Putting the cursor in the right place.

Figure 42 shows how the necessary code might look. Here are some explanatory notes.

REQC (request code) was moved to a working-storage field earlier in the program. It holds the user's "request code."

What is happening in this code is as follows:

- If the user request is to delete a record

  ```
  (IF REQC = 'X'):
  ```

  1. The map title is changed from its default to DELETION
  2. The cursor is placed under the "verify" field

     ```
     (MOVE -1 TO VFYDL)
     ```

     by a technique we'll explain shortly
  3. The attribute byte for that field is changed from its map default of autoskip to unprotected
  4. Instructions for what to do next are put in the message area.

```
Col Col
8   12

BUILD-MAP.
    IF REQC = 'X' MOVE 'DELETION' TO TITLEDO,
      MOVE -1 TO VFYDL, MOVE DFHBMUNP TO VFYDA,
      MOVE 'ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL'
        TO MSGDO,
    ELSE MOVE -1 TO SNAMEDL.
    IF REQC = 'A' MOVE 'NEW RECORD' TO TITLEDO,
      MOVE DFHPROTN TO STATTLDA, LIMTTLDA, HISTTLDA,
      MOVE ACCTC TO ACCTDI,
      MOVE 'FILL IN AND PRESS "ENTER," OR "CLEAR"
        TO CANCEL' TO MSGDO,
      GO TO SEND-DETAIL.
    IF REQC = 'M' MOVE 'RECORD CHANGE' TO TITLEDO,
      MOVE 'MAKE CHANGES AND "ENTER" OR "CLEAR"
        TO CANCEL' TO MSGDO,
    ELSE IF REQC = 'D',
      MOVE 'PRESS "CLEAR" OR "ENTER" WHEN FINISHED'
         TO MSGDO.
      MOVE CORRESPONDING ACCTREC TO ACCTDTLO.
      MOVE CORRESPONDING PAY-HIST (1) TO PAY-LINE.
      MOVE PAY-LINE TO HIST1DO.
      MOVE CORRESPONDING PAY-HIST (2) TO PAY-LINE.
      MOVE PAY-LINE TO HIST2DO.
      MOVE CORRESPONDING PAY-HIST (3) TO PAY-LINE.
      MOVE PAY-LINE TO HIST3DO.
    IF REQC = 'M' GO TO SEND-DETAIL,
    ELSE IF REQC = 'P' GO TO PRINT-PROC.
      MOVE DFHBMASK TO
       SNAMEDA, FNAMEDA, MIDA, TTLDA, TELDA, ADDR1DA,
       ADDR2DA, ADDR3DA, AUTH1DA, AUTH2DA, AUTH3DA,
       AUTH4DA, CARDSDA, IMODA, IDAYDA, IYRDA, RSNDA,
       CCODEDA, APPRDA, SCODE1DA, SCODE2DA, SCODE3DA.
SEND-DETAIL.
    EXEC CICS SEND MAP('ACCTDTL') MAPSET('ACCTSET')
           ERASE FREEKB CURSOR END-EXEC.
```

Figure 42. Building the Detail Display Map

- The cursor is placed under the surname field for all other types of user requests

  `(ELSE MOVE -1 to SNAMEDL).`

- If the request is for an addition:

  1. The title is made NEW RECORD
  2. The titles at the bottom of the screen are given a non-display attribute
  3. The account field (from the request input) is placed in the output map
  4. Instructions are put into the message area.

- If the request is a modification, the title and the message area are set appropriately.

- If the request is a display, instructions for what to do after the display are put in the message area.
- For all types of requests except adds, the display is built from the record on file (`MOVE CORRESPONDING ACCTREC ...` through ... `MOVE PAY-LINE TO HIST3DO`).
- If the request is to print a record, control goes to code at "PRINT-PROC" that will do the special processing required to write to a terminal other than the input terminal.
- If the request is to display or delete, the attribute bytes of all the data fields that can be entered or changed on an addition or a modification are changed to autoskip. This makes it clear to users that they cannot change these fields in the current transaction.
- For all request types except printing, the map is sent to the input terminal.

We need to use a somewhat different type of SEND MAP command later in the same program, when we have to redisplay the input (menu) map because of some error, or to put a message on the screen. Since the map is already on the screen, it is unnecessary (and wasteful of line capacity) to send what is already there again. So we use the DATAONLY option, and we do not erase the screen:

```
EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET')
    DATAONLY CURSOR FRSET FREEKB END-EXEC.
```

We also specify FRSET in this command. This prevents fields that were entered during the previous terminal interaction, and not rekeyed, from being sent on the next transmission. That is, only fields which the user changes (probably because of an error) will be transmitted the next time the terminal sends. This reduces line transmission, but it requires the transaction to save the input from the previous execution for the next one. We'll give you some more information about how to use FRSET in the notes that accompany the program source code in "Part 4. The COBOL Code of our Example Application," which is printed separately.

Positioning the Cursor

We said earlier how important for productivity it was to put the cursor where the user will want to start entering data on the screen. In the first SEND MAP example, we relied on the cursor position specified in the map definition. This puts the cursor under the first data position of the surname field, which is where we want it. In the second and third examples, however, we don't necessarily want the cursor where the map definition puts it. In the second example, where we're using the detail map, we want to use the map default (the SNAMED field) for adds and modifies. For display operations, it doesn't much matter, since there are no fields into which the user may key. For deletes, however, the cursor should be under the verify (VFY) field. In the third example, we want the cursor under the first field where the user entered incorrect information.

As we explained earlier, there are two ways to override the position specified by the IC specification in the map definition:

1. You can specify a screen position, relative to line 1, column 1 (that is, position 0) in the CURSOR option on the SEND MAP command (the procedure we advised against earlier).

2. You can show that you want the cursor placed under a particular field by setting the associated length subfield to minus one (-1) and specifying CURSOR without a value in your SEND MAP command. This causes BMS to place the cursor under the first data position of the field with this length value. If several fields are flagged by this special length subfield value, the cursor is placed under the first one (as opposed to the last one with ATTRB=IC).

The second procedure is called **symbolic cursor positioning**, and is a very handy method of positioning the cursor for, say, the correction of errors. As the program checks the input, it sets the length subfield to -1 for every field found to be in error. Then, when the map is redisplayed for corrections, BMS automatically places the cursor under the first field that the user will have to correct.

In order to place the cursor under the verify field on a delete, therefore, all we have to do is:

```
MOVE -1 TO VFYDL
```

and specify CURSOR in our SEND MAP command.

Sending Control Information Without Data

The SEND CONTROL Command

In addition to the SEND MAP command, there is another terminal output command called SEND CONTROL. It allows you to send control information to the terminal without sending any data. That is, you can open the keyboard, erase all the unprotected fields, and so on, without sending a map. It looks like this:

```
EXEC CICS SEND CONTROL option option  ...  END-EXEC
```

The options you can use are the same as on a SEND MAP command: ERASE, ERASEAUP, FRSET, ALARM, FREEKB, CURSOR, PRINT, and FORMFEED.

An example of this command occurs in program ACCT01. The terminal user has just cleared the screen (of the menu map) to indicate that he or she wants to exit from the control of the online account application. The program is supposed to open the keyboard before returning control to CICS.

Normally, you would do this when writing a message to the terminal. But since we're not doing that at this point, we must unlock the keyboard by an explicit command, instead. The command is:

```
EXEC CICS SEND CONTROL FREEKB END-EXEC
```

If we didn't know the user had just cleared the screen, we'd probably want to add the ERASE option to the command above, so that the user would be all ready to start a new transaction.

Receiving Input from a Terminal

The RECEIVE MAP Command

When you want to receive input from a terminal, you use the RECEIVE MAP command, which looks like this:

```
EXEC CICS RECEIVE MAP(mapname) MAPSET(setname)
          END-EXEC
```

The MAP and MAPSET parameters have exactly the same meaning as for the SEND MAP command. MAP is required and so is MAPSET, unless it is the same as the map name. Again, it does no harm to include it for documentation purposes.

We're showing you a form of the RECEIVE MAP command that does not specify where the input data is to be placed. This causes CICS to bring the data into a structure whose name is the map name suffixed with the letter I, which is assumed to be in either your Working-Storage or Linkage Section.

For example, program ACCT02 requires that we receive the filled-in detail map. The command to do this:

```
EXEC CICS RECEIVE MAP('ACCTDTL') MAPSET('ACCTSET')
          END-EXEC
```

will bring the input data into a data area named ACCTDTLI, which is expected to have exactly the format produced by the DSECT for map ACCTDTL.

As soon as the map is read in, we have access to all the data subfields associated with the map fields. For example, we can test whether the user made any entry in the request field of the menu map:

```
IF REQML > 0, MOVE ...
```

Or we could examine the input in that field:

```
IF REQMI = 'A' GO TO ...
```

Note: Although it generally will not affect your program logic, you should be aware that the first time in a transaction that you use the RECEIVE MAP command, it has a slightly different effect from subsequent times. Since it is input from the terminal that causes a transaction to get started in the first place, CICS has always read the first input by the time the transaction starts to execute. Therefore, on this first RECEIVE MAP command, CICS simply arranges the input it already has into the format dictated by your map, and puts the results in a place accessible to your program.

On subsequent RECEIVE MAP commands in the same task, CICS actually waits for and reads input from the terminal. These subsequent RECEIVE MAPs are what make a task conversational. By contrast, a pseudoconversational task executes at most one RECEIVE MAP command.

Finding Out What Key the Operator Pressed

There is another technique you may wish to use for processing input from a terminal. As we pointed out in "3270 Input Data Stream" on page 28, the 3270 input stream contains an indication of what **attention** key caused the input to be transmitted (ENTER, CLEAR, or one of the PA or PF keys).

There are two ways to cause your program to change the flow of control in your program based on which of these attention keys was used. One way is to use the HANDLE AID command; the other is to use the EIBAID field. AID stands for attention identifier.)

The HANDLE AID Command

The HANDLE AID command looks like this:

```
EXEC CICS HANDLE AID ENTER(label1) CLEAR(label2)
          PA1(label3) ... PF1(label4) ...
          ... ANYKEY(label5) END-EXEC
```

Your program can issue this command at any time before it issues the RECEIVE MAP command. It does not affect the flow of control in the program until the program actually issues the command to get its input.

At that time, CICS does the work required by the RECEIVE MAP, which may be an actual read operation, or just formatting according to the map specified. Before returning control to your program, CICS checks to see if a HANDLE AID command has been issued. If so, it looks at the key that caused the input to be sent (the **attention identifier** (AID) in 3270 parlance). If you've named that key in your HANDLE AID command, then control will go to the label specified for that key instead of to the instruction after the RECEIVE MAP, as it normally would. And if you name that key *without* a label, it will no longer be handled. You can name the ENTER key, the CLEAR key, a program access key (PA1, PA2 or PA3), or any of the program function keys (PF1 through PF24). Note that not all terminals have 24 program function keys; although you could specify a label for one of the missing keys, control would never go there from such a terminal.

In addition to naming specific keys, you can indicate a label where control should go if the key used was *not* one of those mentioned in the most recent HANDLE AID command. For example:

```
EXEC CICS HANDLE AID ENTER(ENTERLBL) PF3(PF3LBL)
    ANYKEY(OTHERLBL) END-EXEC
```

would send control to ENTERLBL if the ENTER key were used, to PF3LBL if the PF3 key were used, and to OTHERLBL if CLEAR or a PA key or one of the other PF keys were used.

These branches remain in force for all subsequent RECEIVE MAP commands until you change the branch for a key (by issuing another HANDLE AID with a different label for that key) or disable the branch. You disable a branch by issuing a HANDLE AID naming the key without a label. That is, if we issued the command:

```
    EXEC CICS HANDLE AID PF3 END-EXEC
```

after the first HANDLE AID shown above, then control on the next RECEIVE MAP command would go to "ENTERLBL" if the ENTER key were used. If any other key, except PF3, were used, control would go to "OTHERLBL." And if PF3 were used, control would "drop through" to the next instruction.

The EXEC Interface Block (EIB)

Before we explain the other way to find out what key was used to send the input, we need to introduce one CICS control block. This is the EIB, which stands for EXEC Interface Block, and it is the only one that you need to know anything about for the type of applications described in this Primer.

You can write programs without using even this one, but it contains information that can be very useful and is worth knowing about.

There is one EIB for each task, and it exists for the duration of the task. Every program that executes as part of the task has access to the same EIB. You can address the fields in it directly in your COBOL program, without any preliminaries. You should only read these fields, however, not try to modify them. All of the EIB fields are discussed in detail in the APRM, but the ones that apply to the commands and options in this Primer are:

EIBAID
The attention identifier (AID), which tells you which keyboard key was used to transmit the last input. This field is one byte long ("PIC X(1)"). It is encoded as shown in "AID Byte Definitions" on page 145.

EIBCALEN
The length of the communication area (COMMAREA) that has been passed *to* this program, either from a program that invoked it using a CICS command (LINK or XCTL - see "Commands for Passing Program Control" on page 176), or from a previous transaction in a pseudoconversational sequence. It is in halfword binary form ("PIC S9(4) COMP"). See "Chapter 3-6. Program Control"

on page 175 and "Chapter 3-5. Saving Data and Communicating Between Transactions" on page 165 for more information on COMMAREA.

EIBCPOSN
The position of the cursor at the time of the last input command, for 3270-like devices only. This position is expressed as a single number relative to position zero on the screen (row 1, column 1), in the same way that you specify the CURSOR parameter on a SEND MAP command. It's also in halfword binary form ("PIC S9(4) COMP").

After a RECEIVE MAP command, your program can find the inbound cursor position by inspecting the value held in EIBCPOSN.

EIBDATE
The date on which the current task started, in Julian form, with two leading zeros. The COBOL "PICTURE" for the field is "S9(7) COMP-3", and the format is: "00YYDDD+".

EIBDS
The name of the last data set used in a file command (for example, read a record, write a record). This field is eight characters long ("PIC X(8)") and is the value in the "DATASET" parameter of the most recent file command.

EIBFN
A code indicating the last command that was issued by the task, in "PIC X(2)" form. The first byte of this two-byte field indicates the type of command. File commands have a code of hex 06, BMS commands are 18, and so on. The second byte tells which particular command: 0602 means READ, 0604 means WRITE, and so on. A full list of the codes appears in the APRM, and the subset that applies to the command and option combinations in this Primer also appears in "Chapter 4-5. Program ACCT04: Error Processing" of the COBOL Source Code book that accompanies this Primer. The codes involved appear in the table HEX-LIST (line 23) and are accessed by the routine CODE-LOOKUP (line 128).

EIBRCODE
The response code resulting from executing the last command. This is a six-byte field ("PIC X(6)"), but for the command types covered in this Primer, you need concern yourself only with the first byte. The HEX-LIST table we mentioned above also contains a list of all the codes that can result from our subset of commands and options. The APRM contains a full list of the possibilities.

EIBRSRCE
The name of the resource used in the most recent command that used such a resource. For file commands, this value is the DATASET parameter, so that EIBRSRCE has the same value as EIBDS after such a command. For temporary storage commands, it is the name of the queue (the QUEUE parameter), and for BMS commands it is the name of the terminal (the four-character name of the

input terminal, or EIBTRMID in the context of this Primer). Eight characters are provided for this information ("PIC X(8)"), although some names, like those of terminals, fill only the first four positions.

EIBTASKN
The task number, as a seven-digit packed decimal number ("PIC S9(7) COMP-3"). CICS assigns a sequential number to each task it executes, and this number is used to identify entries for the task in the Trace Table (see "Transaction Dumps" on page 244).

EIBTIME
The time at which the current task started, also in "PIC S9(7) COMP-3" form, with one leading zero: "0HHMMSS+".

EIBTRMID
The name of the terminal associated with the task (the input terminal, usually, or sometimes a printer, as in our AC03 and AC05 transaction types). This name is four characters long, and the COBOL "PICTURE" is "X(4)".

EIBTRNID
The transaction identifier of the current task, four characters long ("PIC X(4)").

AID Byte Definitions

Getting back to the attention identifier, we can also tell what key was used to send the input by looking at the EIBAID field, as noted above.

When a transaction is started, EIBAID is set according to the key used to send the input that caused the transaction to get started. It retains this value through the first RECEIVE command, which only formats the input already read, until after a subsequent RECEIVE, at which time it is set to the value used to send that input from the terminal.

EIBAID is one byte long and holds the actual attention identifier value used in the 3270 input stream. As it is hard to remember these values and hard to understand code containing them, it is a good idea to use symbolic rather than absolute values when testing EIBAID. CICS provides you with a precoded set which you simply copy into your program by writing:

```
                    COPY DFHAID
```

somewhere in your Working-Storage Section. Figure 43 on page 146 shows some of the definitions this brings into your program:

```
01  DFHAID.
    02  DFHNULL          PIC X VALUE IS ' '.
    02  DFHENTER         PIC X VALUE IS QUOTE.
    02  DFHCLEAR         PIC X VALUE IS '_'.
    02  DFHCLRP          PIC X VALUE IS '¯'.
    02  DFHPEN           PIC X VALUE IS '='.
    02  DFHOPID          PIC X VALUE IS 'W'.
    02  DFHMSRE          PIC X VALUE IS 'X'.
    02  DFHSTRF          PIC X VALUE IS ' '.
    02  DFHTRIG          PIC X VALUE IS '"'.
    02  DFHPA1           PIC X VALUE IS '%'.
    02  DFHPA2           PIC X VALUE IS '>'.
    02  DFHPA3           PIC X VALUE IS ','.
    02  DFHPF1           PIC X VALUE IS '1'.
    02  DFHPF2           PIC X VALUE IS '2'.
        . . .
        . . .
    02  DFHPF23          PIC X VALUE IS '.'.
    02  DFHPF24          PIC X VALUE IS '<'.
```

Figure 43. The Standard Attention Identifier Values

DFHENTER is the ENTER key, DFHPA1 is Program Access (PA) Key 1, DFHPF1 is Program Function Key 1, and so on. As in the case of the DFHBMSCA macro, any values above that appear to be spaces are not; they correspond to bit patterns for which there is no printable character.

In other words, the HANDLE AID command we described on page 142 is equivalent to executing:

```
IF EIBAID = DFHENTER, GO TO ENTERLBL.
IF EIBAID = DFHPF3, GO TO PF3LBL,
ELSE GO TO OTHERLBL.
```

right after the RECEIVE MAP command. Furthermore, this code produces the same results whether executed before or after that first RECEIVE MAP command (or, indeed, at any time until a second RECEIVE MAP command is executed).

Errors on BMS Commands

As we cover each group of commands in this Primer, we'll discuss what can go wrong. We'll classify errors according to the categories described in "Handling Errors and Exceptional Conditions" on page 90, and suggest how you might want to handle them in your coding. Later, in "The HANDLE CONDITION Command" on page 194, we'll explain how to branch when an error occurs.

There are two types of errors that can occur in the subset of BMS commands and map options that we've covered here. They are known as MAPFAIL and INVMPSZ. (Others may occur if you use the additional features of BMS outlined in the next section. They are all described in the APRM.)

MAPFAIL Errors

MAPFAIL occurs on a RECEIVE MAP command when there are no fields at all on the screen for BMS to map for you. This will happen if you issue a RECEIVE MAP after the user has used one of the "short-read" keys (CLEAR or a program access key) that we discussed in "3270 Input Data Stream" on page 28. It can also occur even if the user does not use a short-read key. If, for example, you send a screen to be filled in (without any fields in which the map or the program turns on the modified-data tag), and the user presses the ENTER key or one of the program function keys without keying any data into the screen, you'll get MAPFAIL.

The reason for the failure is essentially the same in both cases. With the short read, the terminal does not send any screen data; hence no fields. In the other case, there are no fields to send, because no modified-data tags have been turned on.

MAPFAIL is almost invariably a user error (or an expected program condition). It may occur on almost any RECEIVE MAP, and therefore you should handle it explicitly in the program. For instance, Figure 44 shows the code that the example application contains to deal with a MAPFAIL that occurs when the menu map is received:

```
NO-MAP.
    IF (EIBAID = DFHPA1 OR DFHPA2 OR
                 DFHPA3 OR DFHENTER)
        MOVE 2 TO MSG-NO, MOVE -1 TO SNAMEML,
        GO TO MENU-RESEND.
    MOVE MSG-TEXT (14) TO MSGMO.
NEW-MENU.
    EXEC CICS SEND MAP('ACCTMNU')
        MAPSET ('ACCTSET') FREEKB END-EXEC.
    . . .

MENU-RESEND.
    IF MSG-NO NOT = 0,
        MOVE MSG-TEXT (MSG-NO) TO MSGMO.
    EXEC CICS SEND MAP ('ACCTMNU')
        MAPSET('ACCTSET') CURSOR DATAONLY
        FRSET FREEKB END-EXEC.
    . . .
```

Figure 44. Code to Handle MAPFAIL

This code gets executed if the MAPFAIL condition is raised because of the HANDLE CONDITION executed earlier. It first tests what key was used to send. (We know it isn't the CLEAR key, having checked that point earlier, to find out if the user wanted to “escape” from the current procedure.) If it was one of the other short-read keys, or if it was ENTER without any data, we know that the screen is still intact and we simply write a message into the message area of the screen reminding the user to use only ENTER or CLEAR, and to key some data in unless he or she is using the CLEAR key to escape. If the failure has some other cause, the program writes the whole map back to the screen, including a similar message, to ensure that the user is looking at a good screen and knows what to do next.

A HANDLE AID command takes precedence over a HANDLE CONDITION command. So here, for example, if an AID is received for which a HANDLE AID is active, control will pass to the label specified regardless of the occurrence of, say, a MAPFAIL condition.

INVMPSZ Errors

INVMPSZ usually results from a coding error. It occurs on either SEND MAP or RECEIVE MAP if the size of the map specified is too wide for the screen. Therefore, you usually do not need to write code to handle it. If it occurs during debugging, the transaction will end abnormally with a code indicating this error. The cause is either that the SIZE parameter on the DFHMDI macro is wrong, or the terminal is defined incorrectly, or the application is being used from a terminal it does not support. Note that if the last-mentioned cause was a possibility, you might want to write code to send the user a message explaining the problem.

Other Features of BMS

BMS is a very powerful component of CICS and offers many facilities beyond those we've discussed so far. We'll list some of the more interesting ones here. They are all described in the APRM. These features of BMS let you do the following:

- **Copy what is on a screen to a printer.** You can use the ISSUE PRINT command or the local copy facilities of CICS to do this.

- **Send formatted data to printers in other formats.** In this Primer, we discuss only one method of formatting the data for a printer, which is to use a map just like the display screen for the printer, in combination with the PRINT option. However, there are other ways to control the format of printed output, by inserting new-line characters where you want them, and so on.

- **Build a single screen with a series of SEND MAP commands,** using more than one map in the process. This is done with the ACCUM option of SEND MAP.

- **Build output messages of more than one screen.** You can send output messages that consist of a series of screens, which can be stored away by BMS until the entire sequence is complete. Then BMS provides a method for the user to display these screens and page backward and forward through them at will, without any support from your program. Multiple-screen outputs use the PAGING option of SEND MAP. The PAGING and ACCUM options can be used together, incidentally.

- **Partition a single screen into sections, and treat each of these areas as a separate screen.** This needs a terminal with the appropriate partition support, of course. You can write to and read from one of these mini-screens (or **partitions**, as the devices call them) without affecting any of the others.
- **Send output to terminals other than the one associated with the transaction.** This is called **routing.** It provides a second way, different from the technique we'll use, to deal with the requirement in the example application of sending output to a printer.
- **Switch messages.** The routing facility provides a basis for a transaction that can be used to send a message from one terminal to another. Not surprisingly, this is called **message switching.** CICS provides the transaction, which has the identifier CMSG. Any CICS system that includes full-function BMS can make this transaction available.
- **Write formatted data to terminals without using maps** (the SEND TEXT command).
- **Support additional 3270 features,** such as color, the extended attributes (extended color, programmed symbols, extended highlighting, data validation), light pen, cursor select key, and magnetic slot reader.
- **Support special facilities provided by VTAM**, such as outboard formatting and logical device controls. These facilities are discussed in sections of the same name in the APRM.
- **Support a wide variety of terminals with different physical characteristics.** BMS even provides facilities for limiting the dependence of the program on the device characteristics; these are described under "Map Set Suffixing."

Now that you know how to talk to a terminal, the next thing you need to know about is how to get something worthwhile to talk about. This means accessing files, and is the next category of CICS services that we'll cover.

Chapter 3-4. Handling Files

CICS allows you to access file data in a variety of ways. In an online system, most file accesses are random, because the transactions to be processed aren't batched and sorted into any kind of order. Therefore CICS supports the usual direct access methods: VSAM, DAM and ISAM. It also allows you to access data using data base managers.

Of these, we'll cover only VSAM key-sequenced data sets, accessed by key, in this Primer. Most of the material applies to ISAM and DAM and other forms of VSAM, however. CICS also supports sequential access in several forms; one of these, browsing, we'll cover in the coming section. The others we'll touch on later.

Before describing how you read and write files, we should explain briefly about an important CICS table, the File Control Table (FCT). This table contains one entry for each file used in any application in the system. The most important information kept for each file is the symbolic file name. This must match the VSE file name or the OS/VS DDNAME that you use in the JCL defining the file. The JCL statement, in turn, is what connects the name with a real file. When a CICS program makes a file request, it always uses the symbolic file name. CICS looks up this name in the FCT, and from the information there makes the appropriate request of the operating system. This technique keeps CICS programs independent not only of specific data sets (the JCL does that), but of the JCL as well. Usually the symbolic file names are assigned by the CICS systems staff.

In the examples which follow we'll use the symbolic file name "ACCTFIL" for the account file and "ACCTIX" for its index.

Read Commands

The read commands that you can use are READ and READNEXT.

Reading a File Record

The command to read a single record from a file is:

```
EXEC CICS READ DATASET(filename) INTO(recarea)
    LENGTH(length) RIDFLD(keyarea) option
    option ... END-EXEC
```

filename
: is the name of the data set from which you wish to read. It is required in all READ commands. This is the CICS symbolic file name which identifies the FCT entry for the file. File names can be up to 7 characters long (8 for OS) and, like any parameter value, should be enclosed in quotes if they are literals.

recarea
: is the name of the data area into which the record is to be read, usually a structure in Working-Storage. The INTO is required for the uses of the READ command discussed in this Primer.

length
: is the maximum number of characters that may be read into the data area specified. The LENGTH parameter is required for the uses of the READ command we're covering in this Primer, and it must be a halfword binary value (that is, it must have a PICTURE of "S9(4) COMP"). After the READ command is completed, CICS replaces the maximum value you specify with the true length of the record. For this reason, you must specify LENGTH as the name of a data area rather than a literal. For the same reason, you must re-initialize this data area if you use it for LENGTH more than once in the program. An overlength record will raise an error condition.

keyarea
: is the name of the data area containing the key of the record you wish to read. This parameter is also required.

option
: can be any of the following options which apply to this command. Except where noted, you can use them in any combination.

  UPDATE
  : means that you intend to update the record in the current transaction. Specifying UPDATE gives your transaction exclusive control of the requested record (possibly the whole control interval in the case of VSAM) and invokes the file protection mechanisms we discussed in "Chapter 2-7. A Basic Decision: Conversational or Pseudoconversational" on page 77. Consequently, you should use it only when you actually need it. That is, when you are ready to modify and rewrite the record.

  EQUAL
  : means that you want only the record whose key exactly matches that specified by RIDFLD. This is a default option, which you get if you either specify it or fail to specify GTEQ.

GTEQ

means that you want the first record whose key is greater than or equal to the key you specified. You cannot use this option at the same time as EQUAL. It provides one means of doing a **generic read** (a read where only the first part of the key is required to match) and we use it for this purpose in our application.

So, how do we read an account file record? Well, in program ACCT01, we need to read the account file to find out whether the requested record is there or not. The command we need is:

```
EXEC CICS READ DATASET('ACCTFIL') RIDFLD(ACCTC)
    INTO(ACCTREC) LENGTH(ACCT-LNG) END-EXEC
```

Here ACCTC is where we've stored the account number taken from the menu map, and ACCT-LNG is a constant in Working-Storage defined as the expected length of a record in the account file:

```
02  ACCT-LNG    PIC S9(4) COMP VALUE +383.
```

We've asked that the record be placed in the data area named "ACCTREC," so ACCTREC should be a data structure corresponding to the file record. We could define this structure directly in the program, but we'll also need it in program ACCT02. So we'll put the record definition into a library and copy it into this program instead:

```
01 ACCTREC.  COPY ACCTREC.
```

In any application, in fact, it is a good idea to keep your record layouts in a library and copy them into the programs that need them. Even in the simplest of applications, the same record is usually used by several programs, and this procedure prevents programs from using different definitions of the same thing.

This argument applies equally well to any structure used in common by multiple programs. Map DSECTs are a prime example, as are parameter lists and communication areas, which we'll discuss later. Apart from its value in the initial programming stage of an application, this technique greatly reduces the effort and hazards associated with any change to a record or map format. You can make the changes in just one place (your library) and then simply recompile all the affected programs.

Figure 45 shows the COBOL record definition we need for the account file in the example application.

```
*    ACCTREC - ACCOUNT FILE RECORD
     02  ACCTDO                   PIC X(5).
     02  SNAMEDO                  PIC X(18).
     02  FNAMEDO                  PIC X(12).
     02  MIDO                     PIC X.
     02  TTLDO                    PIC X(4).
     02  TELDO                    PIC X(10).
     02  ADDR1DO                  PIC X(24).
     02  ADDR2DO                  PIC X(24).
     02  ADDR3DO                  PIC X(24).
     02  AUTH1DO                  PIC X(32).
     02  AUTH2DO                  PIC X(32).
     02  AUTH3DO                  PIC X(32).
     02  AUTH4DO                  PIC X(32).
     02  CARDSDO                  PIC X.
     02  IMODO                    PIC X(2).
     02  IDAYDO                   PIC X(2).
     02  IYRDO                    PIC X(2).
     02  RSNDO                    PIC X.
     02  CCODEDO                  PIC X.
     02  APPRDO                   PIC X(3).
     02  SCODE1DO                 PIC X.
     02  SCODE2DO                 PIC X.
     02  SCODE3DO                 PIC X.
     02  STATDO                   PIC X(2).
     02  LIMITDO                  PIC X(8).
     02  PAY-HIST OCCURS 3.
         04  BAL                  PIC X(8).
         04  BMO                  PIC 9(2).
         04  BDAY                 PIC 9(2).
         04  BYR                  PIC 9(2).
         04  BAMT                 PIC X(8).
         04  PMO                  PIC 9(2).
         04  PDAY                 PIC 9(2).
         04  PYR                  PIC 9(2).
         04  PAMT                 PIC X(8).
```

Figure 45. The COBOL Record Definition for the Account File

We'll not dwell on the naming conventions of the data items that we're leaving to our assumed batch processing system. Nor shall we have anything much to say about the behavior of this batch system. In other words, don't worry about it!

We also need a record definition for the index file records. See Figure 46 on page 155.

```
      *    ACIXREC - INDEX FILE RECORD
           02  SNAMEDO                PIC X(12).
           02  ACCTDO                 PIC 9(5).
           02  FNAMEDO                PIC X(7).
           02  MIDO                   PIC X.
           02  TTLDO                  PIC X(4).
           02  ADDR1DO                PIC X(24).
           02  STATDO                 PIC X(2).
           02  LIMITDO                PIC X(8).
```

Figure 46. The COBOL Record Definition for the Index File Records

You may notice that we've chosen many of the field names in the account record to match the output subfields in the detail map. We did this because when we display a record from the file on the screen, we have to move many fields from the record to the symbolic description map. This choice of names allows us to use MOVE CORRESPONDING instead of writing out the individual moves. It allows us to do the same thing going from the screen to the file, because the input and output fields on the screen overlay each other exactly, as we noted earlier.

Browsing a File

In program ACCT01, when we search by name, we need to point to a particular record in the file, based on a random key. Then we start reading the file sequentially from that point on. The need for this combination of random and sequential file access, called **browsing**, arises frequently in online applications. Consequently, CICS provides a special set of browse commands: STARTBR, READNEXT, and ENDBR.

Starting the Browse Operation

The STARTBR (start browse) command gets the process started. It tells CICS where in the file you want to start reading. The format is:

```
EXEC CICS STARTBR DATASET(filename)
    RIDFLD(keyarea) option END-EXEC
```

The DATASET and RIDFLD parameters are the same as in a READ command. The options allowed are GTEQ and EQUAL; you cannot use them both. They are defined as for READ, except that this time GTEQ is assumed by default. UPDATE isn't allowed; file browsing is strictly a read-only operation.

Reading the Next Record

Starting a browse does *not* make the first eligible record available to your program; it merely tells CICS where you want to start when you begin issuing the sequential read commands.

To get the first record, and for each one in sequence after that, you use the READNEXT command:

```
EXEC CICS READNEXT DATASET(filename)
    INTO(recarea) LENGTH(length)
    RIDFLD(fdbkarea) END-EXEC
```

The DATASET, INTO and LENGTH parameters are defined in the same way as they are in the READ command. You only need the DATASET parameter because CICS allows you to browse several files at once, and this tells which one you want to read next. Note, however, that you cannot name a dataset in a READNEXT command unless you've first issued a STARTBR command for it.

The RIDFLD parameter is used in a somewhat different way. On the READ and STARTBR commands, RIDFLD carries information from the program to CICS; on READNEXT, the flow is primarily in the other direction: RIDFLD points to a data area into which CICS will "feed back" the key of the record it just read. Do make sure that RIDFLD points to an area large enough to contain the full key; otherwise the adjacent field(s) in storage will be overwritten. Don't change it, either, because you'll interrupt the sequential flow of the browse operation.

(There **is** a way to do what is called "skip sequential" processing in VSAM by altering the contents of this key area between READNEXT commands. Although we won't be covering this here, we mention it only to explain why you should not inadvertently change the contents of "fdbkarea" while browsing the file.)

Finishing the Browse Operation

When you've finished reading a file sequentially, you terminate the browse with the ENDBR command:

```
EXEC CICS ENDBR DATASET(filename) END-EXEC
```

Here DATASET functions as it did in the READNEXT command; it tells CICS *which* browse is being terminated, and it must name a data set for which a STARTBR has been issued earlier.

Using the Browse Commands in the Example Application

Let's write the code we need to do the example. The first thing we have to do is construct a key that will start the browse in the right place. The key of the index file consists of the first 12 characters of the surname followed by an account number. We want to build a key that consists of the characters the user keyed in as the surname, followed by something smaller than any file key that starts out the same way. Then we can use the GTEQ option on our STARTBR command to get the first qualifying record. If we define:

```
04  BRKEY.
    06  BRKEY-SNAME PIC X(12).
    06  BRKEY-ACCT  PIC X(5).
```

Then writing:

```
MOVE SNAMEC TO BRKEY-SNAME.
MOVE LOW-VALUES TO BRKEY-ACCT.
```

should do the trick. SNAMEC is where we saved the surname from the input menu (SNAMEMI) earlier in the code. Because CICS pads what the user keys with spaces to produce SNAMEMI, and spaces are lower in the collating sequence than any letter, we can be sure that BRKEY will be smaller than the key of any eligible record in the file.

We also need to know where to stop the browse.

Certainly we'll stop when we overflow the display capacity of the screen, but we may run out of eligible names before that. So we need to construct a surname value that is the highest alphabetically that could meet our match criteria. If the surname in the record exceeds this value, we will know that we've read all the (possibly) eligible records. If this limiting value is named MAX-SNAME and has a picture of "X(12)," then:

```
MOVE SNAMEC TO MAX-SNAME.
TRANSFORM MAX-SNAME FROM SPACES TO HIGH-VALUES.
```

should give the right cutoff.

Finally, as we read, we need to test whether the first name matches sufficiently to display the record on the screen or not. If we define MIN-FNAME as the smallest allowable value and MAX-FNAME as the largest, and if FNAMEC is where we held the first name from the input screen, then we need the following code:

```
        MOVE FNAMEC TO MIN-FNAME, MAX-FNAME.
        TRANSFORM MIN-FNAME FROM SPACES TO LOW-VALUES.
        TRANSFORM MAX-FNAME FROM SPACES TO HIGH-VALUES.
```

Thus, Figure 47 on page 159 shows the code we need to produce the name summary. This code first starts a browse on the index file. Then it begins a loop in which it:

1. Reads the next sequential record in the file.

   This may result in an ENDFILE condition, causing a transfer to paragraph SRCH-DONE.

2. Tests whether the surname in the record is beyond the last in the file that might qualify, and exits the loop to SRCH-DONE if so.

3. Otherwise, determines if the record is eligible on the basis of first name and, if not, returns to the beginning of the loop to check the next record.

4. Determines, if the record is eligible, if it will still fit on the screen. (We need to read one "hit" beyond the point of using up all the space on the screen so that we can tell the user whether there are going to be more names or not.)

5. Adds a message to the output map if the current name won't fit, saying there are more names and how to get them, and then exits the loop at SRCH-DONE.

6. Builds an output line for the map if the name will fit, and returns to the beginning of the loop to check for more hits.

After the loop, at SRCH-DONE, when all eligible names have been read or the screen is full, the program terminates the browse. At this point the name search output is essentially ready to be sent back to the user.

There are two other browse commands. We'll not cover them here, but you can read about them in the APRM. The READPREV command is almost like READNEXT, except that it lets you proceed backward through a data set instead of forward. The RESETBR command allows you to reset your starting point in the middle of a browse.

Write Commands

There are three file output commands: REWRITE modifies a record that is already on a file, WRITE adds a new record, DELETE deletes an existing record from a file.

```
SRCH-RESUME.
    EXEC CICS STARTBR DATASET('ACCTIX') RIDFLD(BRKEY) GTEQ
        END-EXEC.
SRCH-LOOP.
    EXEC CICS READNEXT DATASET('ACCTIX') INTO(ACIXREC)
        LENGTH(ACIX-LNG) RIDFLD(BRKEY) END-EXEC.
    IF SNAMEDO IN ACIXREC > MAX-SNAME GO TO SRCH-DONE.
    IF FNAMEDO IN ACIXREC < MIN-FNAME OR
        FNAMEDO IN ACIXREC > MAX-FNAME, GO TO SRCH-LOOP.
    ADD 1 TO LINE-CNT.
    IF LINE-CNT > MAX-LINES,
        MOVE MSG-TEXT (15) TO MSGMO,
        MOVE DFHBMBRY TO MSGMA, GO TO SRCH-DONE.
    MOVE CORRESPONDING ACIXREC TO SUM-LINE.
    MOVE SUM-LINE TO SUMLNMO (LINE-CNT).
    GO TO SRCH-LOOP.
SRCH-DONE.
    EXEC CICS ENDBR DATASET('ACCTIX') END-EXEC.
```

Figure 47. The Name Summary Search Code

Rewriting a File Record

The REWRITE command updates the record you've just read. You can use it only after you've performed a "read for update" by executing a READ command for the same record with UPDATE specified. REWRITE looks like this:

```
EXEC CICS REWRITE DATASET(filename)
     FROM(recarea) LENGTH(length) END-EXEC
```

filename
has the same meaning as in the READ command: it is the CICS name of the file you are updating. You must specify it.

recarea
is the name of the data area that contains the updated version of the record to be written to the file. This parameter is also required.

length
is the length of the (updated) version of the record. You must specify length, as in a READ command, and it must be a halfword binary value.

Adding (Writing) a File Record

The WRITE command adds a new record to the file. The parameters for WRITE are almost the same as for REWRITE, except that you have to identify the record with the RIDFLD option. (You do not do this with the REWRITE command because the record was identified by the previous READ operation on the same data set.) The format of the WRITE command is:

```
EXEC CICS WRITE DATASET(filename) FROM(recarea)
    LENGTH(length) RIDFLD(keyarea) END-EXEC
```

keyarea
is the data area containing the key of the record to be written. The RIDFLD parameter is required on the WRITE command.

Deleting a File Record

The DELETE command deletes a record from the file, and looks like this:

```
EXEC CICS DELETE DATASET(filename)
     RIDFLD(keyarea) END-EXEC
```

The parameters are defined in the same way as for the WRITE and REWRITE commands. You can delete a record directly, without reading it for update first. When you do this you must specify the key of the record to be deleted by using RIDFLD. Alternatively, you can decide to delete a record after you've read it for update. In this case, you must omit RIDFLD.

Using the Write Commands in the Example Application

Program ACCT02 uses all three of the file output commands. For add requests, the program first constructs a new record in a structure named NEW-ACCTREC. It then issues the command:

```
EXEC CICS WRITE DATASET('ACCTFIL')
    FROM(NEW-ACCTREC) RIDFLD(ACCTC) LENGTH(ACCT-LNG)
    END-EXEC
```

(The variables ACCTC and ACCT-LNG have the same definition as they did in the example of the READ command in "Reading a File Record" on page 151.)

For a modification, the program first reads the record in question, with UPDATE specified:

```
IF REQC NOT = 'A',
    EXEC CICS READ DATASET('ACCTFIL')
        INTO(OLD-ACCTREC) RIDFLD(ACCTC) UPDATE
        LENGTH(ACCT-LNG) END-EXEC
```

Then it builds a new version of the record, again at NEW-ACCTREC, by combining the new data from the screen with the old record. Finally it replaces the old record with the new one, in the command:

```
EXEC CICS REWRITE DATASET('ACCTFIL')
    FROM (NEW-ACCTREC) LENGTH(ACCT-LNG) END-EXEC
```

For a deletion, the program uses the same READ command as in a modification. Therefore the key (RIDFLD) isn't specified in the DELETE command, which is:

```
EXEC CICS DELETE DATASET('ACCTFIL') END-EXEC
```

Errors on File Commands

In contrast to the situation with BMS commands, a wide variety of things can go wrong on the file commands. Here are the errors that can arise when you use the subset of file commands that we've just described.

DSIDERR
: means that the symbolic file name in a file command cannot be found in the File Control Table. This is usually a coding error; look for a difference in spelling between the command and the FCT entry. If it happens after the program is put into actual use ("in production"), look for an accidental change to the entry for that file in the FCT.

DUPREC
: means that there is already a record in the file with the same key as the one that you are trying to add with a WRITE command. This condition may result from a user error or may be expected by the program. In either of these cases, there should be specific code to handle the situation.

It can also fall into the "should-not-occur" category, the third type in the list under "Handling Errors and Exceptional Conditions" on page 90, as it would in our example application. In this case no special code is required beyond identifying the problem to the user. The message to the user should tell him or her what to say to the supervisor (or to the operations staff) and what he or she is allowed to do next.

ENDFILE
means that you've attempted to read sequentially beyond the end of the file in a browse (using the READNEXT command). This is a condition that you should program for in any browse. In the example application, for instance, a search on "Zuckerman" or a similar name might cause ENDFILE, and we'll code for it explicitly by sending control to SRCH-DONE when it occurs.

ILLOGIC
is a catchall class for errors detected by VSAM that don't fall into one of the other categories that CICS recognizes. By far the most common cause is trying to read from or write into a brand-new (empty) VSAM key-sequenced data set (KSDS). In order to use a KSDS in CICS, you must batch load at least one record into it, because VSAM does not build the index component until the first record arrives, and CICS cannot cope with a KSDS whose index isn't built. See "Compiling and Link-Editing the Initialize Program" on page 271 for a suitable job stream.

INVREQ
means that CICS regards your command as an invalid request for one of the following reasons:

- You requested a type of operation (add, update, browse, and so on) that wasn't included in the "service requests" (SERVREQ) parameter of the FCT entry for the file in question.
- You tried to REWRITE a record without first reading it for update.
- You issued a DELETE command without specifying a key (RIDFLD), and without first reading the target record for update.
- You issued a DELETE command specifying a key (RIDFLD) for a VSAM file when a read for update command is outstanding.
- After one read for update, you issued another read for update for another record in the same file without disposing of the first record (by a REWRITE, UNLOCK, or DELETE command).
- You issued a READNEXT or an ENDBR command without first doing a STARTBR on the same file.

Almost all of these INVREQ situations result from program logic errors and should disappear during the course of debugging. The first one, however, can also result from an inadvertent change to the "service requests" parameter in the FCT entry for the file.

IOERR
means that the operating system is unable to read or write the file, presumably because of physical damage. This can happen at any time, and there is usually nothing to do in the program except to abend the transaction and inform the user of the problem.

LENGERR
could mean one of the following:

- You omitted the LENGTH parameter from a READ, READNEXT, WRITE or REWRITE command, or
- The length you specified on a WRITE or REWRITE operation was greater than the maximum record size for the file, or
- You specified a length shorter than the actual record length on a READ operation to a file of variable length records,
- You indicated a wrong length on a READ, READNEXT, WRITE or REWRITE command to a file containing fixed-length records.

LENGERR is usually caused by a coding error.

NOSPACE
means that there's no space in the file to fit the record you've just tried to put there with a WRITE or REWRITE command. This doesn't mean that there's no space at all in the data set; it simply means that the record with the particular key you specified will not fit until the file is extended or reorganized. Like IOERR, this condition may occur at any time, and should be handled accordingly.

NOTFND
means that there is no record in the file with the key specified in the RIDFLD parameter on a READ, READNEXT, STARTBR, or DELETE command.[4] NOTFND may result from a user error, may be expected by the program, or may indicate an error in the program logic. In our example application, we provide code to handle all three of these situations.

In program ACCT01, when we check to see if the requested account record is on file, we expect NOTFND if the request is to add a record. However, it shows a user error (in the account number) if it happens on any other type of request. For both these cases, we need to provide recovery code. On the other hand, by the time we get to program ACCT02, we should have removed all the possibilities for getting a "not found" response on a read. So its occurrence here

[4] It is possible to raise NOTFND on a READNEXT command, but only in connection with skip sequential processing - and that's beyond the scope of the Primer.

would signal an error in our logic, to be handled like any other unexpected error.

NOTOPEN
: means that the file cited was closed at the time the command was executed. NOTOPEN usually results from an operations problem, and you may want to notify the operations staff of the problem, or send a message to the user to do so.

Other File Services

Before leaving the topic of file commands, we'll list some of the other facilities that are available. All of these are described in the APRM.

- You can use relative-record VSAM files (RRDS) as well as key-sequenced files (KSDS), and you can access a KSDS by relative byte address (RBA) instead of a key.
- You can use VSAM files with alternate indexes.
- You can use BDAM and ISAM files.
- You can specify a partial (**generic**) key for a VSAM KSDS. The effect is similar, but not identical, to what we did in the browse example, where we used a full-key filled out with spaces and low-values in combination with the GTEQ option.
- You can release a record that you've read for update if you decide not to update after all. The UNLOCK command is the means of doing this.
- You can access records without moving them into your program by using the SET option on the READ command.
- You can delete a whole block of adjacent records in a VSAM file with a single command (using the "generic delete" option).
- You can insert a whole block of records at once into a VSAM file ("mass insert" option).
- You also can use VSAM entry-sequenced data sets (ESDS).

ESDS support is the second type of sequential file access provided in CICS (the first was browsing). Two other forms of sequential support are also available, but they aren't considered to be part of CICS's file services. One of these is the extrapartition transient data facility, which allows you to read or write SAM files. In addition, the intrapartition transient data and temporary storage facilities provide a means for reading and writing data in queues, providing another form of sequential support. See "Chapter 3-5. Saving Data and Communicating Between Transactions" on page 165.

Chapter 3-5. Saving Data and Communicating Between Transactions

The Need for Scratchpad and Queuing Facilities

Most of the sequential file facilities we mentioned in the previous chapter are provided because we need to save data from the execution of one transaction and pass it to another that occurs later. We've already seen two instances of this requirement in our example application.

The first resulted from our decision to use pseudoconversational transactions; we need to save data from one interaction with the terminal to the next, even though no task exists for that terminal for most of the intervening time. For this we need some sort of scratchpad facility.

The second requirement came from our need to log the changes to the account file. Here we require some sort of queuing facility: a way to add items to a list (one in each update transaction) and read them later (in the log-print transaction).

There are several different scratchpad areas in CICS that you can use to transfer and save data, within or between transactions. One of them is **temporary storage**, which we'll cover in a moment. Others are listed below. The APRM describes how to get access to these areas.

- A **Communication Area** or COMMAREA. This is an area used for passing data both between programs within a transaction and between transactions at a given terminal. We'll describe it in connection with the program control commands in "Chapter 3-6. Program Control" on page 175. The COMMAREA is the recommended scratchpad area.

  It's the COMMAREA that offers an alternative solution to our double updating problem. For example, it would be perfectly feasible for ACCT01 to pass the contents of the account file record over to ACCT02 in the COMMAREA. ACCT02 could then re-retrieve the account record for update and compare it with the version passed in COMMAREA. Any difference would show that some other task had changed the account record.

  Although this solution may be easier to code, it isn't as good from the user's point of view. You see, with this scheme, we don't find out about any conflict over the record until we're ready to update it. Unfortunately, that means we then have to tell one user that his or her update cannot be made, but we can't tell them until they've keyed in all the changed data.

- The **Common Work Area** (known as the CWA). This is an extension of the **Common System Area** (CSA), one of the basic system control blocks in CICS. Any transaction can access the CWA, and since there's only one CWA for the whole system, the format and use of this area must be agreed upon by all transactions in all applications that use it.

- The **Transaction Work Area** (TWA). This area is an extension of the basic control block for a transaction, the **Task Control Area** (TCA), and therefore exists only for the duration of a transaction. Consequently, you can use it to pass data among programs executed in the same transaction (like COMMAREA), but not between transactions (unlike COMMAREA). The TWA isn't commonly used in command level programs.

Temporary Storage

CICS provides two queuing facilities: temporary storage and transient data. The following paragraphs tell you how to use temporary storage, both for queuing and as a scratchpad. Later, in "Transient Data" on page 173, we give a brief description of transient data, outline the differences between the two facilities, and suggest when you might use one or the other.

Temporary storage is just a sequential file; a VSAM data set on a disk, or an area of main storage.

The CICS temporary storage facilities allow a task to create a queue of items, stored under a name selected by the task. This queue, which you can think of as a miniature sequential file, exists until some task deletes it. The task that deletes it isn't usually the same task that created it, although of course it could be. The queue can hold any number of items (from just one to 32767) and any number of different tasks can add to it, read it, or change the contents of items in it.

When there is just one item in a queue, we think of this facility as a scratchpad; when there is more than one, we think of it as a queuing facility. The items can be of almost any length, and they can be of different lengths for the same queue. If you are using the queue as a temporary sequential file, you can think of the items in it as records.

Adding to, and Creating, a Temporary Storage Queue

The command to add one item to an existing temporary storage queue, or to create a brand new queue with one item in it, looks like this:

```
EXEC CICS WRITEQ TS QUEUE(qname) FROM(recarea)
    LENGTH(length) option option ... END-EXEC
```

qname
is the name of the queue to which an item is to be added. If there is no queue with the name you specify, CICS will create one, with the item you specified as the first (and only) item in the queue. Queue names are up to eight characters long. CICS imposes no restrictions on what names may be used, but there are some things to be considered in choosing names, as we will point out later. You should put this name in quotes if it is a literal.

recarea
is the name of the data area containing the item to be added.

length
is the length of that item (record). As in the file commands, length is given as a halfword binary value ("PIC S9(4) COMP").

option
may be any of the following:

MAIN
causes the item to be written to an area of main storage rather than to disk. Only use this option for queues of small size and very short lifetimes.

AUXILIARY
is the opposite of MAIN and causes the item to be written to a special VSAM data set on disk. This is the default (you get it if you specify AUXILIARY or if you fail to specify MAIN) and is what you should use in most circumstances.

ITEM(itemno)
causes CICS to feed back the number of items held in the queue after completion of the command. This number is placed in the "itemno" data area, and you can check the contents after issuing the command. Like the length, the item number is always a halfword binary value.

The MAIN or AUXILIARY option is effective only on the initial write that creates a new queue because a single temporary storage queue cannot be split between main storage and auxiliary storage. It is ignored on subsequent writes.

Replacing Items in a Temporary Storage Queue

Besides adding items to a queue, you can also replace any item in an existing queue by specifying the REWRITE option. The command:

```
EXEC CICS WRITEQ TS QUEUE(qname) FROM(recarea)
    LENGTH(length) ITEM(itemno) REWRITE END-EXEC
```

replaces the item whose number is stored in the "itemno" data area. Notice that the function of the ITEM option is quite different from its function when you write a new item. On a REWRITE, it is required, and passes information from your program to CICS. When you are adding new items to a queue, it is optional, and is used to return information from CICS to your program. The other parameters have the same meanings as above.

Reading Temporary Storage Queues

To read an item from a temporary storage queue, you use:

```
EXEC CICS READQ TS QUEUE(qname) INTO(recarea)
    LENGTH(length) option END-EXEC
```

qname
is the name of the queue you want to read. Put qname in quotes if it is a literal.

recarea
is the name of the data area into which you want to read the item.

length
is the name of a data area (defined as a binary halfword) with two functions:

1. Before issuing the command, you place in this area the maximum length of record that the program will accept (that is, the length of "recarea"), so that storage overlay will not occur if you read an unexpectedly long record. If the record is longer than this length, CICS will truncate it to this size and also turn on the LENGERR condition (about which more later).

2. CICS also returns the true length of the record (before any truncation) in this area at the completion of the command.

option
may be either of two choices to indicate which record you want:

ITEM(itemno)
indicates that the number of the item to be read is stored at "itemno" (in halfword binary form).

NEXT
means that the next item on the queue is to be read. The first time a READQ TS NEXT is issued for a queue by any transaction, the first item is provided. The next time this command is issued, *by any transaction*, the second item is provided, and so on. Moreover, the use of the ITEM option *by any transaction* resets what CICS considers the "next" item to the one following that specified in the ITEM option. Therefore, if more than one transaction can be reading a single queue, you may want to use the ITEM option to ensure that you read the intended item. NEXT is the default, if you do not indicate either NEXT or ITEM.

You can read temporary storage queues, wholly or in part, any number of times. So, reading the queue does not affect the contents of the queue.

Deleting Temporary Storage Queues

Once a temporary storage queue has been created, it stays in existence until explicitly deleted by some transaction. The command to delete a queue is:

```
EXEC CICS DELETEQ TS QUEUE(qname) END-EXEC
```

where "qname" has the same meaning as on a READQ or WRITEQ command.

Notice that you cannot delete individual items from a temporary storage queue; you have to delete the whole queue.

Naming Temporary Storage Queues

In writing any application that uses temporary storage, you should choose your queue names with care. First of all, you should follow a convention for constructing names to ensure that unrelated transactions don't inadvertently use the same queue name. For this reason, many installations insist that all queue names begin with characters that identify the application involved. Usually two to four characters are reserved for this purpose, depending on the installation. In our example, for instance, we start all our temporary storage queue names with the letters *AC*.

Queue names in CICS also provide a means of random access to scratchpad information. In our example, we're interested in keeping information about account numbers in a scratchpad area. If we include the account number in the queue name, we can read the scratchpad information concerning that account number directly, without any need to search the scratchpad.

Another example of using the queue name as an index occurs when you store data between transactions for a particular terminal. In this case, the first of two transactions stores the data to be passed in a queue whose name is formed from the terminal name plus some constant. The last four letters of the queue name are most often used for the terminal identifier. Then the second transaction can find the data for its terminal directly, by constructing the queue name from the name of its own input terminal plus the same constant.

Using Temporary Storage in the Example Application

Let's see how we'll use temporary storage in the example application for our scratchpad requirements. In program ACCT01, we need to find out whether any other task is currently updating the account record that our terminal has asked to update.

We want to observe the house rule that all temporary storage for this particular application should start with the letters "AC", and at the same time take advantage of the indexing aspect of temporary storage names; so we'll do as follows. We'll have one temporary storage queue for each account number in use. The name of the queue will be "AC0" followed by the account number, defined as follows in Working-Storage. (The 0 merely fills out the queue name to the allowed eight characters).

```
        02  USE-QID.
            04  USE-QID1      PIC X(3) VALUE 'AC0'.
            04  USE-QID2      PIC X(5).
```

The queue will contain just one item, which will tell what terminal is updating the record for that account number, and the date and time at which it started doing so. The definition of this record, also in Working-Storage, will be:

```
        02  USE-REC.
            04  USE-TERM      PIC X(4).
            04  USE-TIME      PIC S9(7) COMP-3.
            04  USE-DATE      PIC S9(7) COMP-3.
```

We include the date and time along with the terminal name in the scratchpad entry, so that we can find out whether the account number is currently in use, or whether the scratchpad record is there because of an earlier update attempt that wasn't completed properly. See "Chapter 2-7. A Basic Decision: Conversational or Pseudoconversational" on page 77 for a discussion of this possibility.

The first test to check whether the record is in use, then, is:

```
   MOVE ACCTC TO USE-QID2.
   EXEC CICS READQ TS QUEUE(USE-QID) INTO(USE-REC)
       ITEM(USE-ITEM) LENGTH(USE-LNG) END-EXEC.
```

Here USE-ITEM and USE-LNG are defined in Working-Storage and have initial values of 1 and 12, respectively.

The response we're hoping for on this command is that the read failed because no such queue exists. This will raise the QIDERR exception condition. If we do not get this response, we'll have to look at the scratchpad entry that we read to see whether this is a recent entry or an old, expired one. To do this we'll simply compare the time and date in the scratchpad entry with the time and date when the current transaction started (information that is available in the EIB).

If we find out that the account number is not in use, then the next step is to claim it for the terminal that entered the input. If there is no scratchpad record for this number, then we need:

```
     MOVE EIBTRMID TO USE-TERM,
     MOVE EIBTIME TO USE-TIME.
     MOVE EIBDATE TO USE-DATE.
     EXEC CICS WRITEQ TS QUEUE(USE-QID)
         FROM(USE-REC) LENGTH(12) END-EXEC.
```

If, on the other hand, there was an old, expired record in temporary storage for this number, then the code required is:

```
     MOVE EIBTRMID TO USE-TERM,
     MOVE EIBTIME TO USE-TIME.
     MOVE EIBDATE TO USE-DATE.
     EXEC CICS WRITEQ TS QUEUE(USE-QID)
         FROM(USE-REC) LENGTH(12) ITEM(USE-ITEM) REWRITE END-EXEC.
```

Here again USE-ITEM is defined to be a halfword binary value of 1, because we want to rewrite the first (and presumably only) item in the queue.

This same scratchpad entry gets erased in program ACCT02 when we've finished updating, with the command:

```
  EXEC CICS DELETEQ TS QUEUE(USE-QID) END-EXEC.
```

where the data area USE-QID has been defined and set up in the same way as it was in program ACCT01.

Errors on Temporary Storage Commands

You can experience six different types of error on the temporary storage commands that we've described:

INVREQ
means that the record length you specified is invalid (zero or negative). This is almost always the result of a problem in the code.

IOERR
means the same thing on a temporary storage command as it does on a file command. It means that there is an unrecoverable input/output error, in this case on the temporary storage file, a VSAM entry-sequenced data set (ESDS).

ITEMERR
means that you specified an item number that does not exist. This can happen on either a READQ TS command or a WRITEQ TS with REWRITE specified. ITEMERR may be a condition the program expects, such as when a program reads until it exhausts a queue, or it may result from an error in the program logic.

LENGERR
occurs when you read an item that is longer than the maximum specified in the LENGTH parameter. It usually means a problem in the program logic.

NOSPACE
means that there isn't enough space left in the temporary storage data set, or in main storage (if MAIN is specified) for the record you just wrote. Unlike what happens with most other error conditions, CICS does not terminate your task when this occurs. If you provide code to handle the possibility, CICS sends control there, as it does for any unusual condition. If you don't, CICS simply suspends the task until some other task in the system releases enough temporary storage space for your record to fit.

QIDERR
means that the queue that you've named in a READQ command, or in a WRITEQ with REWRITE specified, does not exist. It might indicate a program error, or it might be a condition expected by the program. When we read temporary storage to find out whether a particular account number is in use, for example, QIDERR is the expected response and indicates that the account number in question is not in use.

Transient Data

There is another facility in CICS, called **transient data**, one form of which is very similar to temporary storage. It comes in two flavors - **intrapartition** and **extrapartition** - and it is intrapartition transient data that is so much like temporary storage. Both temporary storage and transient data allow you to write and read queues of data items, which are often essentially small sequential files. Like temporary storage queues, intrapartition transient data queues are kept in a single VSAM data set managed by CICS.

There are some important differences, however:

- You must define the name and certain other characteristics of every transient data queue to CICS in the **Destination Control Table** (DCT). This means that the names must be known before CICS is brought up, so you cannot just create a transient data queue with an arbitrary name, as we did for temporary storage in the example.

- You cannot modify an item in a transient data queue; you can only add new items to the end of the queue. The Write Transient Data command has nothing corresponding to the ITEM option.

- Transient data queues must be read sequentially. That is, the Read Transient Data command has nothing corresponding to the ITEM option.

  Furthermore, a read operation on transient data is a **destructive read**. That is, once a transaction has read an item on the queue, that item cannot be read again by that transaction or by any other.

- Transient data comes with a very useful mechanism known as a **trigger**. You can request, in the DCT, that CICS initiate a transaction whenever the number of items in a transient data queue reaches a certain value. The DCT entry for the queue tells what this critical number of items is (the "trigger level"), and the name of the transaction to be initiated. You can also specify that a particular terminal must be available to this transaction. (You do this simply by giving the same name to both the terminal and the queue.) In this case, the transaction doesn't start until both the trigger level is reached and the terminal in question is available.

  This can be very useful for printing, as you'll soon see.

- Transient data queues are always written to a file; there is no counterpart to the MAIN option that is used in temporary storage commands.

- The recovery options for transient data are more varied.

Extrapartition transient data is the means by which CICS supports standard sequential (SAM) files. The commands used for extrapartition queues are the same as for intrapartition queues, and each queue requires a DCT entry. In this case, however, a read or write operation is actually a read or write to a sequential file, and each queue is a file. You can either read or write an extrapartition queue, but not both. The trigger mechanism and the recovery options mentioned above do not apply to extrapartition queues.

In the example application, we could have used transient data instead of temporary storage for our log of changes, and it would have been a natural choice. If we had chosen an intrapartition queue, then we'd still need a transaction to print the log (very similar to the one we defined using temporary storage). We might even have specified in the DCT that we wanted that transaction started every time the number of items logged (the length of the queue) reached 100, or some other limit.

Alternatively, we might have selected an extrapartition queue. In this case we'd be creating a SAM file, which could be printed by a batch program. In fact, if you need to use or create SAM files in a CICS application, you must use transient data.

On the other hand, transient data isn't appropriate for our scratchpad use of temporary storage. Because all the queue names have to be defined beforehand, we could not use the trick of including the account number in the name to get direct access to the scratchpad item we want. Moreover, the fact that an item on the queue can be read only once would have caused us trouble.

Chapter 3-6. Program Control

As we explained earlier, a transaction (task) may execute several programs in the course of completing its work. Two important tables in CICS govern the flow of control among programs used in a task: the PPT and the PCT.

Tables for Program Control

The **Processing Program Table** (PPT) contains one entry for every program used by any application in the CICS system. Each entry holds, among other things, three particularly important pieces of information:

1. The language in which the program is written, which CICS needs to know in order to set up its linkages and control blocks properly

2. How many tasks are using the program at the moment

3. Where the program is (in main storage and/or on disk).

In addition to the executable programs, anything that CICS must load in order to respond to a command needs an entry in this table. For example, a physical map.

The other table is the **Program Control Table** (PCT), which isn't so much a program table as a *transaction* table. There's an entry in this table for every transaction type in the system (using "transaction" in the CICS sense of the word). The important information kept about each transaction is the transaction identifier and the name of the *first* program to be executed on behalf of the transaction.

You can see how these two tables work in concert:

1. The user types in a transaction identifier at the terminal (or the previous transaction determined it).

2. CICS looks up this identifier in the PCT.

3. The PCT entry tells CICS which program to invoke first.

4. CICS looks up this program in the PPT, finds out where it is, and loads it if it isn't already in main storage.

5. CICS builds the control blocks necessary for this particular combination of transaction and terminal, using information from both PCT and PPT. For

programs in command-level COBOL, like ours, this includes making a private copy of Working-Storage for this particular execution of the program.

6. CICS passes control to the program, which begins running using the control blocks for this terminal. This program may pass control to any other program in the PPT, if necessary, in the course of completing the transaction.

Commands for Passing Program Control

There are two CICS commands for passing control from one program to another. One is the LINK command, which is similar to a CALL statement in COBOL. The other is the XCTL (transfer control) command, which has no COBOL counterpart. When one program links to another, the first program stays in main storage. When the second (linked-to) program finishes and gives up control, the first program resumes at the point after the LINK. The linked-to program is considered to be operating at one logical level lower than the program that does the linking.

In contrast, when one program transfers control to another, the first program is considered terminated, and the second program operates at the same level as the first. When the second program finishes, control is returned not to the first program, but to whatever program last issued a LINK command.

Some people like to think of CICS itself as the highest program level in this process, with the first program in the transaction as the next level down, and so on. If you look at it from this point of view, CICS links to the program named in the PCT when it initiates the transaction. When the transaction is complete, this program (or another one operating at the same level) returns control to the next higher level, which happens to be CICS itself. Figure 48 may help.

The LINK Command

The LINK command looks like this:

```
EXEC CICS LINK PROGRAM(pgmname)
    COMMAREA (commarea) LENGTH(length) END-EXEC
```

pgmname
is the name of the program to which you wish to link. If the name is a literal, enclose it in quotes. Program names can be up to eight characters long.

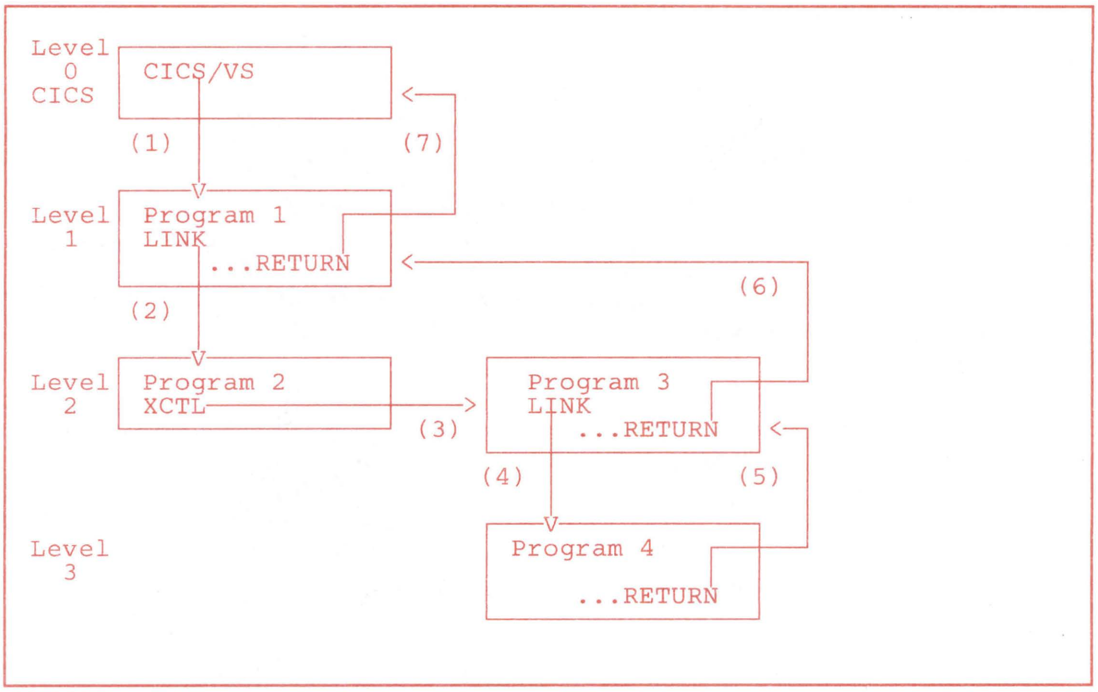


Figure 48. Transferring Control Between Programs (Normal Returns)

commarea
is an optional parameter. It is the name of the area containing the data to be passed and/or the area to which results are to be returned. You use it only if you want to pass information to or receive information from the program being linked to.

length
is the length of "commarea." This parameter is required only if COMMAREA is present. Otherwise don't use it. Like the length parameter in other commands, it must be a halfword binary value.

The XCTL Command

The XCTL command to transfer control is identical to the LINK command except for the command verb itself:

```
EXEC CICS XCTL PROGRAM(pgmname)
    COMMAREA(commarea) LENGTH(length) END-EXEC
```

The RETURN Command

The command to return control to the next higher level within a transaction is simply:

```
EXEC CICS RETURN END-EXEC
```

When the program at the highest level for the transaction (Level 1 in the diagram) returns control to CICS, however, there are two additional options that you can specify:

1. You can say what transaction is to be executed when the next input comes from the same terminal. (This is how we get into pseudoconversational mode.)

2. You can specify data that's to be passed on to that next transaction.

In this case the RETURN command has a slightly different form:

```
EXEC CICS RETURN TRANSID(nextid)
    COMMAREA(commarea) LENGTH(length) END-EXEC
```

nextid
is the identifier of the next transaction (next transid) to be executed from the terminal associated with the current transaction. This next transaction is the one that gets executed the next time the terminal sends input, regardless of any transaction identifier in that input. (Here's a way of overriding any user's input.) The identifier should be enclosed in quotes if it is a literal. TRANSID is an optional parameter.

commarea
is the name of the data area containing the data to be passed to the next transaction. COMMAREA is also optional.

length
is the length of "commarea." LENGTH is required if COMMAREA is present, and must not be there if COMMAREA was not specified.

The COBOL CALL Statement

As well as passing control to other programs by means of LINK and XCTL commands, a CICS COBOL program can invoke another program with a standard COBOL CALL statement. Although there's somewhat less system overhead (in other words, a shorter path length) with this method, there are several considerations that may count against it. For example:

- Unless you're using VS COBOL II, the called program cannot issue CICS commands
- A CALLed program remains in its last-used state after it returns control, so a second CALL finds the program in this state. LINK and XCTL commands, on the other hand, always find the "new" program in its initial state.
- You must link-edit the calling and called programs together and present them to CICS as a single unit, with one name and one entry in the PPT. This has two consequences:
  - It may result in a module that is quite large.
  - It prevents two programs that call the same program from sharing a copy of the called program.
- Only static calls are allowed, not dynamic ones. Static calls result in modules being link-edited together, whereas dynamic calls would use operating system services that aren't allowed in CICS.

Subroutines Revisited

Now, the answer to that problem we met earlier - whether and how to break off a substantial routine. For single-task efficiency, *generally* in-line code is best, PERFORM next, straight CALL third, XCTL next, and LINK last. However, any of the first three choices may make for a very long load unit, and that can impact system behavior and response to other users.

Always use XCTL if it will do, of course, rather than LINK. That's just a program logic issue; you either need control back or you don't. In our example, as you'll see, we've broken our own rule and used a LINK (rather than an XCTL) to the error-handling program. However, we *do* have an excuse ready.... See "Errors Within the Example Application" on page 198.

The probability of the code getting used is another issue. If you have a long complex routine for calculating withholding tax for veterans in a payroll system, but you use it only if salary or dependents change and you have hardly any veterans, then by all means put it in a separate routine and LINK to it.

Finally, how about breaking code into two parts? For example, let's take a standard "edit and update if ok" module, like ACCT02 in our application. Figure 49 shows the outline logic.

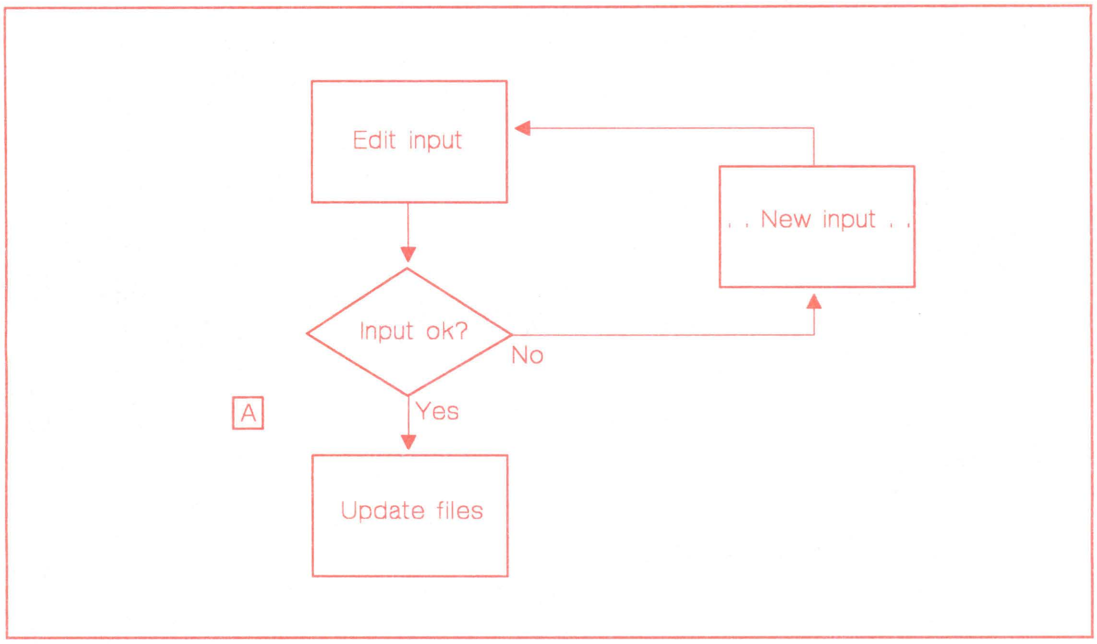


Figure 49. Outline Logic of a Standard "Edit and Update" Module.

If the edit and update logic are short, then it makes sense for the whole thing to be one module. If both are rather long, on the other hand, there's a natural break after the edit has been declared okay; the first program does up to point "A" and then there's an XCTL to a second program.

Examples of Passing Control and Data Between Programs and Transactions

Now that we've explained how to pass data from one transaction to another, you may be wondering how the receiving program accesses this data. To show this, let's code a few program control commands for the example application.

In several of the programs, when we meet an error from which we cannot recover, we transfer control to the general-purpose error program, ACCT04. We pass three items of information to ACCT04:

1. The name of the program that passed control (and where the error was detected)

2. The function that failed

3. The return code from the command that failed.

Figure 50 shows how this information looks in program ACCT01's Working-Storage:

```
   02  COMMAREA-FOR-ACCT04.
       04  ERR-PGRMID     PIC X(8) VALUE 'ACCT01'.
       04  ERR-FN         PIC X.
       04  ERR-RCODE      PIC X.
```

Figure 50. Passing Information to the Error Program

The code in ACCT01 to pass control to ACCT04 is:

```
 EXEC CICS LINK PROGRAM('ACCT04')
     COMMAREA(COMMAREA-FOR-ACCT04) LENGTH(10) END-EXEC
```

Notes:

1. *VS COBOL II avoids the need for the programmer to compute LENGTH.*

2. *We'll discuss the use of LINK rather than XCTL in "Errors Within the Example Application" on page 198*

The program receiving control, ACCT04 in this case, defines this same area in its Linkage Section, as shown in Figure 51.

```
   LINKAGE SECTION.
   01  DFHCOMMAREA.
       02  ERR-PGRMID                 PIC X(8).
       02  ERR-CODE.
           04  ERR-FN                 PIC X.
           04  ERR-RCODE              PIC X.
```

Figure 51. Receiving Information in the Error Program

This area *must* be the first 01 level in the Linkage Section, and you must call it DFHCOMMAREA as shown in the example. You can then use the contents directly, as follows:

```
     MOVE ERR-PGRMID TO PGMEO.
```

Communicating Between Transactions in the Example Application

Apart from the LINK to our error-handling program, ACCT04, which is something of a special case, there's no instance of one program linking to another in the example application, and so no instance of return to a higher level within the transaction either.

However, there are several different types of return to CICS. The simplest occurs in program ACCT01, after the user has indicated a wish to exit from the application. No next transid is set, and no data is passed forward to the next transaction. The return command is just:

```
     EXEC CICS RETURN END-EXEC
```

In program ACCT00, in contrast, we need to indicate that the next transaction to be executed from the same terminal is AC01, so the RETURN command is written:

```
     EXEC CICS RETURN TRANSID('AC01') END-EXEC
```

Later, in program ACCT01, after we complete the initial processing of an update request, we need to show that the next transaction to be executed is AC02. Not only that, but we need to pass data to it as well. The data is the request-type code and the account number that came in on the original map. The communications area in Working-Storage where we've stored this information looks like this:

```
       04  IN-REQ.
           06  REQC             PIC X VALUE SPACES.
           06  ACCTC            PIC X(5) VALUE SPACES.
```

And the code needed is:

```
       EXEC CICS RETURN TRANSID('AC02')
           COMMAREA(IN-REQ) LENGTH(6) END-EXEC.
```

When program ACCT02 is invoked, it finds the data passed to it in the same way as a program to which control is passed by means of an XCTL or LINK command. That is, the area is defined in the first 01 level in the Linkage Section, which is named DFHCOMMAREA and has the same format as it did in the passing program. (We happened to use the same names in these programs for the items passed, but that, of course, isn't required.) So program ACCT02 contains the following:

```
LINKAGE SECTION.
01  DFHCOMMAREA.
    02  REQC                PIC X.
    02  ACCTC               PIC X(5).
```

These variables are directly available to the program (the translator generates the code necessary to make this happen).

Incidentally, if you wanted to pass a communications area from, say, Program 1 to Program 3, you can simply define the area in the Linkage Section of Program 2, even though it's not used in that program, and pass it as COMMAREA on the LINK (or XCTL) to Program 3.

Errors on the Program Control Commands

CICS recognizes only two exceptional conditions on Program Control commands:

INVREQ
: means that one of two things happened. Either (1) you specified COMMAREA or LENGTH on a RETURN command in a program that was not at the highest level (that is, a RETURN that would not terminate the transaction by returning control to CICS), or (2) you specified the TRANSID option on a RETURN from a task that had no terminal associated with it. (There are such tasks; see "Chapter 3-7. Starting Another Task, and Other Time Services" on page 187.) In either form, INVREQ usually means a programming error.

PGMIDERR
: means that the program to which control was passed, on a LINK or an XCTL command, cannot be found in the PPT or isn't in the library, or has been disabled. It corresponds to DSIDERR on a file command, and has similar causes. If it occurs during the testing phase, look for a spelling mismatch; if it occurs once the system has been put into actual use ("in production"), have your systems people check the PPT for damage.

Abending a Transaction

In addition to the normal return sequences that we've described, there is another command that you use in *abnormal* circumstances. This is the ABEND command. It returns control to CICS directly. Figure 48 showed a normal return from program 4 to program 3, and from program 3 to program 1. If, in contrast, an ABEND command had been issued in program 4, the picture would then be as shown in Figure 52:

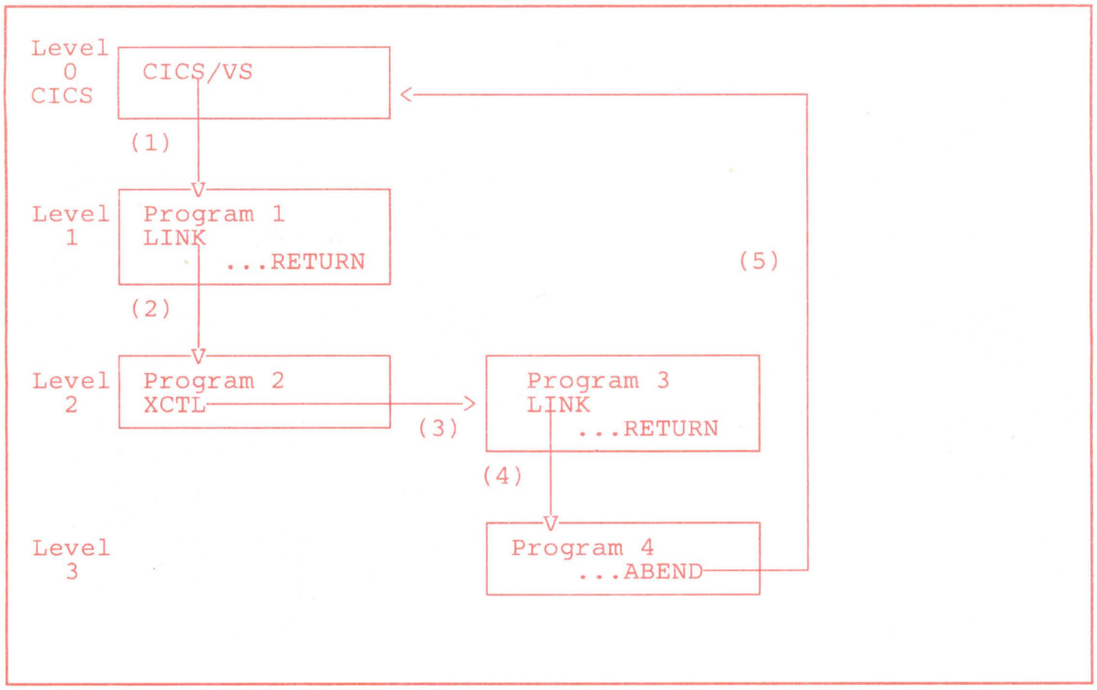


Figure 52. Transferring Control Between Programs (After an Abend)

Use the ABEND command when a situation arises that the program cannot handle. This may be a condition beyond control of the program, such as an input/output error on a file, or it may simply be a combination of circumstances that "should not occur" if the program logic is correct. In either case, ABEND is the right command to terminate the transaction. The format is:

```
EXEC CICS ABEND ABCODE(abcode) END-EXEC
```

abcode
is simply a four-character code identifying the particular ABEND command. It does two jobs: it tells CICS that you want a dump of your transaction, and it identifies the dump. Enclose it in quotes if it is a literal.

In addition to returning control to CICS, the ABEND command has another very important property: it causes CICS to back out all of the changes made by this transaction to recoverable resources (see "Maintaining File Integrity" on page 79 if you've forgotten what "back out" means).

In our example application, we use this command at the end of program ACCT04, where we send control when we've encountered a situation which prevents us from continuing the requested transaction. The code is:

```
EXEC CICS ABEND ABCODE('EACC') END-EXEC
```

Suppose, for example, that program ACCT02 successfully adds a new record to the account file, but meets a "no-space" condition when trying to add the corresponding new record to the index file. The resulting ABEND command issued in program ACCT04 will:

- Produce a dump of all the main storage areas related to the transaction
- Remove the new record from the account file, so that the two files are still synchronized with each other, even after the failure
- Return control to CICS.

Other Program Control Commands

There are two other program control commands that we'll mention here, but not cover in detail.

The LOAD command brings a "program" (any phase or load module in the PPT) into main storage but doesn't give it control. This is useful for tables of the type that are assembled and stored in a program library, but that don't contain executable code.

The RELEASE command tells CICS that you've finished using such a "program".

Chapter 3-7. Starting Another Task, and Other Time Services

CICS allows one transaction (task) to start another one, as we noted in our discussion about printed output. The usual reason for doing this is the one that arose in our example: the originating task needs access to some facility it does not own, usually a terminal other than the input terminal. In our case, we needed a printer to print the log of account file changes.

There are sometimes other reasons as well. You might want a task to be executed at a particular time, or you might want it to run at a different priority from the original task, for instance.

Starting Another Task

The command to start another task is:

```
EXEC CICS START TRANSID(transid) TERMID(termid)
    FROM(recarea) LENGTH(length) option END-EXEC
```

transid
: is the identifier of the transaction that is to be started. This parameter is required. If the identifier is a literal, enclose it in quotes.

termid
: is the identifier of the terminal that must be made available to the task being started. This parameter is optional, and should only be specified if the transaction requires a terminal. Again, if it is a literal, it must be enclosed in quotes.

  You may have to get this name from your systems people. It's the name they put in the Terminal Control Table (TCT).

recarea
: is the name of the data area that contains data to be passed to the transaction being started. This parameter is optional.

length
is the length of the data being passed (that is, the length of recarea), in halfword binary form. The LENGTH parameter is required if FROM is present, but should not be present otherwise.

option
can be either INTERVAL or TIME:

INTERVAL(hhmmss)
tells CICS to start the transaction in hh hours, mm minutes and ss seconds from the current time. The hours may be from 0 to 99, but the minutes and seconds should not exceed 59. To start a task in 40 hours and 10 minutes, you would write "INTERVAL(401000)" in your START command.

TIME(hhmmss)
tells CICS to start the transaction at a specific time, namely "hh:mm:ss." Write the start time in the same format as the interval, using 24-hour military time.

Note: Whereas an INTERVAL always specifies a time in the future (the current time plus the interval specified), the time given in a TIME parameter may be in either the future or the past relative to the time at which the command is executed. The rules that CICS uses are as follows:

- If the current time is 060000 (6 a.m.) or later, and the TIME value is less than 6 hours before the current time, CICS assumes that you mean a time in the past, and so the transaction is started as soon as possible, just as if you had specified INTERVAL(0).

- If the current time is less than 060000, and the expiration time is less than the current time, then the TIME is also considered to be in the past. Note, however, that the TIME given is never taken to be before midnight of the current day.

- Otherwise, CICS assumes that the time is in the future.

- If you specify a time with an hours component greater than 23, you are specifying a time on a day following the current one. That is: a TIME of 250000 means 1 a.m. on the day following the current one, and 490000 means 1 a.m. on the day after that.

If you don't specify either INTERVAL or TIME, CICS assumes that you would like INTERVAL(0), which means right away.

Retrieving Data Passed in the START Command

If data is passed in the START command, the transaction that gets started uses the RETRIEVE command to get access to this data. The RETRIEVE command looks like this:

```
EXEC CICS RETRIEVE INTO(recarea) LENGTH(length)
    END-EXEC
```

Notice the difference between this RETRIEVE command and the RECEIVE command described in "The RECEIVE MAP Command" on page 140. Both commands may be used to get the initial input to a transaction, but they aren't interchangeable: RECEIVE must be used in transactions that are initiated by input from a terminal, and RETRIEVE must be used in transactions that were STARTed by another transaction.

recarea
: is the name of the data area into which the data is to be placed. This parameter is required.

length
: is the maximum length of data that can be read into recarea (that is, the length of recarea). LENGTH is also required, and must be a halfword binary value.

Using the START and RETRIEVE Commands in the Example Application

In our example application, program ACCT01 uses the START command when a user asks for a record to be printed:

```
EXEC CICS START TRANSID('AC03') FROM(ACCTDTLO)
    LENGTH(DTL-LNG) TERMID(PRTRC) END-EXEC
```

This START command tells CICS to start transaction AC03 as soon as possible after the printer whose name is in data-area PRTRC is available to be its terminal.

Program ACCT03, running on behalf of this transaction, in turn issues the following RETRIEVE command to retrieve the data passed from program ACCT01:

```
EXEC CICS RETRIEVE INTO(ACCTDTLI) LENGTH(TS-LNG)
    END-EXEC
```

ACCTDTLO and ACCTDTLI refer to the symbolic map structure, located in Working-Storage in both programs. The map, of course, contains the data read by transaction AC01. This data is to be printed by AC03. DTL-LNG is in the Working-Storage of program ACCT01 and is defined to be

```
PIC S9(4) COMP VALUE +751
```

which happens to be the length of the symbolic map area. TS-LNG has the same definition in the Working-Storage of program ACCT03.

Errors on the START and RETRIEVE Commands

A number of different problems may arise in connection with the START and RETRIEVE commands that we've described.

INVTSREQ
means that the CICS system support for temporary storage, which is required for START commands that specify the FROM option, was not present when a RETRIEVE command was issued. This error is an example of the system/application mismatch (category 4) described in "Handling Errors and Exceptional Conditions" on page 90.

IOERR
on a RETRIEVE or START command means exactly what it does on a temporary storage command: an input/output error on the temporary storage data set where the data to be passed is stored.

LENGERR
occurs when the length of the data retrieved by a RETRIEVE command exceeds the value specified in the LENGTH parameter for the command. LENGERR usually means an error in the program logic.

NOTFND
on a RETRIEVE command means that the requested data could not be found in temporary storage. If a task issuing a RETRIEVE command was not started by a START command, or if it was started by a START command with no FROM parameter (in other words, no data), this condition will occur. Again, it usually means a programming error.

TERMIDERR
occurs when the terminal specified in the TERMID parameter in a START command cannot be found in the Terminal Control Table. TERMIDERR is like DSIDERR for files and PGMIDERR on Program Control commands. During the test phase it usually indicates a problem in the program logic; on a production system it usually means that something has happened to the TCT.

TRANSIDERR
means that the transaction identifier specified in a START command cannot be found in the PCT. Like TERMIDERR, it usually means a programming error during the development of an application, or table damage if it occurs on a production system.

Other Time Services

CICS provides a number of other time services, as well as some extra bits and pieces on the START and RETRIEVE commands. Among other things, a transaction in execution can:

- Synchronize its operations with those of other tasks. Three different commands are provided for this purpose:
  - The DELAY command suspends the processing of the issuing task until some specified time or for a specified interval.
  - The POST command requests that the issuing task be notified when a particular interval of time has elapsed or when some event has occurred.
  - The WAIT command suspends the issuing task until some specified event occurs.
- Cancel the request issued in a previous START command, or in a POST command, through the use of the CANCEL command.
- Ask for the time and date to be updated in the EIB (through the use of the ASKTIME command).
- Assign a name to the data to be passed from the originating task to the started task, through the use of the REQID option on the START and RETRIEVE commands.
- Queue up multiple items of data for a single task to be started, through the use of the QUEUE option on the START command.

We don't use any of these in our example application, but at least you now know they exist.

Chapter 3-8. Errors and Exceptional Conditions

Throughout the previous sections, we've cited ways in which CICS commands may produce results other than those you intended (what CICS cheerfully calls "exceptional conditions").

Commands are checked for validity as far as possible by the CICS translator. If errors are detected at translate time the translator issues a suitable diagnostic and gives a return code greater than 4. Such commands are said to be "syntactically invalid." Programs containing syntactically invalid commands should never be executed and we'll not discuss them any further.

Commands which are syntactically valid may nevertheless fail to execute successfully for a variety of reasons. (And how!)

If a CICS command executes successfully the command is said to have a normal response. Unless you take special action, CICS will check that a command executes normally. If it doesn't, CICS will take some appropriate action and not in general return control to the application. The special action is called "system action" and is usually to abend ("abnormally end") the transaction. As we pointed out in "Handling Errors and Exceptional Conditions" on page 90, this is almost never what you want in these situations.

For many applications the CICS system action will be inappropriate and you'll need to write some special code to be invoked in the event of non-normal response. What sort of code?

Well, you have three choices. You can:

- Explicitly look out for, and act on, a specific error or exceptional condition.
- Choose to ignore a particular condition, carrying on with the next instruction as if everything was normal. This involves the IGNORE CONDITION command.
- Ignore **all** conditions on a particular CICS command, again carrying on with the next instruction as if everything was normal. This involves the NOHANDLE option on the command concerned.

We chose to use the first method in our example application. It uses the HANDLE CONDITION command.

We'll see what these other two choices entail in "Other Facilities for Exceptional Conditions" on page 200.

So, before finally looking in detail at the COBOL code for our example, let's examine our last CICS command, the HANDLE CONDITION command. It allows you to control the sequence of execution in your programs when an error or other unusual condition occurs.

The HANDLE CONDITION Command

The HANDLE CONDITION command tells CICS where to go when an exceptional condition occurs. It looks like this:

```
EXEC CICS HANDLE CONDITION condition(label)
    condition(label) ...
    condition  condition ... END-EXEC
```

condition
: is the CICS name of the unusual condition for which you wish to establish special processing (or return to default processing, as explained below). It can be any of the exceptions that we've described in this part: IOERR, LENGERR, NOTFND, and so on, and you can name up to 16 conditions in one HANDLE CONDITION command.

label
: is the name of the paragraph in your program to which CICS is to pass control when the condition occurs. The paragraph name following a condition is optional; if you specify it you are saying that you want to handle the condition in question with code in the program. If you omit it, you are saying that you want CICS to use its default procedure for the condition (or, more likely, that you want to reestablish the CICS default action after you had specified other handling for the condition earlier).

For the handling code to take effect, a HANDLE CONDITION command must be issued *before* you execute any command on which one of the conditions you list might arise. Nothing visible happens when you execute the HANDLE CONDITION command, although CICS updates its control blocks, of course. The effects are seen later, when a command is executed that produces one of the exceptional conditions now covered by the HANDLE CONDITION.

For example, in program ACCT01, we want to provide program logic to handle the following six exceptional conditions:

1. A **no input** (MAPFAIL) condition when we read the input map.

   This generally results from a keying error, and we would certainly annoy the user if we allowed CICS to abend the transaction for this comparatively minor slip. Therefore, we want to send a message to let the user correct the input instead.

2. A **record not found** (NOTFND) condition when we read the index file for a customer name entered by the user.

   This situation isn't an error; it simply means that there are no customers with that particular name, and we'll so inform the user.

3. A **record not found** (NOTFND) condition when we try to read the account file record named in the input.

   NOTFND in this instance may actually be correct (if the user is trying to add a record) and is at worst an error in the account number, to be treated like any other input error.

4. An **end of file** (ENDFILE) condition when we're browsing through the index file looking for all the matching records on a name search.

   This isn't an error either, just a sign that we've run out of candidate names.

5. A **no such entry** (QIDERR) response to reading the scratchpad.

   This is the expected result when we read temporary storage to see if anyone else is updating the record we want to update. It means no one is using "our" record.

6. A **terminal id error** (TERMIDERR) when we start the AC03 transaction to print a record.

   This condition means that the user entered a printer name that is unknown to CICS. We'll treat it like any other type of input error.

Putting all these possibilities together, we arrive at program ACCT01's first HANDLE CONDITION command, shown in Figure 53.

```
EXEC CICS HANDLE CONDITION MAPFAIL(NO-MAP)
    NOTFND(SRCH-ANY)
    ENDFILE(SRCH-DONE)
    QIDERR(RSRV-1)
    TERMIDERR(TERMID-ERR)
    ERROR(OTHER-ERRORS) END-EXEC.
```

Figure 53. Program ACCT01's Error Condition Handling

NO-MAP is the name of the paragraph where we handle a MAPFAIL condition; SRCH-DONE is the paragraph where we handle an end-of-file on the index file (we never read the account file sequentially, and so will not experience this condition there); and RSRV-1 and TERMID-ERR are the paragraphs that handle the fifth and sixth situations cited above, respectively.

The ERROR condition in this command covers all exceptional conditions, except:

- Those cited by name in this command or another HANDLE CONDITION command executed previously in the program, and
- Those for which the CICS default action is *not* abnormal termination of the program.

We've specified ERROR here because there are many other exceptional conditions that can arise on the commands that we'll issue in this program, besides those listed above. (Figure 54 on page 201 shows which conditions apply to each command.) These conditions are all serious enough to prevent successful completion of the transaction, and we don't want to handle each one individually, but we do want our program to regain control long enough to send the user a message saying what happened and what to do next.

The code at OTHER-ERRORS, where control goes on one of these other exceptional conditions, starts with yet another HANDLE CONDITION command:

```
    EXEC CICS HANDLE CONDITION ERROR END-EXEC.
```

This command disables the previous specification for conditions covered by ERROR (the paragraph OTHER-ERRORS, where we are right now). This is a precaution to prevent a loop. If we failed to do this, a command used in this error routine might produce another condition covered by the catchall ERROR. In this event, CICS would send control back to OTHER-ERRORS, where the same bad command would be issued. (That's a recipe for **disaster**.)

Any **other** condition which could conceivably occur in our error handling (in this module) and which we have specifically handled must also now be "unhandled" at this point. However, here we're only handling MAPFAIL, NOTFND, ENDFILE, QIDERR, TERMIDERR, and ITEMERR. None of these can possibly occur during our error processing - the LINK to ACCT04. So it's enough for us to stop handling just the ERROR condition.

Changing the HANDLE CONDITION "Destinations"

In the original HANDLE CONDITION command shown above, SRCH-ANY is the name of the paragraph to which we want to pass control if "not found" occurs reading the *index* file. Now this is *not* where we want control to go if we get that condition trying to read the account file. CICS does not allow us to specify different NOTFND destinations for different files, and so we have to do one of two things:

- Issue a single HANDLE CONDITION command and test which file was involved at the beginning of the paragraph named to handle NOTFND condition. The EIBDS field in the EIB tells which data set was used most recently in a command and can be used for such a test.
- Issue a HANDLE CONDITION command appropriate for a NOTFND on the first command issued that may encounter it (in our case, the READ of the index file) and then, before the next command on which we want to specify a different paragraph name for that same condition, issue another HANDLE CONDITION command.

We chose to do the latter. The HANDLE CONDITION shown earlier is executed at the very beginning of the program, before any other commands that might produce an exceptional result are issued. The paragraph names it specifies remain in force until explicitly changed by another HANDLE CONDITION or until control leaves the program. Then after the program determines that the index file will not be used, and *before* it tries to read the account file, a second HANDLE CONDITION command is issued:

```
EXEC CICS HANDLE CONDITION NOTFND(NO-ACCT-RECORD)
    END-EXEC.
```

This command changes where control goes on NOTFND from SRCH-ANY (the paragraph name requested in the previous HANDLE CONDITION) to NO-ACCT-RECORD. It has no effect on the specifications for the other conditions in the first HANDLE CONDITION command; they remain just as they were.

A comparable situation arises with conditions that apply to several different commands. You need to use one of the two techniques listed above for these conditions also, unless the processing is the same for all the affected commands. For example, you can raise a "length error" condition on a number of different commands. In program ACCT02, we handle this problem in the same way that we did the multiple files in program ACCT01. We first issue the command:

```
EXEC CICS HANDLE CONDITION QIDERR(NO-OWN)
    MAPFAIL(NO-MAP) ERROR(NO-GOOD) END-EXEC.
```

This causes control to go to NO-GOOD if LENGERR is raised and covers the READ command which follows shortly. Later in the program, we have:

```
EXEC CICS HANDLE CONDITION LENGERR(NO-OWN)
    END-EXEC.
EXEC CICS READQ TS QUEUE(USE-QID) INTO(USE-REC)
    LENGTH(USE-LNG) ITEM(1) END-EXEC.
EXEC CICS HANDLE CONDITION LENGERR(NO-GOOD)
    END-EXEC.
```

This sequence changes the specification for a length error to paragraph NO-OWN just for the READQ TS command, and then promptly restores it to what it was before.

The alternative is to name LENGERR explicitly and only in the first HANDLE CONDITION. Then the code at the paragraph named would test which command was used and go to either NO-OWN or NO-GOOD accordingly. In fact, we've used this technique for unrecoverable errors in our application. We eventually send control to program ACCT04 for all such conditions. There we test both for the command which failed (EIBFN in the EIB) and the particular exception (EIBRCODE) to find out what message to send. Then we abend the transaction.

Errors Within the Example Application

To summarize, we've designed our error handling as follows:

1. We specifically HANDLE exceptional conditions if they are normal and can be dealt with in the application's logic.

   For example, we expect a NOTFND condition when the user tries to add a new customer account - we read the account record just to make sure that it's not already in the file.

2. We use a HANDLE CONDITION ERROR (whatever) command as a catchall to deal with **unexpected** exceptional conditions. We've put this command near the start of ACCT01, ACCT02, and ACCT03.

3. If and when something unexpected happens, CICS passes control to our error routine (named in the HANDLE CONDITION ERROR). The first thing the error routine must do is issue **another** HANDLE CONDITION ERROR, but *without a label*, to prevent a possible error handling loop, as we said a couple of pages back.

   Next, the error routine gives control to ACCT04, passing the first byte of EIBFN and EIBRCODE. We use a LINK, rather than an XCTL, so that we'll get the failing program and its Working-Storage in the transaction dump. (If we use

XCTL, CICS releases the storage associated with the program we're "XCTLing" from.)

ACCT04 finds out what's wrong, builds and displays an appropriate error screen, and finally issues an ABEND command with a code of EACC, telling CICS to produce the transaction dump.

So the dump will contain a *predictable sequence of actions* between the occurrence of the actual error and ACCT04's last act. We'll show you how to follow this sequence of events in "Working Through a Transaction Abend Dump Listing" on page 246 and "A Session With EDF" on page 219.

There *is* a way of using XCTL rather than LINK when transferring control to our error-handling program. It's also a perfectly reasonable alternative: put an EXEC DUMP command immediately before each appropriate XCTL command in programs ACCT01, ACCT02, and ACCT03.

Of course, you'd probably want to remove these DUMP commands before putting the system into production.

Our solution manages with just one ABEND command (a side effect of which is the transaction dump we want) but has to use a LINK instead of the more efficient XCTL.

Summary of Exception Handling Rules

Having shown these examples, let's summarize the basic rules CICS uses for processing exceptional conditions:

- When a command results in an unusual condition, CICS:

  1. Does what is indicated in the most recently executed HANDLE CONDITION command that names that condition explicitly. This may be to send control to a paragraph in the program or it may result in the CICS default processing for that condition (if the condition was named without a paragraph).

  2. If no HANDLE CONDITION has been executed naming the condition, and the default processing is to abend the transaction, then CICS will do whatever was most recently indicated for the ERROR condition.

  3. If ERROR has never been specified, or if the default is not to abend the transaction, CICS will do its default processing.

- The processing specified for a particular condition in a HANDLE CONDITION command remains in force until another HANDLE CONDITION is executed naming that same condition, or until a subsequent IGNORE CONDITION for that condition. (We've chosen not to use IGNORE CONDITION in our example.)

- It is possible for several exceptions to occur on the same command. CICS checks for them in a fixed order, and acts on the first one it finds. The others are *not* reported to the program.

- HANDLE CONDITION commands apply only to the program in which they are issued. When control passes to a second program, they are deactivated; those specified in the successor program, if any, take force. If this second program is at a lower level and returns control to the first one, the deactivated HANDLE CONDITION commands are reactivated there.

- Figure 54 on page 201 lists which unusual conditions may occur for the commands and options covered in this Primer. Note that other exceptions may arise if you use options or facilities of CICS beyond the scope of this Primer.

Other Facilities for Exceptional Conditions

As mentioned at the start of the chapter, CICS provides other means to control the processing sequence when exception conditions occur:

- There's a command to intercept control directly when CICS determines that a transaction should be terminated abnormally (the HANDLE ABEND command). This is rather a last-ditch method in most cases.

- The set of paragraph names specified to handle exceptional conditions in a program can be suspended temporarily (the PUSH HANDLE command), replaced by others (with HANDLE CONDITION commands) and then restored (with a POP HANDLE command). This is useful for closed subroutines within a program, especially if they contain error-processing code.

  PUSH HANDLE and POP HANDLE apply to the paragraph names specified on HANDLE AID and HANDLE ABEND conditions, as well as those specified with HANDLE CONDITION.

These facilities are described in the APRM.

COMMAND	CONDITIONS
SEND MAP	INVMPSZ
SEND CONTROL	(none)
RECEIVE MAP	INVMPSZ, MAPFAIL
HANDLE AID	(none)
READ	DSIDERR, ILLOGIC, INVREQ, IOERR, LENGERR, NOTFND, NOTOPEN
REWRITE, WRITE	DSIDERR, DUPREC, ILLOGIC, IOERR, INVREQ, LENGERR, NOSPACE, NOTOPEN
DELETE, STARTBR	DSIDERR, ILLOGIC, INVREQ, IOERR, NOTFND, NOTOPEN
READNEXT	DSIDERR, ENDFILE, ILLOGIC, IOERR, INVREQ, LENGERR, NOTOPEN
ENDBR	DSIDERR, ILLOGIC, INVREQ, NOTOPEN
WRITEQ TS	INVREQ, IOERR, ITEMERR, QIDERR, NOSPACE *
READQ TS	IOERR, ITEMERR, LENGERR, QIDERR
DELETEQ TS	QIDERR
LINK, XCTL	PGMIDERR
RETURN	INVREQ
ABEND	(none)
START	INVREQ, IOERR, TERMIDERR, TRANSIDERR
RETRIEVE	INVREQ, INVTSREQ, IOERR, LENGERR, NOTFND
HANDLE CONDITION	(none)

* Of all these conditions, NOSPACE on the WRITEQ TS command is the only one for which CICS default processing is *not* to terminate the transaction. When this condition is encountered, the default processing is for CICS to suspend the transaction until space becomes available. (The theory is that since many transactions use temporary storage, others will eventually give up enough space for this one to continue.)

Figure 54. The Exception Conditions for the Primer's Subset of CICS Commands

An Alternative Philosophy

CICS processing of exceptional conditions can also be circumvented altogether.

Code the NOHANDLE option on the command. The NOHANDLE option, which you can place on any command, causes all exceptions encountered on that single command to be ignored. Immediately after execution of the command, test the field EIBRCODE for LOW-VALUES. LOW-VALUES means the response was normal; anything else indicates something abnormal.

You'll find the possible values of EIBRCODE in Appendix A of the APRM.

Programmers who use this method claim that their code is relatively easy to follow and modify since the flow following a non-normal response can be seen by looking at the program only in the vicinity of the command. Labels don't need to be invented and the program is structured.

For example:

```
EXEC CICS READ DATASET('ACCTFIL') RIDFLD(ACCTC) INTO(ACCTREC)
    LENGTH(ACCT-LNG) NOHANDLE END-EXEC.
IF EIBRCODE NOT EQUAL LOW-VALUES
    IF EIBRCODE = RC-DUPREC THEN PERFORM DUPREC
       ELSE PERFORM DISASTER.
```

You'll need to set up a file containing values for the EIBRCODE values. Here, for example, RC-DUPREC is value

```
X'820000000000'
```

That's six bytes, with hex 82 in the first, and zeros in the rest.

Of course, if you choose this approach, you **must** test EIBRCODE after **every** command that contains the NOHANDLE option (except for commands like RETURN for which CICS does not return to the application). And you must be careful not to overlook possible values of EIBRCODE. In the short piece of code above, anything other than a duplicate record is treated as a disaster.

Some programmers feel that the extensive use of HANDLE CONDITION can lead to an unstructured program that can be difficult to modify. This is because the flow following a CICS command that has a non-normal response depends upon previously executed HANDLE and IGNORE commands.

To follow the flow from a command it is necessary to know all the possible conditions that can occur for it, and then to scan the entire program for any HANDLE and IGNORE statements naming these conditions. There may be several HANDLE statements relevant, and it may be necessary to know the order in which they are executed.

On the other hand, many programs are sufficiently short that finding the HANDLEs and IGNOREs is no problem, and much less application code is needed.

Part 4. The COBOL Code of our Example Application

This Part of the Primer:

is printed separately. It lists the COBOL source code of the example application, namely:

- ACCT00 - menu display
- ACCT01 - initial request analysis
- ACCT02 - update processing
- ACCT03 - requests for printing
- ACCT04 - error processing

By all means, break off now for a look at the COBOL source code. After all, at this point you could actually write a CICS application program if you wanted to.

Of course, you'll still need to know how to test and debug your programs. We cover this in the final part.

Don't forget that you'll need to have a CICS system up and running before you can try out your programs. See the note in the Preface.

Part 5. Testing and Diagnosis

This Part of the Primer describes:

- Types of problem
- The CICS Execution Diagnostic Facility (EDF)
- The temporary storage browse transaction
- Transaction dumps
- CICS abend codes

Chapter 5-1. Testing

This chapter discusses the process of testing application code and finding the causes of problems. When you bring up an application under CICS, problems can occur at any of three levels. They may be confined to the application, and affect only that one application. On the other hand, they may affect the whole of CICS. In the worst case, they affect the entire operating system.

We'll discuss how to go about finding problems in application code, describe some of the tools that CICS provides to help in this process, and show an example of a common error using our example application. Even using the subset of CICS facilities described in this Primer, however, we can't confine the discussion to a convenient subset of mistakes - there's no such thing. Debugging is a complex subject and very sensitive to the particular application, so that it isn't possible to discuss exhaustively even the level of errors that might affect only one application.

Problems that affect the whole CICS system are generally even more difficult, as are operating-system problems, so we'll be leaving these entirely to other sources of information.

Preparing to Test

You have to do two main tasks before you can attempt to test and debug an application:

- You need to prepare the application and the system table entries.
- You need to prepare the system for debugging.

Preparing the Application and System Table Entries

1. Translate, compile and link-edit each program. Make sure that there are no error messages on any of these three steps for any program before you begin testing.
2. Use the DEBUG option on your Translator step, so that you can use Translator statement numbers with Execution Diagnostic Facility (EDF) displays.
3. Use the COBOL compiler options CLIST, and SYM (DOS) or DMAP (OS) so that you can relate storage locations in dumps and Execution Diagnostic Facility

(EDF) displays to the original COBOL source statements, and find your variables in Working-Storage.

4. Put an entry in the PCT (or, if you're using **resource definition online** (RDO),[5] use the DEFINE TRANSACTION command) for each transaction in the application.

5. Put an entry in the PPT (or, with RDO, use the DEFINE PROGRAM command) for each program used in the application.

6. Put an entry in the PPT (or, with RDO, use the DEFINE MAPSET command) for each mapset in the application.

7. If you are using RDO, be sure to INSTALL the new definitions.

8. Put an entry in the FCT for each file used.

9. Build at least a test version of each of the files required.

10. Put job control DLBL, EXTENT and ASSGN cards (or the equivalent OS DD cards) in the startup job stream for each file used in the application.

11. Prepare some test data.

Preparing the System for Debugging

1. Make sure that EDF is included in your system. If you're using RDO, include Group DFHEDF in the list you specify in the GRPLIST parameter of the SIT. If not, specify

```
DFHPPT TYPE=GROUP,FN=EDF
DFHPCT TYPE=GROUP,FN=EDF
```

   in the PPT and PCT respectively.

2. Turn the trace on and allow a generous trace table (at least 200 entries, better 500). Specify in the SIT:

5 Resource Definition Online (RDO) allows you to add processing program table (PPT) and program control table (PCT) entries for a new application program to a running CICS system.

```
TRP=(YES,ON) or TRP=(xx,ON)
and TRT=nnn where nnn>200
```

3. Request that dumps be provided, for both the transaction and the system, for all abnormal terminations. Specify in the SIT:

```
DCP=YES or DCP=xx
and FDP=(xx,FORMAT) or FDP=(xx,FULL)
```

4. Be prepared to print the dumps. Have a DFHDUP job stream or procedure ready, and have the CICS dump data set(s) defined in your startup procedure.

5. Enable CICS to detect loops, by setting the ICVR parameter in the SIT to a number greater than zero. Something between 5 and 10 seconds (ICVR=5000 to ICVR=10000) is usually a workable value.

6. Turn off storage recovery (SIT parameter SVD=NO), so that CICS won't try to recover after one of its storage areas is over-written. Then you will know as soon as CICS does that you've made this pernicious error. For production, storage recovery should be on. For testing, unless a great many people are testing at once, it is better left off.

7. Generate shutdown statistics.

Types of Problem

Once you start to test, the first few problems you meet will probably be what we call **startup problems**. Most of these will be in that category we described in "Handling Errors and Exceptional Conditions" on page 90 as category 4 "system-application mismatches." They will produce abends that can be investigated like any others. However, there may also be system initialization problems, terminal problems, and so on. While we won't try to address these directly here, "Reference Materials" on page 256 lists sources of information for help in these areas.

When you reach the point where you can begin executing your code, you will find the problems you meet can be grouped by symptom into four general types. This classification is useful, because you need to take a slightly different approach to each type. Also, it is the same problem-classification scheme used by IBM programming support representatives (PSRs). So if you require assistance, it will help you in identifying your problem to IBM. The four types are:

- Abends
- Loops
- Waits
- Incorrect output.

We'll discuss the identifying symptoms first, and later (in "Chapter 5-2. Finding the Problem" on page 255) suggest approaches for solution.

Abends

Abends are readily identified by the presence of that same unwelcome word in a message from CICS. When a transaction terminates abnormally, CICS sends this message both to the terminal associated with the transaction and to the transient data message destination CSMT. (At most CICS installations, this message destination is directed to a printer used by the master terminal operator, to provide a second immediate notification of the unhappy event.)

Loops

Loops come in two varieties. If you have a loop containing no CICS commands, CICS generally detects this condition and terminates your transaction with an AICA abend. It will fail to do so only if you have disabled this facility (by setting ICVR = 0 in the SIT or by setting it to such a large value that the effect is the same).

If the loop contains a CICS command, however, CICS may not detect it. The problem symptom is that the transaction never ends. It usually produces less than all of the expected output and leaves the keyboard locked, too.

Waits

The symptoms of a transaction in the **wait** state are the same as those described for a loop containing a CICS command: the transaction never ends and may not produce all of its outputs. If your transaction behaves like this, you can tell whether you have a loop or a wait by using the CEMT transaction. Display the task:

```
CEMT INQUIRE TASK FACILITY(tttt)
```

("tttt" is the name of the terminal from which the transaction was entered.) If the task still exists and is active, wait a minute and repeat the inquiry. If the same task is still there, the program is probably in a loop that contains a CICS command.

If the task is not active but suspended, repeat the display once or twice. If the task remains suspended, it's probably waiting for some event that's never going to happen. There is a third possibility when you display your task, of course. It may not be there at all! This disappearing transaction syndrome is really a form of "incorrect output" (as described below), but it's usually tracked down using the techniques used for loops.

When you have a transaction that seems to be stuck in a loop or a wait, cancel it with the CEMT command:

```
CEMT SET TASK FACILITY(tttt) FORCEPURGE
```

This will produce an AMTx abend, and a dump that you can use to help determine where the loop or wait is.

A word of caution about canceling tasks, however. Some perfectly normal tasks spend a lot of time in a suspended state. A transaction that writes multiple messages to a printer, for example, is suspended most of its lifetime, waiting for the printer to print the last message it sent. And, with FORCEPURGE, CICS cannot assure system integrity, so use it with care. It's ok while debugging, but avoid it in a production system.

Incorrect Output

The last category of problem covers those situations in which the transaction appears to run successfully but produces the wrong results. It includes simple wrong answers, missing or extra records in files, screens filled with what appear to be random characters, and no output at all, where a transaction just shuffles off quietly without any indication that it ever existed.

Tools for Debugging

Before trying to describe approaches to solving these four classes of problems (which we tackle in the next chapter), we need to describe three important tools that CICS provides for debugging applications. These are:

- The Execution Diagnostic Facility (EDF)
- The temporary storage browse (CEBR) facility
- The transaction dump.

Execution Diagnostic Facility (EDF)

You'll find a complete EDF session reproduced in "A Session With EDF" on page 219; refer to it whenever you need to. (Please note that it shows the example application misbehaving due to the presence of a deliberate bug...)

EDF allows you to observe the execution of your transaction under the control of another transaction, CEDF. When you execute your transaction in this debugging mode, EDF intercepts your program(s) at the following points:

1. Transaction initiation (just before the first program gets control)
2. Just before the execution of each CICS command
3. Just after the execution of each CICS command (except ABEND, XCTL and RETURN)
4. At the termination of each program
5. At normal task termination
6. When an abend occurs
7. At abnormal task termination.

At these points, EDF interrupts execution of the program and sends a display back to the terminal. This display indicates which of these interception points has been reached and shows information appropriate to the situation.

Other Information Displayed

At any one of these points, you can also display a variety of other information by selecting one of the function-key options listed on the screen. The choices include:

1. The EIB. The values are displayed in symbolic form, as described in the APRM.
2. Working-Storage for the program being executed. The display shows the information in both hexadecimal and character form.
3. The option of showing up to ten previous EDF displays, including all the argument values, responses, and so on.
4. The contents of any temporary storage queue.
5. The contents (in hexadecimal) of any address location within the CICS partition.

Useful Techniques with EDF

Once you have an idea about what is wrong with a program, you can test your theory by intervening in its execution:

1. Before a command is executed, you can modify any argument value (but not the command options) or you can suppress execution of the command altogether.

2. After a command is executed, you can modify the response code (and some of the argument values). This allows you to test branches of the program that are hard to reach using ordinary test data (what happens on an input/output error, for instance). It also allows you to bypass the effects of an error to see if doing so eliminates a problem.

3. At any time except just before execution of a command, you can turn off the debug mode and let the transaction proceed without any further intervention from EDF.

4. Alternatively, at any time you can suppress the displays associated with EDF until some specific condition is reached. When it is, the displays resume again. This is particularly useful when you are debugging a fairly long or repetitive transaction, because you might have to go through a lot of displays before you get to the point where the trouble is, making the process very slow. If you know that the transaction runs properly up to a certain point, you can specify that point as the condition for resuming displays, and suppress them up until then. Once the stop condition is reached, you still have access to the previous ten displays, even though they were not actually sent to the screen when originally created.

   You can express this stop condition in several different ways:

   - When a specific type of command is encountered, such as READQ TS
   - When a specific exceptional condition arises, such as NOTFND
   - When any exceptional condition at all (that CICS classifies as an error) arises
   - When the command at a specific offset is encountered
   - When the command at a specific translator line number is encountered (if the DEBUG option of the Translator has been used)
   - When any abend occurs
   - When the task terminates.

5. At any point at all, you can change the contents of Working-Storage for your program, and you can change most of the fields in the EIB as well.

Invoking EDF

You can run EDF using either one terminal or two.

For Two Terminals: You use the first terminal for the EDF displays and for sending input to EDF; and you use the second terminal for sending input to, and receiving output from, the transaction under test.

You start by entering, at the first terminal, the transaction:

```
CEDF tttt
```

where “tttt” is the name of the other terminal to be used in the EDF session. This second terminal must be in transceive (ATI/TTI) status. This is the most common status for display terminals, but you can check its status with CEMT:

```
CEMT INQUIRE TERMINAL(tttt)
```

and change it if it isn’t already ATI/TTI:

```
CEMT SET TERMINAL(tttt) ATI TTI
```

Then enter the transaction to be tested on this second terminal.

If you want to use EDF to monitor a transaction that’s already running, you can do so from another terminal. If, for example, you believe a transaction at a certain terminal to be looping, you can go to another terminal and enter a CEDF transaction naming the first terminal. EDF picks up control at the next CICS command executed, and you can then observe the sequence of commands that are causing the loop.

For One Terminal: When you use EDF with just one terminal, the EDF inputs and outputs are interleaved with those from the transaction. This sounds complicated, but works quite easily in practice. The only noticeable peculiarity is that when a SEND command is followed by a RECEIVE command, the display sent by the SEND command appears twice: once when the SEND is executed, and again when the RECEIVE is executed. It isn’t necessary to respond to the first display, but if you do, EDF preserves anything that was entered from the first display to the second.

To start a one-terminal session with EDF, just enter the transaction identifier “CEDF.” Then enter the input that invokes the transaction you want to test.

Note: EDF makes a special provision for testing pseudoconversational transactions from a single terminal. If the terminal came out of debug mode between the several tasks that make up a pseudoconversational transaction, it would be very hard to do any debugging after the first task. So, when a task terminates, EDF asks the operator whether debug mode is to continue to the next task. If you are debugging a pseudoconversational task, reply "yes".

EDF Displays

EDF displays consist of a header and the screen "body." The header shows:

- The identifier of the transaction being executed
- The name of the program being executed
- The internal task number assigned by CICS to the transaction.
- A display number.
- Under "STATUS," the reason for the interception by EDF.

The body of the screen contains information which varies with the type of interception point, as follows:

1. **At transaction initiation**, it shows the EIB.

2. **When a command is about to be executed**, it shows the command in source language form, including the keywords, options and argument values. The command is identified by giving the name of the transaction, the name of the program being executed, and the hexadecimal offset of the command in the program. If the Translator DEBUG option has been used, the line number in the *translator* source listing will also be displayed.

3. **After the command has been executed**, the same display as for item 2 appears, along with the results (response code), in source language.

4. **Whenever an abend occurs, and at termination time for a transaction ending abnormally**, the display includes:

   - The EIB
   - The abend code
   - For an ASRA abend, the program status word (PSW) value at the time of the interrupt
   - The offset within the program of this PSW, provided it is within the program being executed.

EDF Options

The last section of an EDF display contains a menu of things you can do at that point. The choices are listed below. Not all choices are available at each interception point; the menu shows which ones are available for the current display. To select an option, press the indicated PF key. If your terminal doesn't have PF keys, place the cursor under the option you want and press the ENTER key instead.

abend user task
Selecting this option causes the transaction being monitored to be abended, just as if an ABEND command had been issued in the program. When you make this choice, EDF asks you to enter an abend code (the ABCODE parameter of the command) to request the abend again, and then to press ENTER again, as confirmation that you really want to do this.

browse temporary storage
This option produces a display of the temporary storage queue CEBRxxxx, where xxxx is the name of the terminal from which the monitored transaction is being run. You can then use CEBR commands, discussed in "Temporary Storage Browse Facility (CEBR)" on page 242, to display or modify other temporary storage queues.

continue
If you've made changes to the screen, EDF redisplays the screen with the changes incorporated. (See "Modifying Execution with EDF" on page 218.) Otherwise it allows the transaction to continue running until the next interrupt point.

current display
If you've modified a screen, this option causes EDF to redisplay the screen with the changes incorporated. Otherwise, it causes EDF to display the screen it showed at the last interrupt point, before you requested other displays.

EIB display
This option displays the EIB contents in symbolic form. If there is a COMMAREA at this time, its contents are also displayed.

end EDF session
This choice terminates EDF control of the transaction. The transaction resumes execution from that point, but no longer runs in debug mode.

previous display
Selecting this option causes the previous display (from the previous command, unless you've requested that other displays be remembered) to be sent to the screen. The number of the display from the current interrupt point is always 00. As you call up previous displays, the display number is decreased by 1 to -01 for the first previous display, -02 for the one before that, and so on down to the oldest display, -10.

next display
This option is the reverse of previous display. When you've gone back to a previous display, this option causes the next one forward to be shown. The display number is increased by 1.

registers at abend
This option is provided only when an ASRA abend occurs. It produces a display of the PSW and the registers at the time of the abend.

scroll forward, scroll back
These options apply to an EIB or command display that will not all fit on one screen. When this happens, a plus sign (+) appears before the first option or field in the display, to show that there are more screens. Choosing scroll forward brings up the next screen in the display. When the screen on view isn't the first one of the display, there is a minus sign (-) before the first option or field, and you can view previous screens in the display by selecting scroll back.

scroll forward full, scroll back full
These two options have the same function for displays of Working-Storage as the scroll forward and scroll back options for EIB displays. Scroll forward full gives a Working-Storage display one full screen forward, showing addresses higher in storage than those on the previous screen. Scroll back full shows the addresses lower in storage than those on the previous screen.

scroll forward half, scroll back half
Scroll forward half is similar to scroll forward full, except that the display of working storage is advanced by only half a screen. This means that the addresses on the bottom half of the previous screen still appear on the top half of the new screen, followed by the next half-screen of higher addresses. Scroll back half is the backward counterpart of scroll forward half.

suppress displays
This option causes EDF to suppress its displays until one of the stop conditions (see next item) is met.

stop conditions
Selecting this option causes EDF to present a menu, in which you can specify conditions under which you want a display. You use this feature when you are about to suppress the displays, to indicate when they should be resumed again. However, you can also use it to get displays at points in the code between the normal EDF interception points. This is particularly helpful in locating loops and finding the cause of incorrect output.

switch hex/char
If EDF is displaying information in character form, this option causes it to switch to hexadecimal for subsequent displays, and back again. It applies only to the basic interrupt display and does not affect Working-Storage displays, stop condition displays, or remembered displays.

user display
This option causes EDF to display what would be on the screen if the transaction were not running under EDF. To get back to EDF from the user display, simply press the ENTER key.

working storage

This option allows you to see the contents of the Working-Storage area in your program, or of any other address in the CICS partition. The address of Working-Storage is displayed at the top of the screen. You can browse through the entire area using the scroll commands, or you can simply enter a new address at the top of the screen. This address can be anywhere within the CICS partition.

remember display

This option allows you to record displays that EDF does not ordinarily save. EDF can save up to ten displays, and it keeps the last ten command displays unless you use this option to save something else. Note, however, that if you save a working storage display, only the screen on view is saved; otherwise all the pages that make up the display are saved and can be recalled.

Modifying Execution with EDF

You can modify the execution of a transaction in four different ways:

- Changing the contents of Working-Storage and the EIB
- Changing the argument values before a command is executed
- Changing the response code afterward
- Suppressing commands altogether.

You make these changes by typing over the information shown on the screen with the information you want used instead. You can change any area of the screen where the cursor stops when you use the tab keys, except for the menu area at the bottom.

When you change the screen, you must observe the following conventions:

- If you want to suppress the execution of a command entirely, type NOP over the first three characters of the command.

- You can change argument values in commands, but not keywords.

- When you change an argument in the command display (as opposed to Working-Storage), you can change only the part shown on the display. If it is such a long argument that only part of it appears on the screen, you should change the area in Working-Storage to which the argument points.

- You can change the response code from a command to any response code that applies to that command, including the all-purpose ERROR. In this way you can test your program's error recovery routines.

- Conversely, if the response code from a command was some exceptional condition, and you want to see what would happen if you'd had a normal response to the command, type NORMAL over the response code.

- When you overtype a field representing a data area in your program, the change is made directly in program storage and is permanent. However, if you change a field that represents a constant (a program literal), program storage isn't changed, because this might affect any other parts of the program that use the same constant. The command is executed with the changed data, but when the command is displayed after execution, the original argument values re-appear. If you execute the same command more than once, you must enter this type of change afresh each time.

- When arguments are displayed in character form, any character that cannot be displayed on the screen is shown as a period (.). So you're not allowed to change any character to a period in a character display. If you must do this, use the switch hex/char option to change to a hexadecimal display and then use "4B" for period.

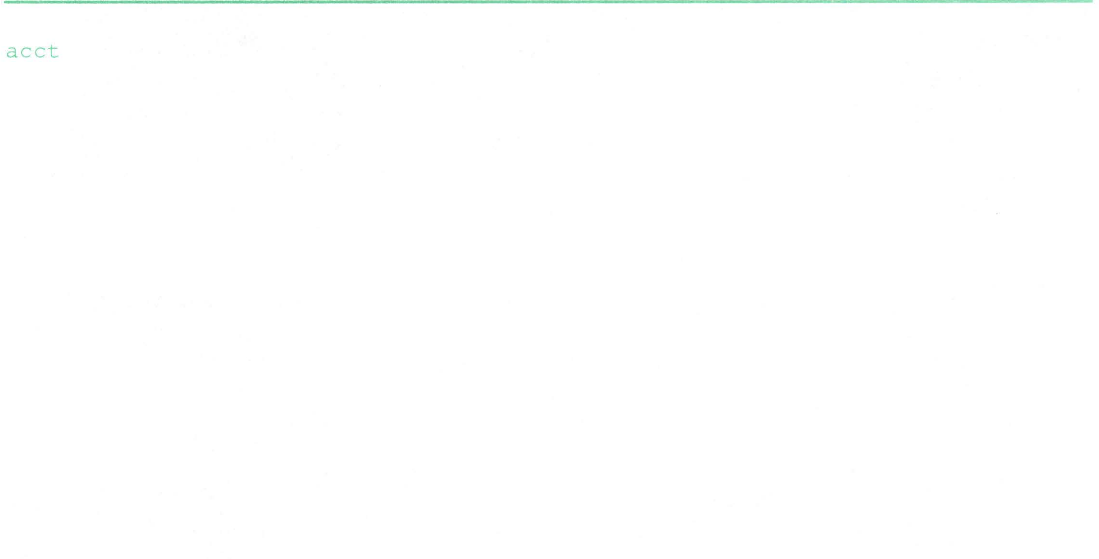
- EDF only accepts uppercase characters. If your terminal has lowercase, and uppercase translation is not specified for it in the TCT, be careful to use uppercase at all times.

A Session With EDF

What follows is an "as it happened" reproduction of an EDF session after we'd found that the example application had a nasty little bug in it.

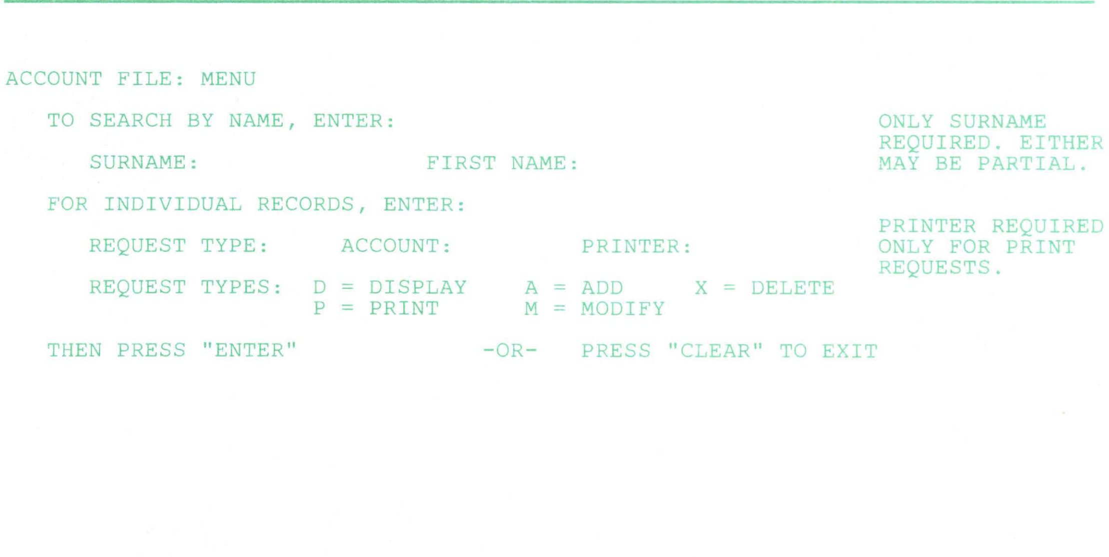
It all began innocently enough, simply by trying to delete account record number 11111 from our account file....

The first thing we did, of course, was type in the transaction id:



```
acct
```

Figure 55. Invoking the Account File Transaction

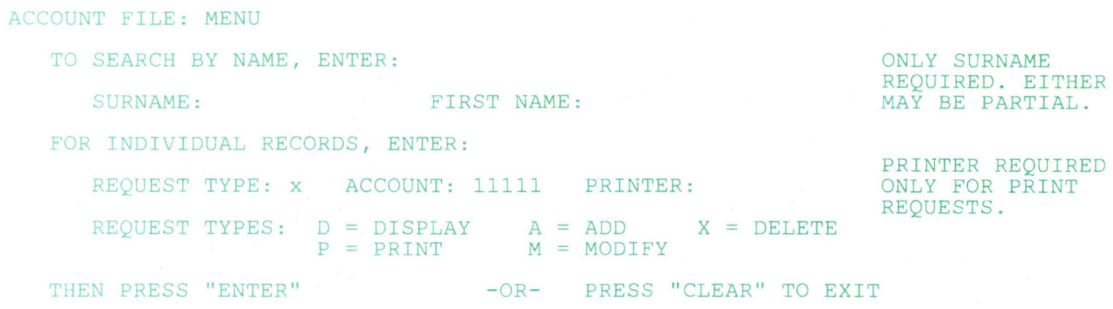


```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                     ONLY SURNAME
                                                                 REQUIRED. EITHER
      SURNAME:                 FIRST NAME:                       MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                 PRINTER REQUIRED
      REQUEST TYPE:      ACCOUNT:        PRINTER:                ONLY FOR PRINT
                                                                 REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD      X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"            -OR-    PRESS "CLEAR" TO EXIT
```

Figure 56. The Account File Menu

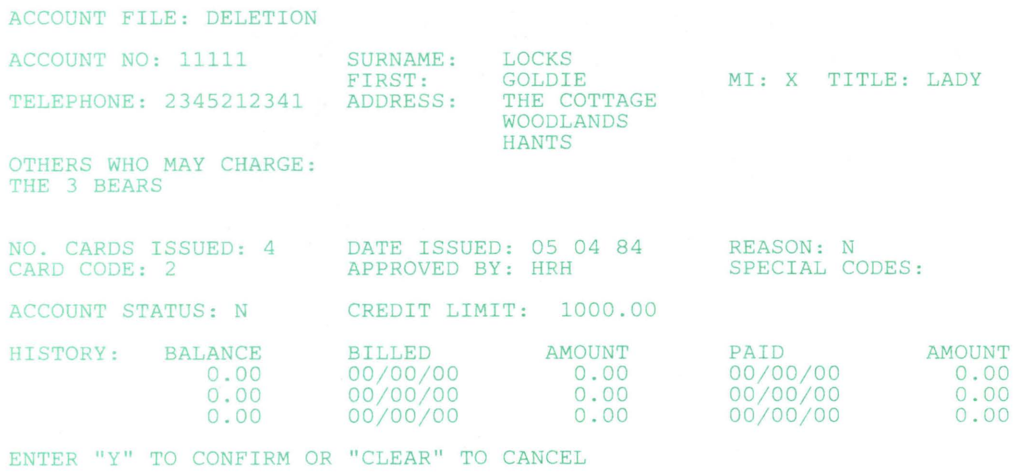
This gave us the menu, as shown above. Next, we had to say which record we wanted to delete.

So we typed in x (for delete) and 11111 (the record number) and pressed the ENTER key.



```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                          ONLY SURNAME
                                                                      REQUIRED. EITHER
      SURNAME:                 FIRST NAME:                            MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                      PRINTER REQUIRED
      REQUEST TYPE: x    ACCOUNT: 11111    PRINTER:                   ONLY FOR PRINT
                                                                      REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD     X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"             -OR-   PRESS "CLEAR" TO EXIT
```

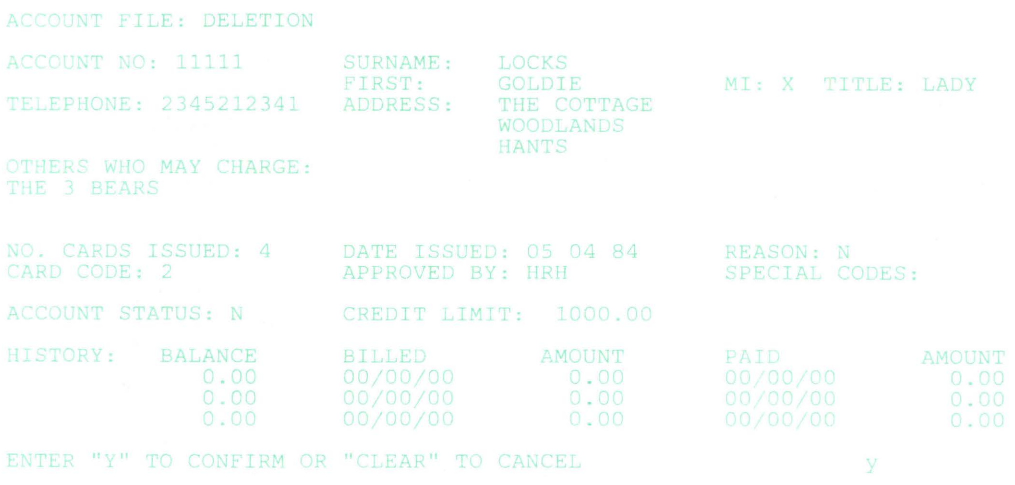
Figure 57. Let's Delete Account Number 11111



```
ACCOUNT FILE: DELETION

ACCOUNT NO: 11111        SURNAME:   LOCKS
                         FIRST:     GOLDIE              MI: X   TITLE: LADY
TELEPHONE: 2345212341    ADDRESS:   THE COTTAGE
                                    WOODLANDS
                                    HANTS

OTHERS WHO MAY CHARGE:
THE 3 BEARS


NO. CARDS ISSUED: 4      DATE ISSUED: 05 04 84          REASON: N
CARD CODE: 2             APPROVED BY: HRH               SPECIAL CODES:

ACCOUNT STATUS: N        CREDIT LIMIT:  1000.00

HISTORY:    BALANCE      BILLED         AMOUNT          PAID           AMOUNT
               0.00      00/00/00         0.00          00/00/00         0.00
               0.00      00/00/00         0.00          00/00/00         0.00
               0.00      00/00/00         0.00          00/00/00         0.00

ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL
```

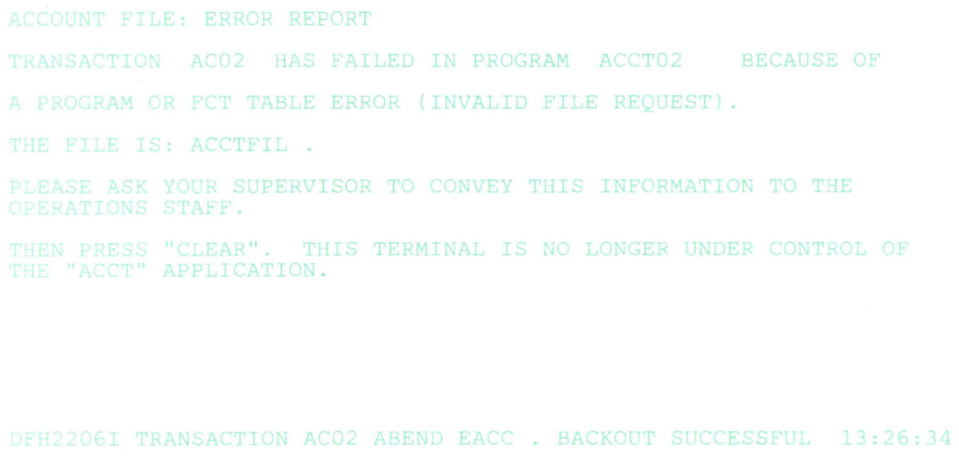
Figure 58. Now Confirm the Deletion...

As you see, this fetched Goldie Locks' record, and asked us to confirm the deletion.



```
ACCOUNT FILE: DELETION

ACCOUNT NO: 11111         SURNAME:    LOCKS
                          FIRST:      GOLDIE           MI: X   TITLE: LADY
TELEPHONE: 2345212341     ADDRESS:    THE COTTAGE
                                      WOODLANDS
                                      HANTS

OTHERS WHO MAY CHARGE:
THE 3 BEARS


NO. CARDS ISSUED: 4       DATE ISSUED: 05 04 84        REASON: N
CARD CODE: 2              APPROVED BY: HRH             SPECIAL CODES:

ACCOUNT STATUS: N         CREDIT LIMIT:  1000.00

HISTORY:    BALANCE       BILLED        AMOUNT         PAID          AMOUNT
               0.00       00/00/00        0.00         00/00/00        0.00
               0.00       00/00/00        0.00         00/00/00        0.00
               0.00       00/00/00        0.00         00/00/00        0.00

ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL                     y
```

Figure 59. ... By typing "Y"



```
ACCOUNT FILE: ERROR REPORT

TRANSACTION  AC02  HAS FAILED IN PROGRAM  ACCT02    BECAUSE OF

A PROGRAM OR FCT TABLE ERROR (INVALID FILE REQUEST).

THE FILE IS: ACCTFIL .

PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORMATION TO THE
OPERATIONS STAFF.

THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGER UNDER CONTROL OF
THE "ACCT" APPLICATION.





DFH2206I TRANSACTION AC02 ABEND EACC . BACKOUT SUCCESSFUL  13:26:34
```

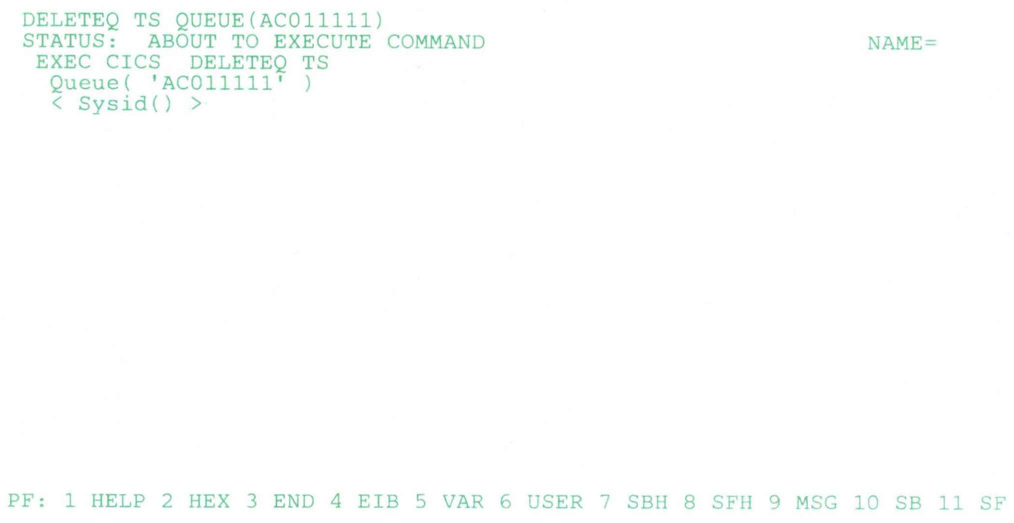
Figure 60. Hold it! We've Got a Problem - and We've Been Backed Out

Well! That didn't work, so what do we do next? First, we'd better delete the scratchpad entry for this record, so we can try again, this time with EDF on. (You see, we've just reserved account number 11111 in ACCT01 before we displayed the Account Detail screen. So, unless we now remove the reservation, we won't be able to try the deletion again for ten minutes. We'll use CECI, a useful CICS transaction - the command interpreter.)

First, we CLEAR the screen, then we can type:

```
ceci deleteq ts queue(ac011111)
```

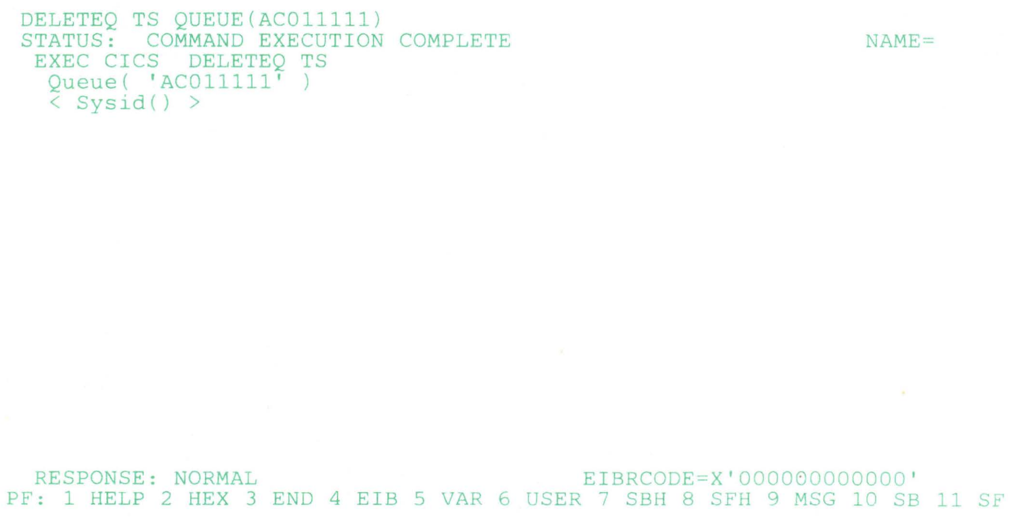
Figure 61. Deleting the Scratchpad Record. We have to do this so that we can retry the deletion.



```
 DELETEQ TS QUEUE(AC011111)
 STATUS:  ABOUT TO EXECUTE COMMAND                           NAME=
  EXEC CICS  DELETEQ TS
   Queue( 'AC011111' )
   < Sysid() >















PF: 1 HELP 2 HEX 3 END 4 EIB 5 VAR 6 USER 7 SBH 8 SFH 9 MSG 10 SB 11 SF
```

Figure 62. Going, Going, ...

We just press ENTER to delete the queue entry.



```
 DELETEQ TS QUEUE(AC011111)
 STATUS:  COMMAND EXECUTION COMPLETE                         NAME=
  EXEC CICS  DELETEQ TS
   Queue( 'AC011111' )
   < Sysid() >














  RESPONSE: NORMAL                       EIBRCODE=X'000000000000'
PF: 1 HELP 2 HEX 3 END 4 EIB 5 VAR 6 USER 7 SBH 8 SFH 9 MSG 10 SB 11 SF
```

Figure 63. Gone!

First we hit PF3 to end the CECI transaction, and CLEAR to get a clear screen.

Now we can use EDF to try and find out what's going wrong. To invoke the facility we simply type CEDF:

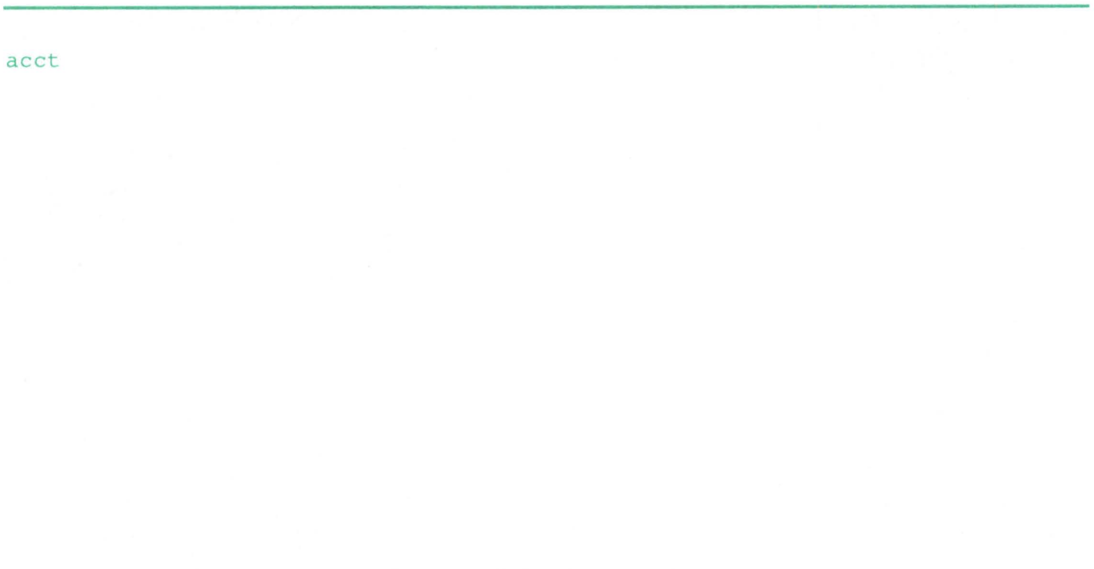
```
cedf
```

Figure 64. Now Activate EDF

```
THIS TERMINAL: EDF MODE ON
```

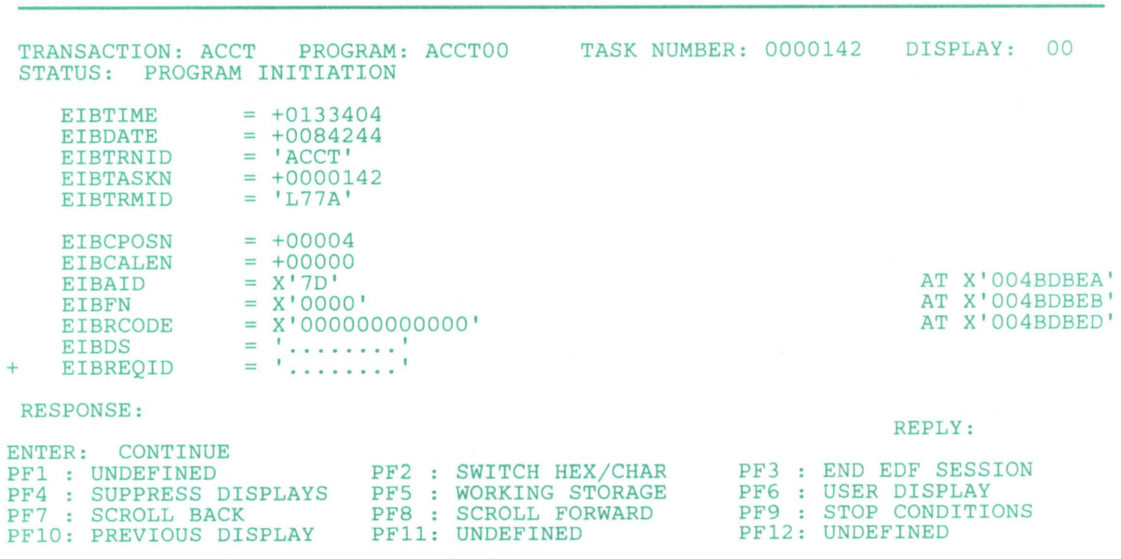
Figure 65. OK

Now we can CLEAR the screen and re-enter the ACCT transaction:



```
acct
```

Figure 66. Now Re-enter the Account File Transaction



```
TRANSACTION: ACCT   PROGRAM: ACCT00     TASK NUMBER: 0000142   DISPLAY:  00
STATUS:  PROGRAM INITIATION

   EIBTIME      = +0133404
   EIBDATE      = +0084244
   EIBTRNID     = 'ACCT'
   EIBTASKN     = +0000142
   EIBTRMID     = 'L77A'

   EIBCPOSN     = +00004
   EIBCALEN     = +00000
   EIBAID       = X'7D'                                  AT X'004BDBEA'
   EIBFN        = X'0000'                                AT X'004BDBEB'
   EIBRCODE     = X'000000000000'                        AT X'004BDBED'
   EIBDS        = '........'
+  EIBREQID     = '........'

 RESPONSE:
                                                       REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED            PF2 : SWITCH HEX/CHAR       PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE       PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD        PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: UNDEFINED             PF12: UNDEFINED
```

Figure 67. And Into EDF

Here's our first EDF screen. From now on, we'll use the PF4 key to suppress displays. EDF goes on building (and remembering) its displays - we simply don't want to be overwhelmed by seeing them all. (At any point, you can use the PF10 key to step back through a maximum of ten previous displays. We'll see how later on.)

Any abnormal response, or any program output, or the end of the task, will all end the display suppression and show us the appropriate screen. Press the PF4 key, then, and away we go!

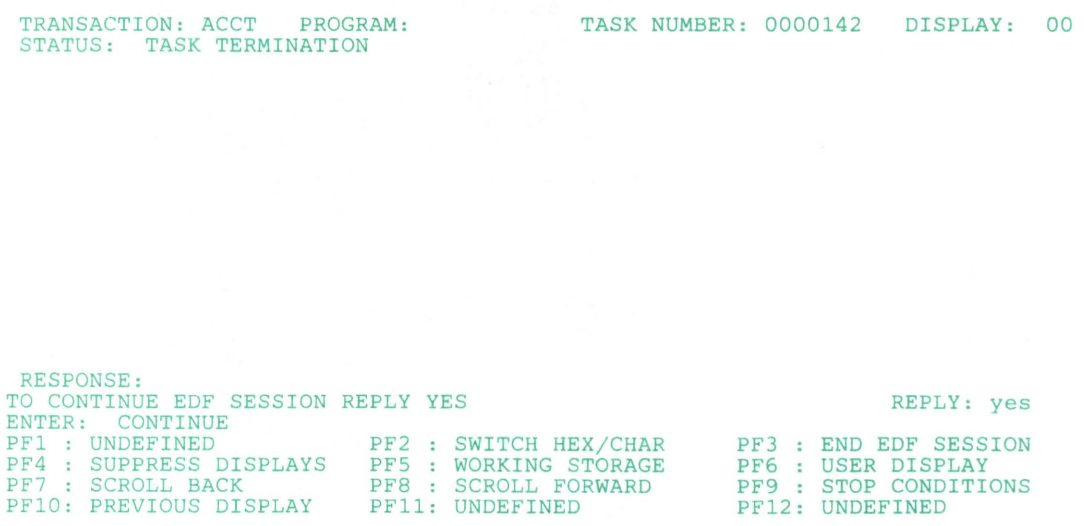
And the next screen we see is this one:

```
 TRANSACTION: ACCT   PROGRAM:               TASK NUMBER: 0000142   DISPLAY:  00
 STATUS:  TASK TERMINATION










 RESPONSE:
TO CONTINUE EDF SESSION REPLY YES                                 REPLY: NO
ENTER:  CONTINUE
PF1 : UNDEFINED              PF2 : SWITCH HEX/CHAR     PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS      PF5 : WORKING STORAGE     PF6 : USER DISPLAY
PF7 : SCROLL BACK            PF8 : SCROLL FORWARD      PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY       PF11: UNDEFINED           PF12: UNDEFINED
```

Figure 68. OK So Far

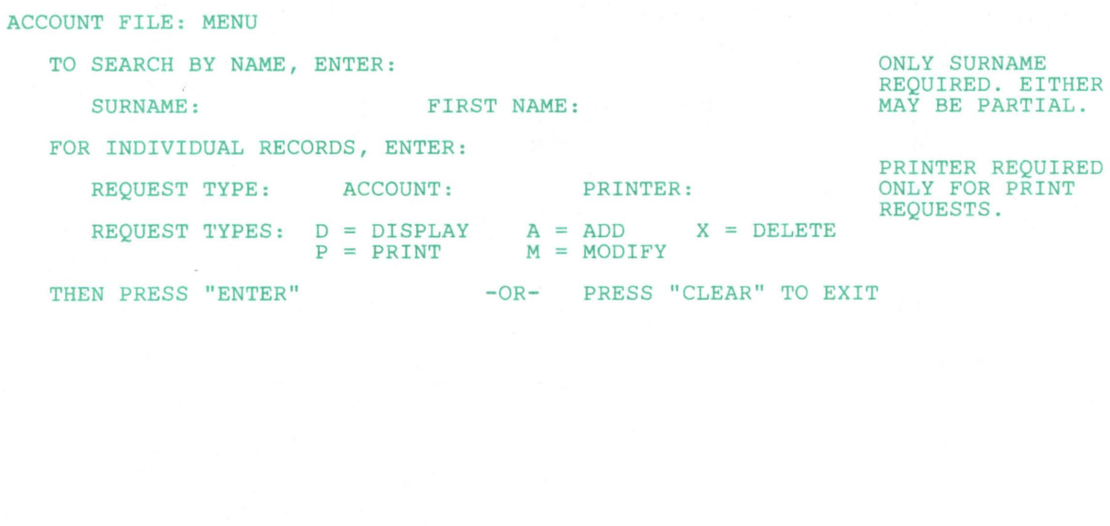
We overtype the "REPLY: NO" with our "yes" and (as usual) press ENTER.

This ensures that EDF will continue monitoring the next transaction (AC01) in our pseudoconversational sequence.



```
 TRANSACTION: ACCT   PROGRAM:              TASK NUMBER: 0000142   DISPLAY:  00
 STATUS:  TASK TERMINATION










 RESPONSE:
TO CONTINUE EDF SESSION REPLY YES                                  REPLY: yes
ENTER:  CONTINUE
PF1 : UNDEFINED           PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS   PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK         PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY    PF11: UNDEFINED            PF12: UNDEFINED
```

Figure 69. Again "yes" to Continue With the Next Transaction



```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                      ONLY SURNAME
                                                                  REQUIRED. EITHER
      SURNAME:                 FIRST NAME:                        MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                  PRINTER REQUIRED
      REQUEST TYPE:     ACCOUNT:          PRINTER:                ONLY FOR PRINT
                                                                  REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD       X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"               -OR-    PRESS "CLEAR" TO EXIT
```

Figure 70. Back to the Menu

Suppression of EDF displays ends for the time being with our user screen, the menu.

Now we type in that troublesome record, 11111.

```
ACCOUNT FILE: MENU

   TO SEARCH BY NAME, ENTER:                                          ONLY SURNAME
                                                                      REQUIRED. EITHER
      SURNAME:                FIRST NAME:                             MAY BE PARTIAL.

   FOR INDIVIDUAL RECORDS, ENTER:
                                                                      PRINTER REQUIRED
      REQUEST TYPE: x    ACCOUNT: 11111    PRINTER:                   ONLY FOR PRINT
                                                                      REQUESTS.
      REQUEST TYPES:  D = DISPLAY     A = ADD      X = DELETE
                      P = PRINT       M = MODIFY

   THEN PRESS "ENTER"             -OR-    PRESS "CLEAR" TO EXIT
```

Figure 71. Now We Can Enter Record 11111

We press ENTER, cross our fingers, and see what happens...

```
 TRANSACTION: AC01   PROGRAM: ACCT01     TASK NUMBER: 0000149   DISPLAY:  00
 STATUS:  PROGRAM INITIATION

    EIBTIME      = +0133428
    EIBDATE      = +0084244
    EIBTRNID     = 'AC01'
    EIBTASKN     = +0000149
    EIBTRMID     = 'L77A'

    EIBCPOSN     = +00691
    EIBCALEN     = +00000
    EIBAID       = X'7D'                                           AT X'004BDBEA'
    EIBFN        = X'0000'                                         AT X'004BDBEB'
    EIBRCODE     = X'000000000000'                                 AT X'004BDBED'
    EIBDS        = '........'
+   EIBREQID     = '........'

 RESPONSE:
                                                                REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED             PF2 : SWITCH HEX/CHAR       PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS     PF5 : WORKING STORAGE       PF6 : USER DISPLAY
PF7 : SCROLL BACK           PF8 : SCROLL FORWARD        PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY      PF11: UNDEFINED             PF12: UNDEFINED
```

Figure 72. Ready to Begin the Request Analysis. Here's the next EDF display.

Again, we'll use PF4 to suppress displays until something unusual happens.

```
 TRANSACTION: AC01   PROGRAM: ACCT01      TASK NUMBER: 0000149    DISPLAY:  00
 STATUS:  COMMAND EXECUTION COMPLETE
 EXEC CICS READQ TS
  QUEUE ('AC011111')
  INTO ('    ........')
  LENGTH (+00012)
  ITEM (+00001)







 OFFSET:X'00203E'    LINE:00263           EIBFN=X'0A04'
 RESPONSE: QIDERR                         EIBRCODE=X'020000000000'
                                                                REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED             PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS     PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK           PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY      PF11: UNDEFINED            PF12: ABEND USER TASK
```

Figure 73. Response: QIDERR. This tells us no-one else owns our record.

And here we are with a QIDERR condition. However, it's what we expect when reading the scratchpad entry, so we can proceed. Using PF4 again to suppress displays, let's carry on....

```
 TRANSACTION: AC01   PROGRAM:                TASK NUMBER: 0000149   DISPLAY:  00
 STATUS:  TASK TERMINATION









 RESPONSE:
TO CONTINUE EDF SESSION REPLY YES                                REPLY: NO
ENTER:  CONTINUE
PF1 : UNDEFINED           PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS   PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK         PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY    PF11: UNDEFINED            PF12: UNDEFINED
```

Figure 74. OK, Carry On

```
 TRANSACTION: AC01   PROGRAM:                TASK NUMBER: 0000149   DISPLAY:  00
 STATUS:  TASK TERMINATION









 RESPONSE:
TO CONTINUE EDF SESSION REPLY YES                                REPLY: yes
ENTER:  CONTINUE
PF1 : UNDEFINED           PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS   PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK         PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY    PF11: UNDEFINED            PF12: UNDEFINED
```

Figure 75. "yes" to Carry On Into AC02

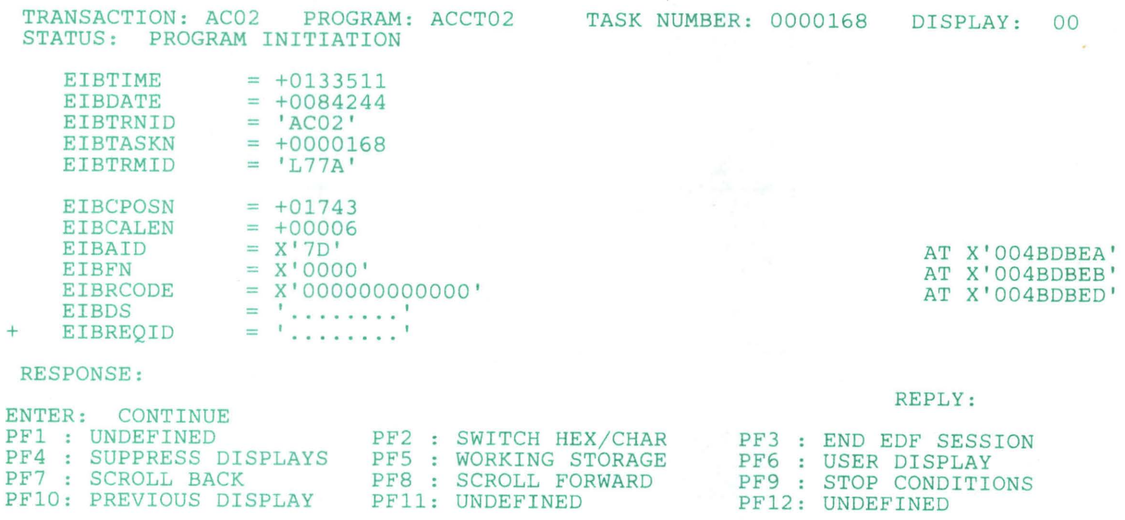
```
ACCOUNT FILE: DELETION

ACCOUNT NO: 11111       SURNAME:   LOCKS
                        FIRST:     GOLDIE          MI: X  TITLE: LADY
TELEPHONE: 2345212341   ADDRESS:   THE COTTAGE
                                   WOODLANDS
                                   HANTS

OTHERS WHO MAY CHARGE:
THE 3 BEARS


NO. CARDS ISSUED: 4     DATE ISSUED: 05 04 84      REASON: N
CARD CODE: 2            APPROVED BY: HRH           SPECIAL CODES:

ACCOUNT STATUS: N       CREDIT LIMIT:  1000.00

HISTORY:   BALANCE      BILLED        AMOUNT       PAID          AMOUNT
              0.00      00/00/00        0.00       00/00/00        0.00
              0.00      00/00/00        0.00       00/00/00        0.00
              0.00      00/00/00        0.00       00/00/00        0.00

ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL
```

Figure 76. OK - the Big Moment is (Nearly) Here!

Let's type "y" and see what happens. Now we should at least find out a bit more about the problem....

```
ACCOUNT FILE: DELETION

ACCOUNT NO: 11111       SURNAME:   LOCKS
                        FIRST:     GOLDIE          MI: X  TITLE: LADY
TELEPHONE: 2345212341   ADDRESS:   THE COTTAGE
                                   WOODLANDS
                                   HANTS

OTHERS WHO MAY CHARGE:
THE 3 BEARS


NO. CARDS ISSUED: 4     DATE ISSUED: 05 04 84      REASON: N
CARD CODE: 2            APPROVED BY: HRH           SPECIAL CODES:

ACCOUNT STATUS: N       CREDIT LIMIT:  1000.00

HISTORY:   BALANCE      BILLED        AMOUNT       PAID          AMOUNT
              0.00      00/00/00        0.00       00/00/00        0.00
              0.00      00/00/00        0.00       00/00/00        0.00
              0.00      00/00/00        0.00       00/00/00        0.00

ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL                    y
```

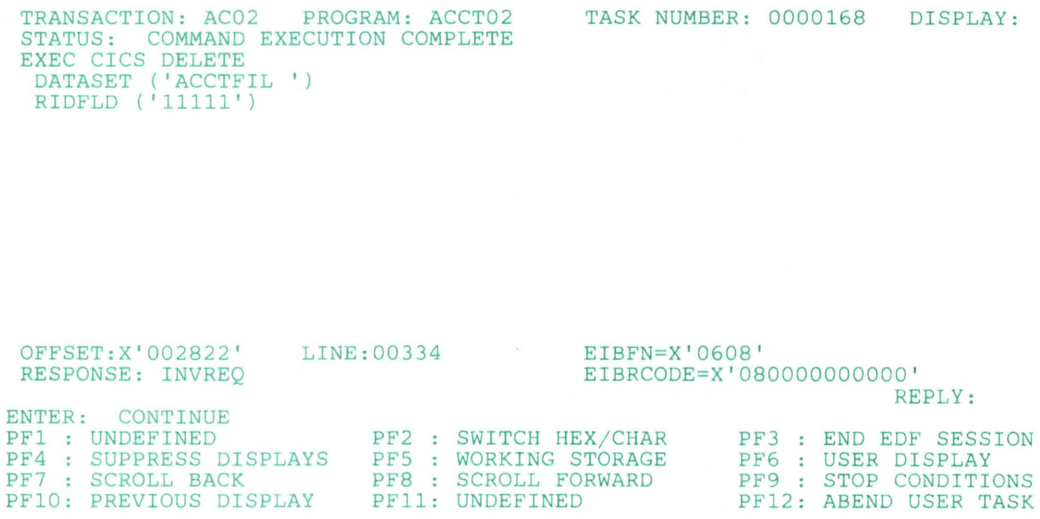
Figure 77. Here We Go



```
 TRANSACTION: AC02   PROGRAM: ACCT02     TASK NUMBER: 0000168   DISPLAY:  00
 STATUS:  PROGRAM INITIATION

    EIBTIME       = +0133511
    EIBDATE       = +0084244
    EIBTRNID      = 'AC02'
    EIBTASKN      = +0000168
    EIBTRMID      = 'L77A'

    EIBCPOSN      = +01743
    EIBCALEN      = +00006
    EIBAID        = X'7D'                                    AT X'004BDBEA'
    EIBFN         = X'0000'                                  AT X'004BDBEB'
    EIBRCODE      = X'000000000000'                          AT X'004BDBED'
    EIBDS         = '........'
+   EIBREQID      = '........'

 RESPONSE:
                                                           REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED            PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: UNDEFINED            PF12: UNDEFINED
```

Figure 78. Ready?

Again we use PF4 to suppress displays, as usual.



```
 TRANSACTION: AC02   PROGRAM: ACCT02     TASK NUMBER: 0000168   DISPLAY:  00
 STATUS:  COMMAND EXECUTION COMPLETE
 EXEC CICS DELETE
  DATASET ('ACCTFIL ')
  RIDFLD ('11111')









 OFFSET:X'002822'    LINE:00334          EIBFN=X'0608'
 RESPONSE: INVREQ                        EIBRCODE=X'080000000000'
                                                           REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED            PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: UNDEFINED            PF12: ABEND USER TASK
```

Figure 79. The INVREQ (Invalid Request) Condition

And here's an INVREQ (invalid request) condition. This is **not** what we expect. If the RIDFLD field looked odd (it doesn't here) we might want to use PF5 to start looking at Working-Storage, or PF6 to examine the user display. However, using PF4 again, let's carry on....

The following screen flashes up briefly and disappears again:

```
ACCOUNT FILE: ERROR REPORT

TRANSACTION  AC02  HAS FAILED IN PROGRAM  ACCT02    BECAUSE OF

A PROGRAM OR FCT TABLE ERROR (INVALID FILE REQUEST).

THE FILE IS: ACCTFIL .

PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORMATION TO THE
OPERATIONS STAFF.

THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGER UNDER CONTROL OF
THE "ACCT" APPLICATION.
```

Figure 80. The Error Report

```
 TRANSACTION: AC02   PROGRAM: ACCT04     TASK NUMBER: 0000168   DISPLAY:  00
 STATUS:  AN ABEND HAS OCCURRED

    EIBTIME      = +0133511
    EIBDATE      = +0084244
    EIBTRNID     = 'AC02'
    EIBTASKN     = +0000168
    EIBTRMID     = 'L77A'

    EIBCPOSN     = +01743
    EIBCALEN     = +00010
    EIBAID       = X'7D'                                       AT X'004BDBEA'
    EIBFN        = X'0E0C'  ABEND                              AT X'004BDBEB'
    EIBRCODE     = X'000000000000'  NORMAL                     AT X'004BDBED'
    EIBDS        = 'ACCTFIL '
+   EIBREQID     = '........'

 ABEND :    EACC
                                                             REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED           PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS   PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK         PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY    PF11: UNDEFINED            PF12: UNDEFINED
```

Figure 81. Here's Our Abend, EACC

And the next EDF display we stop at is this ABEND status warning.

Now we'll use the PF10 key to step back through the remembered displays (that we've been suppressing) in the hope that the cause of the problem will become clearer. Watch the "DISPLAY: " number in the top right hand corner of each screen.

```
 TRANSACTION: AC02   PROGRAM: ACCT04      TASK NUMBER: 0000168   DISPLAY: -01
 STATUS:  ABOUT TO EXECUTE COMMAND
 EXEC CICS ABEND
  ABCODE ('EACC')










 OFFSET:X'00148A'    LINE:00137           EIBFN=X'0E0C'
 RESPONSE:
                                                               REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED            PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 82. Just Prior to the ABEND Command

```
 TRANSACTION: AC02   PROGRAM: ACCT04      TASK NUMBER: 0000168   DISPLAY: -02
 STATUS:  COMMAND EXECUTION COMPLETE
 EXEC CICS SEND MAP
  MAP ('ACCTERR')
  FROM ('...............AC02...ACCT02   ...A PROGRAM OR FCT TABLE ERROR (I'...)
  MAPSET ('ACCTSET')
  TERMINAL
  WAIT
  FREEKB
  ERASE





 OFFSET:X'001456'    LINE:00135           EIBFN=X'1804'
 RESPONSE: NORMAL                         EIBRCODE=X'000000000000'
                                                               REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED            PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: NEXT DISPLAY         PF12: UNDEFINED
```

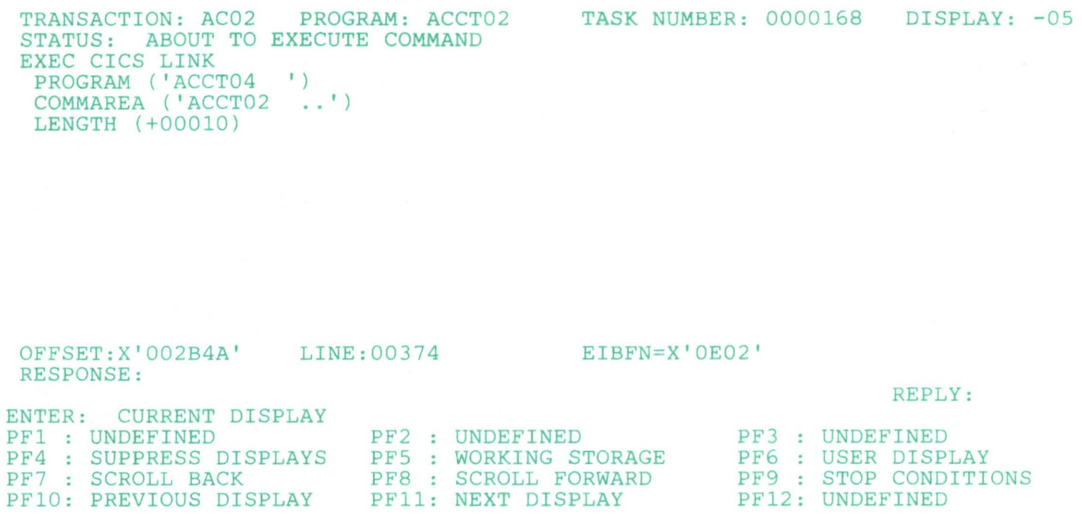
Figure 83. Sent the Error Map

```
 TRANSACTION: AC02   PROGRAM: ACCT04     TASK NUMBER: 0000168   DISPLAY: -03
 STATUS:  ABOUT TO EXECUTE COMMAND
 EXEC CICS SEND MAP
  MAP ('ACCTERR')
  FROM ('...............AC02...ACCT02  ...A PROGRAM OR FCT TABLE ERROR (I'...)
  MAPSET ('ACCTSET')
  TERMINAL
  WAIT
  FREEKB
  ERASE





 OFFSET:X'001456'    LINE:00135          EIBFN=X'1804'
 RESPONSE:
                                                            REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED            PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 84. About to Send the Error Map

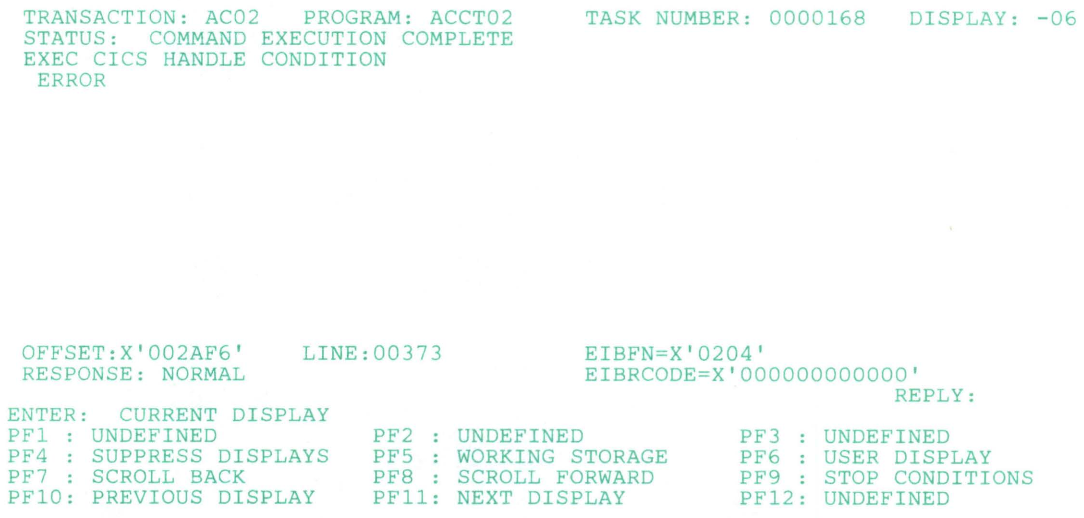
```
 TRANSACTION: AC02   PROGRAM: ACCT04     TASK NUMBER: 0000168   DISPLAY: -04
 STATUS:  PROGRAM INITIATION

    EIBTIME      = +0133511
    EIBDATE      = +0084244
    EIBTRNID     = 'AC02'
    EIBTASKN     = +0000168
    EIBTRMID     = 'L77A'

    EIBCPOSN     = +01743
    EIBCALEN     = +00010
    EIBAID       = X'7D'                                      AT X'004BDBEA'
    EIBFN        = X'0E02'  LINK                              AT X'004BDBEB'
    EIBRCODE     = X'000000000000'  NORMAL                    AT X'004BDBED'
    EIBDS        = 'ACCTFIL '
+   EIBREQID     = '........'

 RESPONSE:
                                                            REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED            PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 85. Starting the Error-Handling Program, ACCT04



```
 TRANSACTION: AC02   PROGRAM: ACCT02      TASK NUMBER: 0000168   DISPLAY: -05
 STATUS:  ABOUT TO EXECUTE COMMAND
 EXEC CICS LINK
  PROGRAM ('ACCT04  ')
  COMMAREA ('ACCT02  ..')
  LENGTH (+00010)








 OFFSET:X'002B4A'    LINE:00374           EIBFN=X'0E02'
 RESPONSE:
                                                                REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED           PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS   PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK         PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY    PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 86. Linking to the Error Program, ACCT04



```
 TRANSACTION: AC02   PROGRAM: ACCT02      TASK NUMBER: 0000168   DISPLAY: -06
 STATUS:  COMMAND EXECUTION COMPLETE
 EXEC CICS HANDLE CONDITION
  ERROR










 OFFSET:X'002AF6'    LINE:00373           EIBFN=X'0204'
 RESPONSE: NORMAL                         EIBRCODE=X'000000000000'
                                                                REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED           PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS   PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK         PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY    PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 87. The HANDLE CONDITION ERROR Command

```
 TRANSACTION: AC02   PROGRAM: ACCT02      TASK NUMBER: 0000168   DISPLAY: -07
 STATUS:  ABOUT TO EXECUTE COMMAND
 EXEC CICS HANDLE CONDITION
  ERROR








 OFFSET:X'002AF6'    LINE:00373           EIBFN=X'0204'
 RESPONSE:
                                                               REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED            PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 88. Do the HANDLE CONDITION ERROR Command

```
 TRANSACTION: AC02   PROGRAM: ACCT02      TASK NUMBER: 0000168   DISPLAY: -08
 STATUS:  COMMAND EXECUTION COMPLETE
 EXEC CICS DELETE
  DATASET ('ACCTFIL ')
  RIDFLD ('11111')








 OFFSET:X'002822'    LINE:00334           EIBFN=X'0608'
 RESPONSE: INVREQ                         EIBRCODE=X'080000000000'
                                                               REPLY:
ENTER:  CURRENT DISPLAY
PF1 : UNDEFINED            PF2 : UNDEFINED            PF3 : UNDEFINED
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: NEXT DISPLAY         PF12: UNDEFINED
```

Figure 89. Here's Our Failing Instruction Again

The delete command is returning with INVREQ.

As we said in Part 4, when discussing Lines 333 to 336 of ACCT02, the problem is that we're trying to delete a record that's been read for update. Our mistake is to quote a value for the RIDFLD at this point.

We shall now press ENTER....

```
 TRANSACTION: AC02   PROGRAM: ACCT04     TASK NUMBER: 0000168   DISPLAY:  00
 STATUS:  AN ABEND HAS OCCURRED

    EIBTIME      = +0133511
    EIBDATE      = +0084244
    EIBTRNID     = 'AC02'
    EIBTASKN     = +0000168
    EIBTRMID     = 'L77A'

    EIBCPOSN     = +01743
    EIBCALEN     = +00010
    EIBAID       = X'7D'                                    AT X'004BDBEA'
    EIBFN        = X'0E0C'  ABEND                           AT X'004BDBEB'
    EIBRCODE     = X'000000000000'  NORMAL                  AT X'004BDBED'
    EIBDS        = 'ACCTFIL '
+   EIBREQID     = '........'

 ABEND :    EACC
                                                          REPLY:
ENTER:  CONTINUE
PF1 : UNDEFINED             PF2 : SWITCH HEX/CHAR      PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS     PF5 : WORKING STORAGE      PF6 : USER DISPLAY
PF7 : SCROLL BACK           PF8 : SCROLL FORWARD       PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY      PF11: UNDEFINED            PF12: UNDEFINED
```

Figure 90. Back With Our Abend, EACC, Again

And ENTER again...

```
 TRANSACTION: AC02   PROGRAM:            TASK NUMBER: 0000168   DISPLAY:  00
 STATUS:  ABNORMAL TASK TERMINATION

    EIBTIME      = +0133511
    EIBDATE      = +0084244
    EIBTRNID     = 'AC02'
    EIBTASKN     = +0000168
    EIBTRMID     = 'L77A'

    EIBCPOSN     = +01743
    EIBCALEN     = +00010
    EIBAID       = X'7D'                                      AT X'004BDBEA'
    EIBFN        = X'0E0C'  ABEND                             AT X'004BDBEB'
    EIBRCODE     = X'000000000000'  NORMAL                    AT X'004BDBED'
    EIBDS        = 'ACCTFIL '
+   EIBREQID     = '........'

 ABEND :   EACC
TO CONTINUE EDF SESSION REPLY YES                           REPLY: NO
ENTER:  CONTINUE
PF1 : UNDEFINED            PF2 : SWITCH HEX/CHAR     PF3 : END EDF SESSION
PF4 : SUPPRESS DISPLAYS    PF5 : WORKING STORAGE     PF6 : USER DISPLAY
PF7 : SCROLL BACK          PF8 : SCROLL FORWARD      PF9 : STOP CONDITIONS
PF10: PREVIOUS DISPLAY     PF11: UNDEFINED           PF12: UNDEFINED
```

Figure 91. The Abnormal Task Termination

Pressing ENTER one final time brings us to this:

```
ACCOUNT FILE: ERROR REPORT

TRANSACTION  AC02  HAS FAILED IN PROGRAM  ACCT02    BECAUSE OF

A PROGRAM OR FCT TABLE ERROR (INVALID FILE REQUEST).

THE FILE IS: ACCTFIL .

PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORMATION TO THE
OPERATIONS STAFF.

THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGER UNDER CONTROL OF
THE "ACCT" APPLICATION.





DFH2206I TRANSACTION AC02 ABEND EACC . BACKOUT SUCCESSFUL  13:37:06
```

Figure 92. This is the CICS Message. Message DFH2206 (suffix "I" for "Information: No action is required") tells us that all recoverable resources associated with the failed transaction have been successfully backed out following the abend.

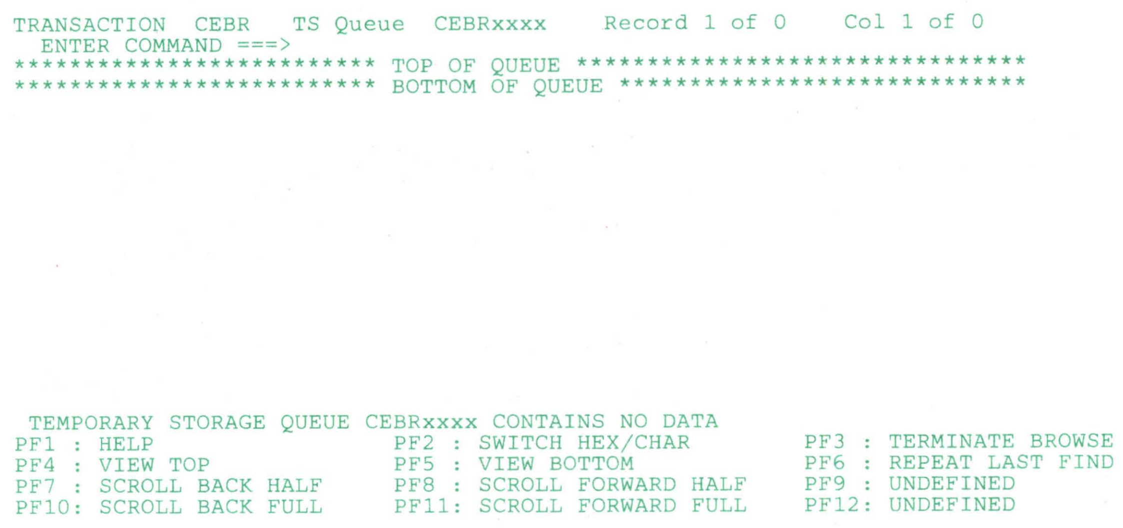
If we'd chosen **not** to suppress displays, you would have faced about another 45 screens to reach this point.

Of course, although you know the EXEC CICS DELETE command is failing, you have to go off and read the APRM carefully to pinpoint the exact reason. Studying the transaction dump leads us to the same conclusion by a different route.

The beauty of EDF as a testing tool is the way you can home in on a problem, and the way you can force your code to behave as though a problem had arisen. We hope you find EDF a useful weapon in your bug-killing armory!

Temporary Storage Browse Facility (CEBR)

We'll describe another diagnostic tool here. This is the CEBR transaction that allows you to look at temporary storage queues. If you need to do this while debugging, enter the transaction identifier CEBR to produce the display shown in Figure 93.



```
TRANSACTION  CEBR   TS Queue  CEBRxxxx    Record 1 of 0     Col 1 of 0
  ENTER COMMAND ===>
************************** TOP OF QUEUE ********************************
************************** BOTTOM OF QUEUE *****************************







 TEMPORARY STORAGE QUEUE CEBRxxxx CONTAINS NO DATA
PF1 : HELP                  PF2 : SWITCH HEX/CHAR        PF3 : TERMINATE BROWSE
PF4 : VIEW TOP              PF5 : VIEW BOTTOM            PF6 : REPEAT LAST FIND
PF7 : SCROLL BACK HALF      PF8 : SCROLL FORWARD HALF    PF9 : UNDEFINED
PF10: SCROLL BACK FULL      PF11: SCROLL FORWARD FULL    PF12: UNDEFINED
```

Figure 93. The Temporary Storage Browse (CEBR) Display

This shows the browse display for the temporary storage queue named "CEBRtttt" ("tttt" is the terminal identifier of the terminal from which you made the entry). Unless you happen to be interested in this particular queue (and this is unlikely), the first thing you do is to enter "QUEUE xxxxxxxx" in the command area, where "xxxxxxxx" is the name of the queue you *do* want to see. The command area is the space right after "ENTER COMMAND" at the top of the screen.

If a queue by this name exists, you'll see a display of it. The items in the queue are displayed one per line, in the area between the command line and the PF key menu. Only as much of each item as will fit on one line of the screen is shown.

Initially the display starts with the first character in the item. However, if you need to see characters beyond those displayed, you can shift the starting character by entering "COLUMN(n)" in the command area. This causes the display of each item to begin with the nth character in the item; "n" can be up to four digits.

You can tell which character the display starts at, and how long the longest item in the queue is, from the "Col X of Y" information at the top of the screen. "X" is the position of the record displayed in the first column of the screen, and "Y" is the length of the longest item. The "Line N of M" message just before that tells you that the "Nth" item in the queue is in the first one on the screen, and there are "M" items in the queue.

You can look through the items in the queue by using the scroll keys shown in the figure (PF7, PF8, PF10, and PF11), or you can specify that the display should start with a particular item in the queue. The scroll keys work just as they do for EDF. To display a particular item, enter "LINE (n)" in the command line. CEBR responds by starting the display one item before the number you specify; this number, too, can be up to four digits long.

You can redisplay the beginning of the queue either by entering "TOP" in the command area or by pressing PF4. Similarly, you can display the last screen's worth of items by entering "BOTTOM" or pressing PF5.

You can also search the items in the queue for the occurrence of a particular character string. If you were looking for the characters "MOUNCE", for example, you would put:

```
FIND /MOUNCE
```

in the command area. CEBR would scroll the display forward until it displayed the first item that contained "MOUNCE".

The slash (/) in the command above is a delimiter. It can be any non-space character that isn't in the search string. That is,

```
FIND X05/07/84      and      FIND S05/07/84
```

are equivalent.

```
FIND /05/07/84
```

```
FIND /JOHN JONES/
```

Once you've entered a find command, you can repeat it (that is, find the next occurrence of the string) by pressing PF6.

You can use PF2 to switch the display from character to hexadecimal format, and back again, just like the corresponding switch hex/char command in EDF.

Indeed, you can use the CEBR transaction while under control of EDF, by using the PF key assigned for BROWSE TEMPORARY STORAGE. Your EDF transaction is suspended; CEBR starts and continues until you end it with the PF3 key. If you are in EDF, PF3 returns you to the point at which you requested CEBR. If you were not in EDF but came in by entering CEBR, PF3 terminates the transaction in the normal way, and frees the terminal for the next transaction.

The CEBR transaction also allows you to delete a temporary storage queue, by entering PURGE in the command area. And finally, there is a HELP facility, explaining how to use CEBR, which you can access by pressing PF1.

Transaction Dumps

The final major debugging tool that CICS provides is the transaction dump.

You can obtain a transaction dump in two ways:

- Your application program can ask for one with an EXEC CICS DUMP request
- You can add the ABCODE option to an EXEC CICS ABEND command to specify the (4-character) name of a dump of main storage associated with the terminated task.

The format of a CICS transaction dump includes a 4-character abend code (this will be the 4-character name you specified for a dump produced under application program control) or a CICS-provided abend code for a program interrupt that has been trapped by CICS. The **ABCODE** appears in the heading of the dump, as does the task identifier (the **TRANSID**). This TRANSID is the one that you'll have coded.

```
CUSTOMER INFORMATION CONTROL SYSTEM STORAGE DUMP   CODE=EACC   TASK=AC02      DATE=08/31/84   TIME=10:13:07   PAGE   23
   TIME OF DAY    ID  REG 14   REQD TASK   FIELD A  FIELD B  CHARS    RESOURCE TRACE TYPE                                    INTERVAL
10:13:03.276288  F7 404A60E2 4103 00022 C1C3C3E3 D3D6C740 ACCTLOG           TSP PUTQ                                      00.000064
10:13:03.276288  F1 404A7CD8 F804 00022 00000020 014630D0 ........          SCP GETMAIN CONDITIONAL INITIMG               00.000000
10:13:03.276320  C8 5049A060 0004 00022 004B7840 98000020 ... ....          SCP ACQUIRED TSTABLE STORAGE                  00.000032
10:13:03.276384  F7 404A7368 0045 00022 004B7840 98000020 ... ....          TSP RETN NORMAL                               00.000064
10:13:03.276416  F1 5046E1BC 4004 00022 004BFC20 014630D0 ........          SCP FREEMAIN                                  00.000032
10:13:03.276448  C9 5049A096 0004 00022 004BFC20 8E000308 ........          SCP RELEASED TEMPSTRG STORAGE                 00.000032
10:13:03.276448  E1 50543D40 00F4 00022 00000000 00000A02 ........          EIP WRITEQ-TS RESPONSE                        00.000000
10:13:03.276480  E1 5054405E 0004 00022 004BE31C 00000608 ..T.....          EIP DELETE ENTRY                              00.000032
10:13:03.276544  E1 004BF810 03F4 00022 08000000 00000608 ........          EIP DELETE RESPONSE                           00.000064
10:13:03.276576  E1 50544332 0004 00022 004BE31C 00000204 ..T.....          EIP HANDLE-CONDITION ENTRY                    00.000032
10:13:03.276608  E1 50544332 00F4 00022 00000000 00000204 ........          EIP HANDLE-CONDITION RESPONSE                 00.000032
10:13:03.276608  E1 50544386 0004 00022 004BE31C 00000E02 ..T.....          EIP LINK ENTRY                                00.000000
10:13:03.276640  F2 6049FA58 8204 00022 00000000 00000000 ........ ACCT04   PCP LOCATE                                    00.000032
10:13:03.276672  EA 4049E536 0003 00022 01000300 004BD9C4 ......RD ACCT04   TMP PPT LOCATE                                00.000032
10:13:03.276736  EA 404988E8 0005 00022 01000300 004A2C00 ........          TMP RETN NORMAL                               00.000064
10:13:03.276768  F2 4049FA94 2044 00022 00000000 00000000 ........ ACCT04   PCP BLDL                                      00.000032
10:13:03.299232  F1 6046E1BC CC04 00022 000000F0 014630D0 ...0....          SCP GETMAIN INITIMG                          *00.022464
10:13:03.299296  C8 5049A060 0004 00022 004BFC20 8C0000F8 .......8          SCP ACQUIRED USER STORAGE                     00.000064
10:13:03.299328  F2 5046E448 8104 00022 00000000 00000000 ........ ACCT04   PCP LINK-CONDITIONAL                          00.000032
10:13:03.299520  EA 4049E536 0003 00022 01000300 004BD9C4 ......RD ACCT04   TMP PPT LOCATE                                00.000192
10:13:03.299584  EA 404988E8 0005 00022 01000300 004A2C00 ........          TMP RETN NORMAL                               00.000064
10:13:03.299616  F1 4049E16E 8904 00022 004B0050 014630D0 ...&....          SCP GETMAIN                                   00.000032
10:13:03.299616  C8 5049A060 0004 00022 004BFD20 894B0058 ........          SCP ACQUIRED RSA STORAGE                      00.000000
10:13:03.299648  F1 4049DE42 8804 00022 004B030B 014630D0 ........          SCP GETMAIN                                   00.000032
10:13:03.317120  C8 5049A060 0004 00022 0053F800 88002000 ..8.....          SCP ACQUIRED PGM STORAGE                     *00.017472
10:13:03.338688  F0 4049DEE4 4004 00022 88000000 004A2C26 ........          KCP WAIT DCI=CICS                            *00.021568
10:13:03.384736  F1 6049EFFC 8C04 00022 00531214 014630D0 ........          SCP GETMAIN                                  *00.046048
10:13:03.394688  C8 5049A060 0004 00022 004BFD80 8C531228 ........          SCP ACQUIRED USER STORAGE                     00.009952
10:13:03.394944  E1 50540C92 0004 00022 004BFDCC 00001804 ........          EIP SEND-MAP ENTRY                            00.000256
10:13:03.395008  FA 504AD1CC 0003 00022 00000DEA 04000020 ........          BMS SEND-OUT CTRL MAP MAPSET SAVE WAIT        00.000064
10:13:03.395040  FA 404ADA68 0003 00022 00000DEA 04000020 ........          BMS SEND-OUT CTRL MAP MAPSET SAVE WAIT        00.000032
10:13:03.395072  F2 504AC1B8 8404 00022 00000000 00000000 ........ ACCTSETM PCP LOAD-CONDITIONAL                          00.000032
10:13:03.395104  EA 4049E536 0003 00022 01000300 004BD9C4 ......RD ACCTSETM TMP PPT LOCATE                                00.000032
10:13:03.421152  EA 404988E8 0405 00022 01000304 00000000 ........          TMP RETN NOT FOUND                           *00.026048
10:13:03.421216  F1 404AC87A 8504 00022 004B018F 014630D0 ........          SCP GETMAIN                                   00.000064
10:13:03.421280  C8 5049A060 0004 00022 004BD000 854B01A8 ........          SCP ACQUIRED TERMINAL STORAGE                 00.000064
10:13:03.421408  FC 504ACDD4 0103 00022 00850000 004630D0 ........          ZCP ZARQ APPL REQ ERASE WRITE WAIT            00.000128
10:13:03.421472  FC 7047C700 1804 00022 000A0001 004630D0 ........          ZCP ZSDS SEND                                 00.000064
10:13:03.423776  F0 7047402C 4004 00022 13000000 014630D0 ........          KCP WAIT DCI=TERMINAL                         00.002304
10:13:03.423936  EE 70477988 2214 TCP   000A0126 014630D0 ........          VIO SEND OIC DATA RQE1                        00.000160
10:13:03.423936  EE 70477988 0024 TCP   0180F5C2 11404013 ..5B.  .          VIO DATA                                      00.000000
10:13:03.423968  FC 70477C04 1204 TCP   00200001 194630D0 ........          ZCP ZFRE FREEMAIN                             00.000032
10:13:03.423968  F1 60477D66 4404 TCP   004BD000 004630D0 ........          SCP FREEMAIN                                  00.000000
10:13:03.424000  C9 5049A096 0004 TCP   004BD000 854B01A8 ........          SCP RELEASED TERMINAL STORAGE                 00.000032
10:13:03.424128  F0 60477ACA 0804 TCP   004BD940 01000022 ..R ....          KCP RESUME                                    00.000128
10:13:03.424160  F0 40473960 4004 TCP   44000000 00464200 ........          KCP WAIT DCI=TCP                              00.000032
10:13:03.424192  FC 40473F3A 0105 00022 00000000 00000000 ........          ZCP RETN ZARQ APPL REQ                        00.000032
10:13:03.424224  FA 404ACDFE 0005 00022 00000000 00000000 ........          BMS RETN                                      00.000032
10:13:03.424224  FA 404ADA86 0005 00022 00000000 00000000 ........          BMS RETN                                      00.000000
10:13:03.424256  E1 50540C92 00F4 00022 00000000 00001804 ........          EIP SEND-MAP RESPONSE                         00.000032
10:13:03.424288  E1 50540CC6 0004 00022 004BFDCC 00000E0C ........          EIP ABEND ENTRY                               00.000032
10:13:03.424320  F2 7046E448 6004 00022 C5C1C3C3 00000000 EACC....          PCP ABEND                                     00.000032
10:13:03.424352  F1 4049D75A CC04 00022 000000A0 014630D0 ........          SCP GETMAIN INITIMG                           00.000032
10:13:03.424416  C8 5049A060 0004 00022 004BD000 8C0000A8 ........          SCP ACQUIRED USER STORAGE                     00.000064
10:13:03.453088  F4 5049D8C8 FE04 00022 00000000 C5C1C3C3 ....EACC          DCP TRANSACTION                              *00.028672
10:13:03.602944  F0 40580A76 4004 00022 80000000 005628E0 ........          KCP WAIT DCI=SINGLE                          *00.149856
```

Figure 94. The Foot of the Trace Table

The transaction dump is formatted into areas such as program storage, transaction storage, and the trace table. There are other areas, but since you'll be concerned mainly with your COBOL program's Working-Storage, they won't be very meaningful to you at this stage.

Working Through a Transaction Abend Dump Listing

Let's look at the dump more closely.

When our error-handling program (ACCT04) gains control it issues an EXEC CICS ABEND command (Line 137). This writes a transaction dump to one of the two dump data sets (A or B). The transaction dump includes hexadecimal and character prints of the program and storage areas associated with the failed task, and the trace table.

You can print out the dump data sets with an IBM-supplied CICS utility called DFHDUP. Your *CICS Installation and Operations Guide* tells you exactly how to do this.

Let's look more closely at the dump printout. Figure 94 on page 245 shows the foot of the trace table.

We're interested in the bottom of the table because that's where the newest (most recent) entries are. We'll scan slowly back up the table looking for the characters "EIP" (Exec Interface Program) over on the right hand side under the heading "Trace Type".

For our EACC abend, the bottom EIP entry in the trace table should say EIP ABEND ENTRY. When you've found this entry, look over to the left of the same line, and make a note of the 5-digit number under the heading "Task". This is the CICS task number; in our case here, it's 00022. We're only going to be interested in trace table entries for this task number. EIP ABEND ENTRY tells us that program ACCT04 has issued its EACC abend command.

Now work your way back up the table (back in time) looking for other EIP type entries for this task number. The next one we find is EIP SEND-MAP RESPONSE. This tells us that ACCT04 has displayed an error screen.

Next, we see EIP SEND-MAP ENTRY. Each command, except the ABEND, appears twice in the trace table. Once (the ENTRY) when the application program passes control to CICS, and once (the RESPONSE) when CICS returns control to the application.

Continuing back up the table, we see EIP LINK ENTRY. This is where the failing program - the one in which the exceptional condition has occurred - is linking to the error-handling program, ACCT04. Notice the absence of a corresponding RESPONSE; this would occur when the LINKed program (ACCT04) issued a RETURN command (which it never does, of course).

```
CUSTOMER INFORMATION CONTROL SYSTEM STORAGE DUMP   CODE=EACC   TASK=AC02       DATE=08/31/84   TIME=10:13:07   PAGE   52
PROGRAM STORAGE                           ADDRESS 00541808 TO 005448D7   LENGTH 0030D0
000027A0    D23C58F0 C00405EF D2106E90 C3C99240  6EA1D20A 6EA26EA1 D2056DF0 C37F9240   *K..0....K...CIk ..K..s..K..0C.k *   00543FA8
000027C0    6DF6D200 6DF76DF6 41106E90 5010D23C  41106DF0 5010D240 41106600 5010D244   *.6K..7.6......K....0..K ......K.*   00543FC8
000027E0    41106006 5010D248 9680D248 4110D23C  58F0C004 05EF5810 C05007F1 D2016000   *..-...K.o.K...K..0.........1K.-.*   00543FE8
00002800    C206D210 6E90C3DA 92406EA1 D20A6EA2  6EA1D206 6DF0C290 92406DF7 41106E90   *B.K...C.k ..K..s..K..0B.k .7....*   00544008
00002820    5010D23C 41106DF0 5010D240 41106E88  5010D244 41106E88 5010D248 58E0D228   *..K....0..K ...h..K....h..K...K.*   00544028
00002840    4110E001 5010D24C 9680D24C 4110D23C  58F0C004 05EFD210 6E90C3EB 92406EA1   *......K.o.K...K..0....K...C.k ..*   00544048
00002860    D20A6EA2 6EA1D205 6DF0C37F 92406DF6  D2006DF7 6DF64110 6E905010 D23C4110   *K..s..K..0C.k .6K..7.6......K...*   00544068
00002880    6DF05010 D2404110 6E885010 D2444110  6E885010 D2484110 602E5010 D24C9680   *.0..K ...h..K....h..K...-...K.o.*   00544088
000028A0    D24C4110 D23C58F0 C00405EF D2106E90  C3FC9240 6EA1D20A 6EA26EA1 41106E90   *K...K..0....K...C.k ..K..s......*   005440A8
000028C0    5010D23C 41106018 5010D240 9680D240  4110D23C 58F0C004 05EF4100 66804110   *..K...-...K o.K ..K..0..........*   005440C8
000028E0    02B55830 C2180E02 4140606D 48206000  4C20C208 1A425B40 C20C5040 D23858E0   *....B....  -...-...B...$ B.. K...*   005440E8
00002900    D238D23B 68F9E000 D2166E90 C40D9240  6EA7D204 6EA86EA7 D2066E78 C424D206   *K.K..9..K...D.k .xK..y.xK...D.K.*   00544108
00002920    6E80C278 41106E90 5010D23C 41106E78  5010D240 41106680 5010D244 41106E88   *..B.......K.......K ......K....h*   00544128
00002940    5010D248 41106E80 5010D24C 9680D24C  4110D23C 58F0C004 05EFD210 6E90C42B   *..K.......K.o.K...K..0....K...D.*   00544148
00002960    92406EA1 D20A6EA2 6EA1D203 6DC8C43C  41106E90 5010D23C 41106DC8 5010D240   *k ..K..s..K..HD.......K....H..K *   00544168
00002980    9680D240 4110D23C 58F0C004 05EF4140  615D4820 60024C20 C2081A42 5B40C20C   *o.K ..K..0..... /)..-...B...$ B.*   00544188
000029A0    5040D238 58E0D238 D23B6BE7 E0004830  60024930 C20458F0 C1DC078F 48306002   *. K...K.K.,X....-...B..0A.....-.*   005441A8
000029C0    4930C206 58F0C1DC 078F4830 60024930  C21058F0 C1E0077F D201695D C1F8D216   *..B..0A.....-...B..0A...K..)A8K.*   005441C8
000029E0    6E90C440 92406EA7 D2046EA8 6EA7D206  6E78C271 D2066E80 C278D201 6D98C1F8   *..D k .xK..y.xK...B.K...B.K..qA8*   005441E8
00002A00    41106E90 5010D23C 41106E78 5010D240  41106938 5010D244 41106E88 5010D248   *......K.......K ......K....h..K.*   00544208
00002A20    41106E80 5010D24C 41106E88 5010D250  41106E88 5010D254 41106E88 5010D258   *......K....h..K....h..K....h..K.*   00544228
00002A40    41106D98 5010D25C 9680D25C 4110D23C  58F0C004 05EFD210 6E90C457 92406EA1   *...q..K*o.K*..K..0....K...D.k ..*   00544248
00002A60    D20A6EA2 6EA1D203 6DC8C468 D2016D98  C2124110 6E905010 D23C4110 6DC85010   *K..s..K..HD.K..qB.......K....H..*   00544268
00002A80    D24058E0 D2284110 E0005010 D2444110  6D985010 D2489680 D2484110 D23C58F0   *K ..K.......K....q..K.o.K...K..0*   00544288
00002AA0    C00405EF 5820C1E4 58E0D224 D500E01A  6D020772 5810C054 07F1D201 6002C204   *......AU..K.N............1K.-.B.*   005442A8
00002AC0    5810C058 07F15820 C1E858E0 D22895E7  E0000772 D2016002 C1FAD201 6C23C1F8   *.....1..AY..K.nX....K.-.A.K...A8*   005442C8
```

Figure 95. The Absolute Address of the Failing Instruction

Next, we have EIP HANDLE-CONDITION RESPONSE and EIP HANDLE-CONDITION ENTRY. The routine in the failing program, given control by CICS at the ERROR condition, is cancelling the HANDLE CONDITION ERROR to avoid a possible loop.

Well, this marks the start of what we called the "predictable sequence of actions" that takes place between the actual error (whatever that is) and the consequent abend. (See "Errors Within the Example Application" on page 198.)

So, what command failed? What went wrong and raised an ERROR condition? Keep on working back through the trace table and here we are:

`EIP DELETE RESPONSE` and `EIP DELETE ENTRY`

The exceptional condition that led to the abend happened on the DELETE command. So this will be the first trace table entry that we really want to take a close look at.

If you've got a copy handy, now's the time to look at your *CICS Program Debugging Reference Summary* (SX33-6010). What we want (from the Contents page) is the "EXEC Interface Trace Table Entries (Figure 3)."

Looking at the column headed "Field B" on the dump listing, you'll see that both the DELETE ENTRY and the DELETE RESPONSE contain the command code. In this case it's 0608. The Summary translates this for us into a File Control DELETE. (By the way, these command (EIBFN) codes are also listed in Appendix A of the APRM.)

Now look at "Field A" on the RESPONSE. This gives us the command's response code (EIBRCODE). We're interested in the value in the first two hexadecimal digits - 08. Both the APRM and the Summary tell us that a value of 08 in the RESPONSE means condition INVREQ (invalid request), as long as the first byte of EIBFN is 06 (which it is).

So where do we stand now? We know that the failure is due to an EXEC CICS DELETE command coming back with an INVREQ condition. And we certainly didn't expect this to happen. Now we need to ask:

1. What does INVREQ mean in this context?
2. Where in our program is this failing DELETE command?

To answer the first question, let's see what the APRM can tell us about invalid requests. If you find the write-up of the DELETE command in the File Control section of the APRM, you'll see that INVREQ is one of eight possible results of an unsuccessful DELETE command. There are three rules mentioned here:

1. The record to be deleted must be identified by means of the RIDFLD option.

2. A record that has been retrieved for update ... can be deleted. ... In this case, the RIDFLD option must **not** be specified.

3. A generic key must not be used for data sets for which LOG=YES has been specified.

A few pages further on in the APRM, in the section "File Control Exceptional Conditions", you'll find a number of different situations that can lead to an INVREQ condition. To help pinpoint our error we need to know exactly which of our DELETE commands is failing, so we can then look at the source code listing and see what operands we specified on it.

Once again, the trace table can help us. The "Register 14" value on the EIP DELETE ENTRY holds the address, or the point within our application program, to which CICS would return control when the DELETE command execution was complete. In other words, Register 14 points to the next COBOL instruction due to be executed after the DELETE that's failing.

Our Register 14 value is 54405E. This is an *absolute address* (an actual location in virtual storage). We must adjust it to become a displacement through a program for it to be useful. If you look beyond (below) the trace table you'll see some blocks of storage. See Figure 95. Some are quite short, others take up several pages of the listing. Over on the right hand side of these blocks of storage are the absolute storage addresses. So we need to look for something close in value to our Register 14 value of 54405E, in the "Program Storage."

It turns out to be near the bottom of the listing in a block of code - Program Storage - that extends from 541808 to 5448D7. The instruction (within this block) at 54405E is D2106E90. This is the Next Sequential Instruction. (Just before this are the digits 05EF - the end of a CALL statement, as we'd expect.)

Over on the left hand side of the listing are the offset values. The offset equivalent to 54405E is 2856. Another route to this same answer is by subtracting the start address for this block of code from our Register 14 address:

```
54405E - 541808 = 2856
```

This offset (2856) is in the phase (DOS) or load module (OS).

Finally, we need the source compilation listing to see, from the link-edit information, how far from the start of the phase is the application module itself. See Figure 98 on page 252.

The "stub" module that is loaded first, at address 32078, turns out to be hexadecimal 30 bytes long (320A8 minus 32078), so we have to subtract this from our 2856 offset. This gives us 2826 as our final offset value.

```
CUSTOMER INFORMATION CONTROL SYSTEM STORAGE DUMP   CODE=EACC   TASK=AC02       DATE=08/31/84   TIME=10:13:07   PAGE   20
   TIME OF DAY    ID  REG 14   REQD TASK   FIELD A  FIELD B  CHARS    RESOURCE  TRACE TYPE                                   INTERVAL
10:13:02.333024  EA 40468C5C 0003 TCP   0C000100 0049D1F4 ......J4 AC02      TMP PCT TRANSFER                             00.000032
10:13:02.333056  EA 404988E8 0025 TCP   0C000100 00000000 ........           TMP RETN NORMAL                              00.000032
10:13:02.333088  FC 40475738 1125 TCP   0C000100 00000000 ........           ZCP RETN ZATT ATTACH                         00.000032
10:13:02.333120  F0 40473960 4004 TCP   44000000 00464200 ........           KCP WAIT DCI=TCP                             00.000032
10:13:02.333216  FD 0000001C 0104 TCP   00382189 00382189 ........           00001 TIMES                      00.000096
10:13:02.333440  FC 054757F8 0503 00022 00200001 004630D0 ........           ZCP ZSUP START UP TASK                       00.000224
10:13:02.333504  E5 404758AA 0C03 00022 00000000 00000000 ........ AC02.*..  XSP SECURITY                                 00.000064
10:13:02.333632  E7 00475FAE 0004 00022 00000000 00000000 ........           ERM ENTRY                                    00.000128
10:13:02.333664  E7 00475FAE 0004 00022 00000000 000000FF ........           ERM RESPONSE                                 00.000032
10:13:02.333664  F2 50475FE0 8804 00022 00000000 00000000 ........ ACCT02    PCP XCTL-CONDITIONAL                         00.000000
10:13:02.333696  EA 4049E536 0003 00022 01000300 004BD9C4 ......RD ACCT02    TMP PPT LOCATE                               00.000032
10:13:02.333760  EA 404988E8 0005 00022 01000300 004A2B58 ........           TMP RETN NORMAL                              00.000064
10:13:02.495936  F1 4049DE42 8804 00022 0000061B 014630D0 ........           SCP GETMAIN                                 *00.162176
10:13:02.599072  C8 5049A060 0004 00022 00541800 88003800 ........           SCP ACQUIRED PGM STORAGE                    *00.103136
10:13:02.924128  F0 4049DEE4 4004 00022 88000000 004A2B7E .......=           KCP WAIT DCI=CICS                           *00.325056
10:13:02.980032  F1 6049EFFC 8C04 00022 0054115C 014630D0 ...*....           SCP GETMAIN                                 *00.055904
10:13:02.980192  C8 5049A060 0004 00022 004BE2D0 8C541168 ..S.....           SCP ACQUIRED USER STORAGE                    00.000160
    .
    .
    .
CUSTOMER INFORMATION CONTROL SYSTEM STORAGE DUMP   CODE=EACC   TASK=AC02       DATE=08/31/84   TIME=10:13:07   PAGE   22
   TIME OF DAY    ID  REG 14   REQD TASK   FIELD A  FIELD B  CHARS    RESOURCE  TRACE TYPE                                   INTERVAL
10:13:03.032320  E1 5054303C 00F4 00022 00000000 00001802 ........           EIP RECEIVE-MAP RESPONSE                     00.000128
10:13:03.032352  E1 5054309A 0004 00022 004BE31C 00000602 ..T.....           EIP READ ENTRY                               00.000032
10:13:03.071136  F5 404A358E F103 00022 00000000 00000000 ........ ACCTFIL   FCP CTYPE LOCATE                            *00.038784
10:13:03.083360  EA 404A58AC 0003 00022 01000500 004BD9C4 ......RD ACCTFIL   TMP FCT LOCATE                               00.012224
10:13:03.083392  EA 404988E8 0005 00022 01000500 004A3358 ........           TMP RETN NORMAL                              00.000032
10:13:03.083424  F5 404A4A36 0045 00022 01000500 004A3358 ........           FCP RETN NORMAL                              00.000032
10:13:03.083456  F1 6046E1BC CC04 00022 00000090 014630D0 ........           SCP GETMAIN INITIMG                          00.000032
10:13:03.083520  C8 5049A060 0004 00022 004BF860 8C000098 ..8-....           SCP ACQUIRED USER STORAGE                    00.000064
10:13:03.083552  F1 6046E1BC 8C04 00022 004B000A 014630D0 ........           SCP GETMAIN                                  00.000032
10:13:03.083552  C8 5049A060 0004 00022 004BF900 8C4B0018 ..9.....           SCP ACQUIRED USER STORAGE                    00.000000
10:13:03.083584  F5 504A38DE 8403 00022 00000000 00000000 ........ ACCTFIL   FCP GET-UPDATE                               00.000032
10:13:03.083616  F1 504A5986 9D04 00022 004B0050 014630D0 ...&....           SCP GETMAIN                                  00.000032
10:13:03.083648  C8 5049A060 0004 00022 004BF920 9D4B0058 ..9.....           SCP ACQUIRED DWE STORAGE                     00.000032
10:13:03.083680  F1 404A56C6 CF04 00022 00000094 014630D0 ........           SCP GETMAIN INITIMG                          00.000032
10:13:03.083712  C8 5049A060 0004 00022 004BF980 8F0000A8 ..9.....           SCP ACQUIRED FILE STORAGE                    00.000032
10:13:03.083712  F1 404A56C6 CF04 00022 0000018B 014630D0 ........           SCP GETMAIN INITIMG                          00.000000
10:13:03.083744  C8 5049A060 0004 00022 004BFA30 8F000198 ........           SCP ACQUIRED FILE STORAGE                    00.000032
10:13:03.274848  F0 504A4E4A 4004 00022 20000000 004A2B7E .......=           KCP WAIT DCI=DISP                           *00.191104
10:13:03.275008  F0 40473960 4004 TCP   44000000 00464200 ........           KCP WAIT DCI=TCP                             00.000160
10:13:03.275072  F5 404A4A36 0045 00022 004BFA30 8F000198 ........           FCP RETN NORMAL                              00.000064
10:13:03.275104  E1 5054309A 00F4 00022 00000000 00000602 ........           EIP READ RESPONSE                            00.000032
10:13:03.275168  E1 50543868 0004 00022 004BE31C 00000204 ..T.....           EIP HANDLE-CONDITION ENTRY                   00.000064
10:13:03.275200  F1 6046E1BC CC04 00022 00000040 014630D0 ... ....           SCP GETMAIN INITIMG                          00.000032
10:13:03.275264  C8 5049A060 0004 00022 004BFBD0 8C000048 ........           SCP ACQUIRED USER STORAGE                    00.000064
10:13:03.275296  E1 50543868 00F4 00022 00000000 00000204 ........           EIP HANDLE-CONDITION RESPONSE                00.000032
10:13:03.275296  E1 505438EA 0004 00022 004BE31C 00000A04 ..T.....           EIP READQ-TS ENTRY                           00.000000
10:13:03.275360  F7 704A60E2 8903 00022 C1C3F0F1 F1F1F1F1 AC011111           TSP GETQ                                     00.000064
```

Figure 96. The Read-For-Update and the XCTL to ACCT02

```
CUSTOMER INFORMATION CONTROL SYSTEM STORAGE DUMP   CODE=EACC   TASK=AC02       DATE=08/31/84   TIME=10:13:07   PAGE   43
REGISTER STORAGE AREA                             ADDRESS 004BFD20 TO 004BFD7F    LENGTH 000060
00000000   894B0058 004BFC20 00000000 FF4A2B58  00000000 004BF1CC 004BE2D0 00404040   *i....................1...S..   *   004BFD20
00000020   5046E448 A049FB38 8049FAF2 004BF558  004BF1AC 004BF10C 004BE35B 0000000A   *..U........2..5...1...1...T$....*   004BFD40
00000040   004BD800 00000002 0046DED8 0049FA30  004A2C00 004BF440 894B0058 004BFC20   *..Q........Q..........4 i.......*   004BFD60
PROGRAM STORAGE                                   ADDRESS 00541808 TO 005448D7    LENGTH 0030D0
00000000   C4C6C8E8 C3F1F6F0 58F00014 58F0F0B4  58F0F00C 58FF000C 07FF58F0 001458F0   *DFHYC160.0...00..00........0...0*   00541808
00000020   F0B458F0 F00858FF 00C858FF 018407FF  05F00700 900EF00A 47F0F082 00565A78   *0..00....H...d...0....0..00b....*   00541828
00000040   004BF4EC 00541908 004BE2E0 00541880  0049EC98 004BD800 00541838 0046D61C   *..4.......S........q..Q.......O.*   00541848
00000060   00542EF2 004A2B58 004BF440 004BD940  004BF4FC 5046D862 00541938 50544446   *...2......4 ..R ..4...Q.........*   00541868
00000080   00544568 004668A8 00541838 4054442E  00541938 00542A07 00542A08 005443EC   *.......y.... ...................*   00541888
000000A0   00541838 00541838 00542A50 005427E8  0049EFB6 58C0F0C6 58E0C000 58D0F0CA   *...............Y......0F......0.*   005418A8
000000C0   9500E000 4770F0A2 9610D048 92FFE000  47F0F0AC 98CEF03A 90ECD00C 185D989F   *n.....0so...k....00.q.0......)q.*   005418C8
000000E0   F0BA9110 D0480719 07FF0700 005443EC  00541838 00541838 00542A50 004BF1CC   *0.j...........................1.*   005418E8
00000100   00542EF2 005443D2 C3D6C2C6 F3F0F0F0  C1C3C3E3 F0F24040 00542A0C F0F861F3   *...2...KCOBF3000ACCT02  ....08/3*   00541908
00000120   F161F8F4 F1F04BF0 F04BF2F2 00000000  00010000 017F003F 02EF0080 5C5C5C5C   *1/8410.00.22................*****   00541928
00000140   5C5C5C5C 5C5C5C5C C1C3F000 00000000  00000000 00000000 00000000 000C0000   *********AC0.....................*   00541948
00000160   00000000 00000000 00000000 000000C1  C3C3E3F0 F2404000 00404040 40F04BF0   *...............ACCT02  ..    0.0*   00541968
00000180   F0F0F0F0 F0F0F040 404040F0 4BF0F0F0  F0F0F0F0 F0404040 40F04BF0 F0D7D9C5   *0000000    0.00000000    0.00PRE*   00541988
000001A0   E5C9D6E4 E240D9C5 D8E4C5E2 E340C3C1  D5C3C5D3 C5C440C1 E240D9C5 D8E4C5E2   *VIOUS REQUEST CANCELED AS REQUES*   005419A8
000001C0   E3C5C440 40404040 40404040 40404040  40404040 40404040 40D9C5D8 E4C5E2E3   *TED                      REQUEST*   005419C8
000001E0   C5C440C1 C4C4C9E3 C9D6D540 C3D6D4D7  D3C5E3C5 C4404040 40404040 40404040   *ED ADDITION COMPLETED          *   005419E8
00000200   40404040 40404040 40404040 40404040  40404040 40D9C5D8 E4C5E2E3 C5C440D4   *                     REQUESTED M*   00541A08
00000220   D6C4C9C6 C9C3C1E3 C9D6D540 C3D6D4D7  D3C5E3C5 C4404040 40404040 40404040   *ODIFICATION COMPLETED          *   00541A28
00000240   40404040 40404040 40404040 40404040  40D9C5D8 E4C5E2E3 C5C440C4 C5D3C5E3   *                 REQUESTED DELET*   00541A48
00000260   C9D6D540 C3D6D4D7 D3C5E3C5 C4404040  40404040 40404040 40404040 40404040   *ION COMPLETED                  *   00541A68
00000280   40404040 40404040 40404040 40C5C9E3  C8C5D940 C5D5E3C5 D9407FE8 7F40E3D6   *             EITHER ENTER .Y. TO*   00541A88
```

Figure 97. Confirming the Application Module is ACCT02

```
PHASE    XFR-AD  LOCORE  HICORE  DSK-AD     LABEL     LOADED   REL-FR OFFSET
ACCT02   0320A8  032078  035147  009 10 0E
                                                      032078   032078 000000
                                            DFHECI    032078   032078 000000
                                           +DFHEI1    032080
                                           *DLZEI01   032080
  (The Stub size =                         *DLZEI02   032080
   LOADED address                          *DLZEI03   032080
       minus                               *DLZEI04   032080
   Phase LOCORE address                    *DFHCBLI   032092
       = 320A8 - 32078                      ACCT02    0320A8   0320A8 000030
       = 30 bytes)                          ILBDATB0  034CD8   034CD8 002C60
                                            ILBDMNS0  034DD8   034DD8 002D60
                                            ILBDPRM0  034DE8   034DD8 002D70
                                            ILBDTC20  034F50   034F50 002ED8
                                            ILBDWTB0  035048   035048 002FD0
```

Figure 98. How to Find the Size of the Program Stub

But just a minute! **Which** application module are we looking at?

The transaction dump title tells us that the transid is AC02, and this transid passes control to ACCT02. To confirm this, we can look back in the dump listing at location 541808, the start of the program storage area. See Figure 97 on page 251. Sure enough, in the character translation section, and just a few lines down, you can see the program id, ACCT02. (And, to triple check, try working back through the trace table. There's a PCP XCTL-CONDITIONAL entry showing control passing to ACCT02. See Figure 96 on page 250.)

So, we'll find the failing DELETE command immediately before displacement 2826 in module ACCT02. Back to the source compilation listing (see Figure 99).

```
 971    VERB  1  002722  972    VERB  1  002732  973    VERB  1  002742
 977    VERB  1  002778  978    VERB  1  002788  979    VERB  1  002798
 981    VERB  1  0027C6  985    VERB  1  0027CC  987    VERB  1  0027D2
 988    VERB  1  0027E2  989    VERB  1  0027EC  993    VERB  1  002826
 994    VERB  1  002836  995    VERB  1  002846  1001   VERB  1  00287C
 1002   VERB  1  00288C  1006   VERB  1  0028AA  1007   VERB  1  0028B8
 1010   VERB  1  0028D8  1011   VERB  1  0028E8  1012   VERB  1  0028EE
 1013   VERB  1  0028F4  1016   VERB  1  00292A  1017   VERB  1  00293A
 1018   VERB  1  002940  1022   VERB  1  00295E  1023   VERB  1  00297E
 1023   VERB  2  0029A8  1026   VERB  1  0029AE  1027   VERB  1  0029BE
 1028   VERB  1  0029C4  1029   VERB  1  0029CA  1030   VERB  1  0029D0
```

Figure 99. How to Find the Failing COBOL Verb

If we find location 2826 in the Condensed Listing (the CLIST), then the **previous** instruction is the one we want. Offset 2826 converts to COBOL statement (Verb number) 993. The previous instruction is 989, and it says (see Figure 100)

```
CALL 'DFHEI1' USING DFHEIV0  DFH....
```

```
975   *EXEC CICS REWRITE DATASET('ACCTIX') FROM(NEW-ACIXREC)
976   *    LENGTH(ACIX-LNG) END-EXEC.
977             MOVE '         00327    ' TO DFHEIV0
978             MOVE 'ACCTIX' TO DFHEIV1
979            CALL 'DFHEI1' USING DFHEIV0  DFHEIV1  NEW-ACIXREC
980         ACIX-LNG.
981        GO TO RELEASE-ACCT.
982   *
983   *    UPDATE THE FILES FOR DELETE REQUESTS.
984    UPDT-DELETE.
985        MOVE 4 TO MENU-MSGNO.
986   *EXEC CICS DELETE DATASET('ACCTFIL') RIDFLD(ACCTC) END-EXEC.
987         MOVE '         00334    ' TO DFHEIV0
988         MOVE 'ACCTFIL' TO DFHEIV1
989        CALL 'DFHEI1' USING DFHEIV0  DFHEIV1  DFHDUMMY DFHDUMMY
990         ACCTC.
991   *EXEC CICS DELETE DATASET('ACCTIX') RIDFLD(OLD-IXKEY)
992   *    END-EXEC.
993         MOVE '         00335    ' TO DFHEIV0
994         MOVE 'ACCTIX' TO DFHEIV1
995        CALL 'DFHEI1' USING DFHEIV0  DFHEIV1  DFHDUMMY DFHDUMMY
996         OLD-IXKEY.
997   *
998   *    RELEASE OWNERSHIP OF ACCOUNT NUMBER.
999    RELEASE-ACCT.
```

Figure 100. The Compiler Listing of the Incorrect Command

This is generated by the CICS translator from what is now a commented-out instruction at Line 986:

```
EXEC CICS DELETE DATASET('ACCTFIL') RIDFLD(ACCTC) END-EXEC.
```

Reviewing the APRM's description of INVREQ situations, and skipping back through the trace table (see Figure 96 again) to see what other EIP entries exist for this failing task (before the DELETE) we finally conclude that a READ FOR UPDATE is outstanding and that we were therefore wrong to specify an RIDFLD value on the DELETE command.

The cure is to write the DELETE command as:

```
EXEC CICS DELETE DATASET('ACCTFIL') END-EXEC.
```

Chapter 5-2. Finding the Problem

Preliminary Checklist

Before looking in detail at how to cope with the various classes of errors, there are some "simple" things for you to check first which may turn up a number of mistakes. For example:

1. Go back and make sure that your translator, compiler and linkage editor outputs were all error-free.

2. Check that the required PPT, PCT and FCT entries are present and correct.

3. If you change a PCT or PPT entry, remember that, unless you're using RDO, the change will not take effect until you restart CICS.

4. If you are using RDO and you DEFINE or ALTER a transaction, program or mapset, then be sure to use the INSTALL option to get the changes invoked.

5. If you changed any maps, be sure that you created both a new load module (TYPE=MAP) and a new DSECT (TYPE=DSECT), and that you then recompiled every program using that new DSECT.

6. If you changed any program or mapset since CICS was last started, make sure that you are executing the most recent version, by using the transaction:

```
CEMT SET PROGRAM(pgrmid) NEWCOPY
```

Documentation

Next, collect all the documentation of the problem. There are many sources of information, including:

1. Output from the translator, compiler and link editor.

2. Messages to the terminal associated with the failing transaction, and messages to the master terminal.

3. Observations from the terminal operator and the master terminal operator. In the case of the master terminal, you should note any unusual messages associated

with the startup of CICS and any that occurred for some time before the actual problem.

4. Dumps. (You may not want to bother to print the dumps until you have tried other techniques. You should be prepared to do so however, because sometimes they are absolutely necessary.)

5. Shutdown statistics. These aren't usually necessary, and you should not automatically shut down your system after a transaction abend to get them. However, there are occasions on which they may give you insight into problems. Among other things, they show:

   - Which transactions were used
   - Which programs were executed
   - Which terminals were used
   - A summary of temporary storage activity
   - A summary of file activity.

6. CEMT output. You can use CEMT to find out status information about files, programs, transactions, and executing tasks.

Reference Materials

You should also collect certain reference materials for debugging. These include:

- *CICS/VS Application Programmer's Reference Manual (Command Level)* . This book contains detail on the error conditions possible on the various commands, and describes the EIB.

- *CICS/VS Messages and Codes.* This book describes all the "DFHxxxx" messages that CICS issues and all the CICS-generated transaction abend codes.

- *CICS/VS Problem Determination Guide.* This manual contains a wealth of useful information, including the following:

  1. Techniques and tools for problem determination in CICS

  2. Flowcharts for solving a number of specific problem types, including both application and CICS-wide failures

  3. Causes of waits, both in CICS and applications

  4. Causes of slow response time and other performance problems

5. Trace table format details, and an annotated example of the trace entries produced by a program

6. CICS system dump format and content

7. Transaction dump format and content, including control blocks, register conventions and save areas

8. Discussion of terminal and line errors

9. List of common coding and system setup errors.

Four other books relate to problem determination, but they are written for persons with some CICS experience, and you'll probably not need them. They are:

- *CICS/VS Diagnosis Reference Manual.* This manual describes the structure and logic flow of CICS in considerable detail.
- *CICS/DOS/VS Data Areas.* This manual gives the format and contents of CICS control blocks in a VSE environment.
- *CICS/OS/VS Data Areas.* This manual gives the format and contents of CICS control blocks in an OS environment.
- *CICS/VS Program Debugging Reference Summary.* A pocket sized summary of trace table and storage management information.

More Testing Considerations

Regression Testing

A **regression** test is used to make sure that all the transactions in a system continue to do their processing in the same way both before and after changes are applied to the system. This is to ensure that fixes that have been applied to solve one problem don't go on to cause further problems. It's often a good idea to build a set of miniature files to perform your tests on, because it's much easier to examine a small data file for changes.

A good regression test will exercise all the code in every program - that is, it will explore all tests and possible conditions. As your system develops to include more transactions, more possible conditions, and so on, add these to your test system to keep it in step. The results of each test should match those from the previous round of testing. Any discrepancies are grounds for suspicion. You can compare terminal output, file changes, and log entries for validity.

Single-thread Testing

A **single-thread** test takes one application transaction at a time, in an otherwise "empty" CICS system, and sees how it behaves. This enables you to test the program logic, and also shows whether or not the basic CICS information (such as PPT, PCT, FCT entries) is correct. It's quite feasible to test this single application in one CICS partition or region while your normal, online production CICS system is active in another.

Multi-thread Testing

A **multi-thread** test involves several, concurrently-active transactions. Naturally, all the transactions will be in the same CICS partition or region, so you can readily test the ability of a new transaction to co-exist with its future partners.

You may find that a transaction that sails through its single-thread testing still fails miserably in the multi-thread test. Or it may cause other transactions to fail, or even terminate CICS!

Now we can take a systematic look at abends, loops, waits, and incorrect output. We'll start with abends.

Abends

The message with which CICS tells you that a transaction abended:

```
    DFH2005 TRANSACTION xxxx PROGRAM yyyyyyyy ABEND zzzz
```

contains several vital pieces of information. It identifies the transaction (xxxx) that failed. It tells which program (yyyyyyyy) was being executed at the time of the failure. And, most important, it indicates *which* of the many things that could go wrong did. This is the **abend** code, zzzz.

There are two kinds of abend codes: yours and CICS's. All the codes that CICS uses begin with the letter A; yours are the ones that appear in the ABCODE parameter on an ABEND command. For ease of recognition, therefore, don't start your ABCODEs with the letter A.

The first step in tracking down the cause of an abend is to look up this code. If it is one of yours, you'll know what condition it represents. From there you can look at other information (values in Working-Storage and the sequence of calls leading up to the crash) to find out how the situation came about. For CICS abends, the place to look is the *Messages and Codes* manual, which describes all of the CICS abend codes and, for many of them, has suggestions for analysis.

When you are using the subset of commands described in this Primer, you are likely to produce only a relatively small number of CICS ABENDs. With some inventiveness you could produce others, but the ones you are most likely to encounter are described under the following headings.

ASRA

To stop a simple error in one transaction from crashing the whole CICS system, CICS issues an operating system SVC to intercept abends.

So, for example, if you try to do packed arithmetic with EBCDIC variables in your COBOL code (producing what the operating system recognizes as a program check) you don't get the abend that you would in a batch program. Instead, when the operating system detects the program check, it returns control to CICS, which terminates the offending transaction with an abend of its own: ASRA. All ASRA means, therefore, is that a program has committed a violation of the program check type. In COBOL, the source of this trouble is almost always an attempt to do arithmetic with variables that are of mixed PICTURE types or that have not been initialized properly.

The first step in diagnosing an ASRA is to find out where it occurred. This means finding out the program status word (PSW) at the time of the program check. You can find this information either in a dump or by using EDF. Next, you need to know in what program it occurred, so that you can find out where in that program the offending instruction was. Usually the program is the application program that was executing at the time.

ASRB

An ASRB abend occurs in almost the same way as an ASRA, but it is the result of an operating system abend other than the common program check. If CICS can contain the damage, it terminates that transaction with ASRB. The procedure for finding the source of the trouble is the same as for ASRA. An operating system abend isn't likely to happen except as a program check in a CICS command-level program, however, and so ASRB is much less common than ASRA.

AICA

As explained earlier, an AICA abend occurs when CICS detects that an application program is looping. Whether CICS considers a program to be looping depends on the length of time that elapses between successive CICS commands. If the time is longer than the runaway task time interval (ICVR) parameter in the SIT, CICS assumes that the program is looping and terminates it with code AICA.

When you have a loop, you need to know where it is in the code. With an AICA, you know by definition that the loop started after the last CICS command was issued and ended before any other command was issued. You can tell either from the trace table in a dump, or by using EDF, what the last CICS command was and where it was in the code, and the program listing will tell you where the next one was expected. If this doesn't pinpoint the problem, look at the values of your Working-Storage variables. Often these values, in combination with your knowledge of the program logic, will tell you almost exactly how far you got in the code.

If you still need further information, however, you can use either EDF or transaction dumps to work out how far through a section of code you are getting, and what the values of the variables in Working-Storage are at each step. To do this with EDF, choose a statement that you aren't sure gets executed. Using its statement number (from the translator if you used DEBUG) or its hex location otherwise, enter it as a stop condition. Then let the program run.

If the loop is far into the code, suppress the displays. If the program reaches the stop condition, then you know that the statement got executed. Pick another statement beyond this one and repeat the process. If the statement does not get executed before the AICA occurs, pick another statement between it and the beginning of the loop. Repeat this process until you've located the loop.

The technique with transaction dumps is very similar, except that you should pick out all the questionable statements at once, and put a DUMP command after each one, each with a different DMPCODE identifier. Then run the program and analyze the dumps. You can tell from the sequence of DMPCODEs how far you got through the code, and your Working-Storage at each point will also be available in the dumps, to help you work out what went wrong.

We'll add two notes of caution here about AICA abends.

1. Since in all but the most recent versions CICS uses real time rather than processor time to detect loops, it's possible for a transaction to get terminated, with AICA, without being in a loop. This can result from setting the runaway task time interval (ICVR) value in the SIT too low, or from too much interference with the CICS partition from other partitions, or a combination of both. If you've any doubt that an AICA is valid, raise the ICVR value somewhat and repeat the transaction several times. If it is a "true" AICA, the last CICS command executed will always be the same one.

2. Certain CICS commands don't pass through task control and don't, therefore, reset the runaway task time interval.

APCT

This abend occurs when you attempt to execute a program that is either (1) disabled, or (2) not defined at all in either the PPT or an active RDO group. For pure command-level programs, APCT can occur only when the first program for a transaction is invoked (before the command-level interface gets established). After that, the same type of failure (during a LINK or XCTL command, for instance) produces an AEI0 abend instead.

So if you get an APCT, the cause is one of the following:

1. The program named as first executed for the transaction in the PCT isn't defined in the PPT (with identical spelling).
2. The program named in the DEFINE TRANSACTION command hasn't been defined in a DEFINE PROGRAM command.
3. The program is disabled.

Programs can be disabled by an operator or even by CICS for sufficiently unsuitable behavior. By far the most common cause, however, is that CICS could not find the program in the load library at startup time, and disabled the program for that reason. If this occurs, therefore, make sure that:

- The name of the program in the load library matches the name in the PPT, and the program has been successfully linked into the library.
- The name in the PCT matches the name in the PPT (or the program name in the DEFINE TRANSACTION command is the same as the name in the corresponding DEFINE PROGRAM command).
- The program is enabled. To find out the status of the program at the time of the APCT failure, use the transaction:

```
CEMT INQUIRE PROGRAM(pgrmid)
```

AFCA

This abend occurs when you try to use a file that has been disabled. This should happen only rarely. If the file is closed for some reason (which is more likely) and if you've not handled this condition, you'll get an AEIS abend instead. If AFCA does occur, use the CEMT transaction to find out which of the files in question is disabled:

```
CEMT INQUIRE DATASET(fileid)
```

The problem should disappear as soon as the file is properly available.

AEIx and AEYx

All of the abend codes that start with the letters "AEI" or "AEY" result from exceptional conditions detected in command-level programs, for which no HANDLE CONDITION command is active.

Figure 101 on page 263 lists all of the AEIx and AEYx abends that may occur using the commands described in this Primer. After each code the figure shows the exceptional condition, and also the command type (such as file or BMS), and the associated EIBFN and EIBRCODE values.

For the most part, the reasons for these abends are exactly what is described in the APRM for the corresponding condition. Some of the errors may have multiple causes, such as ILLOGIC and INVREQ. For example, on an ILLOGIC abend, Byte 1 of EIBRCODE is the VSAM return code and Byte 2 is the VSAM error code.

If you determine that the condition was the result of a logic error in the program, then you can correct that error and retry. If, however, it turns out that the condition could arise naturally, then you should add a HANDLE CONDITION command to the program to deal with it.

ATNI

A terminal error will lead to an ATNI transaction abend, and a CICS transaction dump. In other words, the application will not get control back, and contact with the screen will be lost.

Loops

We've already described a technique for finding loops that do not contain any CICS commands. (It was in the discussion of AICA abends, and involved using either EDF or transaction dumps.) For loops that *do* include CICS commands, the same tools apply.

Using EDF, the easiest method is to invoke the transaction and let it run until you're satisfied that it is looping. Then go to another terminal and invoke EDF for the terminal running the suspect transaction. EDF will interrupt the execution of the transaction at every CICS command, and send a display to this second terminal. As each command is executed, note it in the associated program listing. Let the program continue executing commands until a clear pattern of repetition emerges.

Having located the loop, the next step is to find the cause. There will usually be one or more points in the loop at which the program should exit, provided certain conditions are met. The problem is that the conditions are never met. When, under EDF, you reach the command that is causing the problem, you may need to examine

CODE	CONDITION	SERVICE	EIBFN	EIBRCODE
AEIA	ERROR	Misc	N/A	N/A
AEIK	TERMIDERR	Time	10	12
AEIL	DSIDERR	File	06	01
AEIM	NOTFND	File	06	81
		or Time	10	81
AEIN	DUPREC	File	06	82
AEIP	INVREQ	File	06	08
		or Temp Stge	0A	20
		or Program	0E	E0
AEIQ	IOERR	File	06	80
AEIR	NOSPACE	File	06	83
		or Temp Stge	0A	08
AEIS	NOTOPEN	File	06	0C
AEIT	ENDFILE	File	06	0F
AEIU	ILLOGIC	File	06	02
AEIV	LENGERR	File	06	E1
		or Temp Stge	0A	E1
		or Time	10	E1
AEIZ	ITEMERR	Temp Stge	0A	01
AEI0	PGMIDERR	Program	0E	01
AEI1	TRANSIDERR	Time	10	11
AEI3	INVTSREQ	Time	10	14
AEI8	IOERR	Temp Stge	0A	04
		or Time	10	04
AEI9	MAPFAIL	BMS	18	04
AEYB	INVMPSZ	BMS	18	08
AEYH	QIDERR	Temp Stge	0A	02

Figure 101. AEIx and AEIy Abend Conditions

the values in Working-Storage to find out why this is occurring. The next time the loop is executed, you may want to pause at the preceding command and look at the same variables at that time. If there's too much code between these two commands to see exactly what's going wrong, you can then use the techniques for the other kind of loops (AICA abends) to locate the error within the statements between the CICS commands.

The process is very similar using a transaction dump. Let the transaction run until it's clearly looping, and then cancel it. Use the trace table in the resulting abend dump to find the repeated sequence of CICS commands. At this point the contents of Working-Storage may or may not give you enough information to work out the problem. If they do not, put further dump requests near the expected exit point(s) from the loop, and use the technique described above to close in on the problem.

Waits

Remember we're assuming you have a batch programming background.

With that in mind, you can avoid WAITs by avoiding two programming practices you may be bringing with you from that background. You see, the most common cause of a WAIT in a COBOL program is an ACCEPT FROM CONSOLE or STOP statement to which the operator failed to reply. Check for these before going any further with your debugging of a wait.

Now, what about approaching WAITs from a CICS point of view?

The key to recognizing a wait is the operator's observation. In other words, he or she has typed in some data, pressed the ENTER key, and nothing much seems to be happening.

When you first suspect a wait, use the CEMT transaction to make sure there **is** still a task associated with the terminal. If there isn't, you've got an "incorrect output". A waiting task will show as suspended or active.

If we leave aside the question of data base access (as beyond the scope of the Primer), there are then just five reasons for a task to get suspended:

- terminal control wait
- unsuccessful enqueue - when a task needs, but has failed to gain access to, a resource owned by some other task
- interval control wait
- not enough main storage
- not enough auxiliary storage

There are a further four reasons for a task to be active but waiting:

- dispatchable
- dispatchable, but on the point of an ABEND command
- non-dispatchable, because of too many other tasks in the system, or some other CICS workload control
- waiting for some external or internal event to complete (for example, file input/output or no VSAM string available, respectively)

Whatever the case, purge the task and print the dump. Work through the dump to find the last CALL made by the program. If the troublesome task was suspended, look for the KCP SUSPEND trace table entry. Just before this should be a clue to the reason for the suspend, bearing in mind the above five reasons.

If, on the other hand, the task was active, look for the KCP WAIT trace table entry. Just before this should be a clue to the reason for the wait.

Between them, the source code of the last CALL and the request causing either the wait or the suspend should cast some light on the problem.

Of course, the problem may be entirely outside your task. There are two reasons for the CICS partition or region itself to be in a wait state:

1. No CICS tasks are currently ready to be dispatched, so task control has issued an operating system wait for the length of time specified by the ICV (a SIT operand that basically says how long CICS is to give up control).

2. A wait has been issued from somewhere else in CICS, or an SVC (supervisor call) has been issued.

In the first case, you must check each task to find out what it's waiting for. There may also be some reason why **new** tasks aren't coming along. The system could be short on storage; or the maximum number of concurrent tasks allowed could have been reached; or terminal input could be failing to get through.

In the second case, you must find out what's going on in the operating system and also, perhaps, confirm that a badly-behaved task hasn't issued an SVC. During normal running, CICS issues only the task control operating system wait we mentioned above.

However, this really **isn't** the place to start tackling system waits. The *CICS/VS Problem Determination Guide* has two chapters all about waits, and is there (waiting!) for you.

Incorrect Output

As we've said, the symptoms of incorrect output are garbage on the screen (or printer), a terminal that simply locks up, bad data in files, or wrong screen sequences. In fact, incorrect output problems can present all kinds of bothersome symptoms and be very interesting to pin down.

Here are some suggestions for you to think about when you have a program that's compiled correctly but that seems to misbehave:

- Is the input data correct?

- Are you correctly validating entered data?

- Assuming you **are** getting **some** output at the terminal or printed out, check it over:

  - Is the sequence what you expect?
  - Are the items correct?

  - Are any totals correct?
  - Are some items being repeated when they shouldn't be?
  - Are any items missing?

- Print any output files, data files, and so on to see if they contain what you expect.

- Are you initializing or clearing program variables properly?

Be sure to look up any messages or codes that come up. Work through program dump listings to see what command last executed. (Note, however, that an operation that uncovers incorrect output may be completely innocent of having caused it.)

Try to find out what resource is failing. It's usually data on a disk (on a clear disk, you can seek forever!) or data in a terminal data stream. Of course, data on the terminal may be bad because of a bad file.

Work back, if possible, from the place where the symptoms first occur, and forward from a point where the data is ok. Where you meet should be interesting.

Look at map or file data structures from appropriate listings. Compare each field, as defined in the output from the map assembly, with the map as displayed in Working-Storage. You can use EDF to do this, or a transaction dump. Note the contents of each field carefully, and look at each field suspiciously.

Paranoid patience is sometimes the best approach. Good luck!

CICS System Problems

Problems that affect CICS as a system fall into the same four categories as those which affect transactions: abends, loops, waits, and incorrect output. As noted before, such problems are generally beyond the scope of this Primer.

Appendixes

This Part of the Primer describes:

- How to install the example application
- The remaining facilities of CICS
- The application programmer's reference manual

Appendix A. Getting the Application Into Your CICS System

Introduction

This appendix explains what you must do to enable you to use the example application on your CICS/DOS system. Your systems programmer will probably have to help you with these tasks. You'll need a copy of the CICS/DOS/VS Installation and Operations Guide (SC33-0070) to refer to.

What Has to be Done?

Assuming you already have a working CICS system, you must now do the following before you can run the example application:

1. Copy the picture statements for ACIXREC and ACCTREC into your source statement library.

2. Compile and link-edit the batch programs that

   a. initialize the index and data files, and
   b. perform "forward recovery" by rebuilding the index file from the account file.

3. Create and initialize the index and data files for account records.

4. Update the File Control Table to include records for the sample application files.

5. Update the Program Control Table to include the transaction ID/ program relationship for the sample application.

6. Update the Processing Program Table to include entries for the sample application program and maps.

7. Assemble the ACCTSET source into your core image library and assemble and catalog the map as a copybook in your source statement library.

8. Translate, compile, and linkedit programs ACCT00, ACCT01, ACCT02, ACCT03, and ACCT04 into your core-image library.

```
          02  ACCTDO              PIC 9(5).
          02  FNAMEDO             PIC X(7).
          02  MIDO                PIC X.
          02  TTLDO               PIC X(4).
          02  ADDR1DO             PIC X(24).
          02  STATDO              PIC X(2).
          02  LIMITDO             PIC X(8).
 BKEND
/*
/&
```

Compiling and Link-Editing the Initialize Program

Use the following job stream to compile and link-edit this ACCTINIT program. It initializes the index and data files.

```
// JOB COMPILE ACCTINIT - PRIMER FILE INITIALIZATION PROGRAM
// OPTION CATAL,NODECK
// LIBDEF CL,TO=user-cil-filename
// LIBDEF SL,SEARCH=user-slb-filename
 PHASE ACCTINIT,*
// EXEC FCOBOL
 CBL APOST,CLIST,LIB
      *     ACCTINIT - PRIMER ACCOUNT/INDEX FILE INITIALIZATION
      *
      *     VSAM KSDS FILES MUST BE INITIALIZED BEFORE BEING OPENED
      *     FOR I-O UNDER CICS.  THIS PROGRAM INITIALIZES THE TWO
      *     PRIMER FILES WITH DETAILS OF A DUMMY ACCOUNT.

       IDENTIFICATION DIVISION.
       PROGRAM-ID. ACCTINIT.
       ENVIRONMENT DIVISION.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
      *     REMOVE "SYS005-" FOR OS
            SELECT ACCT-FILE ASSIGN TO SYS005-ACCTFIL
                ORGANIZATION INDEXED
                ACCESS IS DYNAMIC
                RECORD KEY IS ACCT-KEY.
      *     REMOVE "SYS005-" FOR OS
            SELECT ACIX-FILE ASSIGN TO SYS005-ACCTIX
                ORGANIZATION INDEXED
                ACCESS IS DYNAMIC
                RECORD KEY IS ACIX-KEY.
       DATA DIVISION.
       FILE SECTION.
       FD  ACCT-FILE
           LABEL RECORDS ARE STANDARD.
       01  ACCT-RECORD.
         02  ACCT-KEY              PIC X(5).
         02  FILLER                PIC X(378).
       FD  ACIX-FILE
           LABEL RECORDS ARE STANDARD.
       01  ACIX-RECORD.
         02  ACIX-KEY              PIC X(17).
         02  FILLER                PIC X(46).
       WORKING-STORAGE SECTION.
       01  ACCTREC. COPY ACCTREC.
       01  ACIXREC. COPY ACIXREC.
       PROCEDURE DIVISION.
           MOVE SPACES TO ACCTREC, ACIXREC.
           MOVE '79999' TO ACCTDO IN ACCTREC, ACCTDO IN ACIXREC.
           MOVE 'DUMMY' TO SNAMEDO IN ACCTREC, SNAMEDO IN ACIXREC.
           MOVE 'A' TO FNAMEDO IN ACCTREC, FNAMEDO IN ACIXREC.
           MOVE 'MAY BE DELETED' TO ADDR1DO IN ACCTREC,
                 ADDR1DO IN ACIXREC.
           MOVE 'AFTER INSERTING' TO ADDR2DO IN ACCTREC.
           MOVE 'OTHER ACCOUNTS' TO ADDR3DO IN ACCTREC.
           OPEN OUTPUT ACCT-FILE
           WRITE ACCT-RECORD FROM ACCTREC.
           CLOSE ACCT-FILE.
           OPEN OUTPUT ACIX-FILE
           WRITE ACIX-RECORD FROM ACIXREC.
           CLOSE ACIX-FILE.
           STOP RUN.
/*
// EXEC LNKEDT
/&
```

Compiling and Link-Editing the Index File Program

Use the following job stream to compile and link-edit this ACCTINDX program, to prepare it for use. You'll only ever need to *run* it if you need to recreate the index file from the master account file because of some disastrous file error involving the index file.

It's the small batch program we mentioned in "Recovery Requirements" on page 51.

```
// JOB COMPILE ACCTINDX - PRIMER INDEX REBUILD PROGRAM
// OPTION CATAL,NODECK
// LIBDEF CL,TO=user-cil-filename
// LIBDEF SL,SEARCH=user-slb-filename
 PHASE ACCTINDX,*
// EXEC FCOBOL
 CBL APOST,CLIST,LIB
      *     ACCTINDX - REBUILD PRIMER INDEX FROM MASTER FILE
      *
      *     THE PRIMER INDEX FILE IS NOT JOURNALED UNDER CICS SO,
      *     IN THE EVENT OF LOSS OF THE INDEX, FORWARD RECOVERY
      *     IS NOT POSSIBLE.  INSTEAD THIS PROGRAM RECREATES THE
      *     INDEX FROM SCRATCH BY CREATING AN INDEX RECORD FOR EACH
      *     RECORD ON THE CUSTOMER MASTER FILE AFTER THE MASTER FILE
      *     HAS BEEN RECOVERED.  RECORDS ARE WRITTEN IN ACCOUNT NO
      *     SEQUENCE SO THEY MUST BE SORTED INTO NAME/ACCOUNT NO
      *     SEQUENCE FOR LOADING TO THE VSAM INDEX FILE.

       IDENTIFICATION DIVISION.
       PROGRAM-ID. ACCTINDX.
       ENVIRONMENT DIVISION.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
      *     REMOVE "SYS004-" FOR OS
            SELECT ACCT-FILE ASSIGN TO SYS004-ACCTFIL
                ORGANIZATION INDEXED
                RECORD KEY IS ACCT-KEY.
      *     CHANGE ASSIGN FOR OS
            SELECT ACIX-SAM ASSIGN TO SYS005-UT-FBA1-S-ACIXSAM.
       DATA DIVISION.
       FILE SECTION.
       FD  ACCT-FILE
           LABEL RECORDS ARE STANDARD.
       01  ACCT-RECORD.
         02  ACCT-KEY               PIC X(5).
         02  FILLER                 PIC X(378).
       FD  ACIX-SAM
           BLOCK CONTAINS 20 RECORDS
           LABEL RECORDS ARE STANDARD.
       01  ACIXREC. COPY ACIXREC.
       WORKING-STORAGE SECTION.
       01  ACCTREC. COPY ACCTREC.
       PROCEDURE DIVISION.
           OPEN INPUT ACCT-FILE
           OPEN OUTPUT ACIX-SAM.
       READ-MASTER.
           READ ACCT-FILE NEXT INTO ACCTREC
                               AT END GO TO END-MASTER.
           MOVE CORRESPONDING ACCTREC TO ACIXREC.
           WRITE ACIXREC.
           GO TO READ-MASTER.
       END-MASTER.
           CLOSE ACCT-FILE.
           CLOSE ACIX-SAM.
           STOP RUN.
/*
// EXEC LNKEDT
/&
```

If and when you need to rebuild your account index file, use the following job stream:

```
// JOB ACCTIXEX EXECUTE ACCTINEX TO REBUILD ACCTIX
// LIBDEF CL,SEARCH=user-cil-filename
// DLBL IJSYSUC,'user.catalog',,VSAM
// DLBL ACCTFIL,'SAMPLE.TEST.ACCTFILE',,VSAM
// DLBL ACIXSAM,'SAMPLE.UNSORTED.INDEX.FILE',0
// EXTENT SYS005,,,,,extent information
// ASSGN SYS005,DISK,VOL=volser,SHR
// EXEC ACCTINDX,SIZE=AUTO
// EXEC IDCAMS,SIZE=AUTO
 PRINT IFILE(ACCTFIL)
/*
// DLBL IJSYSUC,'P.UCAT',,VSAM
// DLBL SORTIN1,'SAMPLE.UNSORTED.INDEX.FILE'
// EXTENT SYS002,volser
// DLBL SORTOUT,'SAMPLE.TEST.ACCTIX',,VSAM
// DLBL SORTWK1,,0,DA
// EXTENT SYS003,,,,,extent information
// ASSGN SYS002,DISK,VOL=volser,SHR
// ASSGN SYS003,DISK,VOL=volser,SHR
// EXEC SORT,SIZE=32K
 SORT FIELDS=(1,17,CH,A)
 RECORD TYPE=F,LENGTH=63
 INPFIL BLKSIZE=1260
 OUTFIL KSDS
 END
/*
// EXEC IDCAMS,SIZE=AUTO
 PRINT IFILE(SORTOUT)
/*
/&
```

Creating and Initializing the Index and Account Files

These files are VSAM clusters that you create using the IDCAMS utility. Then use ACCTINIT to initialize the files. Here's a sample job stream:

```
// JOB INIT CREATE & INITIALIZE SAMPLE DATA FILES
// EXEC IDCAMS,SIZE=AUTO
 DELETE SAMPLE.TEST.ACCTFILE CLUSTER PURGE        -
        CATALOG(user.catalog)
 DEFINE  CLUSTER                                  -
          (NAME(SAMPLE.TEST.ACCTFILE)             -
           INDEXED                                -
           RECORDSIZE(383 383)                    -
           RECORDS(5 10)                          -
           KEYS(5 0)                              -
           VOLUMES(xxxxxx))                       -
        DATA                                      -
          (NAME(SAMPLE.TEST.ACCTFILE.DATA))       -
        INDEX                                     -
          (NAME(SAMPLE.TEST.ACCTFILE.INDEX))      -
        CATALOG(user.catalog)
 LISTCAT ENTRIES(SAMPLE.TEST.ACCTFILE) ALL        -
        CATALOG(user.catalog)
 DELETE SAMPLE.TEST.ACIXFILE CLUSTER PURGE        -
        CATALOG(user.catalog)
 DEFINE  CLUSTER                                  -
          (NAME(SAMPLE.TEST.ACIXFILE)             -
           INDEXED                                -
           RECORDSIZE(63 63)                      -
           RECORDS(5 10)                          -
           KEYS(17 0)                             -
           VOLUMES(xxxxxx))                       -
        DATA                                      -
          (NAME(SAMPLE.TEST.ACIXFILE.DATA))       -
        INDEX                                     -
          (NAME(SAMPLE.TEST.ACIXFILE.INDEX))      -
        CATALOG(user.catalog)
 LISTCAT ENTRIES(SAMPLE.TEST.ACIXFILE) ALL        -
        CATALOG(user.catalog)
/*
// LIBDEF CL,SEARCH=user-cil-filename
// DLBL ACCTFIL,'SAMPLE.TEST.ACCTFILE',,VSAM
// DLBL ACCTIX,'SAMPLE.TEST.ACIXFILE',,VSAM
// DLBL IJSYSUC,'user.catalog',,VSAM
// EXEC ACCTINIT,SIZE=AUTO
// EXEC IDCAMS,SIZE=AUTO
 PRINT IFILE(ACCTFIL)
 PRINT IFILE(ACCTIX)
/*
/&
```

Updating the File Control Table

You must update the File Control Table to include the following entries:

```
DFHFCT TYPE=DATASET,DATASET=ACCTFIL,                  X
       ACCMETH=VSAM,LOG=YES,JID=SYSTEM,               X
       SERVREQ=(GET,NEWREC,DELETE,UPDATE),            X
       JREQ=(WU,WN),BUFND=2,BUFNI=1,STRNO=1
DFHFCT TYPE=DATASET,DATASET=ACCTIX,ACCMETH=VSAM,      X
       SERVREQ=(GET,NEWREC,DELETE,UPDATE,BROWSE),     X
       LOG=YES,BUFND=2,BUFNI=1,STRNO=1
```

For more information on updating the File Control Table refer to Chapter 2.3 of the CICS/DOS/VS Installation and Operations Guide.

Updating the Program Control Table

Any updates to your PPT and PCT should be done by whoever controls changes to your CICS system as a whole. (Proper "change control" is a topic in its own right, and an important one.)

With that caution in mind, let's update the Program Control Table:

```
DFHPCT TYPE=ENTRY,TRANSID=ACCT,PROGRAM=ACCT00,        X
       DTB=NO,SPURGE=YES,TPURGE=YES
DFHPCT TYPE=ENTRY,TRANSID=AC01,PROGRAM=ACCT01,        X
       DTB=YES,SPURGE=YES,TPURGE=YES
DFHPCT TYPE=ENTRY,TRANSID=AC02,PROGRAM=ACCT02,        X
       DTB=YES,SPURGE=NO,TPURGE=NO
DFHPCT TYPE=ENTRY,TRANSID=AC03,PROGRAM=ACCT03,        X
       DTB=YES,SPURGE=YES,TPURGE=YES
DFHPCT TYPE=ENTRY,TRANSID=ACLG,PROGRAM=ACCT03,        X
       DTB=YES,SPURGE=YES,TPURGE=YES
DFHPCT TYPE=ENTRY,TRANSID=AC05,PROGRAM=ACCT03,        X
       DTB=YES,SPURGE=YES,TPURGE=YES
```

For more information on updating the Program Control Table refer to Chapter 2.3 of the CICS/DOS/VS Installation and Operations Guide.

Updating the Processing Program Table

Next, you must update the Processing Program Table:

```
DFHPPT TYPE=ENTRY,PROGRAM=ACCT00,PGMLANG=COBOL
DFHPPT TYPE=ENTRY,PROGRAM=ACCT01,PGMLANG=COBOL
DFHPPT TYPE=ENTRY,PROGRAM=ACCT02,PGMLANG=COBOL
DFHPPT TYPE=ENTRY,PROGRAM=ACCT03,PGMLANG=COBOL
DFHPPT TYPE=ENTRY,PROGRAM=ACCT04,PGMLANG=COBOL
DFHPPT TYPE=ENTRY,MAPSET=ACCTSET
```

For more information on updating the Processing Program Table refer to Chapter 2.3 of the CICS/DOS/VS Installation and Operations Guide.

ACCTSET

You need to assemble and link-edit a physical and a symbolic description map set named ACCTSET. Use the following job:

```
// JOB ACCTSET ASSEMBLE MAP SET DSECT AND MAP
// DLBL IJSYSPH,'DISK.SYSPCH.EXTENT',0
// EXTENT SYSPCH,,,,extent-information
// DLBL IJSYSIN,'DISK.SYSPCH.EXTENT'
// LIBDEF SL,TO=user-slb-filename
// LIBDEF SL,SEARCH=(user-slb-filename,cics-slb-filename)
// LIBDEF CL,TO=user-cil-filename
// EXEC MAINT                              (see note 1)
 CATALS A.DUMMYMAP
 BKEND A.DUMMYMAP
ACCTSET DFHMSD TYPE=MAP,MODE=INOUT,LANG=COBOL,                        X
               STORAGE=AUTO,TIOAPFX=YES
*       MENU MAP.
ACCTMNU DFHMDI SIZE=(24,80),CTRL=(PRINT,FREEKB)
        DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=18,                X
               INITIAL='ACCOUNT FILE: MENU'
        DFHMDF POS=(3,4),ATTRB=(ASKIP,NORM),LENGTH=25,                X
               INITIAL='TO SEARCH BY NAME, ENTER:'
        DFHMDF POS=(3,63),ATTRB=(ASKIP,NORM),LENGTH=12,               X
               INITIAL='ONLY SURNAME'
        DFHMDF POS=(4,63),ATTRB=(ASKIP,NORM),LENGTH=16,               X
               INITIAL='REQUIRED. EITHER'
        DFHMDF POS=(5,7),ATTRB=(ASKIP,BRT),LENGTH=8,                  X
               INITIAL='SURNAME:'
SNAMEM  DFHMDF POS=(5,16),ATTRB=(UNPROT,NORM,IC),LENGTH=12
        DFHMDF POS=(5,29),ATTRB=(PROT,BRT),LENGTH=13,                 X
               INITIAL='  FIRST NAME:'
FNAMEM  DFHMDF POS=(5,43),ATTRB=(UNPROT,NORM),LENGTH=7
        DFHMDF POS=(5,51),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(5,63),ATTRB=(ASKIP,NORM),LENGTH=15,               X
               INITIAL='MAY BE PARTIAL.'
        DFHMDF POS=(7,4),ATTRB=(ASKIP,NORM),LENGTH=30,                X
               INITIAL='FOR INDIVIDUAL RECORDS, ENTER:'
        DFHMDF POS=(8,63),ATTRB=(ASKIP,NORM),LENGTH=16,               X
               INITIAL='PRINTER REQUIRED'
```

```
         DFHMDF POS=(9,7),ATTRB=(ASKIP,BRT),LENGTH=13,                 X
               INITIAL='REQUEST TYPE:'
REQM     DFHMDF POS=(9,21),ATTRB=(UNPROT,NORM),LENGTH=1
         DFHMDF POS=(9,23),ATTRB=(ASKIP,BRT),LENGTH=10,                X
               INITIAL='  ACCOUNT: '
ACCTM    DFHMDF POS=(9,34),ATTRB=(NUM,NORM),LENGTH=5
         DFHMDF POS=(9,40),ATTRB=(ASKIP,BRT),LENGTH=10,                X
               INITIAL='  PRINTER:'
PRTRM    DFHMDF POS=(9,51),ATTRB=(UNPROT,NORM),LENGTH=4
         DFHMDF POS=(9,56),ATTRB=(ASKIP,NORM),LENGTH=21,               X
               INITIAL='       ONLY FOR PRINT'
         DFHMDF POS=(10,63),ATTRB=(ASKIP,NORM),LENGTH=9,               X
               INITIAL='REQUESTS.'
         DFHMDF POS=(11,7),ATTRB=(ASKIP,NORM),LENGTH=53,               X
               INITIAL='REQUEST TYPES:  D = DISPLAY    A = ADD     X = X
               DELETE'
         DFHMDF POS=(12,23),ATTRB=(ASKIP,NORM),LENGTH=25,              X
               INITIAL='P = PRINT      M = MODIFY'
         DFHMDF POS=(14,4),ATTRB=(ASKIP,NORM),LENGTH=18,               X
               INITIAL='THEN PRESS "ENTER"'
         DFHMDF POS=(14,35),ATTRB=(ASKIP,NORM),LENGTH=28,              X
               INITIAL='-OR-   PRESS "CLEAR" TO EXIT'
SUMTTLM  DFHMDF POS=(16,1),ATTRB=(ASKIP,DRK),LENGTH=79,                X
               INITIAL='ACCT    SURNAME        FIRST    MI   TTL   ADDRESSX
                          ST       LIMIT'
SUMLNM   DFHMDF POS=(17,1),ATTRB=(ASKIP,NORM),LENGTH=79,OCCURS=6
MSGM     DFHMDF POS=(24,1),ATTRB=(ASKIP,BRT),LENGTH=60
*
*        DETAIL MAP.
ACCTDTL  DFHMDI SIZE=(24,80),CTRL=(FREEKB,PRINT)
         DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=13,                X
               INITIAL='ACCOUNT FILE: '
TITLED   DFHMDF POS=(1,15),ATTRB=(ASKIP,NORM),LENGTH=14,               X
               INITIAL='RECORD DISPLAY'
         DFHMDF POS=(3,1),ATTRB=(ASKIP,NORM),LENGTH=11,                X
               INITIAL='ACCOUNT NO:'
ACCTD    DFHMDF POS=(3,13),ATTRB=(ASKIP,NORM),LENGTH=5
         DFHMDF POS=(3,25),ATTRB=(ASKIP,NORM),LENGTH=10,               X
               INITIAL='SURNAME:  '
SNAMED   DFHMDF POS=(3,36),ATTRB=(UNPROT,NORM,IC),                     X
               LENGTH=18
         DFHMDF POS=(3,55),ATTRB=(PROT,NORM),LENGTH=1
         DFHMDF POS=(4,25),ATTRB=(ASKIP,NORM),LENGTH=10,               X
               INITIAL='FIRST:    '
FNAMED   DFHMDF POS=(4,36),ATTRB=(UNPROT,NORM),LENGTH=12
         DFHMDF POS=(4,49),ATTRB=(PROT,NORM),LENGTH=6,                 X
               INITIAL='   MI:'
MID      DFHMDF POS=(4,56),ATTRB=(UNPROT,NORM),LENGTH=1
         DFHMDF POS=(4,58),ATTRB=(ASKIP,NORM),LENGTH=7,                X
               INITIAL=' TITLE:'
TTLD     DFHMDF POS=(4,66),ATTRB=(UNPROT,NORM),LENGTH=4
         DFHMDF POS=(4,71),ATTRB=(PROT,NORM),LENGTH=1
         DFHMDF POS=(5,1),ATTRB=(ASKIP,NORM),LENGTH=10,                X
               INITIAL='TELEPHONE:'
TELD     DFHMDF POS=(5,12),ATTRB=(NUM,NORM),LENGTH=10
         DFHMDF POS=(5,23),ATTRB=(ASKIP,NORM),LENGTH=12,               X
               INITIAL='  ADDRESS:  '
ADDR1D   DFHMDF POS=(5,36),ATTRB=(UNPROT,NORM),LENGTH=24
```

```
        DFHMDF POS=(5,61),ATTRB=(PROT,NORM),LENGTH=1
ADDR2D  DFHMDF POS=(6,36),ATTRB=(UNPROT,NORM),LENGTH=24
        DFHMDF POS=(6,61),ATTRB=(PROT,NORM),LENGTH=1
ADDR3D  DFHMDF POS=(7,36),ATTRB=(UNPROT,NORM),LENGTH=24
        DFHMDF POS=(7,61),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(8,1),ATTRB=(ASKIP,NORM),LENGTH=22,                  X
               INITIAL='OTHERS WHO MAY CHARGE:'
AUTH1D  DFHMDF POS=(9,1),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(9,34),ATTRB=(PROT,NORM),LENGTH=1
AUTH2D  DFHMDF POS=(9,36),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(9,69),ATTRB=(PROT,NORM),LENGTH=1
AUTH3D  DFHMDF POS=(10,1),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(10,34),ATTRB=(PROT,NORM),LENGTH=1
AUTH4D  DFHMDF POS=(10,36),ATTRB=(UNPROT,NORM),LENGTH=32
        DFHMDF POS=(10,69),ATTRB=(PROT,NORM),LENGTH=1
        DFHMDF POS=(12,1),ATTRB=(ASKIP,NORM),LENGTH=17,                 X
               INITIAL='NO. CARDS ISSUED:'
CARDSD  DFHMDF POS=(12,19),ATTRB=(NUM,NORM),LENGTH=1
        DFHMDF POS=(12,21),ATTRB=(ASKIP,NORM),LENGTH=16,                X
               INITIAL='    DATE ISSUED:'
IMOD    DFHMDF POS=(12,38),ATTRB=(UNPROT,NORM),LENGTH=2
IDAYD   DFHMDF POS=(12,41),ATTRB=(UNPROT,NORM),LENGTH=2
IYRD    DFHMDF POS=(12,44),ATTRB=(UNPROT,NORM),LENGTH=2
        DFHMDF POS=(12,47),ATTRB=(ASKIP,NORM),LENGTH=12,                X
               INITIAL='     REASON:'
RSND    DFHMDF POS=(12,60),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF POS=(12,62),ATTRB=(ASKIP,NORM),LENGTH=1
        DFHMDF POS=(13,1),ATTRB=(ASKIP,NORM),LENGTH=10,                 X
               INITIAL='CARD CODE:'
CCODED  DFHMDF POS=(13,12),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF POS=(13,14),ATTRB=(ASKIP,NORM),LENGTH=1
        DFHMDF POS=(13,25),ATTRB=(ASKIP,NORM),LENGTH=12,                X
               INITIAL='APPROVED BY:'
APPRD   DFHMDF POS=(13,38),ATTRB=(UNPROT,NORM),LENGTH=3
        DFHMDF POS=(13,42),ATTRB=(ASKIP,NORM),LENGTH=1
        DFHMDF POS=(13,52),ATTRB=(ASKIP,NORM),LENGTH=14,                X
               INITIAL='SPECIAL CODES:'
SCODE1D DFHMDF POS=(13,67),ATTRB=(UNPROT,NORM),LENGTH=1
SCODE2D DFHMDF POS=(13,69),ATTRB=(UNPROT,NORM),LENGTH=1
SCODE3D DFHMDF POS=(13,71),ATTRB=(UNPROT,NORM),LENGTH=1
        DFHMDF POS=(13,73),ATTRB=(ASKIP,NORM),LENGTH=1
STATTLD DFHMDF POS=(15,1),ATTRB=(ASKIP,NORM),LENGTH=15,                 X
               INITIAL='ACCOUNT STATUS:'
STATD   DFHMDF POS=(15,17),ATTRB=(ASKIP,NORM),LENGTH=2
LIMTTLD DFHMDF POS=(15,20),ATTRB=(ASKIP,NORM),LENGTH=18,                X
               INITIAL='     CHARGE LIMIT:'
LIMITD  DFHMDF POS=(15,39),ATTRB=(ASKIP,NORM),LENGTH=8
HISTTLD DFHMDF POS=(17,1),ATTRB=(ASKIP,NORM),LENGTH=71,                 X
               INITIAL='HISTORY:   BALANCE      BILLED          AMOUNT  X
                   PAID          AMOUNT'
HIST1D  DFHMDF POS=(18,11),ATTRB=(ASKIP,NORM),LENGTH=61
HIST2D  DFHMDF POS=(19,11),ATTRB=(ASKIP,NORM),LENGTH=61
HIST3D  DFHMDF POS=(20,11),ATTRB=(ASKIP,NORM),LENGTH=61
MSGD    DFHMDF POS=(22,1),ATTRB=(ASKIP,BRT),LENGTH=60
VFYD    DFHMDF POS=(22,62),ATTRB=(ASKIP,NORM),LENGTH=1
*
```

```
*        ERROR MAP.
ACCTERR DFHMDI SIZE=(24,80),CTRL=FREEKB
        DFHMDF POS=(4,1),ATTRB=(ASKIP,NORM),LENGTH=26,                 X
               INITIAL='ACCOUNT FILE: ERROR REPORT'
        DFHMDF POS=(6,1),ATTRB=(ASKIP,NORM),LENGTH=12,                 X
               INITIAL='TRANSACTION '
TRANE   DFHMDF POS=(6,14),ATTRB=(ASKIP,BRT),LENGTH=4
        DFHMDF POS=(6,19),ATTRB=(ASKIP,NORM),LENGTH=23,                X
               INITIAL=' HAS FAILED IN PROGRAM '
PGME    DFHMDF POS=(6,43),ATTRB=(ASKIP,BRT),LENGTH=8
        DFHMDF POS=(6,52),ATTRB=(ASKIP,NORM),LENGTH=11,                X
               INITIAL=' BECAUSE OF'
RSNE    DFHMDF POS=(8,1),ATTRB=(ASKIP,BRT),LENGTH=60
FILEE   DFHMDF POS=(10,1),ATTRB=(ASKIP,BRT),LENGTH=22
        DFHMDF POS=(12,1),ATTRB=(ASKIP,NORM),LENGTH=60,                X
               INITIAL='PLEASE ASK YOUR SUPERVISOR TO CONVEY THIS INFORX
               MATION TO THE'
        DFHMDF POS=(13,1),ATTRB=(ASKIP,NORM),LENGTH=17,                X
               INITIAL='OPERATIONS STAFF.'
        DFHMDF POS=(15,1),ATTRB=(ASKIP,NORM),LENGTH=64,                X
               INITIAL='THEN PRESS "CLEAR".  THIS TERMINAL IS NO LONGERX
                UNDER CONTROL OF'
        DFHMDF POS=(16,1),ATTRB=(ASKIP,NORM),LENGTH=23,                X
               INITIAL='THE "ACCT" APPLICATION.'
*
*        MESSAGE MAP.
ACCTMSG DFHMDI SIZE=(24,80),CTRL=FREEKB
MSG     DFHMDF POS=(1,1),ATTRB=(ASKIP,NORM),LENGTH=79
        DFHMSD TYPE=FINAL
 BKEND
/*
// OPTION DECK,SYSPARM='DSECT'
ASSGN SYSPCH,DISK,VOL=volser,SHR
// EXEC ASSEMBLY,SIZE=128K                (see note 2)
         PUNCH ' CATALS C.ACCTSET'
         COPY  DUMMYMAP
         END
/*
CLOSE SYSPCH,PUNCH
ASSGN SYSIPT,DISK,VOL=volser,SHR
// EXEC MAINT                             (see note 3)
CLOSE SYSIPT,SYSRDR
// OPTION CATAL,NODECK,SYSPARM='MAP'
 PHASE ACCTSET,*
// EXEC ASSEMBLY,SIZE=128K                (see note 4)
         COPY  DUMMYMAP
         END
/*
// EXEC LNKEDT                            (see note 5)
// EXEC MAINT                             (see note 6)
 DELETS A.DUMMYMAP
/*
/&
```

Notes:

1. *This step places the BMS source statements in your source statement library using a dummy name.*

   This lets you produce both the physical map and the symbolic map definition statements in a single job, without needing to have two separate copies of your map source.

2. *This step assembles the BMS source statements to create a symbolic description map set.*

3. *This step catalogs the symbolic description map set in your source statement library.*

4. *This step assembles the BMS source statements to create the physical map set.*

5. *This step link-edits and catalogs the physical map set in the core image library.*

6. *This step deletes the dummy set of source statements from your source statement library.*

The Result of the SYSPARM=DSECT Assembly

We've cataloged the DSECT in the source statement library, ready to be copied in during the compilation of the COBOL programs.

This is what it looks like:

```
01  ACCTMNUI.
    02  FILLER PIC X(12).
    02  SNAMEML     COMP  PIC  S9(4).
    02  SNAMEMF     PICTURE X.
    02  FILLER REDEFINES SNAMEMF.
      03 SNAMEMA     PICTURE X.
    02  SNAMEMI  PIC X(12).
    02  FNAMEML     COMP  PIC  S9(4).
    02  FNAMEMF     PICTURE X.
    02  FILLER REDEFINES FNAMEMF.
      03 FNAMEMA     PICTURE X.
    02  FNAMEMI  PIC X(7).
    02  REQML    COMP  PIC  S9(4).
    02  REQMF    PICTURE X.
    02  FILLER REDEFINES REQMF.
      03 REQMA    PICTURE X.
    02  REQMI  PIC X(1).
    02  ACCTML     COMP  PIC  S9(4).
    02  ACCTMF     PICTURE X.
    02  FILLER REDEFINES ACCTMF.
      03 ACCTMA     PICTURE X.
    02  ACCTMI  PIC X(5).
    02  PRTRML     COMP  PIC  S9(4).
    02  PRTRMF     PICTURE X.
```

```
          02  FILLER REDEFINES PRTRMF.
            03 PRTRMA    PICTURE X.
          02  PRTRMI  PIC X(4).
          02  SUMTTLML    COMP  PIC  S9(4).
          02  SUMTTLMF    PICTURE X.
          02  FILLER REDEFINES SUMTTLMF.
            03 SUMTTLMA    PICTURE X.
          02  SUMTTLMI  PIC X(79).
          02  SUMLNMD OCCURS 6 TIMES.
            03  SUMLNML    COMP  PIC  S9(4).
            03  SUMLNMF    PICTURE X.
            03  SUMLNMI  PIC X(79).
          02  MSGML    COMP  PIC  S9(4).
          02  MSGMF    PICTURE X.
          02  FILLER REDEFINES MSGMF.
            03 MSGMA    PICTURE X.
          02  MSGMI  PIC X(60).
      01  ACCTMNUO REDEFINES ACCTMNUI.
          02  FILLER PIC X(12).
          02  FILLER PICTURE X(3).
          02  SNAMEMO  PIC X(12).
          02  FILLER PICTURE X(3).
          02  FNAMEMO  PIC X(7).
          02  FILLER PICTURE X(3).
          02  REQMO  PIC X(1).
          02  FILLER PICTURE X(3).
          02  ACCTMO  PIC X(5).
          02  FILLER PICTURE X(3).
          02  PRTRMO  PIC X(4).
          02  FILLER PICTURE X(3).
          02  SUMTTLMO  PIC X(79).
          02  DFHMS1 OCCURS 6 TIMES.
            03  FILLER PICTURE X(2).
            03  SUMLNMA    PICTURE X.
            03  SUMLNMO  PIC X(79).
          02  FILLER PICTURE X(3).
          02  MSGMO  PIC X(60).
      01  ACCTDTLI.
          02  FILLER PIC X(12).
          02  TITLEDL    COMP  PIC  S9(4).
          02  TITLEDF    PICTURE X.
          02  FILLER REDEFINES TITLEDF.
            03 TITLEDA    PICTURE X.
          02  TITLEDI  PIC X(14).
          02  ACCTDL    COMP  PIC  S9(4).
          02  ACCTDF    PICTURE X.
          02  FILLER REDEFINES ACCTDF.
            03 ACCTDA    PICTURE X.
          02  ACCTDI  PIC X(5).
          02  SNAMEDL    COMP  PIC  S9(4).
          02  SNAMEDF    PICTURE X.
          02  FILLER REDEFINES SNAMEDF.
            03 SNAMEDA    PICTURE X.
          02  SNAMEDI  PIC X(18).
          02  FNAMEDL    COMP  PIC  S9(4).
          02  FNAMEDF    PICTURE X.
          02  FILLER REDEFINES FNAMEDF.
            03 FNAMEDA    PICTURE X.
```

```
02  FNAMEDI  PIC X(12).
02  MIDL     COMP  PIC  S9(4).
02  MIDF     PICTURE X.
02  FILLER REDEFINES MIDF.
  03 MIDA     PICTURE X.
02  MIDI  PIC X(1).
02  TTLDL     COMP  PIC  S9(4).
02  TTLDF     PICTURE X.
02  FILLER REDEFINES TTLDF.
  03 TTLDA     PICTURE X.
02  TTLDI  PIC X(4).
02  TELDL     COMP  PIC  S9(4).
02  TELDF     PICTURE X.
02  FILLER REDEFINES TELDF.
  03 TELDA     PICTURE X.
02  TELDI  PIC X(10).
02  ADDR1DL     COMP  PIC  S9(4).
02  ADDR1DF     PICTURE X.
02  FILLER REDEFINES ADDR1DF.
  03 ADDR1DA     PICTURE X.
02  ADDR1DI  PIC X(24).
02  ADDR2DL     COMP  PIC  S9(4).
02  ADDR2DF     PICTURE X.
02  FILLER REDEFINES ADDR2DF.
  03 ADDR2DA     PICTURE X.
02  ADDR2DI  PIC X(24).
02  ADDR3DL     COMP  PIC  S9(4).
02  ADDR3DF     PICTURE X.
02  FILLER REDEFINES ADDR3DF.
  03 ADDR3DA     PICTURE X.
02  ADDR3DI  PIC X(24).
02  AUTH1DL     COMP  PIC  S9(4).
02  AUTH1DF     PICTURE X.
02  FILLER REDEFINES AUTH1DF.
  03 AUTH1DA     PICTURE X.
02  AUTH1DI  PIC X(32).
02  AUTH2DL     COMP  PIC  S9(4).
02  AUTH2DF     PICTURE X.
02  FILLER REDEFINES AUTH2DF.
  03 AUTH2DA     PICTURE X.
02  AUTH2DI  PIC X(32).
02  AUTH3DL     COMP  PIC  S9(4).
02  AUTH3DF     PICTURE X.
02  FILLER REDEFINES AUTH3DF.
  03 AUTH3DA     PICTURE X.
02  AUTH3DI  PIC X(32).
02  AUTH4DL     COMP  PIC  S9(4).
02  AUTH4DF     PICTURE X.
02  FILLER REDEFINES AUTH4DF.
  03 AUTH4DA     PICTURE X.
02  AUTH4DI  PIC X(32).
02  CARDSDL     COMP  PIC  S9(4).
02  CARDSDF     PICTURE X.
02  FILLER REDEFINES CARDSDF.
  03 CARDSDA     PICTURE X.
02  CARDSDI  PIC X(1).
02  IMODL     COMP  PIC  S9(4).
```

```
02  IMODF    PICTURE X.
02  FILLER REDEFINES IMODF.
 03 IMODA    PICTURE X.
02  IMODI  PIC X(2).
02  IDAYDL    COMP  PIC  S9(4).
02  IDAYDF    PICTURE X.
02  FILLER REDEFINES IDAYDF.
 03 IDAYDA    PICTURE X.
02  IDAYDI  PIC X(2).
02  IYRDL    COMP  PIC  S9(4).
02  IYRDF    PICTURE X.
02  FILLER REDEFINES IYRDF.
 03 IYRDA    PICTURE X.
02  IYRDI  PIC X(2).
02  RSNDL    COMP  PIC  S9(4).
02  RSNDF    PICTURE X.
02  FILLER REDEFINES RSNDF.
 03 RSNDA    PICTURE X.
02  RSNDI  PIC X(1).
02  CCODEDL    COMP  PIC  S9(4).
02  CCODEDF    PICTURE X.
02  FILLER REDEFINES CCODEDF.
 03 CCODEDA    PICTURE X.
02  CCODEDI  PIC X(1).
02  APPRDL    COMP  PIC  S9(4).
02  APPRDF    PICTURE X.
02  FILLER REDEFINES APPRDF.
 03 APPRDA    PICTURE X.
02  APPRDI  PIC X(3).
02  SCODE1DL    COMP  PIC  S9(4).
02  SCODE1DF    PICTURE X.
02  FILLER REDEFINES SCODE1DF.
 03 SCODE1DA    PICTURE X.
02  SCODE1DI  PIC X(1).
02  SCODE2DL    COMP  PIC  S9(4).
02  SCODE2DF    PICTURE X.
02  FILLER REDEFINES SCODE2DF.
 03 SCODE2DA    PICTURE X.
02  SCODE2DI  PIC X(1).
02  SCODE3DL    COMP  PIC  S9(4).
02  SCODE3DF    PICTURE X.
02  FILLER REDEFINES SCODE3DF.
 03 SCODE3DA    PICTURE X.
02  SCODE3DI  PIC X(1).
02  STATTLDL    COMP  PIC  S9(4).
02  STATTLDF    PICTURE X.
02  FILLER REDEFINES STATTLDF.
 03 STATTLDA    PICTURE X.
02  STATTLDI  PIC X(15).
02  STATDL    COMP  PIC  S9(4).
02  STATDF    PICTURE X.
02  FILLER REDEFINES STATDF.
 03 STATDA    PICTURE X.
02  STATDI  PIC X(2).
02  LIMTTLDL    COMP  PIC  S9(4).
02  LIMTTLDF    PICTURE X.
02  FILLER REDEFINES LIMTTLDF.
 03 LIMTTLDA    PICTURE X.
```

```
            02  LIMTTLDI  PIC X(18).
            02  LIMITDL    COMP  PIC  S9(4).
            02  LIMITDF    PICTURE X.
            02  FILLER REDEFINES LIMITDF.
              03 LIMITDA    PICTURE X.
            02  LIMITDI  PIC X(8).
            02  HISTTLDL    COMP  PIC  S9(4).
            02  HISTTLDF    PICTURE X.
            02  FILLER REDEFINES HISTTLDF.
              03 HISTTLDA    PICTURE X.
            02  HISTTLDI  PIC X(71).
            02  HIST1DL    COMP  PIC  S9(4).
            02  HIST1DF    PICTURE X.
            02  FILLER REDEFINES HIST1DF.
              03 HIST1DA    PICTURE X.
            02  HIST1DI  PIC X(61).
            02  HIST2DL    COMP  PIC  S9(4).
            02  HIST2DF    PICTURE X.
            02  FILLER REDEFINES HIST2DF.
              03 HIST2DA    PICTURE X.
            02  HIST2DI  PIC X(61).
            02  HIST3DL    COMP  PIC  S9(4).
            02  HIST3DF    PICTURE X.
            02  FILLER REDEFINES HIST3DF.
              03 HIST3DA    PICTURE X.
            02  HIST3DI  PIC X(61).
            02  MSGDL    COMP  PIC  S9(4).
            02  MSGDF    PICTURE X.
            02  FILLER REDEFINES MSGDF.
              03 MSGDA    PICTURE X.
            02  MSGDI  PIC X(60).
            02  VFYDL    COMP  PIC  S9(4).
            02  VFYDF    PICTURE X.
            02  FILLER REDEFINES VFYDF.
              03 VFYDA    PICTURE X.
            02  VFYDI  PIC X(1).
        01  ACCTDTLO REDEFINES ACCTDTLI.
            02  FILLER PIC X(12).
            02  FILLER PICTURE X(3).
            02  TITLEDO  PIC X(14).
            02  FILLER PICTURE X(3).
            02  ACCTDO  PIC X(5).
            02  FILLER PICTURE X(3).
            02  SNAMEDO  PIC X(18).
            02  FILLER PICTURE X(3).
            02  FNAMEDO  PIC X(12).
            02  FILLER PICTURE X(3).
            02  MIDO  PIC X(1).
            02  FILLER PICTURE X(3).
            02  TTLDO  PIC X(4).
            02  FILLER PICTURE X(3).
            02  TELDO  PIC X(10).
            02  FILLER PICTURE X(3).
            02  ADDR1DO  PIC X(24).
            02  FILLER PICTURE X(3).
            02  ADDR2DO  PIC X(24).
            02  FILLER PICTURE X(3).
        02  ADDR3DO  PIC X(24).
        02  FILLER PICTURE X(3).
        02  AUTH1DO  PIC X(32).
        02  FILLER PICTURE X(3).
        02  AUTH2DO  PIC X(32).
        02  FILLER PICTURE X(3).
        02  AUTH3DO  PIC X(32).
        02  FILLER PICTURE X(3).
        02  AUTH4DO  PIC X(32).
        02  FILLER PICTURE X(3).
        02  CARDSDO  PIC X(1).
        02  FILLER PICTURE X(3).
        02  IMODO  PIC X(2).
        02  FILLER PICTURE X(3).
        02  IDAYDO  PIC X(2).
        02  FILLER PICTURE X(3).
        02  IYRDO  PIC X(2).
        02  FILLER PICTURE X(3).
        02  RSNDO  PIC X(1).
        02  FILLER PICTURE X(3).
        02  CCODEDO  PIC X(1).
        02  FILLER PICTURE X(3).
        02  APPRDO  PIC X(3).
        02  FILLER PICTURE X(3).
        02  SCODE1DO  PIC X(1).
        02  FILLER PICTURE X(3).
        02  SCODE2DO  PIC X(1).
        02  FILLER PICTURE X(3).
        02  SCODE3DO  PIC X(1).
        02  FILLER PICTURE X(3).
        02  STATTLDO  PIC X(15).
        02  FILLER PICTURE X(3).
        02  STATDO  PIC X(2).
        02  FILLER PICTURE X(3).
        02  LIMTTLDO  PIC X(18).
        02  FILLER PICTURE X(3).
        02  LIMITDO  PIC X(8).
        02  FILLER PICTURE X(3).
        02  HISTTLDO  PIC X(71).
        02  FILLER PICTURE X(3).
        02  HIST1DO  PIC X(61).
        02  FILLER PICTURE X(3).
        02  HIST2DO  PIC X(61).
        02  FILLER PICTURE X(3).
        02  HIST3DO  PIC X(61).
        02  FILLER PICTURE X(3).
        02  MSGDO  PIC X(60).
        02  FILLER PICTURE X(3).
        02  VFYDO  PIC X(1).
    01  ACCTERRI.
        02  FILLER PIC X(12).
        02  TRANEL     COMP  PIC  S9(4).
        02  TRANEF     PICTURE X.
        02  FILLER REDEFINES TRANEF.
          03 TRANEA     PICTURE X.
        02  TRANEI  PIC X(4).
        02  PGMEL     COMP  PIC  S9(4).
        02  PGMEF     PICTURE X.
```

```
          02  FILLER REDEFINES PGMEF.
            03 PGMEA    PICTURE X.
          02  PGMEI  PIC X(8).
          02  RSNEL     COMP  PIC  S9(4).
          02  RSNEF     PICTURE X.
          02  FILLER REDEFINES RSNEF.
            03 RSNEA    PICTURE X.
          02  RSNEI  PIC X(60).
          02  FILEEL    COMP  PIC  S9(4).
          02  FILEEF    PICTURE X.
          02  FILLER REDEFINES FILEEF.
            03 FILEEA    PICTURE X.
          02  FILEEI  PIC X(22).
      01  ACCTERRO REDEFINES ACCTERRI.
          02  FILLER PIC X(12).
          02  FILLER PICTURE X(3).
          02  TRANEO  PIC X(4).
          02  FILLER PICTURE X(3).
          02  PGMEO  PIC X(8).
          02  FILLER PICTURE X(3).
          02  RSNEO  PIC X(60).
          02  FILLER PICTURE X(3).
          02  FILEEO  PIC X(22).
      01  ACCTMSGI.
          02  FILLER PIC X(12).
          02  MSGL    COMP  PIC  S9(4).
          02  MSGF    PICTURE X.
          02  FILLER REDEFINES MSGF.
            03 MSGA    PICTURE X.
          02  MSGI  PIC X(79).
      01  ACCTMSGO REDEFINES ACCTMSGI.
          02  FILLER PIC X(12).
          02  FILLER PICTURE X(3).
          02  MSGO  PIC X(79).
```

The installation of map sets is more fully described in the CICS/DOS/VS Installation and Operations Guide.

Installing The Application Programs

Your next step is to install the application programs (ACCT00 through ACCT04). The three steps to do this are called translate, compile and link-edit. A sample job stream to do this for each program is shown below.

```
// JOB ACCT00 TRANSLATE, COMPILE AND LINK
// OPTION CATAL,NODECK,SYM
// DLBL IJSYSPH,'DISK.SYSPCH.EXTENT',0
// EXTENT SYSPCH,,,,extent-information
// DLBL IJSYSIN,'DISK.SYSPCH.EXTENT'
// LIBDEF CL,TO=user-cil-filename,SEARCH=cics-cil-filename
// LIBDEF SL,SEARCH=(user-slb-filename,cics-slb-filename)
// LIBDEF RL,SEARCH=cics-rlb-filename
ASSGN SYSPCH,DISK,VOL=volser,SHR
// EXEC DFHECP1$
 CBL APOST,CLIST,LIB,NOTRUNC,SXREF,XOPT(LANGLVL(2))
```

```
       IDENTIFICATION DIVISION.
       PROGRAM-ID. ACCT00.
       REMARKS. THIS PROGRAM IS THE FIRST INVOKED BY THE 'ACCT'
                TRANSACTION.  IT DISPLAYS A MENU SCREEN FOR THE ON-LINE
                ACCOUNT FILE APPLICATION, WHICH PROMPTS THE USER FOR
                INPUT.  TRANSACTION 'AC01' IS INVOKED WHEN THAT INPUT
                IS RECEIVED.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       PROCEDURE DIVISION.
       INITIAL-MAP.
           EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET') ERASE
                FREEKB MAPONLY END-EXEC.
           EXEC CICS RETURN TRANSID('AC01') END-EXEC.
           GOBACK.
/*
CLOSE SYSPCH,PUNCH
ASSGN SYSIPT,DISK,VOL=volser,SHR
 PHASE ACCT00,*
 INCLUDE DFHECI
// EXEC FCOBOL
CLOSE SYSIPT,SYSRDR
// EXEC LNKEDT
/&

// JOB ACCT01 TRANSLATE, COMPILE AND LINK
// OPTION CATAL,NODECK,SYM
// DLBL IJSYSPH,'DISK.SYSPCH.EXTENT',0
// EXTENT SYSPCH,,,,extent-information
// DLBL IJSYSIN,'DISK.SYSPCH.EXTENT'
// LIBDEF CL,TO=user-cil-filename,SEARCH=cics-cil-filename
// LIBDEF SL,SEARCH=(user-slb-filename,cics-slb-filename)
// LIBDEF RL,SEARCH=cics-rlb-filename
ASSGN SYSPCH,DISK,VOL=volser,SHR
// EXEC DFHECP1$
 CBL APOST,CLIST,LIB,NOTRUNC,SXREF,XOPT(LANGLVL(2))
       IDENTIFICATION DIVISION.
       PROGRAM-ID. ACCT01.
       REMARKS. THIS PROGRAM IS THE FIRST INVOKED BY THE 'AC01'
                TRANSACTION. IT ANALYZES ALL REQUESTS, AND COMPLETES
                THOSE FOR NAME INQUIRIES AND RECORD DISPLAYS.  FOR
                UPDATE TRANSACTIONS, IT SENDS THE APPROPRIATE DATA ENTRY
                SCREEN AND SETS THE NEXT TRANSACTION IDENTIFIER TO
                'AC02', WHICH COMPLETES THE UPDATE OPERATION. FOR PRINT
                REQUESTS, IT STARTS TRANSACTION 'AC03' TO DO THE ACTUAL
                PRINTING.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01  MISC.
           02  MSG-NO                  PIC S9(4) COMP VALUE +0.
           02  ACCT-LNG                PIC S9(4) COMP VALUE +383.
           02  ACIX-LNG                PIC S9(4) COMP VALUE +63.
           02  DTL-LNG                 PIC S9(4) COMP VALUE +751.
           02  STARS                   PIC X(12) VALUE '************'.
           02  USE-QID.
               04  USE-QID1            PIC X(3) VALUE 'AC0'.
               04  USE-QID2            PIC X(5).
       02  USE-REC.
           04  USE-TERM             PIC X(4) VALUE SPACES.
           04  USE-TIME             PIC S9(7) COMP-3.
           04  USE-DATE             PIC S9(7) COMP-3.
       02  USE-LIMIT                PIC S9(7) COMP-3 VALUE +1000.
       02  USE-ITEM                 PIC S9(4) COMP VALUE +1.
       02  USE-LNG                  PIC S9(4) COMP VALUE +12.
       02  IN-AREA.
           04  IN-TYPE              PIC X VALUE 'R'.
           04  IN-REQ.
               06  REQC             PIC X VALUE SPACES.
               06  ACCTC            PIC X(5) VALUE SPACES.
               06  PRTRC            PIC X(4) VALUE SPACES.
           04  IN-NAMES.
               06  SNAMEC           PIC X(18) VALUE SPACES.
               06  FNAMEC           PIC X(12) VALUE SPACES.
       02  COMMAREA-FOR-ACCT04.
           04  ERR-PGRMID           PIC X(8) VALUE 'ACCT01'.
           04  ERR-FN               PIC X.
           04  ERR-RCODE            PIC X.
       02  LINE-CNT                 PIC S9(4) COMP VALUE +0.
       02  MAX-LINES                PIC S9(4) COMP VALUE +6.
       02  IX                       PIC S9(4) COMP.
       02  SRCH-CTRL.
           04  FILLER               PIC X VALUE 'S'.
           04  BRKEY.
               06  BRKEY-SNAME      PIC X(12).
               06  BRKEY-ACCT       PIC X(5).
           04  MAX-SNAME            PIC X(12).
           04  MAX-FNAME            PIC X(7).
           04  MIN-FNAME            PIC X(7).
       02  SUM-LINE.
           04  ACCTDO               PIC X(5).
           04  FILLER               PIC X(3) VALUE SPACES.
           04  SNAMEDO              PIC X(12).
           04  FILLER               PIC X(2) VALUE SPACES.
           04  FNAMEDO              PIC X(7).
           04  FILLER               PIC X(2) VALUE SPACES.
           04  MIDO                 PIC X(1).
           04  FILLER               PIC X(2) VALUE SPACES.
           04  TTLDO                PIC X(4).
           04  FILLER               PIC X(2) VALUE SPACES.
           04  ADDR1DO              PIC X(24).
           04  FILLER               PIC X(2) VALUE SPACES.
           04  STATDO               PIC X(2).
           04  FILLER               PIC X(3) VALUE SPACES.
           04  LIMITDO              PIC X(8).
       02  PAY-LINE.
           04  BAL                  PIC X(8).
           04  FILLER               PIC X(6) VALUE SPACES.
           04  BMO                  PIC 9(2).
           04  FILLER               PIC X VALUE '/'.
           04  BDAY                 PIC 9(2).
           04  FILLER               PIC X VALUE '/'.
           04  BYR                  PIC 9(2).
           04  FILLER               PIC X(4) VALUE SPACES.
           04  BAMT                 PIC X(8).
```

```
               04  FILLER                 PIC X(7) VALUE SPACES.
               04  PMO                    PIC 9(2).
               04  FILLER                 PIC X VALUE '/'.
               04  PDAY                   PIC 9(2).
               04  FILLER                 PIC X VALUE '/'.
               04  PYR                    PIC 9(2).
               04  FILLER                 PIC X(4) VALUE SPACES.
               04  PAMT                   PIC X(8).
           COPY DFHBMSCA.
           COPY DFHAID.
       01  ACCTREC. COPY ACCTREC.
       01  ACIXREC. COPY ACIXREC.
           COPY ACCTSET.
       01  MSG-LIST.
           02  FILLER                 PIC X(60) VALUE
               'NAMES MUST BE ALPHABETIC, AND SURNAME IS REQUIRED.'.
           02  FILLER                 PIC X(60) VALUE
               'ENTER SOME INPUT AND USE ONLY "CLEAR" OR "ENTER".'.
           02  FILLER                 PIC X(60) VALUE
           'REQUEST TYPE REQUIRED; MUST BE "D", "P", "A", "M" OR "X".'.
           02  FILLER                 PIC X(60) VALUE
               'PRINTER NAME REQUIRED ON PRINT REQUESTS'.
           02  FILLER                 PIC X(60) VALUE
               'ACCOUNT NUMBER REQUIRED (BETWEEN 10000 AND 79999)'.
           02  FILLER                 PIC X(60) VALUE
               'ACCOUNT NO. MUST BE NUMERIC AND FROM 10000 TO 79999'.
           02  FILLER                 PIC X(60) VALUE
               'NO NAMES ON FILE MATCHING YOUR REQUEST'.
           02  FILLER                 PIC X(60) VALUE
               'ENTER EITHER NAME OR A REQUEST TYPE AND ACCOUNT NUMBER'.
           02  FILLER                 PIC X(60) VALUE
               'THIS ACCOUNT NUMBER ALREADY EXISTS'.
           02  FILLER                 PIC X(60) VALUE
               'NO RECORD OF THIS ACCOUNT NUMBER'.
           02  FILLER                 PIC X(47) VALUE
               'THIS ACCOUNT NUMBER ALREADY IN USE AT TERMINAL '.
           02  MSG-TERM               PIC X(13).
           02  FILLER                 PIC X(60) VALUE
               'PRINT REQUEST SCHEDULED'.
           02  FILLER                 PIC X(60) VALUE
               'PRINTER NAME NOT RECOGNIZED'.
           02  FILLER                 PIC X(60) VALUE
               'INPUT ERROR; PLEASE RETRY; USE ONLY CLEAR OR ENTER KEY'.
           02  FILLER                 PIC X(60) VALUE
               'THERE ARE MORE MATCHING NAMES. PRESS PA2 TO CONTINUE.'.
       01  FILLER REDEFINES MSG-LIST.
           02  MSG-TEXT               PIC X(60) OCCURS 15.
       LINKAGE SECTION.
       01  DFHCOMMAREA.
           02  SRCH-COMM              PIC X(44).
           02  IN-COMM REDEFINES SRCH-COMM PIC X(41).
           02  CTYPE REDEFINES SRCH-COMM PIC X.
      *
       PROCEDURE DIVISION.
      *
      *
      *    INITIALIZE.
           EXEC CICS HANDLE CONDITION MAPFAIL(NO-MAP)
```

```
               NOTFND(SRCH-ANY)
               ENDFILE(SRCH-DONE)
               QIDERR(RSRV-1)
               TERMIDERR(TERMID-ERR)
               ERROR(OTHER-ERRORS) END-EXEC.
           MOVE LOW-VALUES TO ACCTMNUI, ACCTDTLI.
      *
      *    CHECK BASIC REQUEST TYPE.
           IF EIBAID = DFHCLEAR
               IF EIBCALEN = 0,
                   EXEC CICS SEND CONTROL FREEKB END-EXEC
                   EXEC CICS RETURN END-EXEC
               ELSE GO TO NEW-MENU.
           IF EIBAID = DFHPA2 AND EIBCALEN > 0 AND CTYPE = 'S',
               MOVE SRCH-COMM TO SRCH-CTRL, GO TO SRCH-RESUME.
           IF EIBCALEN > 0 AND CTYPE = 'R', MOVE IN-COMM TO IN-AREA.
      *
      *    GET INPUT AND CHECK REQUEST TYPE FURTHER.
           EXEC CICS RECEIVE MAP('ACCTMNU') MAPSET('ACCTSET') END-EXEC.
           IF REQML > 0 MOVE REQMI TO REQC.
           IF REQMF NOT = LOW-VALUE, MOVE SPACE TO REQC.
           IF ACCTML > 0 MOVE ACCTMI TO ACCTC.
           IF ACCTMF NOT = LOW-VALUE, MOVE SPACES TO ACCTC.
           IF PRTRML > 0 MOVE PRTRMI TO PRTRC.
           IF PRTRMF NOT = LOW-VALUE, MOVE SPACES TO PRTRC.
           IF SNAMEML > 0 MOVE SNAMEMI TO SNAMEC.
           IF SNAMEMF NOT = LOW-VALUE, MOVE SPACES TO SNAMEC.
           IF FNAMEML > 0 MOVE FNAMEMI TO FNAMEC.
           IF FNAMEMF NOT = LOW-VALUE, MOVE SPACES TO FNAMEC.
           MOVE LOW-VALUES TO ACCTMNUI.
           IF IN-NAMES = SPACES GO TO CK-ANY.
      *
      *    NAME INQUIRY PROCESSING.
      *    VALIDATE NAME INPUT.
           IF FNAMEC NOT ALPHABETIC, MOVE 1 TO MSG-NO,
               MOVE -1 TO FNAMEML, MOVE DFHBMBRY TO FNAMEMA.
           IF SNAMEC = SPACES, MOVE STARS TO SNAMEMO,
           ELSE IF SNAMEC ALPHABETIC, GO TO CK-NAME.
           MOVE 1 TO MSG-NO.
           MOVE -1 TO SNAMEML, MOVE DFHBMBRY TO SNAMEMA.
       CK-NAME.
           IF MSG-NO > 0 GO TO MENU-RESEND.
      *
      *    BUILD KEY AND LIMITING NAME VALUES FOR SEARCH.
       SRCH-INIT.
           MOVE SNAMEC TO BRKEY-SNAME, MAX-SNAME.
           MOVE LOW-VALUES TO BRKEY-ACCT.
           TRANSFORM MAX-SNAME FROM SPACES TO HIGH-VALUES.
           MOVE FNAMEC TO MIN-FNAME, MAX-FNAME.
           TRANSFORM MIN-FNAME FROM SPACES TO LOW-VALUES.
           TRANSFORM MAX-FNAME FROM SPACES TO HIGH-VALUES.
      *
      *    INITIALIZE FOR SEQUENTIAL SEARCH.
       SRCH-RESUME.
           EXEC CICS STARTBR DATASET('ACCTIX') RIDFLD(BRKEY) GTEQ
               END-EXEC.
```

```
*
*    BUILD NAME DISPLAY.
 SRCH-LOOP.
     EXEC CICS READNEXT DATASET('ACCTIX') INTO(ACIXREC)
         LENGTH(ACIX-LNG) RIDFLD(BRKEY) END-EXEC.
     IF SNAMEDO IN ACIXREC > MAX-SNAME GO TO SRCH-DONE.
     IF FNAMEDO IN ACIXREC < MIN-FNAME OR
         FNAMEDO IN ACIXREC > MAX-FNAME, GO TO SRCH-LOOP.
     ADD 1 TO LINE-CNT.
     IF LINE-CNT > MAX-LINES,
         MOVE MSG-TEXT (15) TO MSGMO,
         MOVE DFHBMBRY TO MSGMA, GO TO SRCH-DONE.
     MOVE CORRESPONDING ACIXREC TO SUM-LINE.
     MOVE SUM-LINE TO SUMLNMO (LINE-CNT).
     GO TO SRCH-LOOP.
 SRCH-DONE.
     EXEC CICS ENDBR DATASET('ACCTIX') END-EXEC.
 SRCH-ANY.
     IF LINE-CNT = 0, MOVE 7 TO MSG-NO,
         MOVE -1 TO SNAMEML, GO TO MENU-RESEND.
*
*    SEND THE NAME SEARCH RESULTS TO TERMINAL.
     MOVE DFHBMUNP TO SUMLNMA (1), SUMLNMA (2), SUMLNMA (3),
         SUMLNMA (4), SUMLNMA (5), SUMLNMA (6).
     MOVE DFHBMBRY TO MSGMA, MOVE DFHBMASB TO SUMTTLMA.
     EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET')
         FREEKB DATAONLY ERASEAUP END-EXEC.
     IF LINE-CNT NOT > MAX-LINES,
         EXEC CICS RETURN TRANSID('AC01') END-EXEC
     ELSE EXEC CICS RETURN TRANSID('AC01') COMMAREA(SRCH-CTRL)
             LENGTH(44) END-EXEC.
*
*    DISPLAY, PRINT, ADD, MODIFY AND DELETE PROCESSING.
*    CHECK ACCOUNT NUMBER.
 CK-ANY.
     IF IN-REQ = SPACES, MOVE -1 TO SNAMEML,
         MOVE 8 TO MSG-NO, GO TO MENU-RESEND.
 CK-ACCTNO-1.
     IF ACCTC = SPACES, MOVE STARS TO ACCTMO,
         MOVE 5 TO MSG-NO, GO TO ACCT-ERR.
     IF (ACCTC < '10000' OR ACCTC > '79999' OR ACCTC NOT NUMERIC),
         MOVE 6 TO MSG-NO, GO TO ACCT-ERR.
 CK-ACCTNO-2.
     EXEC CICS HANDLE CONDITION NOTFND(NO-ACCT-RECORD) END-EXEC.
     EXEC CICS READ DATASET('ACCTFIL') RIDFLD(ACCTC)
         INTO(ACCTREC) LENGTH(ACCT-LNG) END-EXEC.
     IF REQC = 'A',
         MOVE 9 TO MSG-NO, GO TO ACCT-ERR,
     ELSE GO TO CK-REQ.
 NO-ACCT-RECORD.
     IF REQC = 'A', GO TO CK-REQ.
     MOVE 10 TO MSG-NO.
 ACCT-ERR.
     MOVE -1 TO ACCTML, MOVE DFHBMBRY TO ACCTMA.
*
*    CHECK REQUEST TYPE.
 CK-REQ.
     IF REQC =  'D' OR 'P' OR 'A' OR 'M' OR 'X',
                IF MSG-NO = 0 GO TO CK-USE, ELSE GO TO MENU-RESEND.
            IF REQC = SPACE, MOVE STARS TO REQMO.
            MOVE -1 TO REQML, MOVE DFHBMBRY TO REQMA,
            MOVE 3 TO MSG-NO.
            GO TO MENU-RESEND.
      *
      *     TEST IF ACCOUNT NUMBER IN USE, ON UPDATES ONLY.
       CK-USE.
            IF REQC = 'P' OR 'D' GO TO BUILD-MAP.
            MOVE ACCTC TO USE-QID2.
            EXEC CICS READQ TS QUEUE(USE-QID) INTO(USE-REC)
                ITEM(USE-ITEM) LENGTH(USE-LNG) END-EXEC.
            ADD USE-LIMIT TO USE-TIME.
            IF USE-TIME > 236000, ADD 1 TO USE-DATE,
                SUBTRACT 236000 FROM USE-TIME.
            IF USE-DATE > EIBDATE OR
                (USE-DATE = EIBDATE AND USE-TIME NOT < EIBTIME)
                MOVE USE-TERM TO MSG-TERM, MOVE 11 TO MSG-NO,
                MOVE -1 TO ACCTML, MOVE DFHBMBRY TO ACCTMA,
                GO TO MENU-RESEND.
      *
      *     RESERVE ACCOUNT NUMBER.
       RSRV.
            MOVE EIBTRMID TO USE-TERM, MOVE EIBTIME TO USE-TIME.
            MOVE EIBDATE TO USE-DATE.
            EXEC CICS WRITEQ TS QUEUE(USE-QID) FROM(USE-REC)
                LENGTH(12) ITEM(USE-ITEM) REWRITE END-EXEC.
            GO TO BUILD-MAP.
       RSRV-1.
            MOVE EIBTRMID TO USE-TERM, MOVE EIBTIME TO USE-TIME.
            MOVE EIBDATE TO USE-DATE.
            EXEC CICS WRITEQ TS QUEUE(USE-QID) FROM(USE-REC)
                LENGTH(12) END-EXEC.
      *
      *     BUILD THE RECORD DISPLAY.
       BUILD-MAP.
            IF REQC = 'X' MOVE 'DELETION' TO TITLEDO,
                MOVE -1 TO VFYDL, MOVE DFHBMUNP TO VFYDA,
                MOVE 'ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL'
                    TO MSGDO,
            ELSE MOVE -1 TO SNAMEDL.
            IF REQC = 'A' MOVE 'NEW RECORD' TO TITLEDO,
                MOVE DFHPROTN TO STATTLDA, LIMTTLDA, HISTTLDA,
                MOVE ACCTC TO ACCTDI,
                MOVE 'FILL IN AND PRESS "ENTER," OR "CLEAR" TO CANCEL'
                    TO MSGDO,
                GO TO SEND-DETAIL.
            IF REQC = 'M' MOVE 'RECORD CHANGE' TO TITLEDO,
                MOVE 'MAKE CHANGES AND "ENTER" OR "CLEAR" TO CANCEL'
                    TO MSGDO,
            ELSE IF REQC = 'D',
                    MOVE 'PRESS "CLEAR" OR "ENTER" WHEN FINISHED'
                        TO MSGDO.
            MOVE CORRESPONDING ACCTREC TO ACCTDTLO.
            MOVE CORRESPONDING PAY-HIST (1) TO PAY-LINE.
            MOVE PAY-LINE TO HIST1DO.
            MOVE CORRESPONDING PAY-HIST (2) TO PAY-LINE.
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           MOVE PAY-LINE TO HIST2DO.
           MOVE CORRESPONDING PAY-HIST (3) TO PAY-LINE.
           MOVE PAY-LINE TO HIST3DO.
           IF REQC  = 'M' GO TO SEND-DETAIL,
           ELSE IF REQC = 'P' GO TO PRINT-PROC.
           MOVE DFHBMASK TO
               SNAMEDA, FNAMEDA, MIDA, TTLDA, TELDA, ADDR1DA,
               ADDR2DA, ADDR3DA, AUTH1DA, AUTH2DA, AUTH3DA,
               AUTH4DA, CARDSDA, IMODA, IDAYDA, IYRDA, RSNDA,
               CCODEDA, APPRDA, SCODE1DA, SCODE2DA, SCODE3DA.
      *
      *    SEND THE RECORD DETAIL MAP TO THE TERMINAL.
       SEND-DETAIL.
           EXEC CICS SEND MAP('ACCTDTL') MAPSET('ACCTSET') ERASE FREEKB
               CURSOR END-EXEC.
           IF REQC = 'D', EXEC CICS RETURN TRANSID('ACCT') END-EXEC,
           ELSE EXEC CICS RETURN TRANSID('AC02')
                   COMMAREA(IN-REQ) LENGTH(6) END-EXEC.
      *
      *    START UP A TASK TO PRINT THE RECORD.
       PRINT-PROC.
           IF PRTRC = SPACES, MOVE STARS TO PRTRMO
               MOVE 4 TO MSG-NO, GO TO TERMID-ERR1.
           EXEC CICS START TRANSID('AC03') FROM(ACCTDTLO)
               LENGTH(DTL-LNG) TERMID(PRTRC) END-EXEC.
           MOVE MSG-TEXT (12) TO MSGMO.
           EXEC CICS SEND MAP('ACCTMNU') MAPSET ('ACCTSET') DATAONLY
                ERASEAUP FREEKB END-EXEC.
           EXEC CICS RETURN TRANSID('AC01') END-EXEC.
       TERMID-ERR.
           MOVE 13 TO MSG-NO.
       TERMID-ERR1.
           MOVE -1 TO PRTRML, MOVE DFHBMBRY TO PRTRMA.
      *
      *    ERROR PROCESSING, FOR ALL REQUESTS.
      *    RESEND MENU SCREEN.
       MENU-RESEND.
           MOVE MSG-TEXT (MSG-NO) TO MSGMO.
           EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET')
               CURSOR DATAONLY FRSET FREEKB END-EXEC.
           EXEC CICS RETURN TRANSID('AC01') COMMAREA(IN-AREA)
                   LENGTH(41) END-EXEC.
      *
      *    PROCESSING FOR MAP FAILURES, CLEARS.
       NO-MAP.
           IF (EIBAID = DFHPA1 OR DFHPA2 OR DFHPA3 OR DFHENTER)
               MOVE 2 TO MSG-NO, MOVE -1 TO SNAMEML, GO TO MENU-RESEND.
           MOVE MSG-TEXT (14) TO MSGMO.
       NEW-MENU.
           EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET')
               FREEKB ERASE END-EXEC.
           EXEC CICS RETURN TRANSID ('AC01') END-EXEC.
      *
      *    PROCESSING FOR UNEXPECTED ERRORS.
       OTHER-ERRORS.
           MOVE EIBFN TO ERR-FN, MOVE EIBRCODE TO ERR-RCODE.
           EXEC CICS HANDLE CONDITION ERROR END-EXEC.
           EXEC CICS LINK PROGRAM('ACCT04')
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               COMMAREA(COMMAREA-FOR-ACCT04) LENGTH(10) END-EXEC.
           GOBACK.
/*
CLOSE SYSPCH,PUNCH
ASSGN SYSIPT,DISK,VOL=volser,SHR
 PHASE ACCT01,*
 INCLUDE DFHECI
// EXEC FCOBOL
CLOSE SYSIPT,SYSRDR
// EXEC LNKEDT
/&

// JOB ACCT02 TRANSLATE, COMPILE AND LINK
// OPTION CATAL,NODECK,SYM
// DLBL IJSYSPH,'DISK.SYSPCH.EXTENT',0
// EXTENT SYSPCH,,,,extent-information
// DLBL IJSYSIN,'DISK.SYSPCH.EXTENT'
// LIBDEF CL,TO=user-cil-filename,SEARCH=cics-cil-filename
// LIBDEF SL,SEARCH=(user-slb-filename,cics-slb-filename)
// LIBDEF RL,SEARCH=cics-rlb-filename
ASSGN SYSPCH,DISK,VOL=volser,SHR
// EXEC DFHECP1$
 CBL APOST,CLIST,LIB,NOTRUNC,SXREF,XOPT(LANGLVL(2))
       IDENTIFICATION DIVISION.
       PROGRAM-ID. ACCT02.
       REMARKS. THIS PROGRAM IS THE FIRST INVOKED BY THE 'AC02'
                TRANSACTION.  IT COMPLETES REQUESTS FOR ACCOUNT FILE
                UPDATES (ADDS, MODIFIES, AND DELETES), AFTER THE USER
                ENTERED THE UPDATE INFORMATION.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01  MISC.
           02  MENU-MSGNO              PIC S9(4) COMP VALUE +1.
           02  DTL-MSGNO               PIC S9(4) COMP VALUE +0.
           02  ACCT-LNG                PIC S9(4) COMP VALUE +383.
           02  ACIX-LNG                PIC S9(4) COMP VALUE +63.
           02  DTL-LNG                 PIC S9(4) COMP VALUE +751.
           02  DUMMY                   PIC S9(4) COMP VALUE +128.
           02  FILLER REDEFINES DUMMY.
               04  FILLER              PIC X.
               04  HEX80               PIC X.
           02  STARS                   PIC X(12) VALUE '************'.
           02  USE-QID.
               04  USE-QID1            PIC X(3) VALUE 'AC0'.
               04  USE-QID2            PIC X(5).
           02  USE-REC.
               04  USE-TERM            PIC X(4).
               04  USE-TIME            PIC S9(7) COMP-3.
               04  USE-DATE            PIC S9(7) COMP-3.
           02  USE-LNG                 PIC S9(4) COMP VALUE +12.
           02  OLD-IXKEY.
               04  IXOLD-SNAME         PIC X(12).
               04  IXOLD-ACCT          PIC X(5).
           02  COMMAREA-FOR-ACCT04.
               04  ERR-PGRMID          PIC X(8) VALUE 'ACCT02'.
               04  ERR-FN              PIC X.
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            04  ERR-RCODE          PIC X.
        02  PAY-INIT               PIC X(36) VALUE
               '    0.00000000     0.00000000     0.00'.
*       MESSAGES DISPLAYED ON MENU SCREEN
        02  MENU-MSG-LIST.
            04  FILLER             PIC X(60) VALUE
                'PREVIOUS REQUEST CANCELED AS REQUESTED'.
            04  FILLER             PIC X(60) VALUE
                'REQUESTED ADDITION COMPLETED'.
            04  FILLER             PIC X(60) VALUE
                'REQUESTED MODIFICATION COMPLETED'.
            04  FILLER             PIC X(60) VALUE
                'REQUESTED DELETION COMPLETED'.
*       MESSAGES DISPLAYED ON DETAIL SCREEN
        02  MENU-MSG REDEFINES MENU-MSG-LIST PIC X(60) OCCURS 4.
        02  DTL-MSG-LIST.
            04  FILLER             PIC X(60) VALUE
                'EITHER ENTER "Y" TO CONFIRM OR "CLEAR" TO CANCEL'.
            04  FILLER             PIC X(60) VALUE
            'YOUR REQUEST WAS INTERRUPTED; PLEASE CANCEL AND RETRY'.
            04  FILLER             PIC X(60) VALUE
            'CORRECT HIGHLIGHTED ITEMS (STARS MEAN ITEM REQUIRED)'.
            04  FILLER             PIC X(60) VALUE
            'USE ONLY "ENTER" (TO PROCEED) OR "CLEAR" (TO CANCEL)'.
            04  FILLER             PIC X(60) VALUE
            'MAKE SOME ENTRIES AND "ENTER" OR "CLEAR" TO CANCEL'.
        02  DTL-MSG REDEFINES DTL-MSG-LIST PIC X(60) OCCURS 5.
        02  MOD-LINE.
            04  FILLER             PIC X(25) VALUE
                '==========> CHANGES TO:  '.
            04  MOD-NAME           PIC X(6) VALUE SPACES.
            04  MOD-TELE           PIC X(5) VALUE SPACES.
            04  MOD-ADDR           PIC X(6) VALUE SPACES.
            04  MOD-AUTH           PIC X(6) VALUE SPACES.
            04  MOD-CARD           PIC X(6) VALUE SPACES.
            04  MOD-CODE           PIC X(5) VALUE SPACES.
        02  UPDT-LINE.
            04  FILLER             PIC X(30) VALUE
                '==========> UPDATED AT TERM:   '.
            04  UPDT-TERM          PIC X(4).
            04  FILLER             PIC X(6) VALUE '  AT  '.
            04  UPDT-TIME          PIC 9(7).
            04  FILLER             PIC X(6) VALUE '  ON  '.
            04  UPDT-DATE          PIC 9(7).
 01  NEW-ACCTREC. COPY ACCTREC.
 01  OLD-ACCTREC. COPY ACCTREC.
 01  NEW-ACIXREC. COPY ACIXREC.
 01  OLD-ACIXREC. COPY ACIXREC.
     COPY ACCTSET.
     COPY DFHAID.
     COPY DFHBMSCA.
 LINKAGE SECTION.
 01  DFHCOMMAREA.
     02  REQC                      PIC X.
     02  ACCTC                     PIC X(5).
*
 PROCEDURE DIVISION.
*
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*     INITIALIZE.
      MOVE LOW-VALUES TO ACCTDTLI.
      MOVE SPACES TO OLD-ACCTREC, NEW-ACCTREC,
          OLD-ACIXREC, NEW-ACIXREC.
      EXEC CICS HANDLE AID CLEAR(CK-OWN) PA1(PA-KEY)
          PA2(PA-KEY) PA3(PA-KEY) END-EXEC.
      EXEC CICS HANDLE CONDITION QIDERR(NO-OWN)
          MAPFAIL(NO-MAP) ERROR(NO-GOOD) END-EXEC.
*
*     GET INPUT AND BUILD NEW RECORD.
      EXEC CICS RECEIVE MAP('ACCTDTL') MAPSET('ACCTSET') END-EXEC.
      IF REQC NOT = 'A',
          EXEC CICS READ DATASET('ACCTFIL') INTO(OLD-ACCTREC)
              RIDFLD(ACCTC) UPDATE LENGTH(ACCT-LNG) END-EXEC
          MOVE OLD-ACCTREC TO NEW-ACCTREC,
          MOVE SNAMEDO IN OLD-ACCTREC TO IXOLD-SNAME,
          MOVE ACCTC TO IXOLD-ACCT.
      IF REQC = 'X',
          IF VFYDI = 'Y', GO TO CK-OWN,
          ELSE MOVE -1 TO VFYDL, MOVE DFHUNIMD TO VFYDA,
              MOVE 1 TO DTL-MSGNO,
              GO TO INPUT-REDISPLAY.
      IF SNAMEDL > 0 MOVE SNAMEDI TO SNAMEDO IN NEW-ACCTREC.
      IF FNAMEDL > 0 MOVE FNAMEDI TO FNAMEDO IN NEW-ACCTREC.
      IF MIDL > 0 MOVE MIDI TO MIDO IN NEW-ACCTREC.
      IF TTLDL > 0 MOVE TTLDI TO TTLDO IN NEW-ACCTREC.
      IF TELDL > 0 MOVE TELDI TO TELDO IN NEW-ACCTREC.
      IF ADDR1DL > 0 MOVE ADDR1DI TO ADDR1DO IN NEW-ACCTREC.
      IF ADDR2DL > 0 MOVE ADDR2DI TO ADDR2DO IN NEW-ACCTREC.
      IF ADDR3DL > 0 MOVE ADDR3DI TO ADDR3DO IN NEW-ACCTREC.
      IF AUTH1DL > 0 MOVE AUTH1DI TO AUTH1DO IN NEW-ACCTREC.
      IF AUTH2DL > 0 MOVE AUTH2DI TO AUTH2DO IN NEW-ACCTREC.
      IF AUTH3DL > 0 MOVE AUTH3DI TO AUTH3DO IN NEW-ACCTREC.
      IF AUTH4DL > 0 MOVE AUTH4DI TO AUTH4DO IN NEW-ACCTREC.
      IF CARDSDL > 0 MOVE CARDSDI TO CARDSDO IN NEW-ACCTREC.
      IF IMODL > 0 MOVE IMODI TO IMODO IN NEW-ACCTREC.
      IF IDAYDL > 0 MOVE IDAYDI TO IDAYDO IN NEW-ACCTREC.
      IF IYRDL > 0 MOVE IYRDI TO IYRDO IN NEW-ACCTREC.
      IF RSNDL > 0 MOVE RSNDI TO RSNDO IN NEW-ACCTREC.
      IF CCODEDL > 0 MOVE CCODEDI TO CCODEDO IN NEW-ACCTREC.
      IF APPRDL > 0 MOVE APPRDI TO APPRDO IN NEW-ACCTREC.
      IF SCODE1DL > 0 MOVE SCODE1DI TO SCODE1DO IN NEW-ACCTREC.
      IF SCODE2DL > 0 MOVE SCODE2DI TO SCODE2DO IN NEW-ACCTREC.
      IF SCODE3DL > 0 MOVE SCODE3DI TO SCODE3DO IN NEW-ACCTREC.
      IF REQC = 'A' GO TO EDIT-0.
      IF SNAMEDF = HEX80 MOVE SPACES TO SNAMEDO IN NEW-ACCTREC.
      IF FNAMEDF = HEX80 MOVE SPACES TO FNAMEDO IN NEW-ACCTREC.
      IF MIDF = HEX80 MOVE SPACES TO MIDO IN NEW-ACCTREC.
      IF TTLDF = HEX80 MOVE SPACES TO TTLDO IN NEW-ACCTREC.
      IF TELDF = HEX80 MOVE SPACES TO TELDO IN NEW-ACCTREC.
      IF ADDR1DF = HEX80 MOVE SPACES TO ADDR1DO IN NEW-ACCTREC.
      IF ADDR2DF = HEX80 MOVE SPACES TO ADDR2DO IN NEW-ACCTREC.
      IF ADDR3DF = HEX80 MOVE SPACES TO ADDR3DO IN NEW-ACCTREC.
      IF AUTH1DF = HEX80 MOVE SPACES TO AUTH1DO IN NEW-ACCTREC.
      IF AUTH2DF = HEX80 MOVE SPACES TO AUTH2DO IN NEW-ACCTREC.
      IF AUTH3DF = HEX80 MOVE SPACES TO AUTH3DO IN NEW-ACCTREC.
      IF AUTH4DF = HEX80 MOVE SPACES TO AUTH4DO IN NEW-ACCTREC.
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           IF CARDSDF = HEX80 MOVE SPACE TO CARDSDO IN NEW-ACCTREC.
           IF IMODF = HEX80 MOVE ZERO TO IMODO IN NEW-ACCTREC.
           IF IDAYDF = HEX80 MOVE ZERO TO IDAYDO IN NEW-ACCTREC.
           IF IYRDF = HEX80 MOVE ZERO TO IYRDO IN NEW-ACCTREC.
           IF RSNDF = HEX80 MOVE SPACE TO RSNDO IN NEW-ACCTREC.
           IF CCODEDF = HEX80 MOVE SPACES TO CCODEDO IN NEW-ACCTREC.
           IF APPRDF = HEX80 MOVE SPACES TO APPRDO IN NEW-ACCTREC.
           IF SCODE1DF = HEX80 MOVE SPACES TO SCODE1DO IN NEW-ACCTREC.
           IF SCODE2DF = HEX80 MOVE SPACES TO SCODE2DO IN NEW-ACCTREC.
           IF SCODE3DF = HEX80 MOVE SPACES TO SCODE3DO IN NEW-ACCTREC.
           IF OLD-ACCTREC = NEW-ACCTREC,
               MOVE 5 TO DTL-MSGNO,
               GO TO INPUT-REDISPLAY.
      *
      *    EDIT INPUT.
       EDIT-0.
           MOVE LOW-VALUES TO ACCTDTLI.
           IF SNAMEDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO SNAMEDI,
           ELSE IF SNAMEDO IN NEW-ACCTREC ALPHABETIC GO TO EDIT-1.
           MOVE DFHUNIMD TO SNAMEDA, MOVE -1 TO SNAMEDL.
       EDIT-1.
           IF FNAMEDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO FNAMEDI,
           ELSE IF FNAMEDO IN NEW-ACCTREC ALPHABETIC, GO TO EDIT-2.
           MOVE DFHUNIMD TO FNAMEDA, MOVE -1 TO FNAMEDL.
       EDIT-2.
           IF MIDO IN NEW-ACCTREC NOT ALPHABETIC,
               MOVE DFHUNIMD TO MIDA, MOVE -1 TO MIDL.
           IF TTLDO IN NEW-ACCTREC NOT ALPHABETIC,
               MOVE DFHUNIMD TO TTLDA, MOVE -1 TO TTLDL.
           IF (TELDO IN NEW-ACCTREC NOT = SPACES AND
                   TELDO IN NEW-ACCTREC NOT NUMERIC),
               MOVE DFHUNIMD TO TELDA, MOVE -1 TO TELDL.
           IF ADDR1DO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO ADDR1DI,
               MOVE DFHBMBRY TO ADDR1DA, MOVE -1 TO ADDR1DL.
           IF ADDR2DO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO ADDR2DI,
               MOVE DFHBMBRY TO ADDR2DA, MOVE -1 TO ADDR2DL.
           IF CARDSDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO CARDSDI,
           ELSE IF (CARDSDO IN NEW-ACCTREC > '0' AND
                   CARDSDO IN NEW-ACCTREC NOT > '9'), GO TO EDIT-3.
           MOVE DFHUNIMD TO CARDSDA, MOVE -1 TO CARDSDL.
       EDIT-3.
           IF IMODO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO IMODI,
           ELSE IF IMODO IN NEW-ACCTREC NUMERIC AND
               IMODO IN NEW-ACCTREC > '00' AND
               IMODO IN NEW-ACCTREC < '13', GO TO EDIT-4.
           MOVE DFHUNIMD TO IMODA, MOVE -1 TO IMODL.
       EDIT-4.
           IF IDAYDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO IDAYDI,
           ELSE IF IDAYDO IN NEW-ACCTREC NUMERIC AND
                   IDAYDO IN NEW-ACCTREC > '00' AND
                   IDAYDO IN NEW-ACCTREC < '32',
                GO TO EDIT-5.
           MOVE DFHUNIMD TO IDAYDA, MOVE -1 TO IDAYDL.
       EDIT-5.
           IF IYRDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO IYRDI,
           ELSE IF IYRDO IN NEW-ACCTREC NUMERIC AND
               IYRDO IN NEW-ACCTREC > '75', GO TO EDIT-6.
           MOVE DFHUNIMD TO IYRDA, MOVE -1 TO IYRDL.
       EDIT-6.
           IF RSNDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO RSNDI,
           ELSE IF (RSNDO IN NEW-ACCTREC = 'N' OR
                   RSNDO IN NEW-ACCTREC = 'L' OR
                   RSNDO IN NEW-ACCTREC = 'S' OR
                   RSNDO IN NEW-ACCTREC = 'R'), GO TO EDIT-7.
           MOVE DFHUNIMD TO RSNDA, MOVE -1 TO RSNDL.
       EDIT-7.
           IF CCODEDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO CCODEDI,
               MOVE -1 TO CCODEDL, MOVE DFHBMBRY TO CCODEDA.
           IF APPRDO IN NEW-ACCTREC = SPACES,
               MOVE STARS TO APPRDI,
               MOVE -1 TO APPRDL, MOVE DFHBMBRY TO APPRDA.
           IF ACCTDTLI NOT = LOW-VALUES,
               MOVE 3 TO DTL-MSGNO, GO TO INPUT-REDISPLAY.
           IF REQC = 'A' MOVE ACCTC TO ACCTDO IN NEW-ACCTREC,
               MOVE 'N ' TO STATDO IN NEW-ACCTREC,
               MOVE ' 1000.00' TO LIMITDO IN NEW-ACCTREC,
               MOVE PAY-INIT TO PAY-HIST IN NEW-ACCTREC (1),
                   PAY-HIST IN NEW-ACCTREC (2),
                   PAY-HIST IN NEW-ACCTREC (3).
           MOVE CORRESPONDING NEW-ACCTREC TO NEW-ACIXREC.
      *
      *    CHECK OWNERSHIP OF ACCOUNT NUMBER.
       CK-OWN.
           MOVE ACCTC TO USE-QID2.
           EXEC CICS HANDLE CONDITION LENGERR(NO-OWN) END-EXEC.
           EXEC CICS READQ TS QUEUE(USE-QID) INTO(USE-REC)
               LENGTH(USE-LNG) ITEM(1) END-EXEC.
           EXEC CICS HANDLE CONDITION LENGERR (NO-GOOD) END-EXEC.
           IF USE-TERM NOT = EIBTRMID OR USE-LNG NOT = 12, GO TO NO-OWN.
           IF EIBAID = DFHCLEAR GO TO RELEASE-ACCT.
      *
      *    WRITE HARDCOPY LOG RECORDS.
           MOVE LOW-VALUES TO ACCTDTLO.
           MOVE DFHBMDAR TO HISTTLDA, STATTLDA, STATDA, LIMTTLDA,
               LIMITDA.
           IF REQC = 'A' MOVE 'NEW RECORD' TO TITLEDO, GO TO LOG-1.
           MOVE CORRESPONDING OLD-ACCTREC TO ACCTDTLO.
           IF REQC = 'X' MOVE 'DELETION' TO TITLEDO, GO TO LOG-2.
           MOVE 'BEFORE CHANGE' TO TITLEDO.
           IF SNAMEDO IN OLD-ACCTREC NOT = SNAMEDO IN NEW-ACCTREC OR
               FNAMEDO IN OLD-ACCTREC NOT = FNAMEDO IN NEW-ACCTREC
               OR MIDO IN OLD-ACCTREC NOT = MIDO IN NEW-ACCTREC OR
               TTLDO IN OLD-ACCTREC NOT = TTLDO IN NEW-ACCTREC
               MOVE 'NAME' TO MOD-NAME.
           IF TELDO IN OLD-ACCTREC NOT = TELDO IN NEW-ACCTREC
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              MOVE 'TEL' TO MOD-TELE.
          IF ADDR1DO IN OLD-ACCTREC NOT = ADDR1DO IN NEW-ACCTREC OR
              ADDR2DO IN OLD-ACCTREC NOT = ADDR2DO IN NEW-ACCTREC OR
              ADDR3DO IN OLD-ACCTREC NOT = ADDR3DO IN NEW-ACCTREC
              MOVE 'ADDR' TO MOD-ADDR.
          IF AUTH1DO IN OLD-ACCTREC NOT = AUTH1DO IN NEW-ACCTREC OR
              AUTH2DO IN OLD-ACCTREC NOT = AUTH2DO IN NEW-ACCTREC OR
              AUTH3DO IN OLD-ACCTREC NOT = AUTH3DO IN NEW-ACCTREC OR
              AUTH4DO IN OLD-ACCTREC NOT = AUTH4DO IN NEW-ACCTREC
              MOVE 'AUTH' TO MOD-AUTH.
          IF CARDSDO IN OLD-ACCTREC NOT = CARDSDO IN NEW-ACCTREC OR
              IMODO IN OLD-ACCTREC NOT = IMODO IN NEW-ACCTREC OR
              IDAYDO IN OLD-ACCTREC NOT = IDAYDO IN NEW-ACCTREC OR
              IYRDO IN OLD-ACCTREC NOT = IYRDO IN NEW-ACCTREC OR
              RSNDO IN OLD-ACCTREC NOT = RSNDO IN NEW-ACCTREC OR
              CCODEDO IN OLD-ACCTREC NOT = CCODEDO IN NEW-ACCTREC OR
              APPRDO IN OLD-ACCTREC NOT = APPRDO IN NEW-ACCTREC
              MOVE 'CARD' TO MOD-CARD.
          IF SCODE1DO IN OLD-ACCTREC NOT = SCODE1DO IN NEW-ACCTREC OR
              SCODE2DO IN OLD-ACCTREC NOT = SCODE2DO IN NEW-ACCTREC OR
              SCODE3DO IN OLD-ACCTREC NOT = SCODE3DO IN NEW-ACCTREC
              MOVE 'CODES' TO MOD-CODE.
          MOVE MOD-LINE TO MSGDO.
          EXEC CICS WRITEQ TS QUEUE('ACCTLOG') FROM(ACCTDTLO)
              LENGTH(DTL-LNG) END-EXEC.
          MOVE 'AFTER CHANGE' TO TITLEDO.
      LOG-1.
          MOVE CORRESPONDING NEW-ACCTREC TO ACCTDTLO.
      LOG-2.
          MOVE EIBTRMID TO UPDT-TERM, MOVE EIBTIME TO UPDT-TIME,
          MOVE EIBDATE TO UPDT-DATE, MOVE UPDT-LINE TO MSGDO.
          EXEC CICS WRITEQ TS QUEUE('ACCTLOG') FROM(ACCTDTLO)
              LENGTH(DTL-LNG) END-EXEC.
     *
     *    UPDATE THE FILES FOR ADD REQUESTS.
          IF REQC = 'X' GO TO UPDT-DELETE.
          IF REQC = 'M' GO TO UPDT-MODIFY.
      UPDT-ADD.
          MOVE 2 TO MENU-MSGNO.
          EXEC CICS WRITE DATASET('ACCTFIL') FROM(NEW-ACCTREC)
              RIDFLD(ACCTC) LENGTH(ACCT-LNG) END-EXEC.
          EXEC CICS WRITE DATASET('ACCTIX') FROM(NEW-ACIXREC)
              RIDFLD(SNAMEDO IN NEW-ACIXREC) LENGTH(ACIX-LNG) END-EXEC.
          GO TO RELEASE-ACCT.
     *
     *    UPDATE THE FILES FOR MODIFY REQUESTS.
      UPDT-MODIFY.
          MOVE 3 TO MENU-MSGNO.
          EXEC CICS REWRITE DATASET('ACCTFIL') FROM(NEW-ACCTREC)
              LENGTH (ACCT-LNG) END-EXEC.
          IF SNAMEDO IN NEW-ACCTREC NOT = SNAMEDO IN OLD-ACCTREC
              EXEC CICS DELETE DATASET('ACCTIX') RIDFLD(OLD-IXKEY)
                  END-EXEC
              EXEC CICS WRITE DATASET('ACCTIX') FROM (NEW-ACIXREC)
                  RIDFLD (SNAMEDO IN NEW-ACIXREC) LENGTH(ACIX-LNG)
                  END-EXEC
          ELSE IF FNAMEDO IN NEW-ACCTREC NOT = FNAMEDO IN OLD-ACCTREC
              OR MIDO IN NEW-ACCTREC NOT = MIDO IN OLD-ACCTREC OR
```

```
               TTLDO IN NEW-ACCTREC NOT = TTLDO IN OLD-ACCTREC OR
               ADDR1DO IN NEW-ACCTREC NOT = ADDR1DO IN OLD-ACCTREC
               EXEC CICS READ DATASET('ACCTIX') INTO (OLD-ACIXREC)
                   RIDFLD(OLD-IXKEY) LENGTH(ACIX-LNG) UPDATE END-EXEC
               EXEC CICS REWRITE DATASET('ACCTIX') FROM(NEW-ACIXREC)
                   LENGTH(ACIX-LNG) END-EXEC.
           GO TO RELEASE-ACCT.
      *
      *    UPDATE THE FILES FOR DELETE REQUESTS.
       UPDT-DELETE.
           MOVE 4 TO MENU-MSGNO.
           EXEC CICS DELETE DATASET('ACCTFIL') END-EXEC.
           EXEC CICS DELETE DATASET('ACCTIX') RIDFLD(OLD-IXKEY)
               END-EXEC.
      *
      *    RELEASE OWNERSHIP OF ACCOUNT NUMBER.
       RELEASE-ACCT.
           EXEC CICS DELETEQ TS QUEUE(USE-QID) END-EXEC.
      *
      *    SEND MENU MAP BACK TO TERMINAL.
       MENU-REFRESH.
           MOVE LOW-VALUES TO ACCTMNUO.
           MOVE MENU-MSG (MENU-MSGNO) TO MSGMO.
           EXEC CICS SEND MAP('ACCTMNU') MAPSET('ACCTSET') ERASE FREEKB
               END-EXEC.
           EXEC CICS RETURN TRANSID('AC01') END-EXEC.
      *
      *    FOR INPUT ERRORS, RESEND DETAIL MAP.
       INPUT-REDISPLAY.
           MOVE DTL-MSG (DTL-MSGNO) TO MSGDO.
           IF DTL-MSGNO = 2 OR 4 OR 5, MOVE -1 TO SNAMEDL.
           EXEC CICS SEND MAP('ACCTDTL') MAPSET('ACCTSET') DATAONLY
               CURSOR FREEKB END-EXEC.
           EXEC CICS RETURN TRANSID('AC02') COMMAREA(DFHCOMMAREA)
               LENGTH(6) END-EXEC.
      *
      *    PROCESSING FOR RECOVERABLE ERRORS.
       NO-OWN.
           IF EIBAID = DFHCLEAR GO TO MENU-REFRESH.
           MOVE 2 TO DTL-MSGNO, GO TO INPUT-REDISPLAY.
       NO-MAP.
           IF REQC = 'X' MOVE 1 TO DTL-MSGNO, MOVE -1 TO VFYDL
              ELSE MOVE 5 TO DTL-MSGNO.
           GO TO INPUT-REDISPLAY.
       PA-KEY.
           MOVE 4 TO DTL-MSGNO, GO TO INPUT-REDISPLAY.
      *
      *    PROCESSING FOR UNRECOVERABLE ERRORS.
       NO-GOOD.
           MOVE EIBFN TO ERR-FN, MOVE EIBRCODE TO ERR-RCODE.
           EXEC CICS HANDLE CONDITION ERROR END-EXEC.
           EXEC CICS LINK PROGRAM('ACCT04')
               COMMAREA(COMMAREA-FOR-ACCT04) LENGTH(10) END-EXEC.
           GOBACK.
/*
CLOSE SYSPCH,PUNCH
ASSGN SYSIPT,DISK,VOL=volser,SHR
```

```
 PHASE ACCT02,*
 INCLUDE DFHECI
// EXEC FCOBOL
CLOSE SYSIPT,SYSRDR
// EXEC LNKEDT
/&

// JOB ACCT03 TRANSLATE, COMPILE AND LINK
// OPTION CATAL,NODECK,SYM
// DLBL IJSYSPH,'DISK.SYSPCH.EXTENT',0
// EXTENT SYSPCH,,,,extent-information
// DLBL IJSYSIN,'DISK.SYSPCH.EXTENT'
// LIBDEF CL,TO=user-cil-filename,SEARCH=cics-cil-filename
// LIBDEF SL,SEARCH=(user-slb-filename,cics-slb-filename)
// LIBDEF RL,SEARCH=cics-rlb-filename
ASSGN SYSPCH,DISK,VOL=volser,SHR
// EXEC DFHECP1$
 CBL APOST,CLIST,LIB,NOTRUNC,SXREF,XOPT(LANGLVL(2))
       IDENTIFICATION DIVISION.
       PROGRAM-ID. ACCT03.
       REMARKS. THIS PROGRAM IS THE FIRST INVOKED BY TRANSACTIONS
                'AC03', 'ACLG' AND 'AC05'. 'AC03' COMPLETES A REQUEST FOR
                PRINTING OF A CUSTOMER RECORD, WHICH WAS PROCESSED
                INITIALLY BY TRANSACTION 'AC01'.  'ACLG,' WHICH IS A
                USER REQUEST TO PRINT THE LOG, MERELY REQUESTS 'AC05'
                BE STARTED WHEN THE LOG PRINTER ('L86O') IS AVAILABLE.
                'AC05' TRANSFERS THE LOG DATA FROM TEMPORARY STORAGE TO
                THE PRINTER.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01  COMMAREA-FOR-ACCT04.
           02  ERR-PGM                  PIC X(8) VALUE 'ACCT03'.
           02  ERR-FN                   PIC X.
           02  ERR-RCODE                PIC X.
       01  TS-LNG                       PIC S9(4) COMP VALUE +751.
           COPY ACCTSET.
      *
       PROCEDURE DIVISION.
      *
      *    INITIALIZE.
       INIT.
           EXEC CICS HANDLE CONDITION ITEMERR(LOG-END)
               QIDERR(RTRN) ERROR(NO-GOOD) END-EXEC.
      *
      *    TEST FOR TRANSACTION TYPE.
           IF EIBTRNID = 'AC03' GO TO AC03.
           IF EIBTRNID = 'ACLG' GO TO ACLG, ELSE GO TO AC05.
      *
      *    PROCESS TRANSACTION 'AC03'.
       AC03.
           EXEC CICS RETRIEVE INTO(ACCTDTLI) LENGTH(TS-LNG) END-EXEC.
           EXEC CICS SEND MAP('ACCTDTL') MAPSET('ACCTSET') PRINT
               ERASE END-EXEC.
           GO TO RTRN.
      *
      *    PROCESS TRANSACTION 'ACLG'.
       ACLG.
```

```
                EXEC CICS START TRANSID('AC05') TERMID('L860') END-EXEC.
                MOVE LOW-VALUES TO ACCTMSGO.
                MOVE 'PRINTING OF LOG HAS BEEN SCHEDULED' TO MSGO.
                EXEC CICS SEND MAP('ACCTMSG') MAPSET('ACCTSET')
                    FREEKB END-EXEC.
                GO TO RTRN.
           *
           *    PROCESS TRANSACTION 'AC05'.
            AC05.
                EXEC CICS READQ TS QUEUE('ACCTLOG') INTO (ACCTDTLI)
                    LENGTH(TS-LNG) NEXT END-EXEC.
                EXEC CICS SEND MAP('ACCTDTL') MAPSET('ACCTSET') PRINT ERASE
                    END-EXEC.
                GO TO AC05.
            LOG-END.
                EXEC CICS DELETEQ TS QUEUE('ACCTLOG') END-EXEC.
           *
           *    RETURN TO CICS.
            RTRN.
                EXEC CICS RETURN END-EXEC.
           *
           *    PROCESS UNRECOVERABLE ERRORS.
            NO-GOOD.
                MOVE EIBFN TO ERR-FN, MOVE EIBRCODE TO ERR-RCODE.
                EXEC CICS HANDLE CONDITION ERROR END-EXEC.
                EXEC CICS LINK PROGRAM('ACCT04')
                    COMMAREA(COMMAREA-FOR-ACCT04) LENGTH(10) END-EXEC.
                GOBACK.
/*
CLOSE SYSPCH,PUNCH
ASSGN SYSIPT,DISK,VOL=volser,SHR
 PHASE ACCT03,*
 INCLUDE DFHECI
// EXEC FCOBOL
CLOSE SYSIPT,SYSRDR
// EXEC LNKEDT
/&

// JOB ACCT04 TRANSLATE, COMPILE AND LINK
// OPTION CATAL,NODECK,SYM
// DLBL IJSYSPH,'DISK.SYSPCH.EXTENT',0
// EXTENT SYSPCH,,,,extent-information
// DLBL IJSYSIN,'DISK.SYSPCH.EXTENT'
// LIBDEF CL,TO=user-cil-filename,SEARCH=cics-cil-filename
// LIBDEF SL,SEARCH=(user-slb-filename,cics-slb-filename)
// LIBDEF RL,SEARCH=cics-rlb-filename
ASSGN SYSPCH,DISK,VOL=volser,SHR
// EXEC DFHECP1$
 CBL APOST,CLIST,LIB,NOTRUNC,SXREF,XOPT(LANGLVL(2))
        IDENTIFICATION DIVISION.
        PROGRAM-ID. ACCT04.
        REMARKS. THIS PROGRAM IS A GENERAL PURPOSE ERROR ROUTINE.
                 CONTROL IS TRANSFERRED TO IT BY OTHER PROGRAMS IN THE
                 ONLINE ACCOUNT FILE APPLICATION WHEN AN UNRECOVERABLE
                 ERROR HAS OCCURRED.
                 IT SENDS A MESSAGE TO INPUT TERMINAL DESCRIBING THE
                 TYPE OF ERROR AND ASKS THE OPERATOR TO REPORT IT.
```

```
              THEN IT ABENDS, SO THAT ANY UPDATES MADE IN THE
              UNCOMPLETED TRANSACTION ARE BACKED OUT AND SO THAT AN
              ABEND DUMP IS AVAILABLE.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
           COPY ACCTSET.
       01  MISC.
           02  I                    PIC S9(4) COMP.
           02  IX                   PIC S9(4) COMP VALUE +31.
           02  DSN-MSG.
               04  FILLER           PIC X(13) VALUE 'THE FILE IS: '.
               04  DSN              PIC X(8).
               04  FILLER           PIC X VALUE '.'.
           02  HEX-LIST.
               04  HEX-0601         PIC S9(4) COMP VALUE +1537.
               04  HEX-0602         PIC S9(4) COMP VALUE +1538.
               04  HEX-0608         PIC S9(4) COMP VALUE +1544.
               04  HEX-060C         PIC S9(4) COMP VALUE +1548.
               04  HEX-060F         PIC S9(4) COMP VALUE +1551.
               04  HEX-0680         PIC S9(4) COMP VALUE +1664.
               04  HEX-0681         PIC S9(4) COMP VALUE +1665.
               04  HEX-0682         PIC S9(4) COMP VALUE +1666.
               04  HEX-0683         PIC S9(4) COMP VALUE +1667.
               04  HEX-06E1         PIC S9(4) COMP VALUE +1761.
               04  HEX-0A01         PIC S9(4) COMP VALUE +2561.
               04  HEX-0A02         PIC S9(4) COMP VALUE +2562.
               04  HEX-0A04         PIC S9(4) COMP VALUE +2564.
               04  HEX-0A08         PIC S9(4) COMP VALUE +2568.
               04  HEX-0A20         PIC S9(4) COMP VALUE +2592.
               04  HEX-0AE1         PIC S9(4) COMP VALUE +2785.
               04  HEX-0E01         PIC S9(4) COMP VALUE +3585.
               04  HEX-0EE1         PIC S9(4) COMP VALUE +3809.
               04  HEX-1001         PIC S9(4) COMP VALUE +4097.
               04  HEX-1004         PIC S9(4) COMP VALUE +4100.
               04  HEX-1011         PIC S9(4) COMP VALUE +4113.
               04  HEX-1012         PIC S9(4) COMP VALUE +4114.
               04  HEX-1014         PIC S9(4) COMP VALUE +4116.
               04  HEX-1081         PIC S9(4) COMP VALUE +4225.
               04  HEX-10E1         PIC S9(4) COMP VALUE +4321.
               04  HEX-10E9         PIC S9(4) COMP VALUE +4329.
               04  HEX-10FF         PIC S9(4) COMP VALUE +4351.
               04  HEX-1804         PIC S9(4) COMP VALUE +6148.
               04  HEX-1808         PIC S9(4) COMP VALUE +6152.
               04  HEX-18E1         PIC S9(4) COMP VALUE +6369.
               04  HEX-MISC         PIC S9(4) COMP VALUE +0001.
           02  HEX-CODE REDEFINES HEX-LIST PIC X(2) OCCURS 31.
           02  ERR-LIST.
               04  MSG-0601         PIC X(60) VALUE
                   'A PROGRAM OR FCT TABLE ERROR (INVALID FILE NAME).'.
               04  MSG-0602         PIC X(60) VALUE
                   'A PROGRAM OR FILE ERROR (VSAM ILLOGIC).'.
               04  MSG-0608         PIC X(60) VALUE
               'A PROGRAM OR FCT TABLE ERROR (INVALID FILE REQUEST).'.
               04  MSG-060C         PIC X(60) VALUE
                   'A FILE BEING CLOSED THAT MUST BE OPEN.'.
               04  MSG-060F         PIC X(60) VALUE
                   'A PROGRAM OR FILE ERROR (UNEXPECTED END-OF-FILE).'.
```

```
                04  MSG-0680          PIC X(60) VALUE
                    'A FILE INPUT/OUTPUT ERROR.'.
                04  MSG-0681          PIC X(60) VALUE
                    'A PROGRAM OR FILE ERROR (RECORD NOT FOUND).'.
                04  MSG-0682          PIC X(60) VALUE
                    'A PROGRAM OR FILE ERROR (DUPLICATE RECORD).'.
                04  MSG-0683          PIC X(60) VALUE
                    'INADEQUATE SPACE IN A FILE.'.
                04  MSG-06E1          PIC X(60) VALUE
                'A PROGRAM OR FILE ERROR (LENGTH ERROR, FILE CONTROL).'.
                04  MSG-0A01          PIC X(60) VALUE
                'A PROGRAM OR TEMPORARY STORAGE ERROR (ITEM ERROR).'.
                04  MSG-0A02          PIC X(60) VALUE
                'A PROGRAM OR TEMPORARY STORAGE ERROR (UNKNOWN QUEUE).'.
                04  MSG-0A04          PIC X(60) VALUE
                    'AN INPUT/OUTPUT ERROR IN TEMPORARY STORAGE.'.
                04  MSG-0A08          PIC X(60) VALUE
                    'NO SPACE IN TEMPORARY STORAGE.'.
                04  MSG-0A20          PIC X(60) VALUE
                'A PROGRAM OR SYSTEM ERROR (INVALID REQUEST IN TS).'.
                04  MSG-0AE1          PIC X(60) VALUE
                'A PROGRAM OR TEMPORARY STORAGE ERROR (TS LENGTH ERROR)'.
                04  MSG-0E01          PIC X(60) VALUE
                'A PROGRAM OR PPT TABLE ERROR (UNKNOWN PROGRAM NAME).'.
                04  MSG-0EE0          PIC X(60) VALUE
                    'A PROGRAM ERROR (INVALID PROGRAM REQUEST).'.
                04  MSG-1001          PIC X(60) VALUE
                    'A PROGRAM ERROR (END OF DATA, USING IC).'.
                04  MSG-1004          PIC X(60) VALUE
                'AN INPUT/OUTPUT ERROR IN TEMPORARY STORAGE (USING IC).'.
                04  MSG-1011          PIC X(60) VALUE
                'A PROGRAM OR PCT TABLE ERROR (TRANSID ERROR USING IC).'.
                04  MSG-1012          PIC X(60) VALUE
                    'A PROGRAM OR TCT TABLE ERROR (TERMIDERR USING IC).'.
                04  MSG-1014          PIC X(60) VALUE
                    'A PROGRAM OR SYSTEM ERROR (INVTSREQ USING IC).'.
                04  MSG-1081          PIC X(60) VALUE
                    'A PROGRAM OR SYSTEM ERROR (NOT FOUND USING IC).'.
                04  MSG-10E1          PIC X(60) VALUE
                'A PROGRAM OR TEMP STORAGE ERROR (IC LENGTH ERROR).'.
                04  MSG-10E9          PIC X(60) VALUE
                    'A PROGRAM ERROR (INVALID REQUEST USING IC).'.
                04  MSG-10FF          PIC X(60) VALUE
                    'A PROGRAM ERROR (ENVDEFERR USING IC).'.
                04  MSG-1804          PIC X(60) VALUE
                    'A PROGRAM ERROR (BMS MAPFAIL).'.
                04  MSG-1808          PIC X(60) VALUE
                    'A PROGRAM ERROR (INVALID MAP SIZE).'.
                04  MSG-18E1          PIC X(60) VALUE
                    'A PROGRAM ERROR (BMS LENGTH ERROR).'.
                04  MSG-MISC          PIC X(60) VALUE
                    'AN UNKNOWN TYPE OF ERROR.'.
            02  ERR-MSG REDEFINES ERR-LIST PIC X(60) OCCURS 31.
        LINKAGE SECTION.
        01  DFHCOMMAREA.
            02  ERR-PGRMID            PIC X(8).
            02  ERR-CODE.
```

```
               04  ERR-FN           PIC X.
               04  ERR-RCODE        PIC X.
       PROCEDURE DIVISION.
           MOVE LOW-VALUES TO ACCTERRO.
           PERFORM CODE-LOOKUP THROUGH CODE-END
               VARYING I FROM 1 BY 1 UNTIL I NOT < IX.
           MOVE ERR-MSG (IX) TO RSNEO.
           MOVE EIBTRNID TO TRANEO.
           MOVE ERR-PGRMID TO PGMEO.
           IF IX < 11 MOVE EIBDS TO DSN,
               MOVE DSN-MSG TO FILEEO.
           EXEC CICS SEND MAP('ACCTERR') MAPSET('ACCTSET') ERASE FREEKB
               END-EXEC.
           EXEC CICS ABEND ABCODE('EACC') END-EXEC.
       CODE-LOOKUP.
           IF HEX-CODE (I) = ERR-CODE MOVE I TO IX.
       CODE-END.  EXIT.
       DUMMY-END.
           GOBACK.
/*
CLOSE SYSPCH,PUNCH
ASSGN SYSIPT,DISK,VOL=volser,SHR
 PHASE ACCT04,*
 INCLUDE DFHECI
// EXEC FCOBOL
CLOSE SYSIPT,SYSRDR
// EXEC LNKEDT
/&
```

Appendix B. Additional CICS Facilities and Your Reference Manual (the APRM)

The aim of this appendix is to mention the CICS facilities we haven't covered in the Primer, and to introduce you to your application programming reference manual.

Other CICS Facilities

In no particular order, these include:

- Getting access to control blocks and control information using ADDRESS and ASSIGN commands.

  The ADDRESS command gives you access to the common storage area (CSA), the common work area (CWA), the transaction work area (TWA), and so on.

  The ASSIGN command allows you to get values from outside the local environment of your application program. For example, lengths of storage areas, values needed during BMS operations, information about terminal characteristics, and so on.

- The use of the command interpreter transaction, CECI (which we very briefly met in "A Session With EDF" on page 219 and in "Optional Exercise" on page 126).

  CECI is very useful for deleting, repairing, inspecting, and creating all sorts of items. We used it, if you remember, to delete our temporary storage scratchpad record (to save waiting 10 minutes).

- The DL/I interface.

  DL/I is a general-purpose data base control system. CICS application programs can access DL/I data bases using EXEC DLI... commands.

- The SQL/DS interface (DOS).

  SQL/DS is a relational data base control system. CICS application programs can access SQL data bases using EXEC SQL... commands. You can find out more about it in the *CICS/DOS/VS Release Guide.*

- The DATABASE 2 interface (MVS).

  DATABASE 2 is a relational data base control system. CICS application programs can access DB2 data bases using EXEC SQL... commands. You can find out more about it in the *CICS/OS/VS Release Guide*.

- Terminal operations that don't use BMS.

  This means using native terminal control commands.

- Batch Data Interchange.

  The CICS batch data interchange program allows your application to talk to programmable subsystems such as the IBM 8100.

- The task control commands, SUSPEND, ENQ, and DEQ.

  The SUSPEND command allows you to give up control and allow other, higher priority, tasks to run. The task from which you issue the SUSPEND gets control back as soon as all higher priority tasks that can run have "had their turn".

  ENQ (enqueue) tells CICS that a given task wants a particular resource (of the one-user-at-a-time type). CICS returns control to the task when the resource becomes available.

  Similarly, DEQ (dequeue) tells CICS that a given task has finished with such a resource.

- The storage control commands, GETMAIN, FREEMAIN.

  The GETMAIN command gets a specified amount of main storage. If you want, it can also initialize the contents of that storage to a particular bit configuration.

  The FREEMAIN command, as you'd expect, releases such storage.

- User journal operations.

  The CICS journal control facilities allow you to direct any information you want to special-purpose sequential data sets (called **journals**). These journals are to help you reconstruct events or data changes for both audit purposes and in case of system failures.

- Sync point command.

  The SYNCPOINT command allows you to divide a task - usually a long-running one - into smaller units known as logical units of work. This makes it easier to recover from a task abend or a system failure.

- The DUMP command (which we mentioned on page 199).

  This allows you to dump specified main storage areas without terminating your program, as you do with an ABEND command. You can dump the same areas as appear in a transaction abend dump, and/or other areas too.

- Trace commands.

  CICS trace control uses a trace table (which we've already seen in "Transaction Dumps" on page 244). You can put your own entries into this table for use as "flags" to help you spot what your application program is doing.

- The monitor program and its exits.

  You can define a user event monitoring point (EMP) with the MONITOR option of the ENTER command. At each user EMP you can accumulate all sorts of information of an accounting and performance nature. You'll find more details in the *Customization Guide.*

- Intersystem communication (ISC) and multi-region operation (MRO) facilities.

  These allow independent CICS systems to talk to each other. The systems may be in the same processor or in different processors. ISC and MRO are dealt with in the *Intercommunication Facilities Guide.*

- Exits within the management modules.

  You may, despite the many options that CICS offers, still have special requirements that a standard CICS system cannot meet. In this case, you can add your own **user exit** code to certain CICS modules. This code will then be invoked whenever one of these modules is used.

  See the *Customization Guide* for more details.

- Transaction restart facilities.

  The *Recovery and Restart Guide* tells you all about designing applications with recovery in mind.

- Program error programs (PEPs), node error programs (NEPs), and terminal error programs (TEPs).

  IBM supplies programs to handle certain common error sisuations. There's one to handle program errors (PEP), one for VTAM terminal errors (NEP), and one for non-VTAM terminal errors (TEP). If you prefer, you can supply your own versions of these programs, and tailor the processing of certain types of error for your particular needs. There are special macros to help you build your own versions of these programs. Either way, please see the *Customization Guide* for more information.

- The external security interface.

  CICS offers you an interface to an external security manager. You can write this yourself or, if you use MVS, you can use the Resource Access Control Facility (RACF) program product.

  See the *Customization Guide* for details.

- Dynamic OPEN and CLOSE.

  This facility allows you to open and close data sets dynamically while CICS is running. Again, see the *Customization Guide* for details.

- The phonetic key routine.

  CICS provides a subroutine to convert words to a condensed "phonetic" form. The major use of phonetic codes is for keys to data sets (usually names), so that you can access records in the file without knowing the exact spelling of a name or a word in the file key. We might have chosen to use this subroutine in building the name index to our account file. See the *Customization Guide* for details.

- The master terminal operator (CEMT) transaction application interface.

  The master terminal (CEMT) transaction functions are also available to an application program. See the *Operator's Guide* for details.

The Application Programmer's Reference Manual

This is the application programmer's authoritative source of all information about the application programming interface to CICS.

You'll find within it all that you need to know about every CICS command-level instruction.

Its appendixes also contain a variety of sample material that is available as part of your CICS system. This material contains some useful coding hints, tips, and techniques.

Glossary

This glossary defines special CICS terms used in the library and words used with other than their everyday meaning. It includes terms and definitions from the *IBM Vocabulary for Data Processing, Telecommunications, and Office Systems,* GC20-1699. In some cases the definition given isn't the only one applicable to the term, but gives the particular sense in which we've used it.

American National Standards Institute (ANSI) definitions are preceded by an asterisk.

A

abend. Abnormal end of task.

access method. A technique for moving data between main storage and input/output devices.

application. This refers to a set of one or more **application units of work** designed to fulfill a particular need (or needs) of the user organization.

application program. (1) A program written for or by a user that applies to the user's work. (2) In data communication, a program used to connect and communicate with stations in a network, enabling users to perform application-oriented activities. affecting the contents of a record.

auxiliary storage. Data storage other than main storage; for example, storage on magnetic tape or direct access devices.

B

backout. A general term meaning to restore a previous state of all or part of a system. See dynamic transaction backout.

Basic Mapping Support (BMS). A facility which moves data streams to and from a terminal. It provides device independence and format independence for application programs.

batch. An accumulation of data to be processed.

blanks. See space.

BMS. See Basic Mapping Support.

byte. In System/370, a sequence of eight adjacent binary digits that are operated on as a unit.

C

CEMT. The master terminal transaction.

CI. See control interval.

CICS. Customer Information Control System

COBOL. Common business-oriented language. An English-like programming language designed for business data processing applications.

command. In CICS, an instruction similar in format to a high-level programming language statement. (Contrast with macro.) CICS commands invariably include the verb EXECUTE (or EXEC). They may be issued by an application program to make use of CICS facilities.

command-language statement. In CICS, synonym for command.

common system area (CSA). In CICS, a basic system control block to which all transactions have access.

*** concurrent.** Pertaining to the occurrence of two or more activities within a given interval of time.

control block. In CICS, a storage area used to hold dynamic data during the execution of control programs and application programs. Synonym for control area. Contrast with control table.

control interval (CI). A fixed-length area of direct access storage in which VSAM stores records. The unit of information that VSAM transmits to or from direct access storage.

control table. In CICS, a set of information used to define or describe the configuration or operation of the system in a relatively permanent way. Contrast with control block.

conversational. Pertaining to a program or a system that carries on a dialogue with a terminal user, alternately accepting input and then responding to the input quickly enough for the user to maintain his or her train of thought.

CSA. Common system area.

CWA. Common work area, an extension of the common system area (CSA).

D

DAM. Direct access method.

DASD. Direct access storage device.

data base. An organized collection of interrelated or independent data items stored together without unnecessary redundancy, to serve one or more applications.

data set. The major unit of data storage and retrieval, consisting of a collection of data in one of several prescribed arrangements and described by control information to which the system has access. See file.

DB2. DATABASE 2, IBM's relational data base management system program product for the MVS/XA and MVS/370 environments.

DB/DC. Data-base and data-communication.

deadlock. (1) Unresolved contention for the use of a resource. (2) An error condition in which processing cannot continue because each of two elements of the process is waiting for an action by, or a response from, the other.

device independence. An application program written in such a way that it does not depend on the physical characteristics of devices. BMS provides a measure of device independence.

direct access storage. (1) * A storage device in which the access time is in effect independent of the location of the data. (2) A storage device that provides direct access to data.

DL/1. Data Language/1, the high-level interface between a user application and an IMS/VS data base.

DTB. See dynamic transaction backout.

dynamic transaction backout. The process of canceling changes made to stored data by a transaction following the failure of that transaction for whatever reason.

E

EDF. Execution (command-level) diagnostic facility for testing command-level programs interactively at a terminal.

emergency restart. The CICS facility for use following a system failure. It restores the data files of all interrupted transactions to the condition they were in after the last complete transaction (that affected them) before the failure.

end user. In CICS, a person using a terminal to cause execution of a CICS transaction. Typically, a non-data-processing professional, for example, a reservation clerk.

exception. An abnormal condition such as an I/O error encountered in processing a data set or a file.

F

*** file.** A set of related records treated as a unit, for example, in stock control, a file could consist of a set of invoices. See data set.

file control table. A CICS table containing the characteristics of the files accessed by file control.

*** format.** The arrangement or layout of data on a data medium. In CICS, the data medium is usually a display screen.

format independence. The ability to send data to a device without having to be concerned with the format in which the data will be displayed. The same data may appear in different formats on different devices.

H

high-values. Hexadecimal FF.

I

*** I/O.** Input/Output.

IMS/VS. Information Management System/Virtual Storage.

inquiry. A request for information from storage; for example, a request for the number of available airline seats.

installation. (1) A particular computing system, in terms of the work it does and the people who manage it, operate it, apply it to problems, service it and use the work it produces. (2) The task of making a program ready to do useful work. This task includes generating a program, initializing it, and applying PTFs to it.

interactive. Pertaining to an application in which each entry calls forth a response from a system or program, as in an inquiry system or an airline reservation system. An interactive system may also be conversational, implying a continuous dialogue between the user and the system.

ISAM. Indexed Sequential Access Method.

J

journal. A chronological record of the changes made to a set of data; the record may be used to reconstruct a previous version of the set.

journaling. Recording transactions against a data set in such a way that the data set can be reconstructed by applying transactions in the journal against a previous version of the data set.

K

keyword. (1) A symbol that identifies a parameter. (2) A part of a command operand that consists of a specific character string.

L

label. See paragraph name.

linkage editor. A computer program used to create one load module from one or more independently-translated object modules or load modules by resolving cross references among the modules.

logging. The recording (by CICS) of recovery information onto journal 01 (the system log).

low-values. Hexadecimal 00.

M

main storage. Program-addressable storage from which instructions and data can be loaded directly into registers for subsequent execution or processing. See also real storage, storage.

map. In CICS, a format established for a page or a portion of a page.

master terminal. In CICS, the terminal at which a designated operator is signed-on.

master terminal operator. Any CICS operator authorized to use the master terminal functions.

multitasking. * Pertaining to the concurrent execution of two or more tasks by a computer.

multithreading. Pertaining to the concurrent operation of more than one path of execution within a computer. In CICS, the use, by several transactions, of a single copy of an application program.

N

null. A character encoding of hexadecimal 00 - LOW-VALUE in COBOL.

O

online. (1) * Pertaining to a user's ability to interact with a computer. (2) * Pertaining to a user's access to a computer via a terminal. The term "online" is also used to describe a user's access to a computer via a terminal.

operating system. Software that controls the execution of programs; an operating system may provide services such as resource allocation, scheduling, input/output control, and data management.

OS. Operating System.

P

paragraph name. COBOL term for destination of a branch or GOTO instruction.

*** parameter.** A variable that is given a constant value for a specified application and that may denote the application.

partition. A fixed size subdivision of main storage, allocated to a system task. Contrast with region.

PCT. See program control table.

PPT. See processing program table.

processing program table (PPT). A CICS table defining all application programs valid for processing under CICS. It also keeps track of whether an application program is in main storage or not.

program control. The CICS element that manages CICS application programs.

program control table (PCT). A CICS table defining all transactions that may be processed by the system.

program function (PF) key. A key that passes a signal to a program.

pseudoconversational. A series of CICS transactions designed to appear to the operator as a continuous conversation occurring as part of a single transaction.

Q

quasi-reentrant. Applied to a CICS application program that is serially reusable between CICS calls because it does not modify itself or store data within itself between calls on CICS facilities.

R

real storage. The main storage in a virtual storage system. Physically, real storage and main storage are identical. Conceptually, however, real storage represents only part of the range of addresses available to the user of a virtual storage system.

recoverable resources. Items whose integrity CICS will maintain in the event of a system failure. They include individual CICS files, and auxiliary temporary storage queues.

reentrant. The attribute of a program or routine that allows the same copy of the program or routine to be used concurrently by two or more tasks.

*** response time.** The elapsed time between the end of an inquiry or demand on a data processing system and the beginning of the response. For example, the length of time between an indication of the end of an inquiry and the display of the first character of the response at a user terminal.

S

SAM. Sequential Access Method.

screen page. The amount of data displayed, or capable of being displayed, at any one time on the screen of a terminal.

SIPO. System Installation Productivity Option.

SIT. System initialization table. A CICS table.

space. A character encoding of hexadecimal 40.

SQL/DS. Structured Query Language/Data System. A relational data base management facility.

storage. A functional unit into which data can be placed and from which it can be retrieved. See main storage, real storage.

storage control. The CICS element that manages working storage areas.

system initialization table. A table containing user-specified data that will control a system initialization process.

system log. The (only) journal data set (identification = '01') that is used by CICS to log changes made to resources for the purpose of backout on emergency restart.

T

task. (1) A basic unit of work to be accomplished by a computer. (2) Under CICS, the execution of a transaction for a particular user. Contrast with transaction.

task control. The CICS element that controls all CICS tasks.

task control area (TCA). A basic CICS control block provided for each task.

TCA. See task control area.

TCT. Terminal control table. A CICS table.

terminal. (1) * A point in a system or communication network at which data can either enter or leave. (2) In CICS, a device, often equipped with a keyboard and some kind of display, capable of sending and receiving information over a communication channel.

terminal control. The CICS element that controls all CICS terminal activity.

terminal control table. A table describing a configuration of terminals, logical units, or other CICS systems in a CICS network with which the CICS system may communicate.

terminal operator. The user of a terminal.

terminal paging. A set of CICS commands for retrieving "pages" of an oversize output message in any order.

threading. The process whereby various transactions undergo concurrent execution.

TIOA. Terminal input/output area.

transaction. A transaction may be regarded as a unit of processing (consisting of one or more application programs) started by a single request, often from a terminal. A transaction may require the starting of one or more tasks for its execution. Contrast with task.

transaction backout. The cancellation, as a result of a transaction failure, of all updates performed by a partially-completed task.

transaction identification code. Synonym for transaction identifier. A group of up to four characters used to identify (name) a particular transaction type in the PCT.

transaction identifier. Synonymous with transaction identification code.

transaction restart. The restart of a task after a transaction backout.

U

update. To modify a file with current information.

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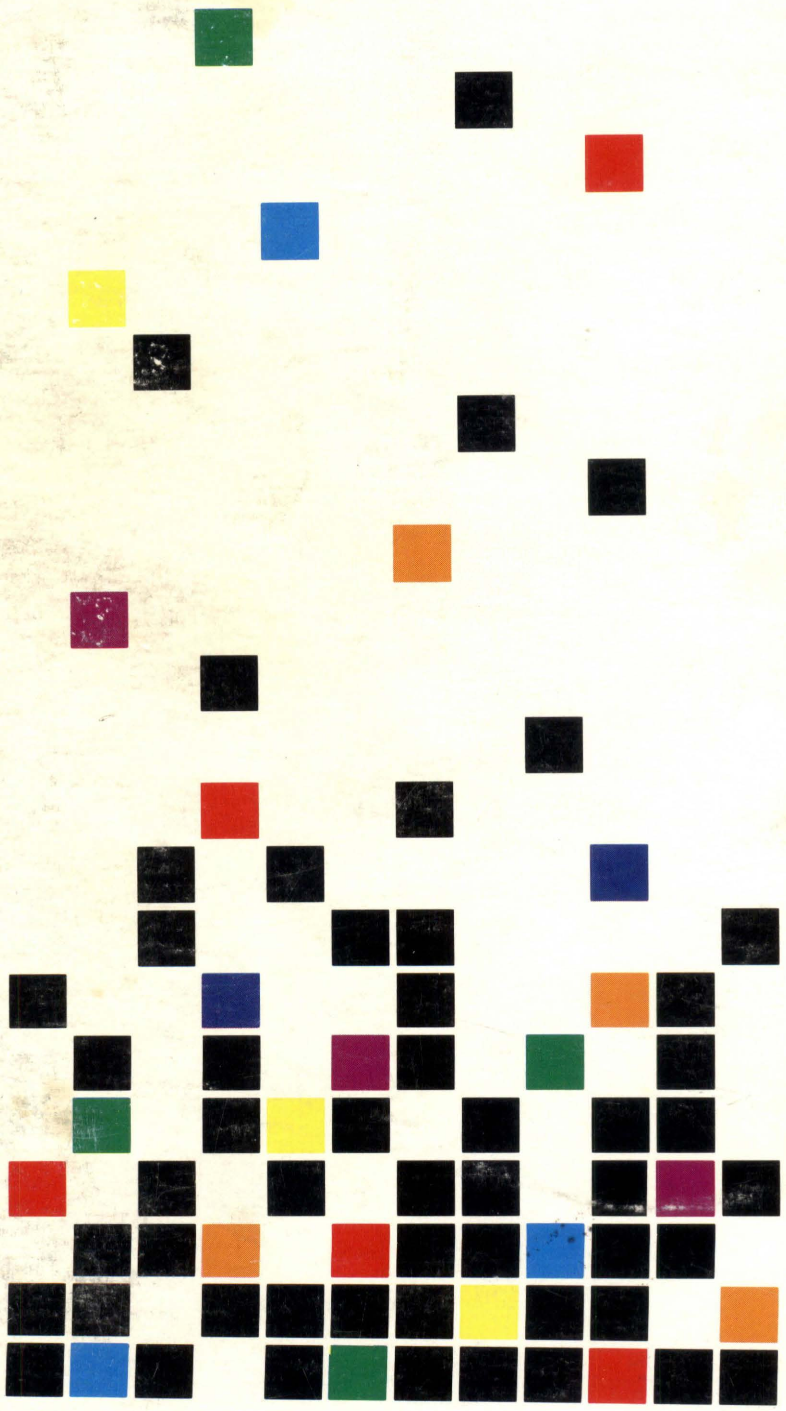

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