DIGITAL RESEARCH™

Access Manager™

Productivity Tool

Programmer's Guide

for the CP/M-86®

Family of Operating Systems

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Programmer's Guide
For the
CP/M-86® Family of Operating Systems

Digital Research
P.O. Box 579
160 Central Avenue
Pacific Grove, CA 93950
(408) 649-3896
TWX 910 360 5001

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```

Foreword

This programmer's guide contains information and instructions for implementing your application programs with Access Manager ™. It is specifically directed at implementations using the CP/M-86® family of operating systems.

The Access Manager Programmer's Guide was designed and written as the companion manual to the Access Manager Reference Manual. Please note that there are two separate versions of the programmer's guide, an 8080 and an 8086 version.

This manual contains information and instructions for implementing your applications programs with Access Manager. Section 1 describes the general guidelines and restrictions you must observe when you use Access Manager with a particular operating system. Section 2 describes how to link Access Manager with CB86™ ; Section 3 describes how to link Access Manager with Pl/I-86™ ; and Section 4 describes how to link Access Manager with Pascal/MT+86™. Each section includes examples.

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Section 1
Implementation Guidelines

1.1 Main Access Manager Components

Your Access Manager distribution disk contains the following files:

- Single-user subroutine libraries

AM86CB86.L86	A complete, binary-relocatable, indexed library of index and data file functions for CB86 application programs.
AM86PLI.L86	A complete, binary-relocatable, indexed library of index and data file functions for PL/I-86 application programs.
AM86PASC.R86	A complete, binary-relocatable library of index and data file functions for Pascal/MT+86 application programs.

- Single-user Access Manager buffer modules

AM86BUF.OBJ	A relocatable object module containing a prespecified buffer area of 3,840 (decimal) bytes for CB86 and PL/I-86 application programs.
AM86BUF.R86	A relocatable object module containing a prespecified buffer area of 3,840 (decimal) bytes for Pascal/MT+86 application programs.
AM86BUF.A86	The assembly language source code for the buffer modules. Contains entry points (AM8FCB and AM8END) that define the beginning and end of the buffer area. This module is for use with RASM86.CMD.
AM86BUF.I86	The assembly language source code for the buffer modules. Contains entry points (AM8FCB and AM8END) that define the beginning and end of the buffer area. This module is for use with ASMT86.CMD.
SETAMBUF.CMD	A program to change the buffer module sizes without reassembling AM86BUF.

- External procedure declarations

AM86EXTR.BAS	External procedure declarations for CB86 application programs.
AM86EXTR.PLI	External procedure declarations for PL/I-86 application programs.
AM86EXTR.PSC	External procedure declarations for Pascal/MT+86 application programs.

- Multiuser application interfaces

AMQ6CB86.L86	Relocatable interface module to coordinate compiled CB86 application programs and the shared Access Manager routines (AM86.CMD).
AMQ6PLI.L86	Relocatable interface module to coordinate compiled PL/I-86 application programs and the shared Access Manager routines (AM86.CMD).
AMQ6PASC.R86	Relocatable interface module to coordinate compiled Pascal/MT+86 application programs and the shared Access Manager routines (AM86.CMD).

- Background server routines

AM86.CMD	A program containing all multiuser functions. AM86.CMD runs in its own memory segment as a shared, background server.
STOPAM86.CMD	A utility program that closes all open index and data files, terminates AM86.CMD, and releases its memory segment.

- Background server customization routines

The following files contain the code you need to create custom versions of AM86.CMD. Additional instructions for creating custom background servers can be found later in this section.

AM86MBUF.A86	Determines the number and size of buffers and reserves the actual space for them. You can significantly affect the size of AM86.CMD by changing this module. This module is for use with RASM86.CMD.

AM86MBUF.I86 — Determines the number and size of buffers and reserves the actual space for them. You can significantly affect the size of AM86.CMD by changing this module. This module is for use with ASMT86.CMD.

AM86SRVx.OBJ — Contains the message handling code that communicates with the multiuser interfaces to coordinate the sharing of Access Manager functions. x is replaced by the number of users. For example, AM86SRV3.OBJ indicates a system with three users. This module is for use with LINK86.CMD.

AM86SRVx.R86 — Contains the message handling code that communicates with the multiuser interfaces to coordinate the sharing of Access Manager functions. x is replaced by the number of users. For example, AM86SRV3.OBJ indicates a system with three users. This module is for use with LINKMT.CMD.

AM86B.L86 — Contains the Access Manager functions for a multiuser environment. For use with LINK86.CMD.

AM86B.R86 — Contains the Access Manager functions for a multiuser environment. For use with LINKMT.CMD.

- Utility programs

RECREATE — A general purpose program for rebuilding index files from existing data files. Source versions of the program are provided in CB86, PL/I-86, and Pascal/MT+86. The program is documented in Section 5 of the Access Manager Reference Manual.

DATABASE — A complete data base example for single- or multiuser environments. Source code is provided in CB86, PL/I-86, and Pascal/MT+86.

1.2 Memory Requirements for Access Manager Code

[SINGLE] Access Manager's modular design ensures that your application program uses only those parts of Access Manager that are actually required. The calls to Access Manager embedded in the application program determine which modules the linking loader brings into the final file.

[MULTI] Only a small interface module combines with your application program. The actual Access Manager code resides in a separate memory segment.

Table 1-1 shows Access Manager's code requirements for single-user and multiuser environments. The following standard abbreviations are used. B means byte and K means kilobyte.

Table 1-1. Access Manager Code Requirements

Module	Memory in Bytes Single	Multi
Kernel: system initialization and index file setup and searching	4.1K	---
Key value insertion	1.5K	---
Key value deletion	1.6K	---
Data file functions	1.7K	---
Buffer Area	0.8K+	---
Background server (w/o buffer area)	---	12.0K
Minimal buffer area	---	2.0K
Application program interface	---	3.0K
Queue space requirements:		
for 3 users	---	568B
for 4 users	---	710B
for 6 users	---	994B
for 8 users	---	1278B

1.3 Access Manager Design Constraints

When using Access Manager, the following design constraints apply in both single-user and multiuser environments:

- Data records in a data file must all be the same length.
- Data records must be a minimum of four bytes in length.
- Access Manager reserves the first 128 bytes of every data file for recording status information.
- Key values must not exceed a length of 48 bytes.
- Data record numbers (pointers) associated with key values must not exceed a length of four bytes.

- The length of an index file record must be a multiple of 128 bytes; for example, 128, 256, 512, 1024, etc.
- There must be a minimum of four key values in any given index file record.
- A minimum of three buffers must be allocated for Access Manager.

If your application program is to run under the CP/M-86® or MP/M-86™ operating system, you must also observe the design constraints shown in Table 1-2. In the table, megabyte is abbreviated as MB.

Table 1-2. Additional Design Constraints

Design Constraints	CP/M-86	MP/M-86
Maximum number of key values per index file record	254	254
Maximum index file size	8 MB	See Note 1
Maximum number of index files that can be open at a given time	254	254
Maximum data file size	8 MB	32 MB
Maximum number of data files that can be open at a given time	254	254
Maximum number of Access Manager disk buffers	256	256
Maximum number of users in a multiuser environment	N/A	8

Note: the maximum number of nodes in an index file is 65,535. If you are using 512-byte nodes, the maximum file size is 32 MB.

1.4 Multiuser Module Under MP/M-86

Correct implementation of Access Manager under MP/M-86 requires proper use of AM86.CMD, which contains the shared index file, data file, and buffer area. AM86.CMD automatically creates the queue structures necessary for its proper use. "Creating Custom Background Servers" in Section 1.4.4 describes how to customize AM86.CMD, including how to change the maximum number of users that are supported simultaneously.

1.4.1 Reserving Access Manager Queue Space

The queues created by AM86.CMD coordinate the multiuser keyed file accessing requests. Table 1-3 shows the queue space memory requirements.

Table 1-3. Queue Space Requirements

Maximum Number of Users	Memory in Bytes (Dec/Hex)	Number of Queue Control Blocks
3	568/238	4
4	710/2C6	5
6	994/3E2	7
8	1278/4FE	9

For a given number of users, the task of reserving queue space need only be performed once during MP/M-86 system generation. The MP/M™ utility program GENSYS.CMD prompts you to determine the number of queue control blocks (in hex) and the size of the queue buffer area (in hex bytes) to be included in the operating system. To set up a three-user system for Access Manager, respond with a value of at least 238 (568 decimal) for queue buffer space when GENSYS prompts you. Be sure there are at least four queue control blocks (usually there are a large number of queue blocks available).

After you complete the GENSYS procedure, a new MP/M system is written to a disk file (MPM.SYS). The next time you boot the system, the new version of MP/M resides on disk.

1.4.2 Invoking Shared Routines

AM86.CMD contains the shared Access Manager code designed to run in its own memory segment under MP/M-86. As distributed, it requires less than 34K bytes of memory, supports up to forty index files and forty data files, and uses twenty buffers with a node size of 512 bytes (NNSEC%=4). Instructions for changing this configuration can be found under "Creating Custom Background Servers" in Section 1.4.4.

To start AM86.CMD under MP/M-86, type

```
AM86
```

If Access Manager starts successfully, a message similar to the following appears on your screen:

```
------------------------------------------------
ACCESS MANAGER(tm) 8086                Version 1.0
Serial No.  AM-9999-000000     All Rights Reserved
Copyright (c) 1982,1983     Digital Research, Inc.
------------------------------------------------

Access Manager(tm) is ready for y users.
```

Access Manager then detaches from the console and AM86.CMD is waiting in the background to service multiuser application programs.

If Access Manager encounters a problem at start-up, one of the following messages appears on the console:

```
Access Manager could not open queues. Call Digital
Research.

Access Manager Background Server (AM86.CMD) has illegal
SETUP parameters.  Check AM86MBUF.A86 for proper setup.

Access Manager could not open lock file.  Are the disk
and/or directory full?

Access Manager could not initialize lock file.  Call
Digital Research.

Error while making Access Manager queues.  Either queues
already exist (is Access Manager already running?); or
there is insufficient space for queue control blocks and/or
queue buffers (GENSYS required).
```

1.4.3 Cancelling Shared Routines

To close all open index and data files, delete the Access Manager queues, and free the memory segment occupied by AM86.CMD, type the command:

```
STOPAM86
```

If successful, the following message appears on the console:

```
Access Manager (tm) Terminated
```

If AM86.CMD is not running when you attempt to start STOPAM86, this message appears on the console:

```
Be sure that Access Manager is operational.  Run MPMSTAT to
see.
```

1.4.4 Creating Custom Background Servers

There are four parameters that affect AM86.CMD that can be modified. These parameters are defined by EQU statements in the AM86MBUF.A86 (and AM86MBUF.I86) file. The parameters are

- NBUFS% The number of index file I/O buffers. NBUFS% must be at least three. However, twenty is a more realistic value for satisfactory multiuser operation.
- NNSEC% The number of 128-byte sectors comprising each index file node. There must be at least one; four are recommended.
- NKEYS% The maximum number of index files that are open at one time.
- NDATF% The maximum number of data files that are open at one time.

Once you enter the appropriate values for the preceding parameters into AM86MBUF.A86, you must assemble it to create a new AM86MBUF.L86. After it is assembled, you can use the following command line to create a new AM86.CMD.

```
LINK86 AM86=AM86SRVx,AM86MBUF,AM86B.L86
```

where x specifies the maximum number of system users; for example, AM86SRV6 indicates a maximum of six.

Because LINK86.CMD uses a default value for the size of the data segment in the AM86.CMD produced by the above link statement, you might want to modify the statement. For instance, if LINK86 forces a 64K byte data area and your AM86.CMD requires only 16K bytes, you waste 48K bytes of memory. After the preceding link, LINK86 reports the minimum data segment required for AM86.CMD. Because of the design of AM86.CMD, this minimum data segment is all that is actually required.

As an example, if the linker reports that you require a data segment of 3A80 hex bytes (14,976 decimal), then relink your background server as follows:

```
LINK86 AM86=AM86SRVx[DATA[MAX[3B0]]],AM86MBUF,AM86B.L86
```

where 3B0 represents a rounded-up number of 16-byte paragraphs required in the data segment.

Consult the Programmer's Utilities Guide for the CP/M-86 Family of Operating Systems for more details on LINK86.CMD.

If you are using ASMT86 and LINKMT, modify AM86MBUF.I86 as shown in the preceding example, assemble it, and link a new background server as follows:

```
LINKMT AM86=AM86SRVx,AM86MBUF,AM86B
```

1.4.5 Data and Index Files

When Access Manager runs in the multiuser environment, index and data files are opened in the locked mode. This places total control of these files under AM86.CMD. Further, the files are in the directory of the MP/M-86 user area from which AM86.CMD is started. In most environments, AM86.CMD is started from user area zero.

1.5 Configuring the Single-user Buffer Area

The primary parameters affecting the buffer area size are NNSEC% (the number of sectors per index file record) and NBUFS% (the number of index file buffers). NNSEC% should be set to a value of four if compatibility of your application program with other software is a factor. However, if response time is a more critical issue, refer to Table 1-4 for suggested NNSEC% values.

Note that NNSEC% determines the length of the records in the index file. For example, if NNSEC% contains a value of four, the resulting index file record length is 512 bytes, regardless of the physical sector size of the disk.

Table 1-4. Suggested Index File Record Lengths

Physical Sector Size of Disk	Suggested Values for NNSEC%*
128	2
256	2,4
512	2,4
1024	4,8

* NNSEC% specifies the number of 128-byte sectors per index file record.

Within the guidelines of Table 1-4, the selection of a value for NNSEC% is usually based on the length of the keys. Long keys lead to higher values of NNSEC% to reduce the levels of the B-Tree index structure.

For any specified value of NNSEC%, the more buffers (larger NBUFS%) there are, the fewer node accesses you need to retrieve a key value. However, when processing one index file at a time, the

payoff from adding buffers diminishes rapidly when five or six buffers are already in use. If more than one index file is in use at a time, increase the number of buffers beyond six. Provided the memory space is available, figuring three buffers per index file (in active use at one time) is a reasonable guideline. Buffers are not assigned to individual index files. They are shared according to a least recently used priority scheme, that ensures the active index files make full use of the buffers.

Finally, the amount of available memory determines the size of the buffer area. If there is very little memory available for buffers, you can reduce NBUFS% to the minimum level of three.

The required buffer size for any given specification of the maximum number of index files (NKEYS%), the node size (NNSEC%), the number of buffers (NBUFS%), and the number of data files (NDATF%), can be computed as follows:

```
(NKEYS% * 70) + (NDATF% * 198) +
                (NBUFS% * ((NNSEC% * 128) + 60))
```

For example, if NKEYS%=3, NBUFS%=6, NDATF%=1, and NNSEC%=4, a buffer size of 3,840 (decimal) bytes is required. Once this buffer space is reserved, however, any combination of the four determining parameters that stays within 3,840 bytes can be passed to the SETUP function that sets up the way the buffer area is used.

If you have the RASM86 assembler, which generates relocatable object files, you can change AM86BUF.A86, then reassemble it to create a new AM86BUF.L86. Similarly, you can modify AM86BUF.I86 and reassemble it with ASMT86. Or, you can run the program SETAMBUF.CMD, that is on your distribution disk. Just make sure AM86BUF.L86 and AM86BUF.R86 are on the same disk as SETAMBUF.CMD. SETAMBUF modifies the buffer modules according to your specifications.

1.6 8080 Compatibility

In virtually all aspects of use, the index and data files produced by Access Manager in an 8080/Z80® environment are compatible with use in 8086/8088 environments. However, because Access Manager in an 8086/8088 environment has a greater capacity for key values per node than the 8080 version, it is necessary to rebuild index files if the combination of parameters listed in Table 1-5 are used in your application program.

Table 1-5. 8080 / 8086 Compatibility Factors

NNSEC%	Critical Key Length
5	1
6	2
7	3
8	4

For a given index file record length, as specified by NNSEC%, key lengths less than, or equal to the critical key lengths shown above, can cause problems. For example, if NNSEC% is eight, key lengths of four or less might cause problems if the index file is created in an 8080 environment and then transferred to an 8086 environment.

For a given NNSEC% value, the critical key length is the largest integer value strictly less than:

```
((NNSEC% * 128) - 10) / 124) - 4
```

End of Section 1

Section 2
Using Access Manager with CBASIC Compiler (CB86) Applications

This section contains instructions for implementing Access Manager with application programs coded in CB86.

Two examples are provided in this section. The first shows the use of many Access Manager functions described in Section 3 of the Access Manager Reference Manual, and how to use CB86 strings for data file buffer areas. The second example illustrates the use of multiple index and data files.

2.1 Linking Access Manager to Your CB86 Program

This section discusses a CB86 application program that you write and compile to produce a binary relocatable file called MYPROG.

2.1.1 Linking Single-user CB86 Applications

You must link your compiled application program to the appropriate Access Manager subroutine library and index file buffer module. The following command line can be used to create an executable version of MYPROG:

```
LINK86 MYPROG,AM86CB86.L86[S],AM86BUF
```

Before linking, be sure that AM86BUF is large enough to contain your buffers (as specified in the SETUP function). You can use SETAMBUF.CMD to create a correctly sized buffer module.

2.1.2 Linking Multiuser CB86 Applications

If your single-user version of MYPROG is coded with appropriate data locking procedures, you do not have to recompile it to create a multiuser version. All that is necessary is to relink the program.

You must link your compiled application program to the appropriate Access Manager multiuser interface. The interface makes the queue calls to the shared code in the background server. The background server resides in its own memory segment.

To create a CMD file that calls the Access Manager background server, use the following command line:

```
LINK86 MYPROG,AMQ6CB86.L86
```

No buffer area module (such as AM86BUF) is permitted in the multiuser link statement. Whereas AM86CB86 contains the actual Access Manager code, AMQ6CB86 simply contains the message handler necessary to get the shared Access Manager code to perform the necessary actions.

2.2 External Declaration of Access Manager Routines

CB86 requires that external routines (those not coded in the program module, but referenced by it) be explicitly declared. The file AM86EXTR.BAS contains the external function declarations for the entire set of Access Manager functions. Use the %INCLUDE feature of CB86 to make these external declarations a part of your application program.

2.3 Coding Numeric Key Values

See the ADDKEY function description in Section 3 of the Access Manager Reference Manual for a discussion of "Coding Numeric Key Values".

2.4 Using the RECREATE.BAS Utility Program

RECREATE.BAS contains the CB86 source code for the RECREATE utility program. You can change the source code in whatever way you want.

To create RECREATE.CMD, compile RECREATE.BAS using CB86 and then link as follows:

```
LINK86 RECREATE,AM86CB86.L86[S],AM86BUF
```

The buffer area for RECREATE is 4,844 bytes based on these parameter values:

- NNSEC% = 4
- NBUFS% = 8
- NDATF% = 1
- NKEYS% = 1

Note that only one data file and one index file are open at the same time RECREATE is running. Use SETAMBUF to configure AM86BUF.OBJ.

Figure 2-1 shows the layout and content of records in a Recreate Parameter File. This particular example file can be used to reconstruct DATABASE.BAS (as shown in Listing 2-2).

Table 2-1. Example CB86 Recreate Parameter File

Record Type	Contents
Header	1,4
Data File	CUSTOMER.DAT,100,3,0
Index File	NAME.IDX,10,0,1,1,Y
Key Part	22,8
Index File	NUMB.IDX,4,0,0,1,N
Key Part	2,4
Index File	ZIPC.IDX,11,0,1,1,Y
Key Part	84,9

If you want to change the capacity of the RECREATE program, and hence its memory requirements, note the following parameters and associated DIMension statements.

- MAX.NO.KEYS% and MAX.NO.KEY.PARTS% specify the maximum number of index files associated with a data file and the maximum number of fields comprising a key value, respectively. If the value for either of these parameters is increased in RECREATE.BAS, the following dimension statements must be modified to reflect the changes.

  ```
  DIM INDEX.NAME$( ...
  DIM AUTO.SUFFIX%( ...
  ```

- MAX.SORT% determines the maximum number of key values that are buffered by RECREATE.BAS before being sorted and added to the index file being recreated. If MAX.SORT% is increased, the following dimension statement must be changed.

  ```
  DIM KEYVAL$( ...
  ```

The routine SORT.SETUP in RECREATE.BAS uses the FRE and MFRE functions of CB86 to determine the amount of available memory for buffered key values. The actual number of key values buffered is stored in NO.SORT%. For long key lengths, the memory space available limits NO.SORT%. To make the value for NO.SORT% more conservative, reduce the values of G.SORT and M.SORT before NO.SORT% is computed.

2.5 CB86 Data File Example Listing

In the following listing, notice how the SADD function determines the value of the buffer pointer (Access Manager parameter BUFFER%) for the READAT and WRTDAT functions. The result of SADD is increased by two because each string variable in CB86 has a two-byte header that contains the length of the string.

When Access Manager fills in the input buffer (INP.BUFFER$) during the READAT function, the two-byte length header is not affected. Therefore, you can use one such string input buffer for all the data files if it is long enough to accommodate the longest record length.

Conversely, the output buffer (OUT.BUFFER$) is constantly adjusted because it is reconstructed for each WRTDAT function. Therefore, it is not advisable to use the input buffer for output. Reserve the input buffer for input only and create the output buffer strings as needed.

```
REM  ------------------------------------------------------
REM  AM86 External Declarations
REM  ------------------------------------------------------

%INCLUDE AM86EXTR.BAS

REM  ------------------------------------------------------
REM  Exception Processing Routines
REM  ------------------------------------------------------

DEF ERROR.HANDLER(LOCALE)
     INTEGER LOCALE

     PRINT "ERROR at ";LOCALE;" with code ";ERRCOD
     STOP
FEND

DEF LOCK.CONFLICT(LOCALE)
     INTEGER LOCALE

     PRINT "LOCK Conflict at ";LOCALE;" with code ";LOKCOD
FEND
```

Listing 2-1. CB86 Data File Example

```
REM  ------------------------------------------------------
REM  Lock Parameter Setup
REM  ------------------------------------------------------

N.LOCK% = 0     REM  No lock request
S.LOCK% = 1     REM  Shared record lock
X.LOCK% = 2     REM  Exclusive record lock
S.FILE% = 3     REM  Shared file lock
X.FILE% = 4     REM  Exclusive file lock

REM  ------------------------------------------------------
REM  System Initialization Parameters
REM  ------------------------------------------------------

NBUF% = 3       REM  3 buffers
NKEYS% = 1      REM  1 index file
NNSEC% = 4      REM  512-byte index file record length
NDATF% = 1      REM  1 data file
ERROPT% = 1     REM  Trap user errors
PROGID% = -1    REM  Program ID assigned to MP/M console no.
TIMOUT% = 3     REM  Background server time-out delay

REM  ------------------------------------------------------
REM  Initialize System
REM  ------------------------------------------------------

PROGID% = INTUSR(PROGID%,ERROPT%,TIMOUT%)
IF ERRCOD <> 0 THEN \
     CALL ERROR.HANDLER(1)
IF SETUP(NBUF%,NKEYS%,NNSEC%,NDATF%) <> 0 THEN \
     CALL ERROR.HANDLER(2)

REM  ------------------------------------------------------
REM  Open Files
REM  ------------------------------------------------------

FILE.NO% = -1        REM  Automatic file number assignment
RECORD.LEN% = 32
FILE.NAME$ = "K:PART.DAT"
FILE.NO% = OPNDAT(FILE.NO%,S.FILE%,FILE.NAME$,RECORD.LEN%)
IF ERRCOD <> 0 THEN \
     CALL ERROR.HANDLER(3)
IF LOKCOD <> 0 THEN \
     CALL LOCK.CONFLICT(3)

REM  ------------------------------------------------------
REM  Create input buffer area and buffer pointer. The buffer
REM  pointer = SADD + 2 because SADD points to the two-byte
REM  length header which precedes the actual string.
REM  ------------------------------------------------------

REM                        1         2         3
INP.BUFFER$ = "12345678901234567890123456789012"
BUFFER.PTR% = SADD(INP.BUFFER$) + 2
```

Listing 2-1. (continued)

```
REM  ------------------------------------------------------
REM  Set exclusive lock on data record no. 65686
REM  ------------------------------------------------------

DRN2% = 1
CALL SETDAT(DRN2%)          REM  Set high-order bytes to 1
                            REM  which implies a base of 65536.
DRN% = 150                  REM  65686 = 65536 + 150
IF SETLOK(FILE.NO%,X.LOCK%,DRN%) <> 0 THEN \
     CALL LOCK.CONFLICT(4)

REM  ------------------------------------------------------
REM  Read data record
REM  ------------------------------------------------------

CALL SETDAT(DRN2%)
IF READAT(FILE.NO%,DRN%,BUFFER.PTR%) <> 0 THEN \
     CALL ERROR.HANDLER(4)

REM  ------------------------------------------------------
REM  Parse buffer into working variables
REM  ------------------------------------------------------

PART.NO$ = LEFT$(INP.BUFFER$,4)
PART.NAME$ = MID$(INP.BUFFER$,5,20)
PART.QUAN = VAL(RIGHT$(INP.BUFFER$,8))

REM  ------------------------------------------------------
REM  Update data record
REM  ------------------------------------------------------

PART.QUAN = PART.QUAN - 100.

REM  ------------------------------------------------------
REM  Create output buffer
REM  ------------------------------------------------------

OUT.BUFFER$ = PART.NO$ + PART.NAME$ + \
     LEFT$(STR$(PART.QUAN),8)
BUFFER.PTR% = SADD(OUT.BUFFER$) + 2

REM  ------------------------------------------------------
REM  Write updated record
REM  ------------------------------------------------------

CALL SETDAT(DRN2%)
IF WRTDAT(FILE.NO%,DRN%,BUFFER.PTR%) <> 0 THEN \
     CALL ERROR.HANDLER(5)
```

Listing 2-1. (continued)

```
REM  ------------------------------------------------------
REM  Release record lock
REM  ------------------------------------------------------

CALL SETDAT(DRN2%)
IF FRELOK(FILE.NO%,X.LOCK%,DRN%) <> 0 THEN \
     CALL LOCK.CONFLICT(6)

REM  ------------------------------------------------------
REM  Close data file and release file lock
REM  ------------------------------------------------------

IF CLSDAT(FILE.NO%) <> 0 THEN \
     CALL ERROR.HANDLER(7)
IF FRELOK(FILE.NO%,S.FILE%,0) <> 0 THEN \
     CALL LOCK.CONFLICT(7)

STOP
```

Listing 2-1. (continued)

2.6 CB86 DATABASE Source Code

Your Access Manager distribution disk contains sample code for building and maintaining a data base in CB86. The code is designed so you can add or substitute your own key attributes as required. The sample code is on your distribution disk in a file named DATABASE.BAS.

DATABASE.BAS demonstrates the integration of Access Manager with CB86 applications. It builds a name and address data base and provides facilities for examining, updating, and/or listing the information contained therein. You might also want to use routines from DATABASE.BAS directly in your application programs.

[SINGLE] To create DATABASE.CMD, compile DATABASE.BAS with CB86.CMD and link as follows:

```
LINK86 DATABASE,AM86CB86.L86,AM86BUF
```

Prior to the preceding link command, make sure AM86BUF.OBJ can accommodate the SETUP parameters of DATABASE.BAS. You can use SETAMBUF.CMD to modify AM86BUF.OBJ.

[MULTI] In the multiuser environment, your link statement should be entered as follows:

```
LINK86 DATABASE,AMQ6CB86.L86
```

Note that the listing of DATABASE.BAS, in Listing 2-2, might not include recent changes. You should always treat the copy on your distribution disk as the definitive version.

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM
REM      DATABASE EXAMPLE    VERSION 0.9  11/30/82
REM
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM
REM      INTERFACE TO AM86(tm)
REM
REM
REM      AM86EXTR.BAS contains the External Definitions of the
REM      AM86 functions
REM

%INCLUDE AM86EXTR.BAS

REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM       Set-up database field and key descriptors
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DIM FLD.NAME$(7),FLD.LEN%(7),NEW.FLD$(7),OLD.FLD$(7)
DIM FLD.PTR%(7)
MAX.FIELD% = 7:NO.FIELDS% = MAX.FIELD% + 1
YES% = 1 : NO% = 0

FLD.NAME$(0) = "Customer Number" :FLD.LEN%(0) = 4
FLD.NAME$(1) = "First Name"      :FLD.LEN%(1) = 16
FLD.NAME$(2) = "Last Name"       :FLD.LEN%(2) = 20
FLD.NAME$(3) = "Street Address"  :FLD.LEN%(3) = 20
FLD.NAME$(4) = "City"            :FLD.LEN%(4) = 20
FLD.NAME$(5) = "State"           :FLD.LEN%(5) = 2
FLD.NAME$(6) = "Zipcode"         :FLD.LEN%(6) = 9
FLD.NAME$(7) = "Customer Status" :FLD.LEN%(7) = 8


DIM KEY.NAME$(2),KEY.LEN%(2),KEY.MAP%(2),KEY.TYPE%(2),KEY.NUM%(2),KEY.DUP%(2)
MAX.KEY% = 2
KEY.LEN%(0)=10:KEY.TYPE%(0)=0:KEY.MAP%(0)=2 REM   KEY 0 = LAST NAME
KEY.LEN%(1)=11:KEY.TYPE%(1)=0:KEY.MAP%(1)=6 REM   KEY 1 = ZIPCODE
KEY.LEN%(2)=4 :KEY.TYPE%(2)=0:KEY.MAP%(2)=0 REM   KEY 2 = CUST NUMBER

UNIQ.KEY% = 2 REM  USED IN TEST OF UNIQUENESS

FOR KEY% = 0 TO MAX.KEY%
        IF KEY% = UNIQ.KEY% THEN \\
                KEY.DUP%(KEY%) = NO% \\
        ELSE \\
                KEY.DUP%(KEY%) = YES%
        KEY.NAME$(KEY%) = FLD.NAME$(KEY.MAP%(KEY%))
NEXT KEY%


DIM INDEX.NAME$(2)
INDEX.NAME$(0) = "NAME.IDX"
INDEX.NAME$(1) = "ZIPC.IDX"
```

Listing 2-2. DATABASE.BAS Source Code Listing

```
INDEX.NAME$(2) = "NUMB.IDX"

NLOCK% = 0 REM IGNORE LOCKS
SLOCK% = 1 REM SHARED RECORD LOCK
XLOCK% = 2 REM EXCLUSIVE RECORD LOCK
SFILE% = 3 REM SHARED FILE LOCK
XFILE% = 4 REM EXCLUSIVE FILE LOCK
RLOCK% = 5 REM RELEASE SLOCK% OR XLOCK%


REM +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
REM
REM              BEGINNING OF UTILITY FUNCTIONS
REM
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM              Clear screen routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

DEF CLEAR.SCREEN%
        FOR DUMMY% = 1 TO 24
                PRINT
        NEXT DUMMY%
        RETURN
FEND

REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM              Main menu routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF MAIN.MENU%
        PRINT TAB(21);"   AM86(tm) DEMONSTRATION" :PRINT
        PRINT TAB(20);"Customer Database Operations"
        PRINT TAB(20);"        Terminal ";TERMINAL%
        PRINT TAB(20);"**************************":PRINT :PRINT
        PRINT TAB(5);"1. Enter New Customers"
        PRINT TAB(5);"2. Scan/Update/Delete Customer Records"
        PRINT TAB(5);"3. List Customer Records"
        PRINT TAB(5);"4. Database Statistics"
        PRINT TAB(5);"5. Save All Files & Restart Operations"
        PRINT TAB(5);"6. Terminate Operations":PRINT :PRINT
1000    INPUT "Enter desired operation number>>";OP%
        IF OP%<1 OR OP%>6 THEN PRINT :PRINT :GOTO 1000
        MAIN.MENU% = OP%
        RETURN
FEND
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Select Search Key Routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF SEARCH.KEY%
        DUMMY% = CLEAR.SCREEN%
        PRINT TAB(25);"Customer Database Search Keys":PRINT :PRINT
        FOR KEY% = 0 TO MAX.KEY%
                KEY.NO% = KEY% + 1
                PRINT TAB(5);KEY.NO%;"- ";KEY.NAME$(KEY%)
        NEXT KEY%
1040    PRINT :PRINT
        INPUT "Enter desired key number>>";OP%
        IF OP%<1 OR OP%>NO.KEYS% THEN 1040
        SEARCH.KEY% = OP%-1
        RETURN
FEND

REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Error Handling
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF ERROR.TYPE%(TYPE%)
        PRINT
        PRINT \\
"User Error #";ERRCOD;" occurred while trying to ";
        ON TYPE% GOTO 9210,9230,9250,9290,9300,9320,9330, \\
                9340,9350,9360,9370,9380,9390,9400,9410,9420
9210    PRINT "open ";INDEX.NAME$(KEY%) : GOTO 9700
9230    PRINT "search ";KEY.NAME$(KEY%);" Index File" : GOTO 9500
9250    PRINT "save ";INDEX.NAME$(KEY%) : GOTO 9600
9290    PRINT "remove old key from ";INDEX.NAME$(KEY%) : GOTO 9500
9300    PRINT "enter key into ";INDEX.NAME$(KEY%) :GOTO 9500
9320    PRINT "delete key from ";INDEX.NAME$(KEY%) :GOTO 9500
9330    PRINT "save ";FILE.NAME$ :KEY% = -1:GOTO 9600
9340    PRINT "get a new data record";" (";FILE.NO%;")" :GOTO 9700
9350    PRINT "delete data record #";DRN% :GOTO 9700
9360    PRINT "open ";FILE.NAME$;" (";FILE.NO%;")" :GOTO 9700
9370    PRINT "read data record #";DRN%:GOTO 9700
9380    PRINT "write data record.":GOTO 9700
9390    PRINT "release shared file lock on ";FILE.NAME$:GOTO 9700
9400    PRINT "initialize user.": STOP
9410    PRINT "close ";FILE.NAME$ :KEY% = -1:GOTO 9600
9420    PRINT "close ";INDEX.NAME$(KEY%) : GOTO 9600
9500    CALL CLSDAT(FILE.NO%)
        FOR T.KEY% = 0 TO MAX.KEY%
                IF T.KEY% <> KEY% THEN CALL CLSIDX(KEY.NUM%(T.KEY%))
        NEXT T.KEY%
        GOTO 9700 REM  STOP ERROR MESSAGE
9600    T.KEY% = KEY% + 1
        IF T.KEY%>MAX.KEY% THEN STOP
        FOR KEY% = T.KEY% TO MAX.KEY%
                CALL CLSIDX(KEY.NUM%(KEY%))
        NEXT KEY%
9700    PRINT
        PRINT "DEMONSTRATION TERMINATING WITH ERROR CODE #";ERRCOD
        STOP
```

Listing 2-2. (continued)

```
FEND
DEF LOCK.TYPE%(TYPE%)
        PRINT "Lock Type: ";TYPE%;"  Lock Code:";LOKCOD
        CALL CLSDAT(FILE.NO%)
        FOR T.KEY% = 0 TO MAX.KEY%
                CALL CLSIDX(KEY.NUM%(T.KEY%))
        NEXT T.KEY%
        STOP
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Strip Trailing Blanks
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF STRIP.BLANKS$(OLD.VAL$,FLD%)
        FOR TEST% = FLD.LEN%(FLD%) TO 1 STEP -1
                IF MID$(OLD.VAL$,TEST%,1) <> " " THEN \\
                        STRIP.BLANKS$ = LEFT$(OLD.VAL$,TEST%) :\\
                        RETURN
        NEXT TEST%
        STRIP.BLANKS$ = ""
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Read Data Record Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF READ.CUST%(DRN%)
        IF READAT(FILE.NO%,DRN%,INPBUF.PTR%) <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(11)
        OFFSET% = 2             REM SKIP DELETE FLAG FIELD
        FOR D.FLD% = 0 TO MAX.FIELD%
                OLD.FLD.VAL$ = MID$(INPBUF$,OFFSET%,FLD.LEN%(D.FLD%))
                OLD.FLD$(D.FLD%) = \\
                        STRIP.BLANKS$(OLD.FLD.VAL$,D.FLD%)
                OFFSET% = OFFSET% + FLD.LEN%(D.FLD%)
        NEXT D.FLD%
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             List Customer Record Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF PRINT.CUST%
        IF ROUTE$ = "Y" THEN \\
                LPRINTER
        PRINT
        PRINT TAB(5);OLD.FLD$(0);TAB(15);OLD.FLD$(7)
        PRINT TAB(25);OLD.FLD$(1);" ";OLD.FLD$(2)
        PRINT TAB(25);OLD.FLD$(3)
        PRINT TAB(25);OLD.FLD$(4);", ";OLD.FLD$(5);"    ";OLD.FLD$(6)
        PRINT
        CONSOLE
        RETURN
FEND
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Pause Routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF PAUSE%
        PRINT
        INPUT "Press 'RETURN' to continue ---";LINE PAUSE$
        RETURN
FEND

REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM     Convert Target Value to Key Format Routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF KEY.FORMAT$(KEY%,TARGET$)
        IF UNIQ.KEY% = KEY% THEN \\
                KEY.FORMAT$ = TARGET$ :\\
                RETURN
        KL% = KEY.LEN%(KEY%)
        KEY.FORMAT$ = LEFT$(TARGET$ + SPACE$,KL%-2) + \\
                CHR$(0) + CHR$(0)
        RETURN
FEND

REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Compare INDEX.KEY & U.VALUE Routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF COMPARE%
        IF KEY% = UNIQ.KEY% THEN \\
                KL% = KEY.LEN%(KEY%) \\
        ELSE \\
                KL% = KEY.LEN%(KEY%)-2
        C1$ = LEFT$(INDEX.KEY$ + SPACE$,KL%)
        C2$ = LEFT$(U.VALUE$ + SPACE$,KL%)
        IF C1$<C2$ THEN \\
                COMPARE% = -1 :\\
                RETURN
        IF C1$>C2$ THEN \\
                COMPARE% = 1 \\
        ELSE \\
                COMPARE% = 0
        RETURN
FEND

REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Check Lock Routines
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF SKIP.LOCK%
        WHILE DRN% <> 0 AND LOKCOD <> 0
                L.VALUE$ = LEFT$(INDEX.KEY$,KEY.LEN%(KEY%))
                INDEX.KEY$ = SET.LENGTH$
                DRN% = AFTKEY(KEY.NUM%(KEY%),FILE.NO%,SLOCK%, \\
                        L.VALUE$,INDEX.KEY$)
        WEND
        RETURN
FEND
DEF CHECK.LOCK%
```

Listing 2-2. (continued)

```
        PRINT
        INPUT \\
"Enter a 'W' if you want to wait for locked record(s)>>"; \\
                LINE DUMMY$
        IF UCASE$(DUMMY$) = "W" THEN \\
                CHECK.LOCK% = YES% :\\
                RETURN
        WHILE DRN% <> 0 AND LOKCOD <> 0
                CONV.TARGET$ = LEFT$(INDEX.KEY$,KEY.LEN%(KEY%))
                INDEX.KEY$ = SET.LENGTH$
                IF OLD.ACTION$ = "CONT" THEN \\
                        DRN% = AFTKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                                SLOCK%, CONV.TARGET$,INDEX.KEY$) \\
                ELSE \\
                        DRN% = BEFKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                                SLOCK%, CONV.TARGET$,INDEX.KEY$)
        WEND
        CHECK.LOCK% = NO%
        RETURN
FEND
DEF SET.XLOCK$(OP$)
30010   IF SETLOK(FILE.NO%,XLOCK%,DRN%) <>  0 THEN \\
                PRINT : \\
                PRINT "Customer update on hold due to record lock" :\\
                INPUT \\
"Enter 'W' if you want to wait or press 'RET' to cancel update>>"; \\
                LINE DUMMY$:\\
                DUMMY$ = UCASE$(DUMMY$) \\
        ELSE \\
                DUMMY$ = "ok"
        IF DUMMY$ = "W" THEN 30010
        IF DUMMY$ = "ok" AND OP$ = "S" THEN \\
                SET.XLOCK$ = "SAVE"
        IF DUMMY$ = "ok" AND OP$ = "D" THEN \\
                SET.XLOCK$ = "DELT"
        IF DUMMY$ <> "ok" THEN \\
                SET.XLOCK$ = OLD.ACTION$
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Customer Number Uniqueness Test Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF TEST.UNIQUENESS%
        TEST$ = NEW.FLD$(KEY.MAP%(UNIQ.KEY%))
        TEST% = GETKEY(UNIQ.KEY%,0,NLOCK%,TEST$)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(12)
        IF TEST% = 0 THEN \\
                TEST.UNIQUENESS% = YES% \\
        ELSE \\
                TEST.UNIQUENESS% = NO% : \\
                PRINT : \\
                PRINT " *** Already Assigned *** " : \\
                PRINT
```

Listing 2-2. (continued)

```
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Update Data Field Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF UPDATE.FIELD%(FIELD.NO%)
        FIELD.NO% = FIELD.NO%-1
1050    PRINT
        PRINT "Input new ";FLD.NAME$(FIELD.NO%);
        INPUT ">>";LINE NEW.FLD$(FIELD.NO%)

        IF FIELD.NO% = KEY.MAP%(UNIQ.KEY%) THEN \\
                NEW.FLD$(FIELD.NO%) = RIGHT$("0000"+NEW.FLD$(FIELD.NO%), \\
                        FLD.LEN%(FIELD.NO%)) \\
        ELSE \\
                NEW.FLD$(FIELD.NO%) = LEFT$(NEW.FLD$(FIELD.NO%), \\
                        FLD.LEN%(FIELD.NO%))

        IF FIELD.NO% <> 0 OR NEW.FLD$(FIELD.NO%) = \\
                OLD.FLD$(FIELD.NO%) THEN RETURN
        UNIQUE% = TEST.UNIQUENESS%
        IF NOT UNIQUE% THEN 1050
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Warning Messages
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF WARNING.TYPE%(TYPE%,RET.CODE%)
        PRINT
        PRINT "WARNING...Return Code #";RET.CODE%; \\
                " occurred while trying to ";
        ON TYPE% GOTO 9930,9940,9950
9930    PRINT "remove old key from ";INDEX.NAME$(KEY%)
        DUMMY% = PAUSE% :RETURN
9940    PRINT "enter key into ";INDEX.NAME$(KEY%)
        DUMMY% = PAUSE% :RETURN
9950    PRINT "delete key from ";INDEX.NAME$(KEY%)
        DUMMY% = PAUSE% :RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Add New Key Value Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF ADD.KEY%(KEY%,DRN%)
        K.FLD% = KEY.MAP%(KEY%)
        OLD.KEY$ = OLD.FLD$(K.FLD%)
        NEW.KEY$ = NEW.FLD$(K.FLD%)
REM
REM REMOVE OLD KEY VALUE
REM
        RET.CODE% = DELKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                XLOCK%,OLD.KEY$,DRN%)
        IF ERRCOD <> 0 THEN \\
```

Listing 2-2. (continued)

```
                DUMMY% = ERROR.TYPE%(4)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(6)
        IF RET.CODE% <> 1 THEN \\
                DUMMY% = WARNING.TYPE%(1,RET.CODE%)
REM  ------------------------------------------------------------
REM       Add New Key Value
REM  ------------------------------------------------------------
        RET.CODE% = ADDKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                XLOCK%,NEW.KEY$,DRN%)
        IF ERRCOD <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(5)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(7)
        IF RET.CODE% <> 1 THEN \\
                DUMMY% = WARNING.TYPE%(2,RET.CODE%)
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Write New Data Record Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF WRITE.CUST%(DRN%)
        OUTBUF$ = CHR$(0)                REM CLEAR DELETE FLAG
        FOR D.FLD% = 0 TO MAX.FIELD%
                OUTBUF$ = OUTBUF$ + LEFT$(NEW.FLD$(D.FLD%) + \\
                        FLD.SPC$, FLD.LEN%(D.FLD%))
        NEXT D.FLD%
        OUTBUF.PTR% = SADD(OUTBUF$) + 2
        IF WRTDAT(FILE.NO%,DRN%,OUTBUF.PTR%) <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(12)
        RETURN
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Delete Key Value from Index Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF DEL.KEY%(KEY%,DRN%)
        K.FLD% = KEY.MAP%(KEY%)
        OLD.KEY$ = OLD.FLD$(K.FLD%)
        RET.CODE% = DELKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                XLOCK%,OLD.KEY$,DRN%)
        IF ERRCOD <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(6)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(10)
        IF RET.CODE% <> 1 THEN \\
                DUMMY% = WARNING.TYPE%(3,RET.CODE%)
        RETURN
FEND
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Data Entry Routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF ENTER.DATA$(ENTER.MODE$)
        IF ENTER.MODE$ = "NEW" THEN \\
                FOR FLD% = 0 TO MAX.FIELD%  : \\
                        OLD.FLD$(FLD%) = "" : \\
                NEXT FLD%
        IF ENTER.MODE$ = "OLD" THEN \\
                FOR FLD% = 0 TO MAX.FIELD%          : \\
                        NEW.FLD$(FLD%) = OLD.FLD$(FLD%) : \\
                NEXT FLD%
        DUMMY% = CLEAR.SCREEN%
        WHILE ENTER.MODE$ = "NEW"
                PRINT TAB(20);"Enter New Customer Information"
                PRINT TAB(20);" ******************************"
                PRINT :PRINT
                PRINT TAB(5); \\
                        "{Press 'RETURN' for customer # to see main menu.}"
                PRINT
                FOR FLD% = 0 TO MAX.FIELD%
                        FLD.NO% = FLD% + 1
1010                    PRINT TAB(4);FLD.NO%;"- ";FLD.NAME$(FLD%); \\
                                TAB(30);"(";FLD.LEN%(FLD%);")";TAB(38);
                        INPUT ">>";LINE NEW.FLD$(FLD%)
                        IF FLD% = 0 AND NEW.FLD$(FLD%) = "" THEN \\
                                ENTER.DATA$ = "STOP" : \\
                                RETURN

                        IF FLD% = KEY.MAP%(UNIQ.KEY%) THEN \\
                          NEW.FLD$(FLD%) = RIGHT$("0000"+NEW.FLD$(FLD%),\\
                                        FLD.LEN%(FLD%)) :\\
                                UNIQUE% = TEST.UNIQUENESS% \\
                        ELSE \\
                                NEW.FLD$(FLD%) = LEFT$(NEW.FLD$(FLD%), \\
                                        FLD.LEN%(FLD%)) :\\
                                UNIQUE% = YES%

                        IF NOT UNIQUE% THEN GOTO 1010
                NEXT FLD%
                ENTER.MODE$ = "NEWMOD"
        WEND
1015    PRINT :PRINT :PRINT
        PRINT TAB(20);"Current customer information" : PRINT
        FOR FLD% = 0 TO MAX.FIELD%
                FLD.NO% = FLD% + 1
                PRINT TAB(4);FLD.NO%;"- ";FLD.NAME$(FLD%);TAB(30); \\
                        NEW.FLD$(FLD%)
        NEXT FLD%
REM  NEW DATA HAS FEWER OPTIONS
        IF ENTER.MODE$ = "NEWMOD" THEN 1030
1020    PRINT :PRINT
        PRINT \\
"Press 'RETURN' to continue scan, enter Field # to change data,"
        PRINT \\
```

Listing 2-2. (continued)

```
"S to save changes, D to delete data, B for back scan, or E"; \\
                " to end scan";
        INPUT ">>";LINE OP$
        OP$ = UCASE$(OP$)
        IF OP$ = ""  THEN ENTER.DATA$ = "CONT":RETURN
        IF OP$ = "S" THEN ENTER.DATA$ = SET.XLOCK$(OP$):RETURN
        IF OP$ = "D" THEN ENTER.DATA$ = SET.XLOCK$(OP$):RETURN
        IF OP$ = "B" THEN ENTER.DATA$ = "BACK":RETURN
        IF OP$ = "E" THEN ENTER.DATA$ = "STOP":RETURN
        OP% = VAL(OP$)
        IF OP%<1 OR OP%>NO.FIELDS% THEN 1020
        DUMMY% = UPDATE.FIELD%(OP%)
        GOTO 1015 REM 'DISPLAY INFO
1030    PRINT :PRINT
        PRINT \\
"Press 'RETURN' to save data, enter Field # to change data,"
        INPUT "D to delete data, or E to end input>>";LINE OP$
        OP$ = UCASE$(OP$)
        IF OP$ = "" OR OP$ = "S" THEN ENTER.DATA$ = "SAVE":RETURN
        IF OP$ = "D" THEN ENTER.DATA$ = "DELT":RETURN
        IF OP$ = "E" THEN ENTER.DATA$ = "STOP":RETURN
        OP% = VAL(OP$)
        IF OP%<1 OR OP%>NO.FIELDS% THEN 1030
        DUMMY% = UPDATE.FIELD%(OP%)
        GOTO 1015
FEND

REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Update Indices & Data File Routine
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF UPDATE%(DATA.RECORD%)
        IF DATA.RECORD% = 0 THEN \\
                DATA.RECORD% = NEWREC(FILE.NO%,XLOCK%)
        UPDATE% = DATA.RECORD%
        IF ERRCOD <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(8)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(3)
        FOR KEY% = 0 TO MAX.KEY%
                FLD% = KEY.MAP%(KEY%)
                IF OLD.FLD$(FLD%) <> NEW.FLD$(FLD%) THEN \\
                        DUMMY% = ADD.KEY%(KEY%,DATA.RECORD%)
        NEXT KEY%
        FOR FLD% = 0 TO MAX.FIELD%
                IF OLD.FLD$(FLD%) <> NEW.FLD$(FLD%) THEN \\
                        DUMMY% = WRITE.CUST%(DATA.RECORD%) :\\
                        RETURN
        NEXT FLD%
        RETURN
FEND
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Delete Index & Data File Entry Routine
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
DEF DELETE%(DATA.RECORD%)
        FOR KEY% = 0 TO MAX.KEY%
                FLD% = KEY.MAP%(KEY%)
                IF OLD.FLD$(FLD%) <> "" THEN \\
                        DUMMY% = DEL.KEY%(KEY%,DATA.RECORD%)
        NEXT KEY%
        IF RETREC(FILE.NO%,XLOCK%,DATA.RECORD%) <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(9)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(9)
        RETURN
FEND

REM             END OF UTILITY FUNCTIONS
REM
REM ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Initialize Index Files
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
2000
        SET.LENGTH$ = "12345678901"
        INDEX.KEY$ = SET.LENGTH$
        SPACE$ =     "           "
REM
REM SET TERMINAL TO -1 FOR AUTOMATIC ASSIGNMENT BY AM86
REM
        TERMINAL% = -1
        TRAP.ERRORS% = YES%
        TIME.OUT.TEST.DELAY% = 2  REM APPROXIMATELY 2 SECONDS
        TERMINAL% = INTUSR(TERMINAL%,TRAP.ERRORS%,TIME.OUT.TEST.DELAY%)
        IF ERRCOD <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(14)

        NO.BUFFERS% = 5
        NO.NODE.SECTORS% = 4
        NO.DATA.FILES% = 1
        NO.KEYS% = MAX.KEY% + 1
        IF SETUP(NO.BUFFERS%,NO.KEYS%,NO.NODE.SECTORS%, \\
                NO.DATA.FILES%) <> 0 THEN \\
                        PRINT "Illegal SETUP Parameters" :\\
                STOP

        FOR KEY% = 0 TO MAX.KEY%
                KEY.NUM%(KEY%) = OPNIDX(-1,INDEX.NAME$(KEY%), \\
                        KEY.LEN%(KEY%), KEY.TYPE%(KEY%),KEY.DUP%(KEY%))
                IF ERRCOD <> 0 THEN \\
                        DUMMY% = ERROR.TYPE%(1)
        NEXT KEY%
REM
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Initialize Data File
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
        FILE.NO% = -1
        RECORD.LENGTH% = 100
        FILE.NAME$ = "CUSTOMER.DAT"
        FILE.NO% = OPNDAT(FILE.NO%,SFILE%,FILE.NAME$,RECORD.LENGTH%)
        IF ERRCOD <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(10)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(1)
4990    REM INITIALIZE STRING UTILITIES
TMPBUF$ = "12345678901234567890123456789012345678901234567890"

        INPBUF$ = TMPBUF$ + TMPBUF$
REM  ------------------------------------------------------------
REM    INPBUF is the buffer area for the READAT function
REM  ------------------------------------------------------------
        INPBUF.PTR% = SADD(INPBUF$) + 2

REM                 12345678901234567890123456789012345678
        FLD.SPC$ = "                                      "
REM
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Begin Database Operation
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
5000    DUMMY% = CLEAR.SCREEN%
        CHOICE% = MAIN.MENU%
        ON CHOICE% GOTO 5100,5300,5500,5700,5900,6100
REM
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Enter New Customers
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
5100    ACTION$ = ENTER.DATA$("NEW")
        LOCK.CODE% = 0
        IF ACTION$ = "SAVE" THEN \\
                NDRN% = UPDATE%(0): \\ UPDATE INDICES & DATA FILE
                LOCK.CODE% = FRELOK(FILE.NO%,XLOCK%,NDRN%)
        IF LOCK.CODE% <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(8)
        IF ACTION$ = "SAVE" THEN \\
                GOTO 5100 \\
        ELSE \\
                GOTO 5000 REM  RETURN TO MENU
REM
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Scan/Update/Delete Customers
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
5300    KEY% = SEARCH.KEY% REM  DETERMINE SEARCH KEY
        PRINT
        PRINT "Enter target value for ";KEY.NAME$(KEY%);","
        INPUT "     or press 'RETURN' to see main menu>>"; \\
                LINE TARGET$
        IF TARGET$ = "" THEN 5000
        CONV.TARGET$ = KEY.FORMAT$(KEY%,TARGET$)
5345    DRN% = SERKEY(KEY.NUM%(KEY%),FILE.NO%,SLOCK%, \\
                CONV.TARGET$,INDEX.KEY$)
        IF ERRCOD <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(2)
        IF LOKCOD <> 0 THEN \\
                STAYPUT% = CHECK.LOCK% \\
        ELSE \\
                STAYPUT% = NO%
        IF STAYPUT% THEN 5345
        OLD.ACTION$ = "CONT"
        CONTINUE% = YES%
        WHILE CONTINUE% AND DRN% <> 0
                LDRN% = DRN%  REM save drn for lock release
                DUMMY% = READ.CUST%(DRN%)
                ACTION$ = ENTER.DATA$("OLD")
                SAVE.KEY% = KEY%
                IF ACTION$ = "SAVE" THEN \\
                        DUMMY% = UPDATE%(DRN%)
                IF ACTION$ = "DELT" \\
                        THEN DUMMY% = DELETE%(DRN%)
                IF ACTION$ <> "DELT" AND FRELOK(FILE.NO%,RLOCK%,LDRN%) <> 0 \\
                        THEN DUMMY% = LOCK.TYPE%(2)
                IF ACTION$ = "SAVE" OR ACTION$ = "DELT" THEN \\
                        KEY% = SAVE.KEY% : \\ RESET SEARCH KEY
                        ACTION$ = OLD.ACTION$ REM reset direction
                OLD.ACTION$ = ACTION$
                CONV.TARGET$ = LEFT$(INDEX.KEY$,KEY.LEN%(KEY%))
                INDEX.KEY$ = SET.LENGTH$
                LOCK.CODE% = 0
5390            IF ACTION$ = "CONT" THEN \\
                        DRN% = AFTKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                                SLOCK%, CONV.TARGET$,INDEX.KEY$) :\\
                        LOCK.CODE% = LOKCOD
                IF ACTION$ = "BACK" THEN \\
                        DRN% = BEFKEY(KEY.NUM%(KEY%),FILE.NO%, \\
                                SLOCK%, CONV.TARGET$,INDEX.KEY$):\\
                        LOCK.CODE% = LOKCOD
                IF LOCK.CODE% <> 0 THEN \\
                        STAYPUT% = CHECK.LOCK% \\
                ELSE \\
                        STAYPUT% = NO%
                IF STAYPUT% THEN 5390
                IF ACTION$ = "STOP" THEN \\
                        CONTINUE% = NO%
        WEND
```

Listing 2-2. (continued)

```
        PRINT
        PRINT "SCAN ENDED"
        DUMMY% = PAUSE%
        GOTO 5000 REM  Return to Main Menu
REM
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM                        List Customers
REM :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
5500    KEY% = SEARCH.KEY%
        PRINT
        INPUT \\
"Do you want listing routed to printer (Y/N)>>";LINE ROUTE$
        ROUTE$ = UCASE$(ROUTE$)
        PRINT
        PRINT \\
"Enter lower and upper limits for ";KEY.NAME$(KEY%);" listing;"
        INPUT \\
"     separate values with a comma >>";L.VALUE$,U.VALUE$
        L.VALUE$ = KEY.FORMAT$(KEY%,L.VALUE$)
        U.VALUE$ = KEY.FORMAT$(KEY%,U.VALUE$)
        DRN% = SERKEY(KEY.NUM%(KEY%),FILE.NO%,SLOCK%, \\
                L.VALUE$,INDEX.KEY$)
        IF LOKCOD <> 0 THEN \\
                DUMMY% = SKIP.LOCK%
        NO.LISTED% = 0
        WHILE DRN% <> 0 AND COMPARE%< = 0
                DUMMY% = READ.CUST%(DRN%)
                DUMMY% = PRINT.CUST%
                NO.LISTED% = NO.LISTED% + 1
                IF FRELOK(FILE.NO%,SLOCK%,DRN%) <> 0 THEN \\
                        DUMMY% = LOCK.TYPE%(4)
                L.VALUE$ = LEFT$(INDEX.KEY$,KEY.LEN%(KEY%))
                INDEX.KEY$ = SET.LENGTH$
                DRN% = AFTKEY(KEY.NUM%(KEY%),FILE.NO%,SLOCK%, \\
                        L.VALUE$,INDEX.KEY$)
                IF LOKCOD <> 0 THEN \\
                        DUMMY% = SKIP.LOCK%
        WEND
        IF DRN% <> 0 THEN \\
                LOCK.CODE% = FRELOK(FILE.NO%,SLOCK%,DRN%) \\
        ELSE \\
                LOCK.CODE% = 0
        IF LOCK.CODE% <> 0 THEN \\
                DUMMY% = LOCK.TYPE%(5)
        PRINT
        PRINT TAB(5);NO.LISTED%;" records listed."
        DUMMY% = PAUSE%
        GOTO 5000 REM  RETURN TO MAIN MENU
```

Listing 2-2. (continued)

```
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Database Statistics
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
5700    DUMMY% = CLEAR.SCREEN%
        PRINT TAB(5);FILE.NAME$;" has ";GETDFS(FILE.NO%); \\
                " records; currently, ";
        PRINT GETDFU(FILE.NO%);" of them are in use."
        PRINT :PRINT :PRINT :PRINT
        PRINT TAB(5);"INDEX";TAB(30);"ENTRIES"
        PRINT TAB(5);"----------------";TAB(30);"-------"
        FOR KEY% = 0 TO MAX.KEY%
                PRINT TAB(5);KEY.NAME$(KEY%);TAB(32);NOKEYS(KEY%)
        NEXT KEY%
        PRINT :PRINT :PRINT :PRINT
        DUMMY% = PAUSE%
        GOTO 5000 REM  RETURN TO MAIN MENU
REM
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Save Database Updates & Restart
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
5900    IF SAVDAT(FILE.NO%) <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(7)
        FOR KEY% = 0 TO MAX.KEY%
                IF SAVIDX(KEY.NUM%(KEY%)) <> 0 THEN \\
                        DUMMY% = ERROR.TYPE%(3)
        NEXT KEY%
        GOTO 5000
REM
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
REM             Save Database Updates & Terminate
REM ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
6100    IF CLSDAT(FILE.NO%) <> 0 THEN \\
                DUMMY = ERROR.TYPE%(15)
        FOR KEY% = 0 TO MAX.KEY%
                IF CLSIDX(KEY.NUM%(KEY%)) <> 0 THEN \\
                        DUMMY% = ERROR.TYPE%(16)
        NEXT KEY%
        IF FRELOK(FILE.NO%,SFILE%,0) <> 0 THEN \\
                DUMMY% = ERROR.TYPE%(13)
        PRINT
        PRINT " ***  SUCCESSFUL TERMINATION ***"
        STOP
```

Listing 2-2. (continued)

End of Section 2

Section 3
Using Access Manager with PL/I-86 Applications

This section contains instructions for implementing Access Manager with application programs coded in PL/I-86.

Two examples are provided in this section. The first shows the use of many Access Manager functions described in the Access Manager Reference Manual, and in particular, how to use the data file functions in your PL/I-86 applications. The second example provides an extensive illustration of using Access Manager to construct and maintain a data base.

3.1 Linking Access Manager to Your Application Program

This section discusses a PL/I-86 application program that you write and compile to produce a binary relocatable file called MYPROG.

3.1.1 Linking Single-user PL/I-86 Applications

You must link your compiled application program to the appropriate Access Manager subroutine library and index file buffer module. The following command line can be used to create an executable version of MYPROG:

```
LINK86 MYPROG,AM86PLI.L86[S],AM86BUF
```

AM86BUF contains the buffer area beginning with entry point AM8FCB and ending with AM8END.

Before linking, be sure that AM86BUF.OBJ is large enough to contain your buffers, as specified in the SETUP function. You can use SETAMBUF.CMD to create a correctly sized buffer module.

3.1.2 Linking Multiuser PL/I-86 Applications

If your single-user version of MYPROG is coded with appropriate data locking procedures, you do not have to recompile it to create a multiuser version. All that is necessary is to relink the program.

You must link your compiled application program to the appropriate Access Manager multiuser interface. The interface makes the queue calls to the shared code in the background server. The background server resides in its own memory segment.

To create a CMD file that calls the Access Manager background server, use LINK86.CMD as follows:

```
LINK86 MYPROG,AMQ6PLI.L86
```

3.2 External Declaration of Access Manager Routines

PL/I-86 requires that external routines (those not coded in the program module but referenced by it) be explicitly declared. The file AM86EXTR.PLI contains external function declarations for the entire set of Access Manager routines. Use the %INCLUDE feature of PL/I-86 to make these external declarations a part of your application program.

Note that AM86EXTR.PLI expects two compile-time constants to be defined with the %REPLACE macro of PL/I-86. NAME_LEN (the maximum length of index and data filenames) and MAX_KEY_LEN (the maximum key value length) must be set to appropriate values before AM86EXTR.PLI is included. For example, you can use the following code segments:

```
%REPLACE
        NAME_LEN BY 14,
        MAX_KEY_LEN BY 48;

%INCLUDE 'AM86EXTR.PLI';
```

It is not necessary to set MAX_KEY_LEN at the Access Manager maximum of 48. Any value less than, or equal to 48, that is sufficient for your particular application is valid.

Note: you should consider these points concerning the passing of parameters between Access Manager and PL/I-86:

- Access Manager requires all string-valued parameters (FILNAME, IDXNAME, KEYVAL, and IDXVAL) to be declared as CHARACTER() VARYING. CHARACTER VARYING strings in PL/I-86 reserve the leading byte for a length counter that Access Manager uses to determine the actual length of a string-valued parameter.

- The output string parameter IDXVAL must be passed by reference, as opposed to value. Therefore, the actual parameter passed to Access Manager (for IDXVAL) must be declared with exactly the same attributes as the formal IDXVAL parameter in AM86EXTR.PLI. This implies the actual variable used for IDXVAL ACTUAL_IDXVAL must be declared as follows:

```
DCL
        ACTUAL_IDXVAL CHAR(MAX_KEY_LEN) VAR;
```

3.3 Coding Numeric Key Values

For a general discussion of coding numeric key values, refer to the ADDKEY function description in Section 3 of the Access Manager Reference Manual.

In the PL/I environment, the easiest approach to represent numeric key values is to use FIXED DECIMAL quantities. Because FIXED DECIMAL quantities are stored in BCD (Binary Coded Decimal) format with the least significant byte first and the sign bit set in the last byte, KEYTYP% should be one. Access Manager requires a CHARACTER VARYING value for the KEYVAL$ and IDXVAL$ parameters. Therefore, FIXED DECIMAL variables should be overlayed or based on KEYVAL$ and IDXVAL$ string variables.

The key length is based on the number of bytes required to store the FIXED DECIMAL quantities. A FIXED DECIMAL with p digits requires

```
INT((p + 2) / 2)
```

bytes where INT returns the integer portion of its argument. For example, a FIXED DECIMAL quantity with eight digits requires five bytes of storage.

The following declarations and assignments permit the use of FIXED DECIMAL quantities as key values in Access Manager.

```
%REPLACE
     MAX_KEY_LEN BY 48,
     NAME_LEN BY 14,
     P BY 8,              /* example precision */
     Q BY 2,              /* fractional places */
     KEYLEN BY 5;         /* INT((P+2)/2)      */

%INCLUDE 'AM86EXTR.PLI';

DCL
     (KEYVAL,IDXVAL)  CHAR(MAX_KEY_LEN) VAR,
     (BCDINP_PTR,BCDOUT_PTR) POINTER;

DCL
     1  BCDINP BASED (BCDINP_PTR),
           2  LEN FIXED BINARY (7),
           2  VAL FIXED DECIMAL (P,Q),

     1  BCDOUT BASED (BCDOUT_PTR),
           2  LEN FIXED BINARY (7),
           2  VAL FIXED DECIMAL (P,Q);

BCDINP_PTR = ADDR(KEYVAL);  /* overlay bcd on string */
BCDINP.LEN = KEYLEN;        /* set length byte
                                  of string  */
```

```
BCDOUT_PTR = ADDR(IDXVAL);
BCDOUT.LEN = KEYLEN;
```

Whenever you use a numeric quantity with an Access Manager function, use KEYVAL for input values and IDXVAL for output values. To manipulate the key as a numeric quantity, refer to BCDINP.VAL and BCDOUT.VAL for input and output key values, respectively. For example,

```
BCDINP.VAL = 123.45;
DRN = SERKEY(KEY_NO,DFILE,DLOCK,KEYVAL,IDXVAL);
IF DRN ~= 0 | DATVAL() ~= 0 THEN
     PUT SKIP LIST (BCDOUT.VAL);
```

prints the numeric value of the first key value in the index greater than, or equal to 123.45, unless no such key exists.

3.4 Using the RECREATE.PLI Utility Program

RECREATE.PLI contains the PL/I-86 source code for the RECREATE utility program. You can change the source code in whatever way you want. To create RECREATE.CMD, use the PLI.CMD to compile RECREATE.PLI, and then link as follows:

```
LINK86 RECREATE,AM86PLI.L86[S],AM86BUF
```

The buffer area for RECREATE is 4,844 bytes based on the following parameter values:

- NNSEC% = 4
- NBUFS% = 8
- NDATF% = 1
- NKEYS% = 1

Note that only one data file and one index file are open at the same time that RECREATE is running. Use SETAMBUF to configure AM86BUF.OBJ.

Table 3-1 shows the layout and content of records in a Recreate Parameter File. This particular example file can be used to reconstruct DATABASE (see Listing 3-2).

Table 3-1. Example PL/I-86 Recreate Parameter File

Record Type	Contents
Header	1,4
Data File	CUSTOMER.DAT,100,3,0
Index File	NAME.IDX,10,0,1,1,Y
Key Part	22,8
Index File	NUMB.IDX,4,0,0,1,N
Key Part	2,4
Index File	ZIPC.IDX,11,0,1,1,Y
Key Part	84,9

If you want to change the capacities of the RECREATE program (and hence its memory requirements), note the following key constants:

- MAX_NO_KEYS specifies the maximum number of index files associated with a data file; MAX_KEY_PARTS indicates the maximum number of fields comprising a key value.
- MAX_SORT is the maximum number of key values that can be buffered by RECREATE.PLI before being sorted and added to the index file being recreated.
- MAX_SPACE specifies the actual number of bytes available for the buffered key values. Each key value requires one more byte than its key length.

The actual number of buffered key values depends on the key length. For short key lengths, MAX_SORT is the limiting factor. MAX_SPACE is the limiting factor for long key lengths.

The constant MAX_REC_LEN should be increased if your applications require data files with record lengths exceeding 1024 bytes.

3.5 PL/I-86 Data File Example

The following listing illustrates the use of the primary Access Manager functions to update records in a data file.

```
EXAMPLE:
     PROC OPTIONS (MAIN);

%REPLACE
     MAX_KEY_LEN BY 48,
     NAME_LEN BY 14;

/*   ------------------------------------------------------
          AM86 External Declarations
     ------------------------------------------------------
*/
%INCLUDE 'AM86EXTR.PLI';

/*   ------------------------------------------------------
          Exception Processing Routines
     ------------------------------------------------------
*/
ERROR_HANDLER:
          PROC (LOCALE);
DCL
     LOCALE FIXED;

     PUT SKIP EDIT ('ERROR at ',LOCALE,' with code ',ERRCOD())
               (A,F(3),A,F(4));
     STOP;
END ERROR_HANDLER;

LOCK_CONFLICT:
          PROC (LOCALE)
DCL
     LOCALE FIXED;

     PUT SKIP EDIT ('LOCK Conflict at ',LOCALE,' with code ',ERRCOD())
               (A,F(3),A,F(4));
     STOP;
END LOCK_CONFLICT;

/*   ------------------------------------------------------
          Variable Declarations
     ------------------------------------------------------
*/
DCL
     (N_LOCK,S_LOCK,X_LOCK,S_FILE,X_FILE) FIXED,
     (NBUF,NKEYS,NNSEC,NDATF,ERROPT,PROGID,TIMOUT) FIXED,
     (DRN,DRN2,FILE_NO,RECORD_LEN) FIXED,
     FILE_NAME CHAR(NAME_LEN) VAR;

DCL
     1 DAT_BUFFER
```

Listing 3-1. Example of PL/I-86 Data File

```
          2 PART_NO CHAR(4)
          2 PART_NAME CHAR(20)
          2 PART_QUAN FIXED DECIMAL (15,2),
     DATBUF_PTR POINTER;

/*   ------------------------------------------------------
          Lock Parameter Setup
     ------------------------------------------------------
*/
N_LOCK = 0;     /*  No lock request          */
S_LOCK = 1;     /*  Shared record lock       */
X_LOCK = 2;     /*  Exclusive record lock    */
S_FILE = 3;     /*  Shared file lock         */
X_FILE = 4;     /*  Exclusive file lock      */

/*   ------------------------------------------------------
          System Initialization Parameters
     ------------------------------------------------------
*/
NBUF = 3;       /*  3 buffers                                */
NKEYS = 1;      /*  1 index file                             */
NNSEC = 4;      /*  512-byte index file record length        */
NDATF = 1;      /*  1 data file                              */
ERROPT = 1;     /*  Trap user errors                         */
PROGID = -1;    /*  Program ID assigned to MP/M console no.  */
TIMOUT = 3;     /*  Background server time-out delay         */

/*   ------------------------------------------------------
          Initialize System
     ------------------------------------------------------
*/
PROGID = INTUSR(PROGID,ERROPT,TIMOUT);
IF ERRCOD () ~= 0 THEN
     CALL ERROR_HANDLER(1);
IF SETUP(NBUF,NKEYS,NNSEC,NDATF) ~= 0 THEN
     CALL ERROR_HANDLER(2);

/*   ------------------------------------------------------
          Open Files
     ------------------------------------------------------
*/
FILE_NO = -1   /*  Automatic file number assignment  */
RECORD_LEN = 32;
FILE_NAME = 'K:PART.DAT';
FILE_NO = OPNDAT(FILE_NO,S_FILE,FILE_NAME,RECORD_LEN);
IF ERRCOD () ~= 0 THEN
     CALL ERROR_HANDLER(3);
IF LOKCOD () ~= 0 THEN
     CALL LOCK_CONFLICT(3);

/*   ------------------------------------------------------
          Initialize Data Buffer Pointer
     ------------------------------------------------------
*/
DATBUF_PTR = ADDR(DAT_BUFFER);
```

Listing 3-1. (continued)

```
/*   ------------------------------------------------------
          Set Exclusive Lock on Data Record No. 65686
     ------------------------------------------------------
*/
DRN2 = 1;
CALL SETDAT(DRN2);        /*  Set two high-order bytes to 1,
                              which implies a base of 65536  */
DRN = 150;                /*  65686 = 65536 + 150            */
IF SETLOK(FILE_NO,DRN,DATBUF_PTR) ~= 0 THEN
     CALL LOCK_CONFLICT(4);

/*   ------------------------------------------------------
          Read Data Record
     ------------------------------------------------------
*/
CALL SETDAT(DRN2);
IF READAT(FILE_NO,DRN,DATBUF_PTR ~= 0 THEN
     CALL ERROR_HANDLER(4);

/*   ------------------------------------------------------
          Update Data Record
     ------------------------------------------------------
*/
PART_QUAN = PART_QUAN - 100.00;

/*   ------------------------------------------------------
          Write Updated Data Record
     ------------------------------------------------------
*/
CALL SETDAT(DRN2);
IF WRTDAT(FILE_NO,DRN,DATBUF_PTR ~= 0 THEN
     CALL ERROR_HANDLER(5);

/*   ------------------------------------------------------
          Release Record Lock
     ------------------------------------------------------
*/
CALL SETDAT(DRN2);
IF FRELOK(FILE_NO,X_LOCK,DRN) ~= 0 THEN
     CALL LOCK_CONFLICT(6);

/*   ------------------------------------------------------
          Close Data File and Release File Lock
     ------------------------------------------------------
*/
IF CLSDAT (FILE_NO) ~= 0 THEN
     CALL ERROR_HANDLER(7);
IF FRELOK (FILE_NO,S_FILE,0) ~= 0 THEN
     CALL LOCK_CONFLICT(7);

END EXAMPLE;
```

Listing 3-1. (continued)

3.6 PL/I-86 DATABASE Source Code

Your Access Manager distribution disk contains sample code for building and maintaining a data base in PL/I-86. The code is designed so you can add or substitute your own key attributes as required. The sample code is on your distribution disk in a file called DATABASE. DATABASE is comprised of these three separate components:

- DATABAS1.PLI
- DATABAS2.PLI
- DATABASE.DCL

DATABASE demonstrates the integration of Access Manager with PL/I-86 applications. It builds a name and address data base and provides facilities for examining, updating, and/or listing the information contained therein. You might also want to use routines from DATABASE directly in your application programs.

[SINGLE] To create DATABASE.CMD, compile DATABAS1.PLI and DATABAS2.PLI with PLI.CMD and link as follows:

```
LINK86 DATABASE=DATABAS1,DATABAS2,
              AM86PLI.186[S],AM86BUF
```

[MULTI] In a multiuser environment, enter the link statement as follows:

```
LINK86 DATABASE=DATABAS1,DATABAS2,AMQ6PLI.186
```

Note that the listing of DATABASE (see Listing 3-2) might not include recent changes. You should always treat the copy on your distribution disk as the definitive version.

```
                        DATABASE.DCL
/* ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

        DATABASE EXAMPLE DECLARATIONS VERSION 0.9  1/4/83

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
%REPLACE
        MAX_KEY BY 2,
        MAX_FIELD BY 7,
        MAX_KEY_LEN BY 20,
        MAX_FLD_LEN BY 20,
        NAME_LEN BY 14,
        FLD_NAME_LEN BY 18,
        ACTION_LEN BY 4,
        NEW_MODE BY 1,
        OLD_MODE BY 2,
        YES BY 1,
        YESBIT BY '1'B,
        NOBIT BY '0'B,
        NO BY 0;

/*
        WORKING VARIABLES
 */
DCL
        (KEY,TERMINAL,TRAP_ERRORS,TIME_OUT_TEST_DELAY,NO_BUFFERS,
                NO_NODE_SECTORS,NO_DATA_FILES,NO_KEYS,FILE_NO,
                RECORD_LENGTH) FIXED STATIC EXTERNAL,
        (SET_LENGTH,IDX_KEY,SPACE) CHAR(MAX_KEY_LEN) VAR STATIC EXTERNAL,
        (SYSLST,SYSCON) FILE,
        OLD_ACTION CHAR(ACTION_LEN) STATIC EXTERNAL,
        FILNAME CHAR(NAME_LEN) VAR STATIC EXTERNAL;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
         DATABASE FIELD & KEY DESCRIPTORS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DCL
        FLD_NAME(0:MAX_FIELD) CHAR(FLD_NAME_LEN) VAR STATIC EXTERNAL,
        FLD_LEN(0:MAX_FIELD) FIXED BINARY(7) STATIC EXTERNAL,
        (OLD_FLD,NEW_FLD) (0:MAX_FIELD) CHAR(MAX_FLD_LEN) VAR STATIC EXTERNAL,
        NO_FIELDS FIXED STATIC EXTERNAL;

DCL
        IDX_NAME(0:MAX_KEY) CHAR(NAME_LEN) VAR STATIC EXTERNAL,
        KEY_NAME(0:MAX_KEY) CHAR(FLD_NAME_LEN) VAR STATIC EXTERNAL,
        (KEY_LEN,KEY_MAP,KEY_TYPE,KEY_NUM,KEY_DUP) (0:MAX_KEY) FIXED
                STATIC EXTERNAL,
        FOR_EVER BIT(1) STATIC EXTERNAL,
        (UNIQ_KEY,NLOCK,SLOCK,XLOCK,SFILE,XFILE,RLOCK) FIXED STATIC EXTERNAL;
```

Listing 3-2. DATABASE Source Code

DATABAS1.PLI

```
DATABASE:
        PROC OPTIONS (MAIN);

/* ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

        DATABASE EXAMPLE   VERSION 0.9   1/4/83

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
%INCLUDE 'DATABASE.DCL';

/*
        INTERFACE TO AM86(tm)

        AM86EXTR.PLI CONTAINS THE EXTERNAL DEFINITIONS OF THE
        AM-86 ROUTINES
 */

%INCLUDE 'AM86EXTR.PLI';

DCL
        ENTDAT ENTRY (CHAR(3),FIXED) RETURNS (CHAR(ACTION_LEN));

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
         SET-UP DATABASE FIELD & KEY DESCRIPTORS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
NO_FIELDS = MAX_FIELD + 1;

FLD_NAME(0) = 'Customer Number';
FLD_LEN(0) = 4;
FLD_NAME(1) = 'First Name';
FLD_LEN(1) = 16;
FLD_NAME(2) = 'Last Name';
FLD_LEN(2) = 20;
FLD_NAME(3) = 'Street Address';
FLD_LEN(3) = 20;
FLD_NAME(4) = 'City';
FLD_LEN(4) = 20;
FLD_NAME(5) = 'State';
FLD_LEN(5) = 2;
FLD_NAME(6) = 'Zipcode';
FLD_LEN(6) = 9;
FLD_NAME(7) = 'Customer Status';
FLD_LEN(7) = 8;
```

Listing 3-2. (continued)

```
DCL
        DATBUF_PTR POINTER,
        1 CUST_REC,
                2 CDF CHAR(1),
                2 CNO CHAR(4),
                2 CFN CHAR(16),
                2 CLN CHAR(20),
                2 CST CHAR(20),
                2 CTY CHAR(20),
                2 CSA CHAR(2),
                2 CZP CHAR(9),
                2 CSU CHAR(8);

KEY_LEN(0)=10;
KEY_TYPE(0)=0;
KEY_MAP(0)=2 ;  /*   KEY 0 = LAST NAME          */
KEY_LEN(1)=11;
KEY_TYPE(1)=0;
KEY_MAP(1)=6 ;  /*   KEY 1 = ZIPCODE            */
KEY_LEN(2)=4 ;
KEY_TYPE(2)=0;
KEY_MAP(2)=0 ;  /*   KEY 2 = CUST NUMBER        */

UNIQ_KEY = 2 ;  /*  USED IN TEST OF UNIQUENESS  */

DO KEY = 0 TO MAX_KEY;
        IF KEY = UNIQ_KEY THEN
                KEY_DUP(KEY) = NO;
        ELSE
                KEY_DUP(KEY) = YES;

        KEY_NAME(KEY) = FLD_NAME(KEY_MAP(KEY));
END;

IDX_NAME(0) = 'NAME.IDX';
IDX_NAME(1) = 'ZIPC.IDX';
IDX_NAME(2) = 'NUMB.IDX';

NLOCK = 0;      /* IGNORE LOCKS                 */
SLOCK = 1;      /* SHARED RECORD LOCK           */
XLOCK = 2;      /* EXCLUSIVE RECORD LOCK        */
SFILE = 3;      /* SHARED FILE LOCK             */
XFILE = 4;      /* EXCLUSIVE FILE LOCK          */
RLOCK = 5;      /* RELEASE SLOCK OR XLOCK       */
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                INITIALIZE INDEX FILES
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
        SET_LENGTH = '12345678901';
        IDX_KEY = SET_LENGTH;
        SPACE =          ';

/*
        SET TERMINAL TO -1 FOR AUTOMATIC ASSIGNMENT BY AM-86
 */

        TERMINAL = -1;
        TRAP_ERRORS = YES;
        TIME_OUT_TEST_DELAY = 2;  /* APPROXIMATELY 2 SECONDS */
        TERMINAL = INTUSR(TERMINAL,TRAP_ERRORS,TIME_OUT_TEST_DELAY);
        IF ERRCOD() ~= 0 THEN
                CALL ERROR_TYPE(0,14);

        NO_BUFFERS = 5;
        NO_NODE_SECTORS = 4;
        NO_DATA_FILES = 1;
        NO_KEYS = MAX_KEY + 1;

        IF SETUP(NO_BUFFERS,NO_KEYS,NO_NODE_SECTORS,NO_DATA_FILES) ~= 0 THEN
                DO;
                PUT SKIP LIST('Illegal SETUP Parameters');
                STOP;
                END;

        DO KEY = 0 TO MAX_KEY;
                KEY_NUM(KEY) = OPNIDX(-1,IDX_NAME(KEY),
                        KEY_LEN(KEY), KEY_TYPE(KEY),KEY_DUP(KEY));
                IF ERRCOD() ~= 0 THEN
                        CALL ERROR_TYPE(KEY,1);
        END;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                INITIALIZE DATA FILE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
        FILE_NO = -1;
        RECORD_LENGTH = 100;
        FILNAME = 'CUSTOMER.DAT';
        FILE_NO = OPNDAT(FILE_NO,SFILE,FILNAME,RECORD_LENGTH);
        IF ERRCOD() ~= 0 THEN
                CALL ERROR_TYPE(0,10);
        IF LOKCOD() ~= 0 THEN
                CALL LOKTYP(1);
```

Listing 3-2. (continued)

```
/*
        CUST_REC IS THE DATA FILE BUFFER AREA
 */
        DATBUF_PTR = ADDR(CUST_REC);

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                BEGIN DATABASE OPERATION
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
        OPEN FILE (SYSCON) OUTPUT TITLE('$CON');
        OPEN FILE (SYSLST) OUTPUT TITLE('$LST');

        FOR_EVER = YESBIT;
        DO WHILE (FOR_EVER);
                CALL DATA_BASE();
        END;

DATA_BASE:
        PROC;
DCL
        (LOCK_CODE,NDRN,DRN,CHOICE) FIXED,
6       (SAVE_KEY,LDRN,NO_LISTED) FIXED,
        ROUTE CHAR(1),
        (CONTINUE,STAYPUT) BIT(1),
        (L_VALUE,U_VALUE,CONV_TARGET,TARGET) CHAR(MAX_KEY_LEN) VAR,
        ACTION CHAR(ACTION_LEN);


        CALL CLRSCR();
        CHOICE = MAIN_MENU();
        GOTO DB(CHOICE);

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                ENTER NEW CUSTOMERS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DB(1):
        ACTION = ENTDAT('NEW',0);
        LOCK_CODE = 0;
        IF ACTION = 'SAVE' THEN
                DO;
                NDRN = UPDATE(0);
                LOCK_CODE = FRELOK(FILE_NO,XLOCK,NDRN);
                END;

        IF LOCK_CODE ^= 0 THEN
                CALL LOKTYP(8);

        IF ACTION = 'SAVE' THEN
                GOTO DB(1);
        ELSE
                RETURN;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                SCAN/UPDATE/DELETE CUSTOMERS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DB(2):
        KEY = SEARCH_KEY();
        PUT SKIP(2) EDIT ('Enter target value for ',KEY_NAME(KEY),',',
                '     or enter a period (.) to see main menu>>')
                (3A,SKIP,A);
        GET LIST (TARGET);
        IF TARGET = '.' THEN RETURN;

        CONV_TARGET = KEY_FORMAT(KEY,TARGET);
        STAYPUT = YESBIT;
        DO WHILE (STAYPUT);
                DRN = SERKEY(KEY_NUM(KEY),FILE_NO,SLOCK,
                        CONV_TARGET,IDX_KEY);
                IF ERRCOD() ~= 0 THEN
                        CALL ERROR_TYPE(KEY,2);
                IF LOKCOD() ~= 0 THEN
                        STAYPUT = CHECK_LOCK(KEY,DRN);
                ELSE
                        STAYPUT =NOBIT;
        END;

        OLD_ACTION = 'CONT';
        CONTINUE = YESBIT;
        DO WHILE (CONTINUE & DRN ~= 0);
                LDRN = DRN;
                CALL READ_CUST(DRN);
                ACTION = ENTDAT('OLD',DRN);
                SAVE_KEY = KEY;
                IF ACTION = 'SAVE' THEN
                        DRN = UPDATE(DRN);
                IF ACTION = 'DELT' THEN
                        CALL DELETE(DRN);
                IF ACTION ~= 'DELT' & FRELOK(FILE_NO,RLOCK,LDRN) ~= 0
                        THEN CALL LOKTYP(2);
                IF ACTION = 'SAVE' | ACTION = 'DELT' THEN
                        DO;
                        KEY = SAVE_KEY;
                        ACTION = OLD_ACTION;
                        END;
                OLD_ACTION = ACTION;
                CONV_TARGET = SUBSTR(IDX_KEY,1,KEY_LEN(KEY));
                IDX_KEY = SET_LENGTH;
                LOCK_CODE = 0;

                STAYPUT = YESBIT;
                DO WHILE (STAYPUT);
                    IF ACTION = 'CONT' THEN
                        DO;
                        DRN = AFTKEY(KEY_NUM(KEY),FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
```

Listing 3-2. (continued)

```
                        LOCK_CODE = LOKCOD();
                        END;
                    IF ACTION = 'BACK' THEN
                        DO;
                        DRN = BEFKEY(KEY_NUM(KEY),FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
                        LOCK_CODE = LOKCOD();
                        END;

                    IF LOCK_CODE ~= 0 THEN
                        STAYPUT = CHECK_LOCK(KEY,DRN);
                    ELSE
                        STAYPUT = NOBIT;
                END;

                IF ACTION = 'STOP' THEN
                        CONTINUE = NOBIT;
        END;

        PUT SKIP(2) LIST ('SCAN ENDED');
        CALL PAUSE();
        RETURN;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                        LIST CUSTOMERS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DB(3):
        KEY = SEARCH_KEY();
        PUT SKIP(2) LIST (
'Do you want listing routed to printer (Y/N) >>');
        GET LIST (ROUTE);
        IF ROUTE = 'y' THEN ROUTE = 'Y';

        PUT SKIP(3) EDIT (
'Enter lower and upper limits for ',KEY_NAME(KEY),' listing',
'     separate values with a space >>') (3A,SKIP,A);
        GET LIST (L_VALUE,U_VALUE);
        L_VALUE = KEY_FORMAT(KEY,L_VALUE);
        U_VALUE = KEY_FORMAT(KEY,U_VALUE);
        DRN = SERKEY(KEY_NUM(KEY),FILE_NO,SLOCK,
                L_VALUE,IDX_KEY);
        IF LOKCOD() ~= 0 THEN
                CALL SKIP_LOCK(KEY,DRN);

        NO_LISTED = 0;
        DO WHILE (DRN ~= 0 & COMPARE(KEY,IDX_KEY,U_VALUE) <= 0);
                CALL READ_CUST(DRN);
                CALL PRINT_CUST(ROUTE);
                NO_LISTED = NO_LISTED + 1;
                IF FRELOK(FILE_NO,SLOCK,DRN) ~= 0 THEN
                        CALL LOKTYP(4);
                L_VALUE = SUBSTR(IDX_KEY,1,KEY_LEN(KEY));
                IDX_KEY = SET_LENGTH;
```

Listing 3-2. (continued)

```
                DRN = AFTKEY(KEY_NUM(KEY),FILE_NO,SLOCK,
                        L_VALUE,IDX_KEY);
                IF LOKCOD() ~= 0 THEN
                        CALL SKIP_LOCK(KEY,DRN);
        END;

        IF DRN ~= 0 THEN
                LOCK_CODE = FRELOK(FILE_NO,SLOCK,DRN);
        ELSE
                LOCK_CODE = 0;
        IF LOCK_CODE ~= 0 THEN
                CALL LOKTYP(5);

        PUT SKIP(2) EDIT (NO_LISTED,' records listed.') (F(6),A);
        CALL PAUSE();
        RETURN;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                DATABASE STATISTICS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DB(4):
        CALL CLRSCR();
        PUT SKIP EDIT (FILNAME,' has ',GETDFS(FILE_NO),
                ' records; currently, ',GETDFU(FILE_NO),
                ' of them are in use.') (2A,F(6),A,F(6),A);
        PUT SKIP(4) EDIT ('    INDEX','ENTRIES') (A,COLUMN(30),A);
        PUT SKIP EDIT ('----------------','-------') (A,COLUMN(30),A);
        DO KEY = 0 TO MAX_KEY;
                PUT SKIP EDIT (KEY_NAME(KEY),NOKEYS(KEY)) (A,COLUMN(30),F(6));
        END;

        PUT SKIP(4);
        CALL PAUSE();
        RETURN;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                SAVE DATABASE UPDATES & RESTART
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DB(5):
        IF SAVDAT(FILE_NO) ~= 0 THEN
                CALL ERROR_TYPE(0,7);
        DO KEY = 0 TO MAX_KEY;
                IF SAVIDX(KEY_NUM(KEY)) ~= 0 THEN
                        CALL ERROR_TYPE(KEY,3);
        END;
        RETURN;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                SAVE DATABASE UPDATES & TERMINATE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DB(6):
        CLOSE FILE (SYSLST);

        IF CLSDAT(FILE_NO) ~= 0 THEN
                CALL ERROR_TYPE(0,15);
        DO KEY = 0 TO MAX_KEY;
                IF CLSIDX(KEY_NUM(KEY)) ~= 0 THEN
                        CALL ERROR_TYPE(KEY,16);
        END;
        IF FRELOK(FILE_NO,SFILE,0) ~= 0 THEN
                CALL ERROR_TYPE(0,13);

        PUT SKIP(2) LIST (' ***  SUCCESSFUL TERMINATION ***');
        STOP;
END DATA_BASE;


/*
   ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

                BEGINNING OF UTILITY FUNCTIONS


   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                CLEAR SCREEN ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
CLRSCR:
        PROC EXTERNAL;
DCL
        DUMMY FIXED BINARY(7);

        DO DUMMY = 1 TO 24;
                PUT SKIP;
        END;
END CLRSCR;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                MAIN MENU ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */

MAIN_MENU:
        PROC RETURNS (FIXED);
DCL
        OP FIXED;

        PUT SKIP EDIT ('   AM-86(tm)  DEMONSTRATION') (X(20),A);
        PUT SKIP(2) EDIT(' Customer Database Operations') (X(20),A);
```

Listing 3-2. (continued)

```
        PUT SKIP EDIT('        Terminal ',TERMINAL) (X(20),A,F(2));
        PUT SKIP EDIT(' ***************************') (X(20),A);
        PUT SKIP(3) EDIT('1. Enter New Customers') (X(5),A);
        PUT SKIP EDIT('2. Scan/Update/Delete Customer Records') (X(5),A);
        PUT SKIP EDIT('3. List Customer Records') (X(5),A);
        PUT SKIP EDIT('4. Database Statistics') (X(5),A);
        PUT SKIP EDIT('5. Save All Files & Restart Operations') (X(5),A);
        PUT SKIP EDIT('6. Terminate Operations') (X(5),A);

        OP = 0;
        DO WHILE (OP < 1 | OP > 6);
                PUT SKIP(2) LIST ('Enter desired operation number>>');
                GET LIST (OP);
        END;
        RETURN(OP);
END MAIN_MENU;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                SELECT SEARCH KEY ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
SEARCH_KEY:
        PROC RETURNS (FIXED);
DCL
        (KEY,KEY_NO) FIXED;

        CALL CLRSCR();
        PUT EDIT ('Customer Database Search Keys') (X(25),A);
        PUT SKIP (3);

        DO KEY = 0 TO MAX_KEY;
                KEY_NO = KEY + 1;
                PUT SKIP EDIT(KEY_NO,' - ',KEY_NAME(KEY)) (X(5),F(3),2A);
        END;

        KEY = 0;
        DO WHILE (KEY < 1 | KEY > NO_KEYS);
                PUT SKIP(3) LIST('Enter desired key number>>');
                GET LIST (KEY);
        END;
        RETURN(KEY-1);
END SEARCH_KEY;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                ERROR HANDLING
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
ERROR_TYPE:
        PROC (INFO,TYPE);
DCL
        (T_KEY,INFO,DUMMY,TYPE) FIXED;

        PUT SKIP(3) EDIT ('User Error #',ERRCOD(),' occurred while trying to ')
                (A,F(4),A);

        GOTO ET(TYPE);

ET(1):  PUT EDIT ('open ',IDX_NAME(INFO)) (2A);
        GOTO ET_STOP;
ET(2):  PUT EDIT ('search ',KEY_NAME(INFO),' Index File') (3A);
        GOTO ET_CLOSE;
ET(3):  PUT EDIT('save ',IDX_NAME(INFO)) (2A);
        GOTO ET_PCLOSE;
ET(4):  PUT EDIT('remove old key from ',IDX_NAME(INFO)) (2A);
        GOTO ET_CLOSE;
ET(5):  PUT EDIT('enter key into ',IDX_NAME(INFO)) (2A);
        GOTO ET_CLOSE;
ET(6):  PUT EDIT('delete key from ',IDX_NAME(INFO)) (2A);
        GOTO ET_CLOSE;
ET(7):  PUT EDIT('save ',FILNAME) (2A);
        INFO = -1;
        GOTO ET_PCLOSE;
ET(8):  PUT EDIT('get a new data record',' (',FILE_NO,')') (2A,F(3),A);
        GOTO ET_STOP;
ET(9):  PUT EDIT('delete data record #',INFO) (A,F(6));
        GOTO ET_STOP;
ET(10): PUT EDIT('open ',FILNAME,' (',FILE_NO,')') (2A,F(3),A);
        GOTO ET_STOP;
ET(11): PUT EDIT('read data record #',INFO) (A,F(6));
        GOTO ET_STOP;
ET(12): PUT EDIT('write data record #',INFO) (A,F(6));
        GOTO ET_STOP;
ET(13): PUT EDIT('release shared file lock on ',FILNAME) (2A);
        GOTO ET_STOP;
ET(14): PUT EDIT('initialize user.') (A);
        STOP;
ET(15): PUT EDIT('close ',FILNAME) (2A);
        INFO = -1;
        GOTO ET_PCLOSE;
ET(16): PUT EDIT('close ',IDX_NAME(INFO)) (2A);
        GOTO ET_PCLOSE;
```

Listing 3-2. (continued)

```
ET_CLOSE:
        DUMMY = CLSDAT(FILE_NO);
        DO T_KEY = 0 TO MAX_KEY;
                IF T_KEY ^= INFO THEN DUMMY = CLSIDX(KEY_NUM(T_KEY));
        END;
        GOTO ET_STOP;

ET_PCLOSE:
        T_KEY = INFO + 1;
        IF T_KEY>MAX_KEY THEN STOP;
        DO INFO = T_KEY TO MAX_KEY;
                DUMMY = CLSIDX(KEY_NUM(INFO));
        END;

ET_STOP:
        PUT SKIP(2) EDIT('DEMONSTRATION TERMINATING WITH ERROR CODE #',
                ERRCOD()) (A,F(4));
        STOP;

END ERROR_TYPE;

LOKTYP:
        PROC (TYPE) EXTERNAL;
DCL
        (T_KEY,DUMMY,TYPE) FIXED;

        PUT SKIP EDIT('Lock Type: ',TYPE,'  Lock Code:',LOKCOD())
                (A,F(3),A,F(3));
        DUMMY = CLSDAT(FILE_NO);
        DO T_KEY = 0 TO MAX_KEY;
                DUMMY = CLSIDX(KEY_NUM(T_KEY));
        END;
        STOP;
END LOKTYP;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                STRIP TRAILING BLANKS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
STRIP_BLANKS:
        PROC (OLD_VAL) RETURNS(CHAR(MAX_FLD_LEN) VAR);
DCL
        OLD_VAL CHAR(MAX_FLD_LEN),
        (TEST,FLDLEN) FIXED;

        FLDLEN = LENGTH(OLD_VAL);
        DO TEST = FLDLEN TO 1 BY -1;
                IF SUBSTR(OLD_VAL,TEST,1) ^= ' ' THEN
                        RETURN (SUBSTR(OLD_VAL,1,TEST));
        END;
        RETURN('');
END STRIP_BLANKS;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                READ DATA RECORD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
READ_CUST:
        PROC (DRN);
DCL
        DRN FIXED;

        IF READAT(FILE_NO,DRN,DATBUF_PTR) ^= 0 THEN
                CALL ERROR_TYPE(DRN,11);

        OLD_FLD(0) = STRIP_BLANKS(CNO);
        OLD_FLD(1) = STRIP_BLANKS(CFN);
        OLD_FLD(2) = STRIP_BLANKS(CLN);
        OLD_FLD(3) = STRIP_BLANKS(CST);
        OLD_FLD(4) = STRIP_BLANKS(CTY);
        OLD_FLD(5) = STRIP_BLANKS(CSA);
        OLD_FLD(6) = STRIP_BLANKS(CZP);
        OLD_FLD(7) = STRIP_BLANKS(CSU);
END READ_CUST;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                LIST CUSTOMER RECORD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
PRINT_CUST:
        PROC (ROUTE);
DCL
        ROUTE CHAR(1),
        LIST_FILE FILE VARIABLE;

LFRMT:
        FORMAT(X(24),5A);

        IF ROUTE = 'Y' THEN
                LIST_FILE = SYSLST;
        ELSE
                LIST_FILE = SYSCON;


        PUT FILE(LIST_FILE) SKIP (2) EDIT(OLD_FLD(0),OLD_FLD(7))
                (X(4),A,COLUMN(15),A);
        PUT FILE(LIST_FILE) EDIT(OLD_FLD(1),' ',OLD_FLD(2)) (R(LFRMT));
        PUT FILE(LIST_FILE) EDIT(OLD_FLD(3)) (R(LFRMT));
        PUT FILE(LIST_FILE) EDIT(OLD_FLD(4),', ',OLD_FLD(5),'    ',OLD_FLD(6))
                (R(LFRMT));
        PUT FILE(LIST_FILE) SKIP;
END PRINT_CUST;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                PAUSE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
PAUSE:
        PROC;
DCL
        DUMMY CHAR(1);

        PUT SKIP(2) LIST ('Enter any character to continue ---');
        GET LIST (DUMMY);
END PAUSE;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
        CONVERT TARGET VALUE TO KEY FORMAT ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
KEY_FORMAT:
        PROC (KEY,TARGET) RETURNS (CHAR(MAX_KEY_LEN) VAR);
DCL
        KEY FIXED,
        TEMP CHAR(40) VAR,
        TARGET CHAR(MAX_KEY_LEN) VAR;

        IF UNIQ_KEY = KEY THEN
                RETURN(TARGET);
        ELSE
                DO;
                TEMP = TARGET || SPACE;
                RETURN(SUBSTR(TEMP,1,KEY_LEN(KEY)-2) ||
                        ASCII(0) || ASCII(0));
                END;
END KEY_FORMAT;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                COMPARE IDX_KEY & U_VALUE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
COMPARE:
        PROC (KEY,IDXVAL,UPVAL) RETURNS (FIXED);
DCL
        (KL,KEY) FIXED,
        (C1,C2) CHAR(40) VAR,
        (IDXVAL,UPVAL) CHAR(MAX_KEY_LEN) VAR;

        IF KEY = UNIQ_KEY THEN
                KL = KEY_LEN(KEY);
        ELSE
                KL = KEY_LEN(KEY)-2;

        C1 = IDXVAL || SPACE;
        C1 = SUBSTR(C1,1,KL);
```

Listing 3-2. (continued)

```
        C2 = UPVAL || SPACE;
        C2 = SUBSTR(C2,1,KL);

        IF C1<C2 THEN
                RETURN(-1);
        ELSE IF C1>C2 THEN
                RETURN(1);
        ELSE
                RETURN(0);
END COMPARE;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                CHECK LOCK ROUTINES
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
SKIP_LOCK:
        PROC (KEY,DRN);
DCL
        L_VALUE CHAR(MAX_KEY_LEN) VAR,
        (KEY,DRN) FIXED;

        DO WHILE (DRN ^= 0 & LOKCOD() ^= 0);
                L_VALUE = SUBSTR(IDX_KEY,1,KEY_LEN(KEY));
                IDX_KEY = SET_LENGTH;
                DRN = AFTKEY(KEY_NUM(KEY),FILE_NO,SLOCK,
                        L_VALUE,IDX_KEY);
        END;
END SKIP_LOCK;

CHECK_LOCK:
        PROC (KEY,DRN) RETURNS (BIT(1));
DCL
        CONV_TARGET CHAR(MAX_KEY_LEN) VAR,
        (KEY,DRN) FIXED,
        DUMMY CHAR(1);

        PUT SKIP(2) LIST(
'Enter a "W" if you want to wait for locked record(s)>>');
        GET LIST (DUMMY);

        IF DUMMY = 'W' | DUMMY = 'w' THEN
                RETURN(YESBIT);

        DO WHILE (DRN ^= 0 & LOKCOD() ^= 0);
                CONV_TARGET = SUBSTR(IDX_KEY,1,KEY_LEN(KEY));
                IDX_KEY = SET_LENGTH;
                IF OLD_ACTION = 'CONT' THEN
                        DRN = AFTKEY(KEY_NUM(KEY),FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
                ELSE
                        DRN = BEFKEY(KEY_NUM(KEY),FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
```

Listing 3-2. (continued)

```
        END;
        RETURN(NOBIT);
END CHECK_LOCK;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                WARNING MESSAGES
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
WARNING_TYPE:
        PROC (KEY,TYPE,RET_CODE);
DCL
        (KEY,TYPE,RET_CODE) FIXED;

        PUT SKIP(2) EDIT ('WARNING...Return Code #',RET_CODE,
                ' occurred while trying to ') (A,F(3),A);
        GOTO WT(TYPE);

WT(1):  PUT EDIT ('remove old key from ',IDX_NAME(KEY)) (2A);
        CALL PAUSE();
        RETURN;

WT(2):  PUT EDIT ('enter key into ',IDX_NAME(KEY)) (2A);
        CALL PAUSE();
        RETURN;

WT(3):  PUT EDIT ('delete key from ',IDX_NAME(KEY)) (2A);
        CALL PAUSE();
        RETURN;

END WARNING_TYPE;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                ADD NEW KEY VALUE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
ADD_KEY:
        PROC (KEY,DRN);
DCL
        (KEY,RET_CODE,K_FLD,DRN) FIXED;

        K_FLD = KEY_MAP(KEY);

/*
        REMOVE OLD KEY VALUE
 */

        RET_CODE = DELKEY(KEY_NUM(KEY),FILE_NO,
                XLOCK,OLD_FLD(K_FLD),DRN);

        IF ERRCOD() ~= 0 THEN
                CALL ERROR_TYPE(KEY,4);
        IF LOKCOD() ~= 0 THEN
                CALL LOKTYP(6);
```

Listing 3-2. (continued)

```
        IF RET_CODE ~= 1 THEN
                CALL WARNING_TYPE(KEY,1,RET_CODE);

/*
        ADD NEW KEY VALUE
*/

        RET_CODE = ADDKEY(KEY_NUM(KEY),FILE_NO,
                XLOCK,NEW_FLD(K_FLD),DRN);

        IF ERRCOD() ~= 0 THEN
                CALL ERROR_TYPE(KEY,5);
        IF LOKCOD() ~= 0 THEN
                CALL LOKTYP(7);
        IF RET_CODE ~= 1 THEN
                CALL WARNING_TYPE(KEY,2,RET_CODE);

END ADD_KEY;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                WRITE NEW DATA RECORD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
WRITE_CUST:
        PROC (DRN);
DCL
        DRN FIXED;

        CDF = ASCII(0);                 /* CLEAR DELETE FLAG */
        CNO = NEW_FLD(0);
        CFN = NEW_FLD(1);
        CLN = NEW_FLD(2);
        CST = NEW_FLD(3);
        CTY = NEW_FLD(4);
        CSA = NEW_FLD(5);
        CZP = NEW_FLD(6);
        CSU = NEW_FLD(7);

        IF WRTDAT(FILE_NO,DRN,DATBUF_PTR) ~= 0 THEN
                CALL ERROR_TYPE(DRN,12);
END WRITE_CUST;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                DELETE KEY VALUE FROM INDEX ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DEL_KEY:
        PROC (KEY,DRN);
DCL
        (KEY,RET_CODE,K_FLD,DRN);

        K_FLD = KEY_MAP(KEY);

        RET_CODE = DELKEY(KEY_NUM(KEY),FILE_NO,
                XLOCK,OLD_FLD(K_FLD),DRN);

        IF ERRCOD() ~= 0 THEN
                CALL ERROR_TYPE(KEY,6);
        IF LOKCOD() ~= 0 THEN
                CALL LOKTYP(10);
        IF RET_CODE ~= 1 THEN
                CALL WARNING_TYPE(KEY,3,RET_CODE);

END DEL_KEY;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                UPDATE INDICES & DATA FILE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
UPDATE:
        PROC (DATA_RECORD) RETURNS (FIXED);
DCL
        (FLD,KEY) FIXED,
        (TMP_REC,DATA_RECORD) FIXED;

        IF DATA_RECORD = 0 THEN
                DO;
                TMP_REC = NEWREC(FILE_NO,XLOCK);
                IF ERRCOD() ~= 0 THEN
                        CALL ERROR_TYPE(0,8);
                IF LOKCOD() ~= 0 THEN
                        CALL LOKTYP(3) ;
                END;
        ELSE
                TMP_REC = DATA_RECORD;

        DO KEY = 0 TO MAX_KEY;
                FLD = KEY_MAP(KEY);
                IF OLD_FLD(FLD) ~= NEW_FLD(FLD) THEN
                        CALL ADD_KEY(KEY,TMP_REC);
        END;

        DO FLD = 0 TO MAX_FIELD;
                IF OLD_FLD(FLD) ~= NEW_FLD(FLD) THEN
                        DO;
```

Listing 3-2. (continued)

```
                        CALL WRITE_CUST(TMP_REC);
                        RETURN(TMP_REC);
                        END;
        END;

        RETURN(TMP_REC);
END UPDATE;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                DELETE INDEX & DATA FILE ENTRY ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DELETE:
        PROC (DATA_RECORD);
DCL
        (DATA_RECORD,FLD,KEY) FIXED;

        DO KEY = 0 TO MAX_KEY;
                FLD = KEY_MAP(KEY);
                IF OLD_FLD(FLD) ^= '' THEN
                        CALL DEL_KEY(KEY,DATA_RECORD);
        END;

        IF RETREC(FILE_NO,XLOCK,DATA_RECORD) ^= 0 THEN
                CALL ERROR_TYPE(DATA_RECORD,9);
        IF LOKCOD() ^= 0 THEN
                CALL LOKTYP(9);
END DELETE;

/*
                END OF UTILITY FUNCTIONS

   ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 */

END;
```

DATABAS2.PLI

```
ENTDAT:
        PROC (ENTER_MODE,DRN) RETURNS (CHAR(4)) EXTERNAL;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                DATA ENTRY ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
DCL
        UNIQUE BIT(1),
        (DRN,FLD,OP_VAL,FLD_NO) FIXED,
        OP CHAR(2) VAR,
        OP1 CHAR(1),
        TEMP_MODE FIXED,
        ENTER_MODE CHAR(3);

%INCLUDE 'DATABASE.DCL';
%INCLUDE 'AM86EXTR.PLI';

DCL
        CLRSCR ENTRY,
        LOKTYP ENTRY (FIXED);

        IF ENTER_MODE = 'NEW' THEN
                DO FLD = 0 TO MAX_FIELD;
                        OLD_FLD(FLD) = '';
                END;

        IF ENTER_MODE = 'OLD' THEN
                DO FLD = 0 TO MAX_FIELD;
                        NEW_FLD(FLD) = OLD_FLD(FLD);
                END;

        CALL CLRSCR();

        IF ENTER_MODE = 'NEW' THEN
                DO;
                PUT SKIP EDIT ('Enter New Customer Information') (X(19),A);
                PUT SKIP EDIT ('******************************') (X(19),A);
                PUT SKIP(3) LIST (
                    '    [Enter zero for customer # to see main menu.]');
                PUT SKIP(2);

                DO FLD = 0 TO MAX_FIELD;
                        FLD_NO = FLD + 1;
REDO_DATA:
                        PUT EDIT (FLD_NO,' - ',FLD_NAME(FLD),
                                '(',FLD_LEN(FLD),') >>')
                                (F(6),2A,COLUMN(30),A,F(2),A);
                        GET LIST (NEW_FLD(FLD));
                        IF FLD = KEY_MAP(UNIQ_KEY) & NEW_FLD(FLD) = '0' THEN
                                RETURN('STOP');

                        IF FLD = KEY_MAP(UNIQ_KEY) THEN
                                DO;
                                NEW_FLD(FLD) = RIGHT('0000' || NEW_FLD(FLD),
                                        FLD_LEN(FLD));
                                UNIQUE = TEST_UNIQUENESS();
```

Listing 3-2. (continued)

```
                        END;
                    ELSE
                        DO;
                        NEW_FLD(FLD) = SUBSTR(NEW_FLD(FLD),1,
                                FLD_LEN(FLD));
                        UNIQUE = YESBIT;
                        END;

                    IF ^UNIQUE THEN GOTO REDO_DATA;
                END;
                TEMP_MODE = NEW_MODE;
                END;
        ELSE
                TEMP_MODE = OLD_MODE;

        DO WHILE (FOR_EVER);
                PUT SKIP(4) EDIT ('Current customer information')
                        (X(19),A);
                PUT SKIP;

                DO FLD = 0 TO MAX_FIELD;
                        FLD_NO = FLD + 1;
                        PUT SKIP EDIT (FLD_NO,' - ',FLD_NAME(FLD),NEW_FLD(FLD))
                                (F(6),2A,COLUMN(30),A);
                END;

                IF TEMP_MODE = OLD_MODE THEN
                        BEGIN;
                        OP_VAL = 0;
                        ON ERROR(1)
                                BEGIN;
                                OP_VAL = 0;
                                GOTO RETRY_OLD;
                                END;
RETRY_OLD:
                        DO WHILE (OP_VAL < 1 | OP_VAL > NO_FIELDS);
                                PUT SKIP(3) EDIT (
'Enter C to continue scan, Field # to change data, S to save changes,',
'D to delete data, B for back scan, or E to end scan >>') (A,SKIP,A);
                                GET LIST (OP);
                                OP1 = OP;
                                IF OP1 = 'C' | OP1 = 'c' THEN RETURN('CONT');
                                IF OP1 = 'S' | OP1 = 's' THEN
                                        RETURN(SET_XLOCK(OP1,DRN));
                                IF OP1 = 'D' | OP1 = 'd' THEN
                                        RETURN(SET_XLOCK(OP1,DRN));
                                IF OP1 = 'B' | OP1 = 'b' THEN RETURN('BACK');
                                IF OP1 = 'E' | OP1 = 'e' THEN RETURN('STOP');
                                OP_VAL = OP;
                        END;
                        CALL UPDATE_FIELD(OP_VAL);
                        END;
                ELSE
                        BEGIN;
                        OP_VAL = 0;
```

Listing 3-2. (continued)

```
                        ON ERROR(1)
                                BEGIN;
                                OP_VAL = 0;
                                GOTO RETRY_NEW;
                                END;
RETRY_NEW:
                        DO WHILE (OP_VAL < 1 | OP_VAL > NO_FIELDS);
                                PUT SKIP (3) EDIT (
'Enter S to save data, Field # to change data,',
'D to delete data, or E to end input >>') (A,SKIP,A);
                                GET LIST (OP);
                                OP1 = OP;
                                IF OP1 = 'S' | OP1 = 's' THEN RETURN('SAVE');
                                IF OP1 = 'D' | OP1 = 'd' THEN RETURN('DELT');
                                IF OP1 = 'E' | OP1 = 'e' THEN RETURN('STOP');
                                OP_VAL = OP;
                        END;
                        CALL UPDATE_FIELD(OP_VAL);
                        END;
        END;


SET_XLOCK:
        PROC (OP,DRN) RETURNS (CHAR(ACTION_LEN));
DCL
        DRN FIXED,
        (DUMMY,OP) CHAR(1);

        DUMMY = 'W';
        DO WHILE (DUMMY = 'W' & SETLOK(FILE_NO,XLOCK,DRN) ^=  0);
                PUT SKIP (2) EDIT (
'Customer update on hold due to record lock',
'Enter W if you want to wait or any other key to cancel update>>')
(A,SKIP,A);
                GET LIST (DUMMY);
                IF DUMMY = 'w' THEN DUMMY = 'W';
        END;

        IF DUMMY = 'W' THEN
                DO;
                IF OP = 'S' THEN
                        RETURN('SAVE');
                ELSE
                        RETURN('DELT');
                END;
        ELSE
                RETURN(OLD_ACTION);
END SET_XLOCK;
```

Listing 3-2. (continued)

```
/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                UPDATE DATA FIELD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
UPDATE_FIELD:
        PROC (FLD_NO);
DCL
        TEST BIT(1),
        (FLD_NO,FIELD_NO) FIXED;

        FIELD_NO = FLD_NO-1;
        TEST = NOBIT;

        DO WHILE (~TEST);
                PUT SKIP(2) EDIT ('Input new ',FLD_NAME(FIELD_NO),'>>')
                        (3A);
                GET LIST (NEW_FLD(FIELD_NO));

                IF FIELD_NO = KEY_MAP(UNIQ_KEY) THEN
                        NEW_FLD(FIELD_NO) = RIGHT('0000' || NEW_FLD(FIELD_NO),
                                FLD_LEN(FIELD_NO));
                ELSE
                        NEW_FLD(FIELD_NO) = SUBSTR(NEW_FLD(FIELD_NO),1,
                                FLD_LEN(FIELD_NO));

                IF FIELD_NO = KEY_MAP(UNIQ_KEY) & NEW_FLD(FIELD_NO) ~=
                    OLD_FLD(FIELD_NO) THEN
                        TEST = TEST_UNIQUENESS();
                ELSE
                        TEST = YESBIT;
        END;
END UPDATE_FIELD;

/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                CUST # UNIQUENESS TEST ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
TEST_UNIQUENESS:
        PROC RETURNS (BIT(1));
DCL
        TEMP FIXED,
        TEST CHAR(MAX_FLD_LEN) VAR;

        TEST = NEW_FLD(KEY_MAP(UNIQ_KEY));
        TEMP = GETKEY(UNIQ_KEY,0,NLOCK,TEST);

        IF LOKCOD() ~= 0 THEN
                CALL LOKTYP(12);
        IF TEMP = 0 THEN
                RETURN(YESBIT);
        ELSE
                DO;
```

Listing 3-2. (continued)

```
                PUT SKIP(2) LIST (' *** Already Assigned ***');
                PUT SKIP;
                RETURN(NOBIT);
                END;
END TEST_UNIQUENESS;


/*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                RIGHT STRING ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 */
RIGHT:
        PROC (FLDSTR,FLDLEN) RETURNS (CHAR(MAX_FLD_LEN) VAR);
DCL
        FLDLEN FIXED,
        FLDSTR CHAR(MAX_FLD_LEN) VAR;

        RETURN(SUBSTR(FLDSTR,LENGTH(FLDSTR)-FLDLEN+1));
END RIGHT;

END ENTDAT;
```

Listing 3-2. (continued)

End of Section 3

Section 4
Using Access Manager with Pascal/MT+86 Applications

This section contains instructions for implementing Access Manager with application programs coded in Pascal/MT+86.

Two examples are provided. The first illustrates the use of many Access Manager functions described in the Access Manager Reference Manual, and in particular, how to use the data file functions in your Pascal/MT+86 applications. The second example illustrates the use of Access Manager to create and maintain a data base.

4.1 Linking Access Manager to Pascal/MT+86 Application Programs

This section discusses a Pascal/MT+86 application program that you write and compile to produce a binary relocatable file called MYPROG.

4.1.1 Linking Single-user Pascal/MT+86 Applications

You must link your compiled application program to the appropriate Access Manager subroutine library and index file buffer module. You can use the following command line to create an executable version of MYPROG:

```
LINKMT MYPROG,AM86PASC/S,AM86BUF,PASLIB/S
```

Before linking, be sure that AM86BUF.R86 is large enough to contain your buffers, as specified in the SETUP function. You can use SETAMBUF to create a correctly sized buffer module. For further details, see the example link statements for DATABASE.SRC and RECREATE.SRC in this section.

4.1.2 Linking Multiuser Pascal/MT+86 Applications

If your single-user version of MYPROG is coded with appropriate data locking procedures, you do not have to recompile it to create a multiuser version. All that is necessary is to relink the program.

You must link your compiled application program to the appropriate Access Manager multiuser interface. The interface makes the queue calls to the shared code in the background server. The background server resides in its own memory segment.

To create a CMD file that calls the Access Manager background server, use LINKMT.CMD as follows:

```
LINKMT MYPROG,AMQ6PASC,PASLIB/S
```

4.2 External Delcaration of Access Manager Routines

Pascal/MT+86 requires that external routines (i.e., those not coded in the program module but referenced by it) be explicitly declared. The file AM86EXTR.PSC contains external function declarations for the entire set of Access Manager routines. Use the Include File compiler toggle of Pascal/MT+86 to make these external declarations a part of your application program. For example,

```
{$I AM86EXTR.PSC}
```

includes the external declarations as required.

All Access Manager string-valued parameters (FILNAME, IDXNAME, KEYVAL, and IDXVAL) must be declared as type STRING. Strings, as compared to character arrays, reserve the leading byte for a length counter Access Manager needs to determine the actual length of a string-valued parameter.

4.3 Coding Numeric Key Values

For a general discussion of coding numeric key values, refer to the ADDKEY function description in Section 3 of the Access Manager Reference Manual.

In a Pascal/MT+86 environment, the most straightforward use of numeric keys is with the BCD REAL variables that store numeric quantities with the most significant digits in the first byte position, the least significant digits in the ninth byte, and the sign indicator in the tenth byte. Because the most significant byte comes last, negative quantities are not properly handled and you should avoid them. The BCD REALS provide eighteen digits including four decimal places.

The following declarations and assignments overlay BCD REALS onto the string variables that must be passed to the Access Manager functions.

```
CONST
     KEYLEN BY 10;              (* BCD REAL uses ten bytes *)

TYPE
     BCDOVL = RECORD;
           LEN : BYTE;
           VAL : REAL;          (* use compiler B switch *)

VAR
     KEYVAL,IDXVAL : STRING[KEYLEN];
     BCDINP,BCDOUT : ^BCDOVL;

{$I AM86EXTR.PSC}

BCDINP := ADDR(KEYVAL);         (* overlay bcd on string *)
BCDINP^.LEN := KEYLEN;          (* set length byte of string *)
BCDOUT := ADDR(IDXVAL);
BCDOUT^.LEN := KEYLEN;
```

Use KEYVAL and IDXVAL, respectively to pass key values to and from Access Manager. Use BCDINP^.VAL and BCDOUT^.VAL to manipulate the key values as numeric quantities. For example,

```
BCDINP^.VAL := 123.4567;
DRN := BEFKEY(KEY_NO,DFILE,DLOCK,KEYVAL,IDXVAL);
IF (DRN <> 0) OR (DATVAL <> 0) THEN
     WRITELN(BCDOUT^.VAL);
```

prints the numeric value of the index entry that immediately precedes 123.4567, unless no such entry exists.

The space savings for this approach with Pascal/MT+86 is only meaningful if numbers with more than ten digits are involved because BCD REALS are forced to use ten bytes, and hence the key length must be set to ten bytes. Note that you can accomplish the same kind of overlaying with INTEGER variables. If you overlay integers instead of reals, the key length must be set as necessary (that is, two bytes for regular integers and four bytes for long integers), and then set KEYTYP to one. The key values are treated as signed integers.

4.4 Using the RECREATE.SRC Utility Program

RECREATE.SRC contains the Pascal/MT+86 source code for the RECREATE utility program. You can change the source code in whatever way you want.

To create RECREATE.CMD, compile RECREATE.SRC using MT+86.CMD and then link as follows:

```
LINKMT RECREATE,AM86PASC/S,AM86BUF,FPREALS/S,
       RANDOMIO/S,PASLIB/S
```

The buffer area for RECREATE is 4,844 bytes based on the following parameter values:

- NNSEC% = 4
- NBUFS% = 8
- NDATF% = 1
- NKEYS% = 1

Note that only one data file and one index file are open at the same time that RECREATE is running. Use SETAMBUF to configure AM86BUF.R86.

Table 4-1 shows the layout and content of records in a Recreate Parameter File. This particular example file can be used to reconstruct DATABASE.SRC (see Listing 4-2).

Table 4-1. Example Pascal/MT+86 Recreate Parameter File

Record Type	Contents
Header	1 4
Data File	CUSTOMER.DAT
Data File	100 3 0
Index File	NAME.IDX
Index File	10 0 1 1
Index File	Y
Key Part	22 8
Index File	NUMB.IDX
Index File	4 0 0 1
Index File	N
Key Part	2 4
Index File	ZIPC.IDX
Index File	11 0 1 1
Index File	Y
Key Part	84 9

If you want to change the capacities of the RECREATE program and, hence, its memory requirements, note the following key Pascal constants.

- MAX_NO_KEYS and MAX_KEY_PARTS specify the maximum number of index files associated with a data file and the maximum number of fields comprising a key value, respectively.
- MAX_SORT is the maximum number of key values that can be buffered by RECREATE.SRC before being sorted and added to the index file being recreated.
- MAX_SPACE specifies the actual number of bytes available for the buffered key values. Each key value requires one more byte than its key length.

The actual number of buffered key values depends on the key length. For short key lengths, MAX_SORT is the limiting factor. For long key lengths, MAX_SPACE is the limiting factor.

4.5 Pascal/MT+86 Data File Example

The following listing illustrates the use of the primary Access Manager functions to update records in a data file.

```
PROGRAM EXAMPLE;

CONST
     MAX_KEY_LEN = 48;
     NAME_LEN = 14;

TYPE
     INVENTRY = RECORD
          PART_NO : ARRAY[1..4] OF CHAR;
          PART_NAME : ARRAY[1..18] OF CHAR;
       PART_QUAN : REAL; (* 10-byte BCD Real => use B switch
                            of PASCAL/MT+ Compiler          *)
     END;

(*   ------------------------------------------------------
          Variable Declarations
     ------------------------------------------------------
*)
VAR
     N_LOCK,S_LOCK,X_LOCK,S_FILE,X_FILE : INTEGER;
     NBUF,NKEYS,NNSEC,NDATF,ERROPT,PROGID,TIMOUT : INTEGER;
     DRN,DRN2,FILE_NO,RECORD_LEN : INTEGER;
     DAT_BUFFER : INVENTRY;
     DATBUF_PTR : ^INVENTRY;

(*   ------------------------------------------------------
          AM86 External Declarations
     ------------------------------------------------------
*)
{$I AM86EXTR.PSC}
```

Listing 4-1. Pascal/MT+86 Data File Example

```
(*   ------------------------------------------------------
          Exception Processing Routines
     ------------------------------------------------------
*)
PROCEDURE ERROR_HANDLER(LOCALE : INTEGER);
     BEGIN
     WRITELN('ERROR at ',LOCALE,' with code ',ERRCOD);
     END;

PROCEDURE LOCK_CONFLICT(LOCALE : INTEGER);
     BEGIN
     WRITELN('LOCK Conflict at ',LOCALE,' with code ',LOKCOD);
     END;

BEGIN

(*   ------------------------------------------------------
          Lock Parameter Setup
     ------------------------------------------------------
*)
N_LOCK := 0;    (*  No lock request       *)
S_LOCK := 1;    (*  Shared record lock    *)
X_LOCK := 2;    (*  Exclusive record lock *)
S_FILE := 3;    (*  Shared file lock      *)
X_FILE := 4;    (*  Exclusive file lock   *)

(*   ------------------------------------------------------
          System Initialization Parameters
     ------------------------------------------------------
*)
NBUF := 3;      (*  3 buffers                                *)
NKEYS := 1;     (*  1 index file                             *)
NNSEC := 4;     (*  512-byte index file record length        *)
NDATF := 1;     (*  1 data file                              *)
ERROPT := 1;    (*  Trap user errors                         *)
PROGID := -1;   (*  Program ID assigned to MP/M console no.  *)
TIMOUT := 3;    (*  Background server time-out delay         *)

(*   ------------------------------------------------------
          Initialize System
     ------------------------------------------------------
*)
PROGID := INTUSR(PROGID,ERROPT,TIMOUT);
IF ERRCOD <> 0 THEN
     BEGIN
     ERROR_HANDLER(1);
     EXIT;
     END
IF SETUP(NBUF,NKEYS,NNSEC,NDATF) <> 0 THEN
     BEGIN
     ERROR_HANDLER(2);
     EXIT;
     END;
```

Listing 4-1. (continued)

```
(*   ------------------------------------------------------
          Open Files
     ------------------------------------------------------
*)
FILE_NO := -1;       (*  Automatic file number assignment  *)
RECORD_LEN := 32;
FILE_NAME := 'K:PART.DAT';
FILE_NO := OPNDAT(FILE_NO,S_FILE,FILEF_NAME,RECORD_LEN);

IF ERRCOD <> 0 THEN
     BEGIN
     ERROR_HANDLER(3);
     EXIT;
     END
IF LOKCOD <> 0 THEN
     BEGIN
     LOCK_CONFLICT(3);
     EXIT;
     END;

(*   ------------------------------------------------------
          Initialize Data Buffer Pointer
     ------------------------------------------------------
*)
DATBUF_PTR := ADDR(DAT_BUFFER);

(*   ------------------------------------------------------
          Set Exclusive Lock on Data Record No. 65686
     ------------------------------------------------------
*)
DRN2 := 1;
SETDAT(DRN2);        (*  Set two high-order bytes to 1,
                         which implies a base of 65536  *)
DRN := 150;          (*  65686 = 65536 + 150            *)
IF SETLOK(FILE_NO,X_LOCK,DRN) <> 0 THEN
     BEGIN
     LOCK_CONFLICT(4);
     EXIT;
     END;

(*   ------------------------------------------------------
          Read Data Record
     ------------------------------------------------------
*)
SETDAT(DRN2);
IF READAT(FILE_NO,DRN,DATBUF_PTR) <> 0 THEN
     BEGIN
     ERROR_HANDLER(4);
     EXIT;
     END;
```

Listing 4-1. (continued)

```
(*   ------------------------------------------------------
          Update Data Record
     ------------------------------------------------------
*)
DAT_BUFFER.PART_QUAN := DAT_BUFFER.PART_QUAN - 100.00;

(*   ------------------------------------------------------
          Write Updated Record
     ------------------------------------------------------
*)
SETDAT(DRN2);
IF WRTDAT(FILE_NO,DRN,DATBUF_PTR) <> 0 THEN
     BEGIN
     ERROR_HANDLER(5);
     EXIT;
     END;

(*   ------------------------------------------------------
          Release Record Lock
     ------------------------------------------------------
*)
SETDAT(DRN2);
IF FRELOK(FILE_NO,X_LOCK,DRN) <> 0 THEN
     BEGIN
     LOCK_CONFLICT(6);
     EXIT;
     END;

(*   ------------------------------------------------------
          Close Data File and Release File Lock
     ------------------------------------------------------
*)
IF CLSDAT(FILE_NO) <> 0 THEN
     ERROR_HANDLER(7);
ELSE IF FRELOK(FILE_NO,S_FILE,0) <> 0 THEN
     LOCK_CONFLICT(7);

END.
```

Listing 4-1. (continued)

4.6 Pascal/MT+86 DATABASE Source Code

Your Access Manager distribution disk contains sample code for building and maintaining a data base in Pascal/MT+86. The code is designed so you can add or substitute your own key attributes as required. The sample code is on your distribution disk in a file called DATABASE.SRC.

DATABASE.SRC demonstrates the integration of Access Manager with Pascal/MT+86 applications. It builds a name and address data base and provides facilities for examining, updating, and/or listing the information contained therein. You might also want to use routines from DATABASE.SRC directly in your application programs.

[SINGLE] To create DATABASE.CMD, compile DATABASE.SRC with MT+86.CMD and link as follows:

```
LINKMT DATABASE,AM86PASC/S,AM86BUF,PASLIB/S
```

[MULTI] In a multiuser environment, your link statement should be entered as follows:

```
LINKMT DATABASE,AMQ6PASC,PASLIB/S
```

Note that the listing of DATABASE.SRC (Listing 4-2) might not include recent changes. You should always treat the copy on your distribution disk as the definitive version.

```
PROGRAM DATABASE;

(* ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

        DATABASE EXAMPLE VERSION 1.0 9/14/82  0935

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 *)

(*$E-*)

CONST
        MAX_KEY = 2;
        MAX_FIELD = 7;
        MAX_KEY_LEN = 20;
        MAX_FLD_LEN = 20;
        NAME_LEN = 14;
        FLD_NAME_LEN = 18;
        ACTION_LEN = 4;
        NEW_MODE = 1;
        OLD_MODE = 2;
        YES = 1;
        NO = 0;
        SAVE = 1;
        DELT = 2;
        BACK = 3;
        CONT = 4;
        STOP = 5;

TYPE
        BYTEPTR = ^BYTE;
        KEYSTR = STRING[MAX_KEY_LEN];
        FLDSTR = STRING[MAX_FLD_LEN];

        FLD_REC = RECORD;
                LENBYTE : BYTE;
                FLDCHR  : ARRAY[1..MAX_FLD_LEN] OF CHAR;
        END;

        CUST_REC = RECORD;
                CDF : CHAR;
                FLD : ARRAY[1..99] OF CHAR;
        END;
```

Listing 4-2. DATABASE.SRC Source Code Listing

```
(*
        WORKING VARIABLES
 *)

VAR
        KEY,TERMINAL,TRAP_ERRORS,TIME_OUT_TEST_DELAY,NO_BUFFERS : INTEGER;
        NO_NODE_SECTORS,NO_DATA_FILES,NO_KEYS,FILE_NO : INTEGER;
        RECORD_LENGTH : INTEGER;
        SET_LENGTH,IDX_KEY,SPACE : KEYSTR;
        OLD_ACTION : INTEGER;
        FILNAME : STRING[NAME_LEN];
        NULL_BYT : BYTE;
        NULL_CHR : CHAR;

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
          DATABASE FIELD & KEY DESCRIPTORS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
        DATBUF : CUST_REC;
        DATBUF_PTR : ^CUST_REC;
        FLD_NAME,KEY_NAME : ARRAY[0..MAX_FIELD] OF STRING[FLD_NAME_LEN];
        FLD_LEN : ARRAY[0..MAX_FIELD] OF BYTE;
        OLD_FLD,NEW_FLD : ARRAY[0..MAX_FIELD] OF FLDSTR;
        NO_FIELDS : INTEGER;

        IDX_NAME : ARRAY[0..MAX_KEY] OF STRING[NAME_LEN];
        KEY_LEN,KEY_MAP,KEY_TYPE,KEY_NUM,KEY_DUP : ARRAY[0..MAX_KEY] OF
                INTEGER;
        FOR_EVER : BOOLEAN;
        UNIQ_KEY,NLOCK,SLOCK,XLOCK,SFILE,XFILE,RLOCK : INTEGER;

(*
        INTERFACE TO ACCESS MANAGER(tm)

        AM86EXTR.PSC CONTAINS THE EXTERNAL DEFINITIONS OF THE ACCESS MANAGER
        ROUTINES
 *)

{$I AM86EXTR.PSC}

EXTERNAL FUNCTION @BDOS86(FUNC:INTEGER; PARM:BYTEPTR) : INTEGER;

PROCEDURE GO_OP_SYS;

VAR
        DUMMY : INTEGER;
        DPARM : BYTEPTR;

        BEGIN
        DUMMY := @BDOS86(0,DPARM);
        END;{GO_OP_SYS}
```

Listing 4-2. (continued)

```
PROCEDURE DATA_BASE;

        BEGIN
        CLRSCR;

        CASE MAIN_MENU OF

1: DBNEW;
2: DBSCAN;
3: DBLIST;
4: DBSTAT;
5: DBSAVE;
6: DBTERM;
        END;{OF CASE}
        END;{DATA_BASE}


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                ENTER NEW CUSTOMERS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DBNEW;
VAR
        KEY,LOCK_CODE,NDRN,DRN,CHOICE : INTEGER;
        SAVE_KEY,LDRN,NO_LISTED : INTEGER;
        ROUTE : CHAR;
        CONTINUE,STAYPUT : BOOLEAN;
        L_VALUE,U_VALUE,CONV_TARGET,TARGET : KEYSTR;
        ACTION : INTEGER;


  BEGIN
     ACTION := SAVE;
     WHILE (ACTION = SAVE) DO
        BEGIN
        ACTION := NEWDAT;
        LOCK_CODE := 0;
        IF ACTION = SAVE THEN
                BEGIN
                NDRN := UPDATE(0);
                LOCK_CODE := FRELOK(FILE_NO,XLOCK,NDRN);
                END;

        IF LOCK_CODE <> 0 THEN
                LOCK_TYPE(8);
        END;
   END;{DBNEW}
```

Listing 4-2. (continued)

```
(* ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                SCAN/UPDATE/DELETE CUSTOMERS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DBSCAN;
VAR
        KEY,LOCK_CODE,NDRN,DRN,CHOICE : INTEGER;
        SAVE_KEY,LDRN,NO_LISTED : INTEGER;
        ROUTE : CHAR;
        CONTINUE,STAYPUT : BOOLEAN;
        L_VALUE,U_VALUE,CONV_TARGET,TARGET : KEYSTR;
        ACTION : INTEGER;


   BEGIN
     KEY := SEARCH_KEY;
     WRITELN;
     WRITELN ('Enter target value for ',KEY_NAME[KEY],',');
     WRITE('     or enter a period (.) to see main menu>>');
     READLN(TARGET);
     IF TARGET <> '.' THEN
        BEGIN
        CONV_TARGET := TARGET;
        KEY_FORMAT(KEY,CONV_TARGET);
        STAYPUT := TRUE;
        WHILE (STAYPUT) DO
                BEGIN
                DRN := SERKEY(KEY_NUM[KEY],FILE_NO,SLOCK,
                        CONV_TARGET,IDX_KEY);
                IF ERRCOD <> 0 THEN
                        ERROR_TYPE(KEY,2);
                IF LOKCOD <> 0 THEN
                        STAYPUT := CHECK_LOCK(KEY,DRN)
                ELSE
                        STAYPUT :=FALSE;
                END;

        OLD_ACTION := CONT;
        CONTINUE := TRUE;
        WHILE (CONTINUE) AND (DRN <> 0) DO
                BEGIN
                LDRN := DRN;
                READ_CUST(DRN);
                ACTION := OLDDAT(DRN);
                SAVE_KEY := KEY;
                IF ACTION = SAVE THEN
                        DRN := UPDATE(DRN);
                IF ACTION = DELT THEN
                        DELETE(DRN);
                IF (ACTION <> DELT) AND (FRELOK(FILE_NO,RLOCK,LDRN) <> 0)
                        THEN LOCK_TYPE(2);
                IF (ACTION = SAVE) OR (ACTION = DELT) THEN
                        BEGIN
                        KEY := SAVE_KEY;
                        ACTION := OLD_ACTION;
```

Listing 4-2. (continued)

```
                    END;
                OLD_ACTION := ACTION;
                CONV_TARGET := COPY(IDX_KEY,1,KEY_LEN[KEY]);
                IDX_KEY := SET_LENGTH;
                LOCK_CODE := 0;

                STAYPUT := TRUE;
                WHILE (STAYPUT) DO
                    BEGIN
                    IF ACTION = CONT THEN
                        BEGIN
                        DRN := AFTKEY(KEY_NUM[KEY],FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
                        LOCK_CODE := LOKCOD;
                        END;
                    IF ACTION = BACK THEN
                        BEGIN
                        DRN := BEFKEY(KEY_NUM[KEY],FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
                        LOCK_CODE := LOKCOD;
                        END;

                    IF LOCK_CODE <> 0 THEN
                        STAYPUT := CHECK_LOCK(KEY,DRN)
                    ELSE
                        STAYPUT := FALSE;
                    END;

                IF ACTION = STOP THEN
                        CONTINUE := FALSE;
                END;

        WRITELN;
        WRITELN('SCAN ENDED');
        PAUSE;
        END;
    END;{DBSCAN}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                        LIST CUSTOMERS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DBLIST;
VAR
        KEY,LOCK_CODE,NDRN,DRN,CHOICE : INTEGER;
        SAVE_KEY,LDRN,NO_LISTED : INTEGER;
        ROUTE : CHAR;
        CONTINUE,STAYPUT : BOOLEAN;
        L_VALUE,U_VALUE,CONV_TARGET,TARGET : KEYSTR;
        ACTION : INTEGER;
```

Listing 4-2. (continued)

```
  BEGIN
       KEY := SEARCH_KEY;
       WRITELN;
       WRITE('Do you want listing routed to printer (Y/N) >>');
       READLN(ROUTE);
       IF ROUTE = 'y' THEN ROUTE := 'Y';

       WRITELN;
       WRITELN;
       WRITELN(
'Enter lower and upper limits for ',KEY_NAME[KEY],' listing;');
       WRITE('     place values on separate lines >>') ;
       READLN(L_VALUE);
       READLN(U_VALUE);
       KEY_FORMAT(KEY,L_VALUE);
       KEY_FORMAT(KEY,U_VALUE);
       DRN := SERKEY(KEY_NUM[KEY],FILE_NO,SLOCK,
              L_VALUE,IDX_KEY);
       IF LOKCOD <> 0 THEN
              SKIP_LOCK(KEY,DRN);

       NO_LISTED := 0;
       WHILE (DRN <> 0) AND (COMPARE(KEY,IDX_KEY,U_VALUE) <= 0) DO
              BEGIN
              READ_CUST(DRN);
              PRINT_CUST(ROUTE);
              NO_LISTED := NO_LISTED + 1;
              IF FRELOK(FILE_NO,SLOCK,DRN) <> 0 THEN
                     LOCK_TYPE(4);
              L_VALUE := COPY(IDX_KEY,1,KEY_LEN[KEY]);
              IDX_KEY := SET_LENGTH;
              DRN := AFTKEY(KEY_NUM[KEY],FILE_NO,SLOCK,
                     L_VALUE,IDX_KEY);
              IF LOKCOD <> 0 THEN
                     SKIP_LOCK(KEY,DRN);
              END;

       IF DRN <> 0 THEN
              LOCK_CODE := FRELOK(FILE_NO,SLOCK,DRN)
       ELSE
              LOCK_CODE := 0;
       IF LOCK_CODE <> 0 THEN
              LOCK_TYPE(5);

       WRITELN;
       WRITELN(NO_LISTED,' records listed.');
       PAUSE;
  END;{DBLIST}
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                  DATABASE STATISTICS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DBSTAT;
VAR
        KEY,LOCK_CODE,NDRN,DRN,CHOICE : INTEGER;
        SAVE_KEY,LDRN,NO_LISTED : INTEGER;
        ROUTE : CHAR;
        CONTINUE,STAYPUT : BOOLEAN;
        L_VALUE,U_VALUE,CONV_TARGET,TARGET : KEYSTR;
        ACTION : INTEGER;


   BEGIN
        CLRSCR;
        WRITELN(FILNAME,' has ',GETDFS(FILE_NO),
                ' records; currently, ',GETDFU(FILE_NO),
                ' of them are in use.');
        WRITELN;
        WRITELN;
        WRITELN('    INDEX','ENTRIES':30);
        WRITELN ('----------------','-------':22);
        FOR KEY := 0 TO MAX_KEY DO
                WRITELN(KEY_NAME[KEY]:16,' ':16,NOKEYS(KEY):7);

        WRITELN;
        WRITELN;
        PAUSE;
   END;{DBSTAT}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                  SAVE DATABASE UPDATES & RESTART
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DBSAVE;
VAR
        KEY,LOCK_CODE,NDRN,DRN,CHOICE : INTEGER;
        SAVE_KEY,LDRN,NO_LISTED : INTEGER;
        ROUTE : CHAR;
        CONTINUE,STAYPUT : BOOLEAN;
        L_VALUE,U_VALUE,CONV_TARGET,TARGET : KEYSTR;
        ACTION : INTEGER;


   BEGIN
        IF SAVDAT(FILE_NO) <> 0 THEN
                ERROR_TYPE(0,7);
        FOR KEY := 0 TO MAX_KEY DO
                IF SAVIDX(KEY_NUM[KEY]) <> 0 THEN
                        ERROR_TYPE(KEY,3);
   END;{DBSAVE}
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                SAVE DATABASE UPDATES & TERMINATE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DBTERM;
VAR
        KEY,LOCK_CODE,NDRN,DRN,CHOICE : INTEGER;
        SAVE_KEY,LDRN,NO_LISTED : INTEGER;
        ROUTE : CHAR;
        CONTINUE,STAYPUT : BOOLEAN;
        L_VALUE,U_VALUE,CONV_TARGET,TARGET : KEYSTR;
        ACTION : INTEGER;


   BEGIN
        IF FRELOK(FILE_NO,SFILE,0) <> 0 THEN
                ERROR_TYPE(0,13);
        IF CLSDAT(FILE_NO) <> 0 THEN
                ERROR_TYPE(0,15);
        FOR KEY := 0 TO MAX_KEY DO
                IF CLSIDX(KEY_NUM[KEY]) <> 0 THEN
                        ERROR_TYPE(KEY,16);


        WRITELN;
        WRITELN(' ***  SUCCESSFUL TERMINATION ***');
        FOR_EVER := FALSE;
   END;{DBTERM}

(*
   ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

                Beginning of Utility Functions

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                        CLEAR SCREEN ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE CLRSCR;
VAR
        DUMMY : INTEGER;

        BEGIN
        FOR DUMMY := 1 TO 24 DO
                WRITELN;
        END;{CLRSCR}
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                        MAIN MENU ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
FUNCTION MAIN_MENU : INTEGER;
VAR
        OP : INTEGER;

        BEGIN
        WRITELN(' ':19,' ACCESS MANAGER(tm) DEMONSTRATION');
        WRITELN;
        WRITELN(' ':19,'   Customer Database Operations') ;
        WRITELN(' ':19,'          Terminal ',TERMINAL);
        WRITELN(' ':19,'   ***************************');
        WRITELN;
        WRITELN;
        WRITELN('    1. Enter New Customers');
        WRITELN('    2. Scan/Update/Delete Customer Records');
        WRITELN('    3. List Customer Records');
        WRITELN('    4. Database Statistics');
        WRITELN('    5. Save All Files & Restart Operations');
        WRITELN('    6. Terminate Operations');

        OP := 0;
        WHILE (OP < 1) OR (OP > 6) DO
                BEGIN
                WRITELN;
                WRITE('Enter desired operation number>>');
                READLN(OP);
                END;
        MAIN_MENU := OP;
        END;{MAIN_MENU}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                    SELECT SEARCH KEY ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
FUNCTION SEARCH_KEY : INTEGER;
VAR
        KEY,KEY_NO : INTEGER;

        BEGIN
        CLRSCR;
        WRITELN(' ':24,'Customer Database Search Keys');
        WRITELN;
        WRITELN;
        WRITELN;

        FOR KEY := 0 TO MAX_KEY DO
                BEGIN
                KEY_NO := KEY + 1;
                WRITELN(KEY_NO,' - ',KEY_NAME[KEY])
                END;
```

Listing 4-2. (continued)

```
        KEY := 0;
        WHILE (KEY < 1) OR (KEY > NO_KEYZ) DO
                BEGIN
                WRITELN;
                WRITELN;
                WRITE('Enter desired key number>>');
                READLN(KEY);
                END;
        SEARCH_KEY := KEY-1;
        END;{SEARCH_KEY}


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                ERROR HANDLING
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE ERROR_TYPE(INFO,LOCALE : INTEGER);
VAR
        DUMMY : INTEGER;

PROCEDURE ET_CLOSE;
VAR
        T_KEY : INTEGER;

        BEGIN
        DUMMY := CLSDAT(FILE_NO);
        FOR T_KEY := 0 TO MAX_KEY DO
                IF T_KEY <> INFO THEN DUMMY := CLSIDX(KEY_NUM[T_KEY]);
        ET_STOP;
        END;

PROCEDURE ET_PCLOSE;
VAR
        L_KEY,T_KEY : INTEGER;

        BEGIN
        L_KEY := INFO + 1;
        IF L_KEY > MAX_KEY THEN GO_OP_SYS;
        FOR T_KEY := L_KEY TO MAX_KEY DO
                DUMMY := CLSIDX(KEY_NUM[T_KEY]);
        END;

PROCEDURE ET_STOP;

        BEGIN
        WRITELN;
        WRITELN('DATABASE TERMINATING WITH ERROR CODE #',ERRCOD);
        GO_OP_SYS;
        END;


        BEGIN
        WRITELN;
```

Listing 4-2. (continued)

```
        WRITELN;
        WRITE('User Error #',ERRCOD,' occurred while trying to ');

        CASE LOCALE OF

1:      WRITELN('open ',IDX_NAME[INFO]);
2:      WRITELN('search ',KEY_NAME[INFO],' Index File');
3:      WRITELN('save ',IDX_NAME[INFO]);
4:      WRITELN('remove old key from ',IDX_NAME[INFO]);
5:      WRITELN('enter key into ',IDX_NAME[INFO]);
6:      WRITELN('delete key from ',IDX_NAME[INFO]);
7: BEGIN
        WRITELN('save ',FILNAME);
        INFO := -1;
   END;
8:      WRITELN('get a new data record',' (',FILE_NO,')');
9:      WRITELN('delete data record #',INFO);
10:     WRITELN('open ',FILNAME,' (',FILE_NO,')');
11:     WRITELN('read data record #',INFO);
12:     WRITELN('write data record #',INFO);
13:     WRITELN('release shared file lock on ',FILNAME);
14: BEGIN
        WRITELN('initialize user.');
        GO_OP_SYS;
    END;
15: BEGIN
        WRITELN('close ',FILNAME);
        INFO := -1;
    END;
16:     WRITELN('close ',IDX_NAME[INFO]);

        END;{OF CASE}

        IF (LOCALE = 1) OR ((LOCALE > 7) AND (LOCALE < 13)) THEN
                ET_STOP
        ELSE IF (LOCALE = 2) OR ((LOCALE > 3) AND (LOCALE < 7)) OR
            (LOCALE = 13) THEN
                ET_CLOSE
        ELSE
                ET_PCLOSE;


        END;{ERROR_TYPE}

PROCEDURE LOCK_TYPE(LOCALE : INTEGER);
VAR
        T_KEY,DUMMY : INTEGER;

        BEGIN
        WRITELN('Lock Type: ',LOCALE,'  Lock Code:',LOKCOD);
        DUMMY := CLSDAT(FILE_NO);
        FOR T_KEY := 0 TO MAX_KEY DO
                DUMMY := CLSIDX(KEY_NUM[T_KEY]);
        GO_OP_SYS;
        END;{LOCK_TYPE}
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                READ DATA RECORD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE READ_CUST(DRN : INTEGER);
VAR
        FLD,CHR,POS_PTR : INTEGER;
        TMP_FLD : FLDSTR;
        FLDPTR : ^FLD_REC;

        BEGIN
        IF READAT(FILE_NO,DRN,DATBUF_PTR) <> 0 THEN
                ERROR_TYPE(DRN,11);

        FLDPTR := ADDR(TMP_FLD); (* PTR TO STRING *)

        POS_PTR := 0;
        FOR FLD := 0 TO MAX_FIELD DO
                BEGIN
                FLDPTR^.LENBYTE := FLD_LEN[FLD];
                FOR CHR := 1 TO FLDPTR^.LENBYTE DO
                        FLDPTR^.FLDCHR[CHR] := DATBUF.FLD[POS_PTR + CHR];

                WHILE (FLDPTR^.FLDCHR[FLDPTR^.LENBYTE] = ' ') AND
                    (FLDPTR^.LENBYTE > 0) DO
                        FLDPTR^.LENBYTE := FLDPTR^.LENBYTE - 1;
                OLD_FLD[FLD] := TMP_FLD;
                POS_PTR := POS_PTR + FLD_LEN[FLD];
                END;

        END;{READ_CUST}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                LIST CUSTOMER RECORD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE PRINT_CUST(ROUTE : CHAR);
VAR
        DUMMY : INTEGER;
        LIST_FILE : TEXT;

        BEGIN
        IF ROUTE = 'Y' THEN
                ASSIGN(LIST_FILE,'LST:')
        ELSE
                ASSIGN(LIST_FILE,'CON:');
        RESET(LIST_FILE);

        WRITELN(LIST_FILE);
        WRITELN(LIST_FILE,' ':4,OLD_FLD[0]:10,OLD_FLD[7]);
        WRITELN(LIST_FILE,' ':24,OLD_FLD[1],' ',OLD_FLD[2]);
        WRITELN(LIST_FILE,' ':24,OLD_FLD[3]);
        WRITELN(LIST_FILE,' ':24,OLD_FLD[4],', ',OLD_FLD[5],'    ',OLD_FLD[6]);
```

Listing 4-2. (continued)

```
        WRITELN(LIST_FILE);
        CLOSE(LIST_FILE,DUMMY);
        END;{PRINT_CUST}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                PAUSE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE PAUSE;
VAR
        NULL : CHAR;

        BEGIN
        WRITE('Press "RETURN" to continue ---');
        READLN(NULL);
        END;{PAUSE}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
        CONVERT TARGET VALUE TO KEY FORMAT ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE KEY_FORMAT(KEY : INTEGER;VAR TARGET : KEYSTR);
VAR
        TEMP : STRING[40];

        BEGIN
        IF UNIQ_KEY = KEY THEN
                EXIT
        ELSE
                BEGIN
                TEMP := CONCAT(TARGET,SPACE);
                TEMP :=COPY(TEMP,1,KEY_LEN[KEY]-2);
                TARGET :=  CONCAT(TEMP,NULL_CHR,NULL_CHR);
                END;
        END;{KEY_FORMAT}


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                COMPARE IDX_KEY & U_VALUE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
FUNCTION COMPARE(KEY : INTEGER; IDXVAL,UPVAL : KEYSTR) : INTEGER;
VAR
        KL : INTEGER;
        C1,C2 :  STRING[40];

        BEGIN
        IF KEY = UNIQ_KEY THEN
                KL := KEY_LEN[KEY]
        ELSE
                KL := KEY_LEN[KEY]-2;
```

Listing 4-2. (continued)

```
        C1 := CONCAT(IDXVAL,SPACE);
        C1 := COPY(C1,1,KL);
        C2 := CONCAT(UPVAL,SPACE);
        C2 := COPY(C2,1,KL);

        IF C1<C2 THEN
                COMPARE := -1
        ELSE IF C1>C2 THEN
                COMPARE := 1
        ELSE
                COMPARE := 0;
        END;{COMPARE}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                CHECK LOCK ROUTINES
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE SKIP_LOCK(KEY,DRN : INTEGER);
VAR
        L_VALUE : KEYSTR;

        BEGIN
        WHILE (DRN <> 0) AND (LOKCOD <> 0) DO
                BEGIN
                L_VALUE := COPY(IDX_KEY,1,KEY_LEN[KEY]);
                IDX_KEY := SET_LENGTH;
                DRN := AFTKEY(KEY_NUM[KEY],FILE_NO,SLOCK,
                        L_VALUE,IDX_KEY);
                END;
        END;{SKIP_LOCK}


FUNCTION CHECK_LOCK(KEY,DRN : INTEGER) : BOOLEAN;
VAR
        CONV_TARGET : KEYSTR;
        DUMMY : CHAR;

        BEGIN
        WRITELN;
        WRITE(
'Enter a "W" if you wish to wait for locked record(s)>>');
        READLN(DUMMY);

        IF (DUMMY = 'W') OR (DUMMY = 'w') THEN
                BEGIN
                CHECK_LOCK := TRUE;
                EXIT;
                END;

        WHILE (DRN <> 0) AND (LOKCOD <> 0) DO
                BEGIN
                CONV_TARGET := COPY(IDX_KEY,1,KEY_LEN[KEY]);
                IDX_KEY := SET_LENGTH;
                IF OLD_ACTION = CONT THEN
```

Listing 4-2. (continued)

```
                        DRN := AFTKEY(KEY_NUM[KEY],FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY)
                ELSE
                        DRN := BEFKEY(KEY_NUM[KEY],FILE_NO,
                                SLOCK, CONV_TARGET,IDX_KEY);
                END;
        CHECK_LOCK := FALSE;
        END;{CHECK_LOCK}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                WARNING MESSAGES
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE WARNING_TYPE(KEY,LOCALE,RET_CODE : INTEGER);

        BEGIN
        WRITELN;
        WRITE('WARNING...Return Code #',RET_CODE,
                ' occurred while trying to ');

        CASE LOCALE OF

1:      WRITELN('remove old key from ',IDX_NAME[KEY]);
2:      WRITELN('enter key into ',IDX_NAME[KEY]);
3:      WRITELN('delete key from ',IDX_NAME[KEY]);

        END; {OF CASE}
        PAUSE;
        END;{WARNING_TYPE}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                ADD NEW KEY VALUE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE ADD_A_KEY(KEY,DRN : INTEGER);
VAR
        RET_CODE,K_FLD : INTEGER;

        BEGIN
        K_FLD := KEY_MAP[KEY];

(*  ----------------------------
        Remove Old Key Value
 *) ----------------------------
        RET_CODE := DELKEY(KEY_NUM[KEY],FILE_NO,
                XLOCK,OLD_FLD[K_FLD],DRN);

        IF ERRCOD <> 0 THEN
                ERROR_TYPE(KEY,4);
        IF LOKCOD <> 0 THEN
                LOCK_TYPE(6);
        IF RET_CODE <> 1 THEN
                WARNING_TYPE(KEY,1,RET_CODE);
```

Listing 4-2. (continued)

```
(*  ----------------------------
        Add New Key Value
*)  ----------------------------

        RET_CODE := ADDKEY(KEY_NUM[KEY],FILE_NO,
                XLOCK,NEW_FLD[K_FLD],DRN);

        IF ERRCOD <> 0 THEN
                ERROR_TYPE(KEY,5);
        IF LOKCOD <> 0 THEN
                LOCK_TYPE(7);
        IF RET_CODE <> 1 THEN
                WARNING_TYPE(KEY,2,RET_CODE);

        END;{ADD_A_KEY}


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

                WRITE NEW DATA RECORD ROUTINE

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE WRITE_CUST(DRN : INTEGER);
VAR
        FLD,CHR,POS_PTR : INTEGER;
        TMP_FLD : FLDSTR;
        FLDPTR : ^FLD_REC;

        BEGIN
        DATBUF.CDF := NULL_CHR;

        FLDPTR := ADDR(TMP_FLD); (* PTR TO STRING *)

        POS_PTR := 0;
        FOR FLD := 0 TO MAX_FIELD DO
                BEGIN
                TMP_FLD := NEW_FLD[FLD];
                FOR CHR := 1 TO FLDPTR^.LENBYTE DO
                        DATBUF.FLD[POS_PTR + CHR] :=
                                FLDPTR^.FLDCHR[CHR];

                WHILE (FLDPTR^.LENBYTE < FLD_LEN[FLD]) DO
                        BEGIN
                        FLDPTR^.LENBYTE := FLDPTR^.LENBYTE + 1;
                        DATBUF.FLD[POS_PTR + FLDPTR^.LENBYTE] := ' ';
                        END;
                POS_PTR := POS_PTR + FLD_LEN[FLD];
                END;

        IF WRTDAT(FILE_NO,DRN,DATBUF_PTR) <> 0 THEN
                ERROR_TYPE(DRN,12);
        END;{WRITE_CUST}
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                DELETE KEY VALUE FROM INDEX ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DEL_A_KEY(KEY,DRN : INTEGER);
VAR
        RET_CODE,K_FLD : INTEGER;

        BEGIN
        K_FLD := KEY_MAP[KEY];

        RET_CODE := DELKEY(KEY_NUM[KEY],FILE_NO,
                XLOCK,OLD_FLD[K_FLD],DRN);

        IF ERRCOD <> 0 THEN
                ERROR_TYPE(KEY,6);
        IF LOKCOD <> 0 THEN
                LOCK_TYPE(10);
        IF RET_CODE <> 1 THEN
                WARNING_TYPE(KEY,3,RET_CODE);

        END;{DEL_A_KEY}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                UPDATE INDICES & DATA FILE ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
FUNCTION UPDATE(DATA_RECORD : INTEGER) : INTEGER;
VAR
        FLD,KEY : INTEGER;

        BEGIN
        IF DATA_RECORD = 0 THEN
                BEGIN
                DATA_RECORD := NEWREC(FILE_NO,XLOCK);
                IF ERRCOD <> 0 THEN
                        ERROR_TYPE(0,8);
                IF LOKCOD <> 0 THEN
                        LOCK_TYPE(3) ;
                END;

        UPDATE := DATA_RECORD;
        FOR KEY := 0 TO MAX_KEY DO
                BEGIN
                FLD := KEY_MAP[KEY];
                IF OLD_FLD[FLD] <> NEW_FLD[FLD] THEN
                        ADD_A_KEY(KEY,DATA_RECORD);
                END;

        FOR FLD := 0 TO MAX_FIELD DO
                IF OLD_FLD[FLD] <> NEW_FLD[FLD] THEN
                        BEGIN
```

Listing 4-2. (continued)

```
                        WRITE_CUST(DATA_RECORD);
                        EXIT;
                        END;
        END;{UPDATE}


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                DELETE INDEX & DATA FILE ENTRY ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE DELETE(DATA_RECORD : INTEGER);
VAR
        FLD,KEY : INTEGER;

        BEGIN
        FOR KEY := 0 TO MAX_KEY DO
                BEGIN
                FLD := KEY_MAP[KEY];
                IF OLD_FLD[FLD] <> '' THEN
                        DEL_A_KEY(KEY,DATA_RECORD);
                END;

        IF RETREC(FILE_NO,XLOCK,DATA_RECORD) <> 0 THEN
                ERROR_TYPE(DATA_RECORD,9);
        IF LOKCOD <> 0 THEN
                LOCK_TYPE(9);
        END;{DELETE}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                NEW DATA ENTRY ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
FUNCTION NEWDAT : INTEGER;


VAR
        TMPFLD : STRING[40];
        UNIQUE : BOOLEAN;
        TMPDAT : INTEGER;
        FLD,OP_VAL,FLD_NO : INTEGER;
        OP1 : CHAR;
        OP1_BYT : BYTE;

LABEL
        111;

        BEGIN
                FOR FLD := 0 TO MAX_FIELD DO
                        OLD_FLD[FLD] := '';

                CLRSCR;
```

Listing 4-2. (continued)

```
                WRITELN(' ':19,'Enter New Customer Information');
                WRITELN(' ':19,'******************************');
                WRITELN;
                WRITELN;
                WRITELN(
                        '  [Press "RETURN" for customer # to see main menu.]');
                WRITELN;

                FOR FLD := 0 TO MAX_FIELD DO
                        BEGIN
                        FLD_NO := FLD + 1;
111:
                        WRITE(FLD_NO:6,' - ',FLD_NAME[FLD]:20,
                                '(',FLD_LEN[FLD]:2,') >>');
                        READLN(NEW_FLD[FLD]);
                        IF (FLD = KEY_MAP[UNIQ_KEY]) AND (NEW_FLD[FLD] = '')
                                THEN BEGIN
                                NEWDAT := STOP;
                                EXIT;
                                END;

                        IF FLD = KEY_MAP[UNIQ_KEY] THEN
                                BEGIN
                                NEW_FLD[FLD] := CONCAT('0000',NEW_FLD[FLD]);
                                RIGHT(NEW_FLD[FLD],FLD_LEN[FLD]);
                                UNIQUE := TEST_UNIQUENESS;
                                END
                        ELSE
                                BEGIN
                                TMPFLD := CONCAT(NEW_FLD[FLD],
                                                '                ');
                                NEW_FLD[FLD] := COPY(TMPFLD,1,FLD_LEN[FLD]);
                                UNIQUE := TRUE;
                                END;

                        IF ~UNIQUE THEN GOTO 111;
                        END;

        WHILE (FOR_EVER) DO
                BEGIN
                WRITELN;
                WRITELN;
                WRITELN;
                WRITELN(' ':19,'Current customer information');
                WRITELN;

                FOR FLD := 0 TO MAX_FIELD DO
                        BEGIN
                        FLD_NO := FLD + 1;
                        WRITELN(FLD_NO:6,' - ',FLD_NAME[FLD]:20,'    ',
                                NEW_FLD[FLD]);
                        END;
```

Listing 4-2. (continued)

```
                        OP_VAL := 0;
                        WHILE (OP_VAL < 1) OR (OP_VAL > NO_FIELDS) DO
                                BEGIN
                                WRITELN;
                                WRITELN;
                                WRITELN(
'Enter S to save data, Field # to change data,');
                                WRITE(
'D to delete data, or E to end input >>') ;
                                READLN(OP1);
                                TMPDAT := 0;
                                IF (OP1 = 'S') OR (OP1 = 's') THEN
                                        TMPDAT := SAVE;
                                IF (OP1 = 'D') OR (OP1 = 'd') THEN
                                        TMPDAT := DELT;
                                IF (OP1 = 'E') OR (OP1 = 'e') THEN
                                        TMPDAT := STOP;
                                IF TMPDAT <> 0 THEN
                                        BEGIN
                                        NEWDAT := TMPDAT;
                                        EXIT;
                                        END;
                                OP1_BYT := OP1;
                                OP_VAL := OP1_BYT - 48;
                                END;
                        UPDATE_FIELD(OP_VAL);
                        END;

        END;{NEWDAT}

FUNCTION OLDDAT(DRN: INTEGER) : INTEGER;

VAR
        UNIQUE : BOOLEAN;
        TMPDAT : INTEGER;
        FLD,OP_VAL,FLD_NO : INTEGER;
        OP1 : CHAR;
        OP1_BYT : BYTE;


        BEGIN

                FOR FLD := 0 TO MAX_FIELD DO
                        NEW_FLD[FLD] := OLD_FLD[FLD];

                CLRSCR;

        WHILE (FOR_EVER) DO
                BEGIN
                WRITELN;
                WRITELN;
                WRITELN;
                WRITELN(' ':19,'Current customer information');
                WRITELN;
```

Listing 4-2. (continued)

```
                FOR FLD := 0 TO MAX_FIELD DO
                        BEGIN
                        FLD_NO := FLD + 1;
                        WRITELN(FLD_NO:6,' - ',FLD_NAME[FLD]:20,'    ',
                                NEW_FLD[FLD]);
                        END;

                        OP_VAL := 0;
                        WHILE (OP_VAL < 1) OR (OP_VAL > NO_FIELDS) DO
                                BEGIN
                                WRITELN;
                                WRITELN;
                                WRITELN(
'Enter C to continue scan, Field # to change data, S to save changes,');
                                WRITE(
'D to delete data, B for back scan, or E to end scan >>');
                                READLN(OP1);
                                TMPDAT := 0;
                                IF (OP1 = 'C') OR (OP1 = 'c') THEN
                                        TMPDAT := CONT;
                                IF (OP1 = 'S') OR (OP1 = 's') THEN
                                        TMPDAT := SET_XLOCK(OP1,DRN);
                                IF (OP1 = 'D') OR (OP1 = 'd') THEN
                                        TMPDAT := SET_XLOCK(OP1,DRN);
                                IF (OP1 = 'B') OR (OP1 = 'b') THEN
                                        TMPDAT := BACK;
                                IF (OP1 = 'E') OR (OP1 = 'e') THEN
                                        TMPDAT := STOP;
                                IF TMPDAT <> 0 THEN
                                        BEGIN
                                        OLDDAT := TMPDAT;
                                        EXIT;
                                        END;
                                OP1_BYT := OP1;
                                OP_VAL := OP1_BYT - 48;
                                END;
                        UPDATE_FIELD(OP_VAL);

                END;
        END;{OLDDAT}


FUNCTION SET_XLOCK(OP : CHAR; DRN : INTEGER) : INTEGER;
VAR
        DUMMY : CHAR;

        BEGIN
        DUMMY := 'W';
        WHILE (DUMMY = 'W') AND (SETLOK(FILE_NO,XLOCK,DRN) <>  0) DO
                BEGIN
                WRITELN;
                WRITELN('Customer update on hold due to record lock');
                WRITE(
'Enter W if you wish to wait or any other key to cancel update>>');
                READLN(DUMMY);
```

Listing 4-2. (continued)

```
                IF DUMMY = 'w' THEN DUMMY := 'W';
                END;

        IF DUMMY = 'W' THEN
                BEGIN
                IF OP = 'S' THEN
                        SET_XLOCK := SAVE
                ELSE
                        SET_XLOCK := DELT;
                END
        ELSE
                SET_XLOCK := OLD_ACTION;
        END;{SET_XLOCK}


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                UPDATE DATA FIELD ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE UPDATE_FIELD(FLD_NO : INTEGER);
VAR
        TMPFLD : STRING[40];
        TEST : BOOLEAN;
        FIELD_NO : INTEGER;

        BEGIN
        FIELD_NO := FLD_NO-1;
        TEST := FALSE;

        WHILE (~TEST) DO
                BEGIN
                WRITELN;
                WRITE('Input new ',FLD_NAME[FIELD_NO],'>>');
                READLN(NEW_FLD[FIELD_NO]);

                IF FIELD_NO = KEY_MAP[UNIQ_KEY] THEN
                        BEGIN
                        NEW_FLD[FIELD_NO] := CONCAT('0000',NEW_FLD[FIELD_NO]);
                        RIGHT(NEW_FLD[FIELD_NO],FLD_LEN[FIELD_NO]);
                        END
                ELSE
                        BEGIN
                        TMPFLD := CONCAT(NEW_FLD[FIELD_NO],
                                                        ');
                        NEW_FLD[FIELD_NO] := COPY(TMPFLD,1,FLD_LEN[FIELD_NO]);
                        END;

                IF (FIELD_NO = KEY_MAP[UNIQ_KEY]) AND (NEW_FLD[FIELD_NO] <>
                    OLD_FLD[FIELD_NO]) THEN
                        TEST := TEST_UNIQUENESS
                ELSE
                        TEST := TRUE;
                END;
        END;{UPDATE_FIELD}
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                CUST # UNIQUENESS TEST ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
FUNCTION TEST_UNIQUENESS : BOOLEAN;
VAR
        TEMP : INTEGER;
        TEST : FLDSTR;

        BEGIN
        TEST := NEW_FLD[KEY_MAP[UNIQ_KEY]];
        TEMP := GETKEY(UNIQ_KEY,0,NLOCK,TEST);

        IF LOKCOD <> 0 THEN
                LOCK_TYPE(12);
        IF TEMP = 0 THEN
                TEST_UNIQUENESS := TRUE
        ELSE
                BEGIN
                WRITELN;
                WRITELN(' *** Already Assigned ***');
                WRITELN;
                TEST_UNIQUENESS := FALSE;
                END;
        END;{TEST_UNIQUENESS}

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                RIGHT STRING ROUTINE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
PROCEDURE RIGHT(VAR FLDVAL : FLDSTR; FLDLEN : INTEGER);

        BEGIN
        FLDVAL := COPY(FLDVAL,LENGTH(FLDVAL)-FLDLEN+1,FLDLEN);
        END;{RIGHT}

(*
                END OF UTILITY FUNCTIONS

   ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 *)
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
         SET-UP DATABASE FIELD & KEY DESCRIPTORS
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
BEGIN
NO_FIELDS := MAX_FIELD + 1;

FLD_NAME[0] := 'Customer Number';
FLD_LEN[0] := 4;
```

Listing 4-2. (continued)

```
FLD_NAME[1] := 'First Name';
FLD_LEN[1] := 16;
FLD_NAME[2] := 'Last Name';
FLD_LEN[2] := 20;
FLD_NAME[3] := 'Street Address';
FLD_LEN[3] := 20;
FLD_NAME[4] := 'City';
FLD_LEN[4] := 20;
FLD_NAME[5] := 'State';
FLD_LEN[5] := 2;
FLD_NAME[6] := 'Zipcode';
FLD_LEN[6] := 9;
FLD_NAME[7] := 'Customer Status';
FLD_LEN[7] := 8;


KEY_LEN[0]:=10;
KEY_TYPE[0]:=0;
KEY_MAP[0]:=2 ; (*    KEY 0 = LAST NAME          *)
KEY_LEN[1]:=11;
KEY_TYPE[1]:=0;
KEY_MAP[1]:=6 ; (*    KEY 1 = ZIPCODE            *)
KEY_LEN[2]:=4 ;
KEY_TYPE[2]:=0;
KEY_MAP[2]:=0 ; (*    KEY 2 = CUST NUMBER        *)

UNIQ_KEY := 2 ; (*  USED IN TEST OF UNIQUENESS   *)

FOR KEY := 0 TO MAX_KEY DO
        BEGIN
        IF KEY = UNIQ_KEY THEN
                KEY_DUP[KEY] := NO
        ELSE
                KEY_DUP[KEY] := YES;

        KEY_NAME[KEY] := FLD_NAME[KEY_MAP[KEY]];
        END;

IDX_NAME[0] := 'NAME.IDX';
IDX_NAME[1] := 'ZIPC.IDX';
IDX_NAME[2] := 'NUMB.IDX';

NLOCK := 0;     (* IGNORE LOCKS                  *)
SLOCK := 1;     (* SHARED RECORD LOCK            *)
XLOCK := 2;     (* EXCLUSIVE RECORD LOCK         *)
SFILE := 3;     (* SHARED FILE LOCK              *)
XFILE := 4;     (* EXCLUSIVE FILE LOCK           *)
RLOCK := 5;     (* RELEASE SLOCK) OR (XLOCK      *)
```

Listing 4-2. (continued)

```
(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                INITIALIZE INDEX FILES
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
        SET_LENGTH := '12345678901';
        IDX_KEY := SET_LENGTH;
        SPACE :=        T           ';

(*
        SET TERMINAL TO -1 FOR AUTOMATIC ASSIGNMENT BY ACCESS MANAGER
 *)

        TERMINAL := -1;
        TRAP_ERRORS := YES;
        TIME_OUT_TEST_DELAY := 2;  (* APPROXIMATELY 2 SECONDS *)
        TERMINAL := INTUSR(TERMINAL,TRAP_ERRORS,TIME_OUT_TEST_DELAY);
        IF ERRCOD <> 0 THEN
                ERROR_TYPE(0,14);

        NO_BUFFERS := 5;
        NO_NODE_SECTORS := 4;
        NO_DATA_FILES := 1;
        NO_KEYZ := MAX_KEY + 1;


        IF SETUP(NO_BUFFERS,NO_KEYZ,NO_NODE_SECTORS,NO_DATA_FILES) <> 0 THEN
                BEGIN
                WRITELN('Illegal SETUP Parameters');
                EXIT;
                END;

        FOR KEY := 0 TO MAX_KEY DO
                BEGIN
                KEY_NUM[KEY] := OPNIDX(-1,IDX_NAME[KEY],
                        KEY_LEN[KEY], KEY_TYPE[KEY],KEY_DUP[KEY]);
                IF ERRCOD <> 0 THEN
                        ERROR_TYPE(KEY,1);
                END;


(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                INITIALIZE DATA FILE
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
        FILE_NO := -1;
        RECORD_LENGTH := 100;
        FILNAME := 'CUSTOMER.DAT';
        FILE_NO := OPNDAT(FILE_NO,SFILE,FILNAME,RECORD_LENGTH);
        IF ERRCOD <> 0 THEN
                ERROR_TYPE(0,10);
        IF LOKCOD <> 0 THEN
                LOCK_TYPE(1);
```

Listing 4-2. (continued)

```
(*
        CUST_REC IS THE DATA FILE BUFFER AREA
 *)

        DATBUF_PTR := ADDR(DATBUF);

(*
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                BEGIN DATABASE OPERATION
   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
 *)
        NULL_BYT := 0;
        NULL_CHR := NULL_BYT;

        FOR_EVER := TRUE;

        WHILE (FOR_EVER) DO
                DATA_BASE;
        EXIT;
END.
```

Listing 4-2. (continued)

End of Section 4

Index

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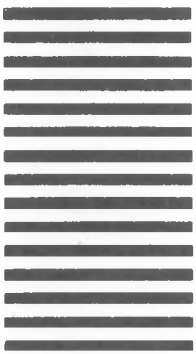

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