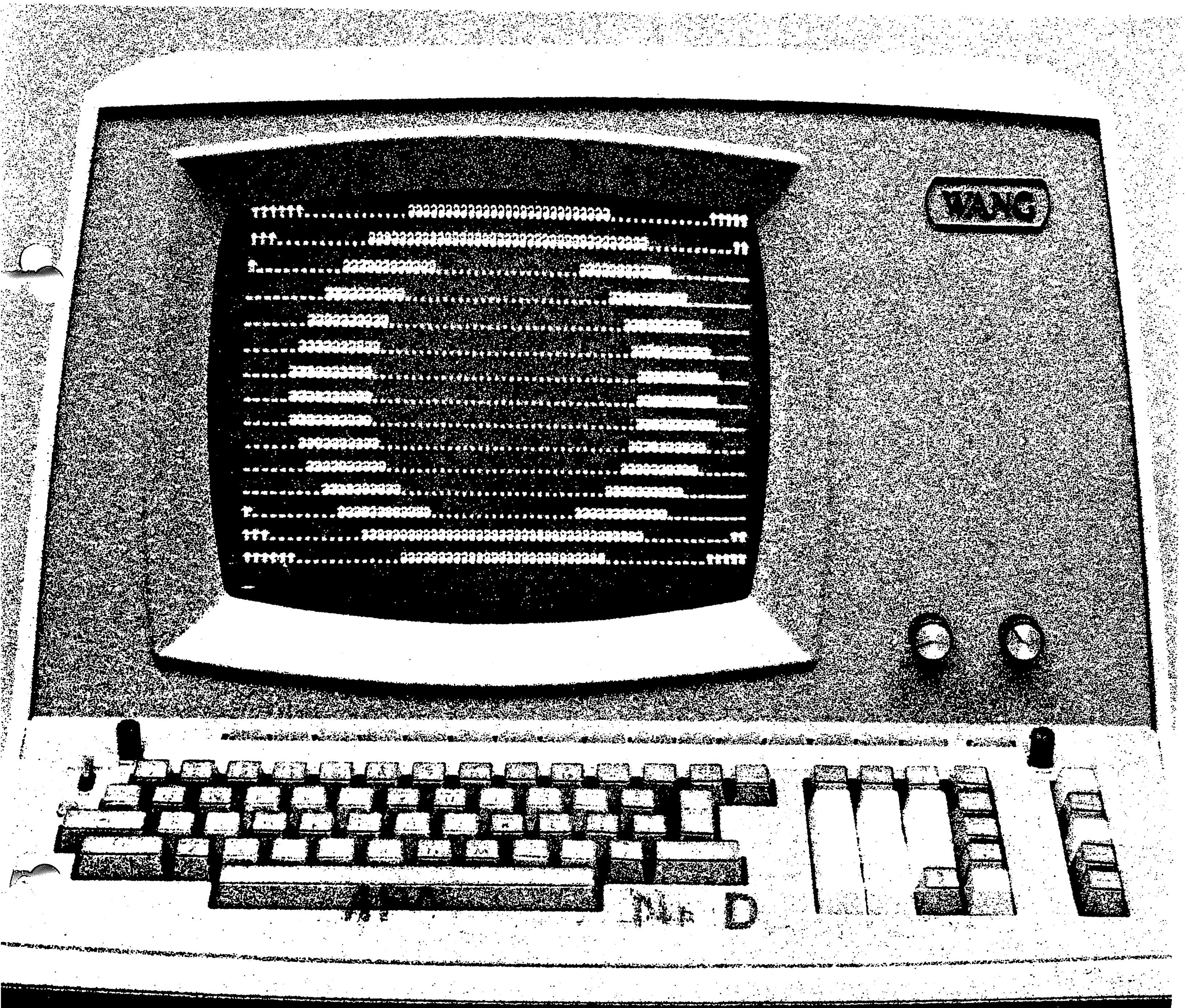
WANG

KFAM 3/KFAM 4 USER MANUAL

SYSTEM 2200



KFAM 3/KFAM 4 USER MANUAL

WANG LABORATORIES, INC.

ONE INDUSTRIAL AVENUE, LOWELL, MASSACHUSETTS 01851, TEL. (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE, LOWELL, MASSACHUSETTS 01851, TEL. (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

HOW TO USE THIS MANUAL

This manual is a guide to the use of the disk file access systems KFAM-3 and KFAM-4.

KFAM-3 and KFAM-4 are part of Wang's Integrated Support System (ISS) package. They occupy Application Support Diskettes 2 and 3, respectively, of that system. As a convenience to customers, Wang Laboratories makes these two ISS diskettes available independently. The diskettes are identical to the diskettes that are part of the ISS system, and the text of this document is identical to the KFAM portion of the ISS Users Manual.

The user who obtains the software on diskette should consult Appendix B for instructions on how to load the menu module.

The user who obtains the software on tape cassette should consult Appendix A for instructions on how to copy the cassette contents to disk. (The cassette contains its own copy program which must be used to copy it to disk.) He should then read Appendix B for instructions on how to load the menu module from disk.

KFAM-3 requires at a minimum a 2200C processor equipped with Option 5 or a 2200S with Option 24, 12K of memory, and a dual disk handling capability. KFAM-4 requires a 2200C processor equipped with Options 2 and 5 or a 2200S with Option 24, 16K of memory and a dual disk handling capability. Both versions use a printer, but instructions on how to eliminate the printer are provided (Chapter 12).

The package numbers are as follows:

System	Medium	Package No.
KFAM-3	Flexible Disk	195-0015-2
KFAM-3	Diskette	195-0015-3
KFAM-3	Cassette	195-0015-7
KFAM-4	Flexible Disk	195-0025-2
KFAM-4	Diskette	195-0025-3
KFAM-4	Cassette	195-0025-7

TABLE OF CONTENTS

CHAPTER 1
OVERVIEW OF THE KFAM SYSTEMS

1.1 WHAT IS KFAM?

The 2200 BASIC language includes a group of statements used for disk operations that are known as the Catalog Mode statements. They are given this name because they create and maintain on a disk, a catalog, or index, of the files which are stored on the disk. This catalog includes, among other things, the name given to the file and the file's starting and ending sector addresses. The catalog system allows a file to be found by simply supplying its name (a service performed for data files by the statement DATA LOAD DC OPEN).

Though the catalog system keeps track of where each file is located on a disk, and thereby allows files to be easily found, it does not keep track of the individual records within a file. For example, a given disk may have an employee file called "PAY", an accounts receivable file called "A/R", and an inventory file called "INVT". The disk catalog system keeps track of where each of these files is located. However, the "PAY" file may consist of 250 employee records, the "A/R" file of 400 customer records, and the "INVT" file of 5000 product records. KFAM is a system for keeping track of and locating these individual records within a file.

For each file of records, KFAM creates and maintains an index of the individual records and their locations in the file. For the purpose of this index, each record is identified by some key field that can serve to mark it off from all other records. For example, for a payroll file, the employee name or number might be designated as the key field; for an inventory file a product number might be the key field. A record's key field is called its "key". The index constructed and maintained by KFAM can be thought of as a list of all the keys for a given file. Associated with each key in the index is the location of the record that the key identifies.

The index that KFAM constructs and maintains is itself kept as cataloged file on a disk. It is called the Key File to distinguish it fro the file of records that it indexes. The latter is called the User File.

When a file is indexed by KFAM, you can say in a program, "Find me the record for product AB-4975-1." KFAM subroutines, incorporated into the program, then search the Key File index and put the sector address of record AB-4975-1 into the User File's Current Sector address parameter in the Device Table. The program can then simply execute a DATA LOAD DC statement to read the desired record.

KFAM subroutines, incorporated into the user's programs, do all the work of searching and updating the Key File. There are KFAM subroutines to find records in a random sequence and in ascending key sequence; there are subroutines to delete records, and to find a location for a new record and add the new key to the Key File. Thus, the programmer who uses KFAM need never know how the Key File is constructed. KFAM subroutines carry out all the necessary operations on the Key File.

The Key File that KFAM constructs is a sophisticated tree structure, designed so that keys can be found quickly in a random sequence, and even more quickly in ascending key sequence. It allows keys to be added and deleted easily, without disturbing the organization of the Key File.

Whenever a KFAM subroutine is to find a record, or add a new key to the key file and find a location for the record in the User File, the KFAM subroutine puts the User File record location into the Current Sector addres parameter of the Device Table, opposite the file number (#0-#6) being used for the User File. Thus, on return from the subroutine, an ordinary Catalog Mode DATA LOAD DC or DATA SAVE DC can be executed, and will take place at the desired sector location.

There are two versions of KFAM included in this manual. KFAM-3 is the general purpose KFAM system for use when a file is to be accessed by only one CPU at a time. KFAM-4 is a modification of the KFAM-3 system designed for a multiplexed disk environment, in which more than one CPU may wish to access a file simultaneously. The key file structures built by KFAM-3 and KFAM-4 are identical, and operations performed by the utilities and subroutines are very similar. The chief difference is that KFAM-4 includes special protective procedures to prevent destructive conflict by different CPU's. Though the main functions performed by KFAM-4 software are very similar to those of KFAM-3, once a file is organized under one version, only the software associated with that version may be used on it. A conversion program is provided to convert a KFAM-3 Key File to a KFAM-4 Key File. KFAM-3 offers better performance than KFAM-4, and should be used whenever it is certain that a file is used by only one CPU at a time.

There are two versions of KFAM not included in this manual. These are the original KFAM (referred to as KFAM-1 in this document) and KFAM-2. Unlike these versions of KFAM, KFAM-3 and KFAM-4 use the BASIC statements described in SORT STATEMENTS (Publication #700-3559A). This permits improvements in execution speed, memory requirements, program simplicity, and system flexibility which could not otherwise be achieved. Utility programs are provided to convert to KFAM-3 from KFAM-1 and KFAM-2.

1.2 THE FUNCTIONAL COMPONENTS OF KFAM-3 AND KFAM-4

KFAM-3 and KFAM-4 can each be broken down into the following functional types of software.

1. Set-up Utilities: Stand-alone programs used to initialize a new Key File, and to create a Key File for an already existent User File.

2. KFAM Subroutines: DEFFN' subroutines which are incorporated into a User program. These are used to locate records in the user file and to add and delete keys from the Key File. These are the operational heart of KFAM.

3. Supplementary Maintenance Utilities: Stand-alone programs which perform a variety of tasks related to the maintenance of a Key File and User File.

1.3 HOW TO GET STARTED WITH KFAM

KFAM provides a means for accessing records that are saved in a disk file. However, it does not process these records in any way. After it has found a record, the processing of the record (loading it, updating it, saving it, etcetera) is left to the user-written program. Thus, to use KFAM, one must have a working knowledge of elementary BASIC and of the fundamentals of Catalog Mode disk operations.

It is strongly recommended that the first-time user of KFAM begin by setting up a dummy KFAM-3 file, and experiment with the subroutines and utilities on this file before attempting to operate on valuable files.

The following is a step-by-step outline of how to begin setting up KFAM files.

1. Decide whether to use KFAM-3 or KFAM-4. If your system includes just one CPU then you should use KFAM-3. If your system includes more than one CPU attached to a multiplexed disk drive, and the file to be accessed may be accessed by several CPU's simultaneously, then you must use KFAM-4. If you are a first time user and wish to learn to use KFAM-4, it may be advisable for you to begin by experimenting with a dummy KFAM-3 file and then graduate to KFAM-4 as you gain confidence.

2. Read Chapter 2, KFAM Requirements and Conventions. This chapter describes the four types of User File records which are acceptable to KFAM, limitations on the size and characteristics of the key field, and certain KFAM conventions which must be adhered to.

3. A Key File is stored as a cataloged file on a disk. It may reside on the same disk as the User File, or on another disk (which must be mounted whenever the User File is accessed). A set-up utility called INITIALIZE KFAM FILE must be run whenever a new KFAM file (Key File and User File) is to be established.

   INITIALIZE KFAM FILE calculates the required size of the Key File, given an estimate of the maximum number of records to be saved in the User File, and will catalog a Key File with the required number of sectors. It saves in the Key File some vital information about the User File, based on information supplied by the operator. Optionally it will also catalog a User File with the proper number of sectors, if the User File does not already exist.

   A guide to the information required by INITIALIZE KFAM FILE and detailed operating instructions are provided in Chapter 3.

4. If your User File already exists, a second set-up utility program can be run after INITIALIZE KFAM FILE. It reads your User File and creates an entry in the Key File for each record in the User File.

   This utility is called KEY FILE CREATION. Operating instructions are provided in Chapter 3.

5. If your User File does not already exist, then after running INITIALIZE KFAM FILE, you will use the KFAM subroutines in a program you write to build your User File and Key File simultaneously.

6. The KFAM subroutines are DEFFN' subroutines which are incorporated into an application program (written by the KFAM user) to perform standard tasks for files indexed by KFAM. Before writing a program, or program module, you should determine the KFAM subroutines that will be needed. You should then run the Utility BUILD SUBROUTINE MODULE. This allows you to choose what subroutines and optional subroutine features you wish to have. It builds a program file on disk which contains the selected subroutines. (BUILD SUBROUTINE MODULE for KFAM-3 is described in Chapter 4. The KFAM-4 version appears in Chapter 5.)

Subroutines are available to perform the following tasks:

TYPE AND NAME	FUNCTION
General Purpose	
OPEN	Opens specified User File and companion Key File.
CLOSE	Closes User File and companion Key File.
Random Access	
FINDOLD	Locates specified key in the Key File; sets User File Current Sector Address to record in User File with that key.
Key Sequence Access	
FINDFIRST	Locates record with lowest key in User File; sets User File Current Sector address to that sector.
FINDNEXT	Locates next record in User File in logical key sequence; sets User File Current Sector Address to that sector.
FINDLAST	Locates record with highest key in User File; sets the User File Current Sector Address to that sector.
Add and Delete	
FINDNEW	Adds specified key to Key File; allocates space for a new record in the User File, and sets the User File Current Sector Address to that sector.
FINDNEW (HERE)	Adds specified key to Key File; sets the User File Current Sector Address to the sector where the new record is to be written.
DELETE	Removes specified key from Key File; sets the User File Current Sector Address to the record that has the deleted key.

Special Purpose (KFAM-4 ONLY)

RELEASE	Allows a User File record, previously protected by one CPU, to be accessed by any CPU.

Since the KFAM subroutines allow records to be added and deleted, as well as accessed, all routine file maintenance takes place in application programs which use KFAM subroutines. As a general rule all operations on the Key File are accomplished by the KFAM subroutines, while all operations on the User File are accomplished by user written statements in the application program.

Detailed descriptions of the GOSUB' statements needed to call each of the KFAM subroutines are given in Chapter 4 for KFAM-3 and 5 for KFAM-4.

7. Though the KFAM subroutines are the heart of the KFAM system, and perform most of the file maintenance, a group of Supplementary Maintenance Utilities are included to carry out certain maintenance tasks that will occasionally be required.

a) The REORGANIZE Utilities: When a record is "deleted" by using the DELETE subroutine, its key and location are simply removed from the Key File. It then cannot be accessed by KFAM. The record itself in the user file is not removed. It is possible to reuse the spaces occupied by deleted records in the User File, but if this is not done, the User File gradually becomes bloated with DELETED records. The reorganize utilities reorganize the User File putting its records into key sequence and eliminating DELETED records. They then automatically construct a new Key File for accessing the reorganized User File. KFAM-3 and KFAM-4 each have two versions of REORGANIZE utilities.

THE REORGANIZE SUB-SYSTEM: Is a three-module utility program which reorganizes a file by outputting a new reorganized User File and Key File. The old Key File and User File are left intact. It is called by a user written set-up module which provides parameters for the reorganization.

REORGANIZE KFAM FILE: Is a utility program which reorganizes the User File and Key File in place. It should be used only for a file so large that adequate

output files could not be mounted at the same time as the file to be reorganized.

Detailed instructions for KFAM-3 and KFAM-4 Reorganize utilities are given in Chapter 6.

b) The Adjust Files Utilities include two utilities which can be used together to copy a KFAM file and increase or decrease the amount of disk space allocated to the file. These utilities are called REALLOCATE KFAM FILE SPACE and DISK COPY AND REORGANIZE. The latter can be used alone to copy any cataloged file to another disk.

c) PRINT KEY FILE: This utility prints the complete contents of the Key File with appropriate labeling of data. It can be useful as a diagnostic tool, and helpful to advanced programmers who may wish to examine the Key File structure.

d) Recovery Utilities: A KEY FILE RECOVERY utility is provided to reconstruct a Key File in the event of its accidental destruction. The User File must be intact for this program to operate successfully.

   For KFAM-4 only, there is a second kind of recovery utility called RESET ACCESS TABLE. KFAM-4 maintains in the Key File information about which CPU's are operating on the file. This information is kept in a part of the Key File called the "access table". This access table will contain erroneous information if a CPU fails to CLOSE a file it has opened, due to power failure or program error. The RESET ACCESS TABLE utility is provided to clear this erroneous information from the access table.

e) The KFAM Conversion Utilities. Utility programs are provided with KFAM-3 to convert from KFAM-1 to KFAM-3, and from KFAM-2 to KFAM-3. A utility program is provided with KFAM-4 to convert from KFAM-3 to KFAM-4.

1.4 OVERVIEW OF KFAM-4

KFAM-4 is a modification of the KFAM-3 system, designed for a disk multiplexed envircnment. It allows up to four CPU's to access a KFAM disk file, and includes protective procedures designed to prevent destructive intrusions of one CPU into the file operation of another CPU. These procedures are designed to offer the minimal protection consistent with the type of operation being performed, so that other CPU's can have the safe maximum availability of the disk and the file.

To use KFAM-4 in a multiplex environment one must have some understanding of the types of problems presented by this environment. To illustrate these problems, assume that several CPU's attempt to use KFAM-3 to access a User file, via a single Key File. Serious problems can occur at several different levels:

1. The key file can be accidentally destroyed simply by two CPU's executing KFAM subroutines contemporaneously. Recall that the disk multiplexer (Model 2224 or 2230MXA/B) allows a CPU to execute a single disk instruction, and then polls the other CPU's to see if they are waiting to execute a disk instruction. Since a single KFAM-3 subroutine (FINDNEW, FINDOLD, DELETE, etc.) may execute many disk instructions, its disk instructions could be interspersed with those of another CPU. Several of the KFAM-3 subroutines can alter the Key File structure, and require that that structure be stable from the time the key file is read until it is successfully restructured. Two such subroutines operating on the key file contemporaneously could result in an illegitimate Key File structure, which would destroy its effectiveness as an index to the User File.

2. If one CPU is attempting to access records sequentially using FINDNEXT, and, during record processing, another CPU accesses the file, then a subsequent execution of FINDNEXT by the first CPU will not access the next sequential record.

3. If one CPU is attempting to perform an operation on an entire User File (Print Closing Balances, etc.) and another is updating records in the file, then the overall file status reported may, in fact, have never existed at any one point in time.

4. If two or more CPU's contemporaneously access the same User Record for updating, so that, from the point of view of the disk, the accessing sequence looks like this:

```
DATALOAD DC X            (CPU #1)
DATALOAD DC X            (CPU #2)
.
.
.
DATASAVE DC X+4          (CPU #1)
DATASAVE DC X+7          (CPU #2)
```

   The record is now erroneous. It should contain X+11 but instead contains X+7.

There are, of course, other problems which can occur, but these problems may be taken as characteristic of the types of problems involved. KFAM-4 offers solutions to these types of problems by several different means:

1. KFAM-4 subroutines hog the disk during their execution. Before passing contrcl back to the User program, the KFAM subroutine returns the disk to normal, non-hog, mode. This solves the problem of key file destruction caused by simultaneous execution of KFAM subroutines.

2. Information which pertains to the program accessing the file rather than to the Key File itself is maintained in the CPU's by KFAM-4, rather than in the Key File (KDR) as in KFAM-3. This information includes last key accessed, limb path, file numbers, etcetera. By keeping the information for a CPU, in the respective CPU, one CPU

   can be accessing the file sequentially with FINDNEXT while another is accessing it, and the FINDNEXT from the first CPU always accesses the next sequential record.

3. In KFAM-4 an additional GOSUB' parameter is required to call the OPEN subroutine. With this additional parameter a CPU initiating operations on a KFAM-4 file can request exclusive access to the entire file for the duration of its operation. When exclusive access is requested, the OPEN subroutine checks to see if any other CPU currently has the file open; if not, it grants exclusive access. Once exclusive access is granted, no other CPU can open the file until the CPU with exclusive access has executed the CLOSE subroutine. This permits operations on an entire file to be completed with the file protected from outside alteration. Files may also be opened in a non-exclusive mode which permits other CPU's to open the file.

   The information as to how many of the four possible CPU's have opened the file, and whether it is open in exclusive or non-exclusive mode is saved in an access table. The access table is part of the KDR record in the Key File. In order that this information be accurate, it is essential that each CPU execute the CLOSE subroutine when its program is finished with the file. If the file is not CLOSED, the entry will remain in the KDR. Four non-exclusive entries fill the access table and bar any CPU from opening it; one exclusive entry, left in file, has the same effect.

   KFAM-4 includes a utility called RESET ACCESS TABLE. The purpose of this utility is to clear the access table in the event of a power failure or other disaster. This utility clears the entire access table, and therefore should be run only when no CPU has the file open.

4. In KFAM-4 an additional GOSUB' parameter is required to call each record-access subroutine. With this parameter the CPU accessing a record can set a protect flag for the accessed record. If a CPU has set a protect flag for a record, then that record may be accessed only by that CPU, until the protect flag is turned off. If records are blocked, setting a protect flag for one record in the block prevents other CPU's from accessing any of the records in the block.

   When a CPU performs an update of a record, it must set a protect flag for that record. This ensures that it can complete its update operation before another CPU can access the record, and thereby eliminates the problem of simultaneous updates described as problem 4 above.

The protect flag on a record (or block of records) is automatically turned off when the CPU that set the protect flag executes any other KFAM subroutine on the same file. Thus, for example, if a series of updates are being performed by a CPU, each access of a record turns off the protect flag for the record previously accessed by that CPU, and, optionally, sets the protect flag for the new record.

KFAM-4 includes a subroutine called RELEASE. When executed by a particular CPU, this subroutine simply turns off a protect flag previously set by that CPU. This subroutine should be used if there may be a substantial delay before the next KFAM subroutine call.

It is not possible for a single CPU to have open a KFAM-4 file and a KFAM-3 file at the same time.

CHAPTER 2
KFAM REQUIREMENTS AND CONVENTIONS (KFAM-3 AND KFAM-4)

2.1 USER FILE

The User File must be a cataloged disk file. It must be wholly contained on one disk platter. (See KFAM Advanced Programming Techniques for files too large to fit on one platter.) All records must be of a fixed length. Four record types are supported. All records in a file must be the same type. The record types are:

Type "N" - No Blocking

Each record occupies exactly one sector.

The key must be located in the same position within each record.

Records may be written in the "DC" mode, with control bytes, or in the "BA" mode, without control bytes.

(This corresponds to record type "F" in KFAM-1.)

Type "A" - Array Type Blocked Records

Records must be written in array form:

```
DIM A$(4)3, B(4), C$(4)20
DATASAVE DC n, A$(), B(), C$()
```

indicating 4 records per block, each containing an A$, B, and C$. The block of records must be written with control bytes; DATASAVE BA may not be used.

All records must have the same format.

The key must be located in the same position within each record. The key may be a part of a field, i.e., STR(C$, 11, 10), but may not span fields, may not include control bytes, and may not be a numeric field or any part of a numeric field.

The block of records may not exceed one sector in length.

There may not be more than 38 fields per record.

Type "C" - Contiguous Blocked Records

All records must be the same length.

All the fields of a given record are stored contiguously on the disk, for example:

```
     DIM A1$3, C1$20, A2$3, C2$20, A3$3, C3$20, A4$3, C4$20
     DATASAVE DC#n, A1$, B1, C1$, A2$, B2, C2$, A3$, B3, C3$,
         A4$, B4, C4$
```

indicating 4 records per block, each containing an Aj$, Bj, and Cj$. (This corresponds to record type "FB" in KFAM-1.)

The key must be located in the same position within each record.

The block of records may not exceed one sector in length.

Records may be written in the "DC" mode, with control bytes, or in the "BA" mode without control bytes. However, if the file must be reorganized in place using the REORGANIZE KFAM FILE utility, it must be written with control bytes.

Type "M" - Multiple Sector Records

Each record occupies more than one sector.

Each record occupies the same number of sectors.

The key must be located in the same position within each record. The key may be located in any sector of the record, but may not span sectors.

Records may be written in the "DC" mode, with control bytes, or in the "BA" mode, without control bytes.

Records may be up to 255 sectors in length. However, the following restrictions apply in REORGANIZE KFAM FILE:

a. Records may not exceed 40 sectors in length.

b. Reorganization cannot be executed in 12K of memory if the record length exceeds 8 sectors.

(This corresponds to record type "FM" in KFAM-1.)

User File Name

The User file name, as recorded in the disk catalog, must conform to the following conventions:

The 5th character must be the letter "F".

The 6th character must be a digit 0-9.

2.2 KEY

The record key as it appears in the User File may be from 1 to 30 bytes of alphanumeric data (including hexadecimal data or packed numbers). The key may not be a numeric field.

The first byte of an active key may not contain the value HEX(FF). The value HEX(FF) in the first byte of a key in the User file indicates that the record has been deleted from the Key File.

The key may not contain a value of all bytes HEX(00). (This corresponds to the packed number 0, or the binary number 0, as a key value.) This lowest possible value is reserved for the system.

Duplicate keys are not allowed.

2.3 KEY FILE

The Key File name is constructed by INITIALIZE KFAM FILE from the User File name, as follows:

The 5th character in the User File Name is changed from "F" to "K".

The 6th character is assigned the Key File number. This is always 1 unless multiple Key Files are maintained for the one User File, in which case it may be any digit 1-9.

Size of the Key File

The first sector of the Key File contains the Key Descriptor Record (KDR). The KDR contains control information necessary for KFAM.

The remaining sectors of the Key File are available for Key Index Records (KIR's). Each KIR occupies one sector and contains Key Index Entries (KIE's). The KIE is a field containing a key and a 3-byte pointer. The key is the same as one of the keys in the User File. The pointer points to a User record on the disk, either directly or indirectly. The maximum number of KIE's per KIR is given by:

N = INT (240/(K+3))

where: K = Key length
3 = pointer length
N = maximum KIE's per KIR

The average number, A, of KIE's per KIR is calculated (conservatively) as follows:

A = INT(N*.6)

The number of sectors required for the Key File, for a given number of records, R, is as follows:

S = INT(R/(A-1))+5

2.4 DEVICE ADDRESSES

Device addresses, 310, 320, 330, 350, B20, B30 and B10, are recognized by KFAM as valid disk device addresses. KFAM-4 also uses the hog mode versions of these addresses.

CHAPTER 3
THE KFAM SET-UP UTILITIES

3.1 OVERVIEW OF INITIALIZE KFAM FILE (KFAM-3 and KFAM-4)

INITIALIZE KFAM FILE must be run, as the first step in setting up a KFAM file.

INITIALIZE KFAM FILE optionally catalogs an area on disk for the User File, or the Key File, or both, or operates with an existing User File, or Key File, or both. It sets up the KDR record (the first record of the Key File, containing vital information about the User File and the Key File), based on information supplied by the operator. It then creates a "null" (empty) Key File.

The DATASAVE DC END trailer is set to the next to last sector in the User File, regardless of whether or not the User File was cataloged prior to running the utility.

Information Required by the Utility

The utility requires that the following information be supplied by the operator:

User File Name
Device Address for User File: 310, 320, 330, 350, B10, B20, B30
Is User File Cataloged?: Y OR N
Key File Number: 1-9
Device Address for Key File: 310, 320, 330, 350, B10, B20, or B30
Is Key File Cataloged?: Y or N
Record Type: A, C, M, or N
Logical Record Length (Type A or C): nnn
Blocking Factor (Type A or C): nn
Sectors per Record (Type M): nnn
Key Length: 1-30

```
Starting Position of Key: nnnnn
Estimated Number of Records: nnnnn
Are File Specifications OK?: Y or N
Hard Copy Printout?: Y or N
Do Another File:  Y or N
```

This is a formidable set of questions for an operator. It is suggested that this utility be run by the application programmer, or that the programmer write a set of specific answers for a specific KFAM file, as a supplement to the general operating instructions below.

Some of the answers to the above questions are not obvious, and require some discussion:

User File Name

The User File Name must conform to the KFAM naming convention. The 5th byte must be "F". The 6th byte must be a digit 0-9. The remaining bytes may be any alphanumeric characters.

An existing User File may be renamed to conform to KFAM's requirements by executing the following two commands in Immediate Mode:

```
SCRATCH d "old name"
DATASAVE DC OPEN d "old-name", "new-name"
```

where d = the disk platter, F or R
old-name = the original file name
new-name = new name, conforming to KFAM convention

The data trailer record, or "END" record, is lost following this procedure. This should do no harm if the file is to be used strictly as a KFAM file, because INITIALIZE KFAM FILE always sets the "END" record at the next-to-last sector of the cataloged space, regardless of where it was before, and the Key File Creation Utility uses the last key, not the "END" record, to determine end-of-file.

Key File Number

Normally, 1 should be entered. However, if multiple Key Files are to be used to index the same User File, they must be uniquely identified by the Key File Number, which can be any digit from 1 to 9.

The Key File name is derived from the User File name, by replacing the "F" in position 5 with "K", and the digit in position 6 with the Key File Number.

Record Type

KFAM supports four different record types:

Type A: Array type blocked records.

More than one data record is contained in a sector. The block of records is written as an array, i.e.:

```
 DIM A$(4)12, B(4), C$(4)36
 DATASAVE DC #n, A$(), B(), C$()
```

indicating 4 records per sector, each record containing an A$, B, and C$.

Type C: Contiguous blocked records.

More than one data record is contained in a sector. Each record occupies a contiguous amount of space on the disk. For example, there are three records per sector, each containing a key (K$) and data (D$):

```
 DIM K1$12, D1$64, K2$12, D2$64, K3$12, D3$64
 DATASAVE DC #n, K1$, D1$, K2$, D2$, K3$, D3$
```

This corresponds to record type "FB" in the original KFAM.

Type N: No blocking

Each data record occupies one sector. This corresponds to record type "F" in the original KFAM, except that in KFAM-3 data may begin at byte 0 and extend to byte 255.

Type M: Multiple Sectors per record.

Each data record occupies two or more sectors. This corresponds to record type "FM" in the original KFAM.

Logical Record Length

The logical record length for record types A and C is calculated as follows:

a.   Add up the lengths of the fields contained in a single record (numeric fields are 8 bytes long).

b.   Add 1 per field of the record, for control bytes.

For example, in the above example for type A records, the record length is 59. In the above example for type C records, the record length is 78.

All records of the file must have the same length. For type A, all records must also have the same format, for example, a 12-byte alpha field, followed by a numeric field, followed by a 36-byte alpha field, each field contained in an array of 4 elements.

Blocking Factor

The blocking factor is the number of records per sector (Type A and C).

Starting Position of Key

This is the absolute starting position of the key within the sector or sectors, except for type A records, where it is the position within the record plus two for sector control bytes. This requires some explanation.

When a record is written on disk, in the normal mode (DATASAVE DC or DATASAVE DA), two control bytes are written at the start of the sector. Following these two control bytes, the Start-of-Value (SOV) control byte for the first data value is written, followed by the data itself. Then the SOV control byte for the second value, and the second value itself, are written, and so on. An end-of-block (EOB) control byte is written following the last data value written.

The layout of the sector on disk looks like this:

CONTROL	CONTROL	SOV	Field 1	SOV	Field 2	SOV	Field 3	SOV	Field 4	SOV	Field 5	EOB	Not Used
0	1	2	3										

For the purposes of determining the starting position of the key, the bytes of the sector are numbered from 0 to 255. The starting control bytes are bytes 0 and 1. The SOV control byte for the first field is byte 2. The first byte of data is byte 3. The second field starts in byte 3 + L1 + 1, where L1 is the length of the first field, and so on.

The starting position of the key is the number of the first byte of the key. For blocked records, the blocking is ignored when calculating the starting position of the key. It is calculated as if there were only one record per block. The KFAM utilities make the necessary adjustments to calculate the position of the key in subsequent records within the sector.

In particular, with type A records, the blocking should be ignored when calculating the starting position of the key. Given the record in the example:

```
DIM A$(4)12, B(4), C$(4)36
DATASAVE DC #n, A$(), B(), C$()
```

the actual layout of the sector is as follows:

Bytes	Contents
0,1	Control bytes
2	SOV
3-14	A$(1)
15	SOV
16-27	A$(2)
28	SOV
29-40	A$(3)
41	SOV
42-53	A$(4)
54	SOV
55-62	B(1)
63	SOV
64-71	B(2)
72	SOV
73-80	B(3)
81	SOV
82-89	B(4)
90	SOV
91-126	C$(1)
127	SOV
128-163	C$(2)
164	SOV
165-200	C$(3)
201	SOV
202-237	C$(4)
238	EOB

The fact that there are four records per sector should be ignored in determining the starting position of the key. The sector should be seen as if it contained only one record, as follows:

Byte	Contents
0,1	Control bytes
2	SOV
3-14	A$(1)
15	SOV
16-23	B(1)
24	SOV
25-60	C$(1)
61	EOB

If the key starts in the first byte of C$(), the starting key position is 25, and not 91, as would be indicated by the actual blocking.

For record types C, M and N, it is possible to have records written in the DATASAVE BA mode. In that case, no control bytes are inserted, and the starting position of the key is exactly where it is located in the array defining the record (starting byte 0).

For record type M, it is possible to have the key begin in the second, or higher, sector of the record. In that case, add 256 for each sector preceding the one containing the key, and then add the starting position of the key within the sector (first byte of the sector = 0).

When writing multiple sectors in the normal mode (DATASAVE DC or DATASAVE DA), it is necessary to determine which field will begin the second sector, etc. The 2200 System does not write partial fields in a sector. Where there is not room to write the next field in the current sector, the 2200 System writes an EOB control byte, leaves the rest of the space unused, and starts another sector. For example, if the record is defined:

```
DIM D$(6)64
DATASAVE DC #n, D$()
```

the record occupies 2 sectors, as follows:

First sector:

Bytes	Contents
0,1	Control bytes
2	SOV
3-66	D$(1)
67	SOV
68-131	D$(2)
132	SOV
133-196	D$(3)
197	EOB
198-255	Not used (58 bytes, not room to write next complete field)

Second sector:

Bytes	Contents
0,1	Control bytes
2	SOV
3-66	D$(4)
67	SOV
68-131	D$(5)
132	SOV
133-196	D$(6)
197	EOB
198-255	Not used (end of data)

Once the actual record layout is determined, then the starting position f the key can be calculated. If the key occupies, for example, the first 8 bytes of D$(4), then the starting position of the key is 259, and not 198 as might be calculated by ignoring the actual way that the system writes records.

Estimated Number of Records

This is the maximum number of records that the User File will contain. If the User File is not yet cataloged, the program will catalog enough sectors to hold this many records. If the User File is already cataloged, the program checks that enough space is cataloged to contain this many records.

The program also calculates the size of the Key File, based on the estimated number of records. If the Key File is not yet cataloged, the program catalogs the required number of sectors. If the Key File is already cataloged, the program checks to see that enough space is cataloged. If there is not enough space cataloged, the program issues a warning message.

The estimated number of records should be calculated in advance, as the maximum number of records which the User File will contain, plus an estimate of the number of deleted records which will be in the file when it is at its maximum size.

This estimate is not critical. It can be revised later, using the REALLOCATE KFAM SPACE and DISK COPY/REORGANIZE utilities.

Hard Copy Printout

If the configuration of the available 2200 system does not include a printer, the answer to this question should always be "N".

NOTE:

In the KFAM-4 version of this utility, hog mode is selected for the disks containing the Key File and User File. To operate the KFAM-4 utility in non-hog mode or to execute it at a non-multiplexed disk drive, key

M$ = "X" (EXEC)

at KFAM-4 utilities menu, prior to loading the utility.

3.2 INITIALIZE KFAM FILE OPERATING INSTRUCTIONS (KFAM-3 and KFAM-4)

	DISPLAY		INSTRUCTIONS
1.		1.	From KFAM-3 or KFAM-4 menu, access the INITIALIZE KFAM FILE utility via the specified Special Function Key.
2.		2.	Mount the disk platter(s) containing, or to contain, the User File and Key File.
3.	ENTER USER FILE NAME (SSSSFJNN)	3.	Enter the name of the User File. MESSAGE: 2,4,5 **NOTE:** Error messages and recovery procedures follow the operating instructions.
4.	ENTER THE NUMBER FOR THE DATA FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	4.	Enter the selection number for the user file disk device address. MESSAGE: 2, 6, 7
5.	IS DATA FILE CATALOGED? (Y OR N)	5.	Enter "Y" if the User File already exists. Enter "N" if the User File does not exist. MESSAGE: 2, 9, 10
6.	ENTER KEY FILE NUMBER	6.	Normally enter 1. If there is more than one Key File for a single user file, the Key File Number is used to distinguish the Key Files. The Key File Number can be any digit from 1 to 9. MESSAGE: 2, 3, 11

7.	ENTER NUMBER OF THE KEY FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	7.	Enter the selection number for the key file device address. MESSAGE: 2, 6, 7
8.	IS KEY FILE CATALOGED? (Y OR N)	8.	Enter "Y" if space has already been cataloged for a Key File. Enter "N" if the Key File has not been cataloged.
9.	ENTER RECORD TYPE (A,C,N,M)	9.	Enter A, C, N or M. A=array type blocking C=contiguous blocking N=no blocking M=multiple sector records If record type A or C, proceed with Step 10, below. If record type M, proceed with Step 12, below. If record type N, proceed with Step 13, below. MESSAGE: 2, 14
10.	ENTER LOGICAL RECORD LENGTH	10.	Enter logical record length. See above for calculation of logical record length. MESSAGE: 2, 3
11.	ENTER BLOCKING FACTOR	11.	Enter number of records per sector. Proceed with Step 13, below. MESSAGE: 2, 3, 15
12.	ENTER NUMBER OF SECTORS PER RECORD	12.	Enter the number of Sectors per record. Record Type M only. MESSAGE: 2, 3, 16

13.	ENTER KEY LENGTH	13.	Enter key length (1 to 30). All record types. MESSAGE: 2, 3, 17
14.	ENTER STARTING POSITION OF KEY	14.	Enter starting position of key field within sector. See above for calculation of starting position of key. MESSAGE: 2, 3, 7, 8 18, 19
15.	ENTER ESTIMATED NUMBER OF RECORDS	15.	Enter estimated maximum number of records in User File. See above for calculation of number of records. MESSAGE: 2, 3, 20
16.		16.	The system calculates disk space required for User File and Key File. MESSAGE: 21, 22
17.		17.	The system displays file specifications on the screen. MESSAGE: 23
18.	ARE FILE SPECIFICATIONS OK (Y OR N)	18.	Check file specifications displayed on the screen. Enter Y to continue. Enter N to start again at Step 3. MESSAGE: 2
19.	DO YOU WANT A HARD COPY PRINTOUT OF FILE DESCRIPTION? (Y OR N)?	19.	For a hard copy printout, mount paper on printer and enter Y. For no hardcopy, enter N. MESSAGE: 2, 24

20.		20.	The system prints file specifications on the printer. This is an exact duplicate of the screen display, Step 17.
21.		21.	The system initializes the User File and Key File. MESSAGE: 7, 8
22.	DO YOU WISH TO DO ANOTHER FILE (Y OR N)	22.	Enter Y to do another file. Enter N to stop. If Y is entered, the program repeats from Step 3, above. MESSAGE: 2
23.		23.	The system returns to the KFAM menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered. RECOVERY: Repeat the step, entering not more than the number of characters indicated on the screen. Not "Y" or "N", in response to a "yes" or "no" question. RECOVERY: Repeat the step, entering "Y" or "N".
3.	ERR29	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Reenter numeric quantity.
4.	FILE NAME MUST HAVE F IN POSITION 5	User File name must have an "F" in the 5th position.

		RECOVERY: Repeat Step 3 with correct User File name.
5.	FILE NAME MUST HAVE NUMBER IN POSITION 6	User File name must have a digit, 0-9, in the 6th position. RECOVERY: Repeat step 3 with correct user file name.
6.	INVALID DEVICE ADDRESS	Number entered not an integer 1-7. RECOVERY: Repeat the step, entering a valid selection number.
7.	ERR72	Disk read error. RECOVERY: Rerun the program. If the error persists, recreate the platter from a backup copy (#1 = Key File, #2 = User File).
8.	ERR85	Disk write error. RECOVERY: Rerun the program. If the error persists, the platter has a bad sector and must be replaced.
9.	FILE NOT FOUND	The User File is not cataloged on the specified device. RECOVERY: Repeat from Step 3.
10.	FILE ALREADY CATALOGED	The User File, specified as not cataloged, is cataloged on the specified device. RECOVERY: Repeat from Step 3.
11.	ZERO INVALID	The Key File Number may not be 0. RECOVERY: Repeat Step 6, entering a Key File Number from 1 to 9.
12.	FILE NOT FOUND	The Key File is not cataloged on the specified device. RECOVERY: Repeat from Step 6.
13.	FILE ALREADY CATALOGED	The Key File, specified as not cataloged, is cataloged on the specified device. RECOVERY: Repeat from Step 6.
14.	INVALID RECORD TYPE	Record type must be A, C, M, or N. RECOVERY: Repeat Step 9.

15. BLOCKING FACTOR OR RECORD LENGTH INCORRECT	Record Length times blocking factor, for record type A, may not be greater than 253; for type C may not be greater than 256. RECOVERY: Repeat from Step 10. Recalculate record length or blocking factor if the product is too large.
16. INVALID-MUST BE 2 TO 255	Type M: Number of sectors per record must be 2-255. RECOVERY: Repeat Step 12 with correct value.
17. INVALID-KEY MUST BE 1 TO 30	The key length must be 1-30. RECOVERY: Repeat Step 13 with correct value.
18. KEY OVERLAPS END OF RECORD	The key goes beyond the boundaries of the record, as determined by the record type and record length. RECOVERY: Recalculate starting position of key and reenter (Step 14).
19. KEY MAY NOT SPAN SECTORS	Type M: The key goes over a boundary between sectors. RECOVERY: Recalculate starting position of key and reenter (Step 14).
20. USER FILE TOO SMALL	The User File, which is already cataloged, does not have room for the estimated number of records. RECOVERY: Repeat Step 15 with a smaller estimate. If necessary, reallocate KFAM space and DISK/COPY REORGANIZE can be run later to

		increase the size of the User Fil and Key File.
21.	STOP NO ROOM FOR KEY FILE	The User File is already cataloged. There is not sufficient space on the designated platter to catalog the Key File. RECOVERY: The Key File must be cataloged on another platter, or the User File must be shortened.
22.	See error display SECTORS AVAILABLE SECTORS REQUESTED	There is not enough available space on the designated platter(s) to catalog User File and/or Key File. RECOVERY: Repeat Step 15 with a smaller estimate. If necessary, rerun the program, using disk platters with more available space, or split the User File into 2 parts (see "KFAM Programming Techniques").
23.	WARNING--KEY FILE TOO SMALL	An existing Key File is too small to accommodate the estimated number of records. The program continues with a warning message. RECOVERY: Run REALLOCATE KFAM SPACE and DISK/COPY REORGANIZE to increase the size of the Key File.
24.	System hangs up - no message.	Printer not turned on, or no device 215. RECOVERY: Turn on printer.

3.3 THE FILE CREATION UTILITY (KFAM-3 AND KFAM-4)

Program Description

The KEY FILE CREATION utility creates a Key File for the records in an existing User File. INITIALIZE KFAM FILE must have been run first, to initialize both the User File and the Key File.

KEY FILE CREATION ignores any records which have HEX(FF) in the first byte of the key, under the assumption that they are deleted records. It also ignores records which have duplicate keys, but lists the relative sector number and record number where such duplicate keys are encountered.

The utility requires the operator to enter the key for the last record in the User File in physical sequence. The program uses this to detect the end-of-file condition. The value of the last key should be made available to the operator before running this program.

For KFAM-4 only, the file is opened in the exclusive mode.

KEY FILE CREATION Operating Instructions

	DISPLAY		INSTRUCTIONS
1.		1.	From KFAM-3 or KFAM-4 menu, access KEY FILE CREATION utility via the specified Special Function Key.
2.	ENTER USER FILE NAME (SSSSFJNN)	2.	Enter the name of the User File. MESSAGE: 2,4 NOTE: Error messages and recovery procedures follow the operating instructions.
3.	ENTER THE NUMBER OF THE USER FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	3.	Enter the selection number for the user file disk device address. MESSAGE: 2, 3, 5
4.	ENTER KEY FILE NUMBER (NORMAL=1)	4.	Enter the Key File Number. The Key File Number should always be 1, unless there are multiple key files for a single User File, in which case the Key File Number may be any digit from 1 to 9. In any case it must have been initialized. MESSAGE: 2, 3, 6

5.	ENTER THE NUMBER OF THE KEY FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	5.	Enter the selection number for the Key File Device addre MESSAGE: 2, 3, 5
6.	ENTER LAST KEY	6.	Enter the key of the last record in the User File. MESSAGE: 2
7.	TURN ON PRINTER KEY RETURN(EXEC) TO RESUME	7.	Mount paper on printer; key RETURN(EXEC) to resume. Duplicate keys, if any exist, are printed. If the system configuration does not include a printer, ignore this instruction; key RETURN(EXEC). MESSAGE: 2
8.	Record locations and keys are displayed on the screen so that the operator can check the progress of the program.	8.	The system opens the files, sets up the screen display, and creates the Key File. MESSAGE: 7, 8, 9, 10 11, 12, 13, 14 15, 16, 17, 18
9.		9.	The system returns to KFAM subsidiary menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered. RECOVERY: Repeat the step, entering not more than the number of characters indicated on the screen.

	ERR29	A non-numeric quantity was entered when a numeric quantity was requested.
		RECOVERY: Reenter numeric quantity.
4.	NOT KFAM FILE NAME	The User File name must have an "F" in position 5 and a digit 0-9 in position 6.
		RECOVERY: Repeat Step 2. Enter correct User File name.
5.	INVALID DEVICE ADDRESS	The device address is invalid.
		RECOVERY: Repeat the step. Enter correct device address selection number.
6.	INVALID	The Key File Number may not be 0.
		RECOVERY: Repeat step 4. Enter a Key File Number 1-9.
7.	ERR80	File not found. Either the User File or the Key File specified is not on the device specified.
		RECOVERY: Rerun the program, making sure the platters containing the User File and Key File are mounted, and that User File name, Key File number, and device addresses are specified correctly.
8.	STOP ERROR OPENING FILES	File could not be opened. Possible cause: The program was stopped and restarted after processing had begun.
		RECOVERY: Rerun INITIALIZE KFAM FILE. Rerun this utility. If the error persists, notify Wang Laboratories, Inc.
9.	KEY FILE NOT INITIALIZED (STOP)	Either INITIALIZE KFAM FILE was not run, or an attempt was made to rerun this utility without rerunning INITIALIZE KFAM FILE.

	RECOVERY: Run INITIALIZE KFAM FILE for this User File and Key File. Rerun this utility.
10. INVALID RECORD FORMAT (STOP)	Record type A, array-type blocking: more than one sector per block, more than 38 fields per record, or not written with correct control bytes. RECOVERY: See "KFAM Specifications." Recreate User File according to specifications for A-type records.
11. NOT BLOCKED AS SPECIFIED	Record type A, array-type blocking: records per block specified incorrectly, or records not written in array format. RECOVERY: See "KFAM Specifications." Recreate User File according to specifications or correct blocking factor in INITIALIZE KFAM FILE. Rerun INITIALIZE KFAM FILE. Rerun this utility.
12. RECORD LENGTH NOT SPECIFIED CORRECTLY (STOP)	Record type A, array-type blocking: record length specified in INITIALIZE KFAM FILE does not equal record length of sample record. RECOVERY: See instructions for INITIALIZE KFAM FILE. Recalculate record length. Rerun INITIALIZE KFAM FILE. Rerun this utility.
13. KEY FIELD OUT OF BOUNDS (STOP)	Record type A, array-type blocking: the key must be wholly contained within one field of the record. RECOVERY: See instructions for INITIALIZE KFAM FILE. Recalculate starting position of key. Rerun INITIALIZE KFAM FILE. Rerun this utility.
14. NUMERIC KEY INVALID (STOP)	Record type A, array-type blocking: the key falls within a numeric field.

	RECOVERY: See "KFAM Specifications." See instructions for INITIALIZE KFAM FILE. Recalculate starting position of key so that it falls within an alphanumeric field. Rerun INITIALIZE KFAM file. Rerun this utility.
15. PROGRAM ERROR	Should not occur. RECOVERY: Notify Wang Laboratories, Inc.
16. NO SPACE	Not sufficient space for Key File. Possibly last key was entered incorrectly. RECOVERY: Run DISK/COPY/REORGANIZE to increase Key File space. INITIALIZE KFAM FILE. Rerun this utility.
17. SYSTEM HANGS	Printer not turned on or not selected manually, or no device 215 in system. RECOVERY: Turn printer on and press "SELECT". If no device 215, this program will not run without modification. (See "KFAM Programming Techniques"- Eliminating the Printer.)
18. LAST KEY NOT FOUND	The program has reached the physical end of the User File without finding the "last key." Last key was entered incorrectly. RECOVERY: Rerun INITIALIZE KFAM FILE. Rerun this utility with correct "last key" entered.

CHAPTER 4
KFAM-3 SUBROUTINES

4.1 OVERVIEW OF KFAM-3 SUBROUTINES

The KFAM-3 subroutines are designed to simplify the file access and maintenance operations most frequently performed on files organized by KFAM-3. Included are GOSUB' subroutines to add new records to a file, delete old records, and locate existing records.

A single KFAM-3 file consists of two cataloged disk files, a User File and its Key File. KFAM subroutines never alter the data in the User File They operate upon the data in the Key File, locate a record, update the Key File whenever a record is to be added or deleted. Their function in relation to the User File is only to set the User File's Current Sector address to the location of the desired record in the User File, and, for blocked records, to pass back to the application program the record location within the sector. This process is initiated when the application program passes a key to the KFAM subroutine in one of the GOSUB' arguments. Upon completion of the KFAM subroutine, the application program must perform the proper operation on the User File.

Just as KFAM-3 does not operate upon the User File, so the application program should never operate directly upon the Key File. All operations involving the Key File, including OPEN and CLOSE, should be accomplished via the KFAM-3 subroutines.

The functions performed by the KFAM-3 subroutines are:

Name	Function
OPEN	Open specified User File and companion Key File.

DELETE	Remove specified key from Key File; set User File Current Sector address to record in User File whose key has been deleted from the Key File.
FINDOLD	Locate specified Key in the Key File; set Current Sector address to record in User File with that key.
FINDNEW	Add specified key to Key File; allocate space for a new record in the User File, and set User File Current Sector address to the location for the new record.
FINDNEW (HERE)	Add specified key to Key File; set Current Sector address to User File sector where the new record is to be written.
FINDFIRST	Locate record with lowest key in User File; set User File Current Sector address to that sector.
FINDLAST	Locate record with highest key in User File; set User File Current Sector address to that sector.
FINDNEXT	Locate next record in User File in logical key sequence; set User File Current Sector address to that sector.
CLOSE	Close User File and companion Key File.

Programming Procedure

The first step for the programmer is to decide what subroutines will be required for a given program or program module. The utility program BUILD SUBROUTINE MODULE is used to build a cataloged program file containing the desired subroutines.

The subroutines occupy statement lines 200-3075. It is recommended that the user-written application program follows them, beginning at a line number greater than 3075. If necessary, KFAM-3 subroutines can be renumbered taking care that the rules of BASIC be observed for COM and DIM statement location.

KFAM-3 subroutines use Q, T, and V variables and arrays (alpha and numeric) for storage of critical internal pointers. The user-written progra should, therefore, strictly avoid the use of a Q, T, or V variable.

Identification of KFAM Files

A User File and Key File can be thought of collectively as a KFAM file. To use a KFAM file, the User File and the Key File must be open simultaneously. Thus, each KFAM file requires two "slots" or "rows" in the processor's Device Table. The 2200 system offers a total of seven Device Table slots, each identified by a "file number" symbol #0-#6. Since each KFAM file uses two file numbers, and there are seven file numbers available, a total of three KFAM files can be open concurrently.

The OPEN subroutine must be used to open a Key File and User File, before any KFAM file access operations can take place. The user-written application program must pass to the OPEN subroutine the file numbers (#0-#6) to be used for the Key File and User File. The application program also passes to OPEN a digit, 1-3, which will be used to identify this KFAM file (User File/Key File)

for all other KFAM subroutines. This digit, 1-3, is called the "KFAM ID number." When passed to OPEN, OPEN establishes this number as the single identifier for the pair of cataloged files being opened. In subsequent operations, while these files are open, they are identified collectively simply by passing the KFAM I.D. Number to the desired KFAM subroutine.

The file number for the User File is employed only when a record is to b written to or read from a User File. Then, the file number of the User File (#0 - #6) must be specified in the DATASAVE DC or DATALOAD DC statement. The KFAM I.D. Number is not used. In general, the file number of the Key File is never used, since any reference to the Key File should be via a KFAM subroutine. Note that accidental use of the Key File's file number in place of the User File's file number in a DATASAVE DC statement causes the user data to be written over data in the Key File. This destroys the Key File.

The same User File may be open concurrently with more than one Key File, but each such pair (User File/Key File) must have a different KFAM I.D. Number, and the User File must be referenced by a different file number in each case.

Key File Recovery Information

The KFAM maintenance utilities include a program called KEY FILE RECOVERY. The purpose of this program is to reconstruct a Key File from an existing User File, in the event that the Key File is accidentally destroyed. Unlike the program KEY FILE CREATION, it does not require that the key of the last physical record in the User File be known. However, it does require that all user-written application programs operating on the file adhere to two conventions:

1. All DELETE'ed records in the User File must have hex FF as the first byte of the key. This means that after a program calls the DELETE subroutine, it must then save hex FF into the first byte of the record's key.

2. If FINDNEW is to be executed on a file, the RECOVERY option must be included in the OPEN, FINDNEW, and CLOSE subroutines, and the file must be closed with the CLOSE subroutine at the conclusion of operations on the file. (The RECOVERY OPTION is offered in BUILD SUBROUTINE MODULE as one of several optional additional capabilities for the selected subroutine.)

4.2 BUILD SUBROUTINE MODULE

BUILD SUBROUTINE MODULE builds a module of selected KFAM subroutines for use in an application program. It allows the programmer to include in an application program module only those subroutines and subroutine capabilities which actually are used in the application program module, and, thereby, keeps to a minimum the amount of memory occupied by KFAM subroutines.

Each KFAM subroutine may be included or excluded independently of the others. After selecting the desired subroutines, the capability to operate on multiple files (two or three KFAM files open at the same time) may be included or excluded for the chosen subroutines. If only one KFAM file is to be open at any one time, then excluding the multiple file capability further reduces memory requirements.

Finally, the RECOVERY OPTION is offered. Whenever FINDNEW is executed, the RECOVERY OPTION must be included in the OPEN, FINDNEW, and CLOSE subroutines, if the ability to execute KEY FILE RECOVERY is desired. If the ability to use KEY FILE RECOVERY is not desired, the RECOVERY OPTION need not be included.

The OPEN subroutine, when chosen for a module, includes all the common variables needed for subroutine operation, except those for FINDNEW and FINDNEW(HERE). The utility separately asks whether the variables for FINDNEW and FINDNEW(HERE) are to be included in the OPEN subroutine. These variables must be included in the OPEN subroutine, if it is to be used to OPEN a file on which, subsequently, FINDNEW or FINDNEW(HERE) is executed.

NOTE:

All subroutine modules operating on a given open KFAM file must include the same options. (Options are OPEN FOR FINDNEW, MULTIPLE FILES, RECOVERY.) For example, if RECOVERY is chosen, it must be chosen for the module that contains OPEN, any processing modules, and the module that contains CLOSE.

To illustrate how BUILD SUBROUTINE MODULE might be used to maximize available memory, suppose that a file is to be "purged" in key sequence, deleting all obsolete records. The subroutines which are needed are:

OPEN
FINDFIRST
FINDNEXT
DELETE

These subroutines require 3370 bytes, approximately, if loaded at the same time. Suppose, further, that there is not enough memory available to accomplish the processing and include all of these subroutines. Two separate modules could be built, the first to contain OPEN and FINDFIRST, the second to contain the rest. The first two of these subroutine modules would then become part of a start-up module in the application program which would open the KFAM file, perform other preliminary processing, and then FINDFIRST. This start-up module would then overlay the processing module, clearing the OPEN and FINDFIRST subroutines as it does so. The processing module would contain FINDNEXT and DELETE. Memory overhead at any one time, due to subroutines, is thereby reduced from 3370 bytes to:

OPEN FINDFIRST	2975 bytes
FINDNEXT DELETE	2380 bytes

NOTE:

There are two modules of KFAM-3 subroutines included with the KFAM-3 system. If desired, the programmer may simply use one of these modules rather than building a custom module with the BUILD SUBROUTINE MODULE utility. The modules are as follows:

MODULE NAME	INCLUDES
KFAM0003	All subroutines and subroutine options.
KFAM0103	All subroutines and options except: DELETE, FINDNEW, FINDNEW(HERE), RECOVERY, OPEN FOR FINDNEW.

Operating Instructions - BUILD SUBROUTINE MODULE

DISPLAY	INSTRUCTIONS
1.	1. From KFAM subsidiary menu access its "BUILD SUBROUTINE MODULE" utility via the specified Special Function key.
2. ENTER THE NAME OF PROGRAM TO BE GENERATED?	2. Enter the name of the program file which is to contain the selected subroutines, maximum of 8 characters. If a file of the same name is not already cataloged, the utility allocates just enough space for the selected subroutines. If a file of the same name is already cataloged, that file is used for the output program and overwritten. If the file is a data file, it is changed to a program file.

CAUTION:

Before entering a name, ensure that the name entered is not the name of a valuable data file or program file. If a file already exists with the same name, its contents are destroyed by this utility.

If extra space is desired in the output file, it should be cataloged in advance as a data file. For example,
DATASAVE DC OPEN T/B10, 50, "FILE"

	ENTER THE NO. OF THE OUTPUT PROGRAM DEVICE? 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	3. Enter the selection number for the device address at which the subroutines are to be saved. ERROR MESSAGE: 1,2,3
4.	230 OPEN (Y OR N)? OPEN FOR FINDNEW (Y OR N)? 231 DELETE (Y OR N)? 232 FINDOLD (Y OR N)? 233 FINDNEW (Y OR N)? 234 FINDNEW (HERE) (Y OR N)? 235 FINDFIRST (Y OR N)? 236 FINDLAST (Y OR N)? 237 FINDNEXT (Y OR N)? 239 CLOSE (Y OR N)? MULTIPLE FILES (Y OR N)? RECOVERY OPTION (Y OR N)?	4. Each of the listed prompts is displayed sequentially. For each subroutine or subroutine capability enter Y to include it in the output module; to exclude it, enter N. ERROR MESSAGE: 1
5.	OK TO PROCEED?	5. Enter Y to accept selected subroutines, or N to return to step 4. ERROR MESSAGE: 1
6.	PHASE 2 - BUILDING PROGRAM NAME	6. The output module is generate ERROR MESSAGE: 4, 5, 6, 7
		7. The system returns to the KFAM-3 subsidiary menu.

Error Messages

ERROR MESSAGE	EXPLANATION/RECOVERY
1. RE-ENTER	1. Too many characters were entered, or an invalid character was entered in response to a "yes" (Y) or "no" (N) question. RECOVERY: Repeat the step. Re-enter the data.
2. INVALID DEVICE ADDRESS	2. The numbers 1-7 may be used to specify a device address, according to the table of device addresses displayed.

			RECOVERY: Repeat the step. Re-enter the data.
3.	ERR29	3.	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Repeat the step. Enter a number.
4.	INVALID DELIMITER (STOP)	4.	Errors 4,5, and 6 are hardware or software errors. They should not occur. RECOVERY: Rerun the program. If the error persists, notify Wang Laboratories.
5.	OUTPUT PROGRAM SPACE EXCEEDED (STOP)		
6.	SYSTEM ERROR (STOP)		
7.	NO ROOM ON DISK FOR OUTPUT PROGRAM (STOP)	7.	There is not room enough on the disk for the output program to be cataloged. RECOVERY: Rerun the program, with an output disk with more free space (25 sectors maximum requirement).

4.3 CALLING THE SUBROUTINES

Dummy Variable Names

In defining the argument lists for the subroutines, certain standard dummy variable names are used. These dummy names are used only to describe the general forms of the respective GOSUB' statements. In the actual program, the programmer may use any value or expression valid for use in a GOSUB' statement. Zeros in the general statement represent parameters which are not used by KFAM-3. They should be included, as zeros in the GOSUB' statement.

For example, the general statement:

```
GOSUB'232 (I, 0, A$)
```

y be written as:

```
GOSUB'232(I,0,K$)
GOSUB'232(2,0,"A48-3029")
GOSUB'232(F1+1,0,STR(P1$,7,8))
etc.
```

The dummy variable names for KFAM-3, and their meanings, are as follows:

Dummy Variable	Meaning
I	KFAM I.D. Number (1, 2, or 3).
K	File number assigned to the Key File (#0-#6).
U	File number assigned to the User File (#0-#6).
F	Key File number (1-9), specified as the 6th character in the Key File name, as assigned in INITIALIZE KFAM FILE.
A$	The record key (alphanumeric).
N$	User File name.

Return Codes

Upon returning to the main line program from the subroutines, the variables Q and Q$ contain the following information:

Q returns the record position indicator for blocked files (i.e., files with more than one record per sector). The record position indicator is a numeric value which specifies the position of a desired record within a block. For example, if Q=2, the key passed to the subroutine specifies the second record in the block. For unblocked records Q is returned as 1, and may be ignored.

Q is not defined following the OPEN or CLOSE subroutines.

Q$ contains the completion return code. It indicates the result of the particular operation. The possible values of Q$, and their meanings, are as follows:

Q$ Value	Meaning
blank	The subroutine execution was OK.
D	Duplicate key (attempting to add a duplicate key to the file). The Key File is unchanged.
E	End of file (FINDNEXT only).
N	Key not found.
S	No more space, either for the User File or the Key File, or 8 levels of index have been exhausted attempting to add a record to the file. The Key File is unchanged. (FINDNEW and FINDNEW(HERE) only.)
X	Improper call to a KFAM subroutine (argument values erroneous, etc.).

If Q$ is anything other than blank, the User File Current Sector address parameter is undefined, and the value of Q is undefined.

Immediately upon return from any of the subroutines, the main li rogram should check Q$ for possible error indications.

The system assumes there are no programming errors in the main line program. The KFAM Subroutines can perform improperly, and can destroy a file, if the parameters supplied by the main line program are erroneous. Therefore, during the testing stage, it is recommended that the user keep a backup file so that test data can be recovered in the event that it is destroyed.

The subroutines check data errors, and the kind of errors likely to occur during normal operation, such as duplicate key, key not found, or no more space. The following errors, which are programming errors, may or may not be caught by the subroutines:

Error	Q$ Value, or ERR code
KFAM I.D. Number not an integer between 1 and 3.	X ERR 18
KFAM I.D. Number is the same as I.D. Number for a file already open.	X

File to be opened is already open.	X
Individual file numbers not integers between 0 and 6.	ERR 18 ERR 41
Individual file number is duplicate of another file number.	X
File name not in proper format, with 5th byte="F" and 6th byte a 0 (zero).	ERR 78 ERR 80
Key File number not an integer from 1 to 9.	ERR 56
File to be accessed has not been opened.	X
SELECT statements and file numbers do not actually correspond.	none
File names are not correct, or do not exist on the disk platters specified.	ERR 78

4.4 OPEN

The OPEN subroutine is used to open a User File and its companion Key File. OPEN must be executed prior to execution of any other KFAM-3 subroutine. In the OPEN subroutine, a pair of DATALOAD DC OPEN statements are executed to open the named User File and its companion Key File. Specified file numbers are assigned to each file. OPEN also assigns a specified KFAM I.D. Number to the pair of files. To call the OPEN subroutine you must write two statements of the following general form:

```
SELECT #U XXX, #K YYY
GOSUB' 230 (I,K,U,F,N$)
```

For the SELECT Statement

"#U" is the file number to be associated with the User File; "U" can be a number from 1 to 6. "#U" must be used in all subsequent DATASAVE DC or DATALOAD DC statements to reference the User File.

"XXX" is the device address of the platter on which the User File is stored. .

"#K" is the file number to be associated with the Key File; "K" can be number from 1 to 6.

"YYY" is the device address of the platter on which the Key File is stored.

For the GOSUB' Statement

"I" is the KFAM I.D. Number to be associated with the newly opened pair of files and must be used to reference the KFAM file in subsequent KFAM subroutines. "I" can be a number from 1 to 3.

"K" is the file number to be assigned to the Key File (see "#K" above).

"U" is the file number to be assigned to the User File (see "#U" above).

"F" is the Key File number (the sixth character in the Key File name). It may be an integer from 1 to 9, but normally is 1.

"N$" is the name of the User File to be opened. The Key File name need not be specified; it is built from the User File name and the Key File number by KFAM itself.

Return Codes for OPEN

Q$ = " " (space) if the subroutine execution was O.K.

Q$ = "X" for an improper call (i.e., one of the arguments in the GOSUB' 230 argument list was incorrect, or the file is already open). Note, if a file is already open, or the KFAM I.D. number is already in use, OPEN returns Q$ = "X".

4.5 DELETE

The DELETE subroutine deletes from the Key File a specified key and its associated record location pointer. The Current Sector address for the User File is set to the location of the record whose key has been deleted, and for blocked records the variable Q is set to the record position within the sector. The record itself, in the User File, is not altered or removed. Thus, although the record is not physically removed from the User File, its key entry is removed from the Key File, and the record can no longer be accessed through KFAM.

The calling sequence for DELETE is:

GOSUB' 231 (I, 0, A$)

"I" is the KFAM I.D. Number, assigned to the file in an OPEN subroutine.

"A$" is the key of the record that is to be deleted from the file.

DELETE Return Codes

Q$ = "N" if the key passed cannot be found in the Key File.
Q$ = "X" for an improper call.
Q$ = " " ("space") if the subroutine executed properly.

After calling a DELETE subroutine and checking for its successful completion, the application program should flag the DELETED record in the User File by changing the first character of the deleted record's key to hex FF. For unblocked files this can be done as follows:

Suppose:

```
     DIM A$15, H(4,4), J(6)
and
     DATA SAVE DC #1, A$, H(), J()
```

define a type "N" record where A$ is the key field.

The DELETE-and-flag operation might look like this:

```
4060 GOSUB' 231 (1, 0, A$): REM DELETE
4070 IF Q$<>" " THEN 6000:REM ERROR?
4080 DATA LOAD DC #1, A$, H(), J()
4090 STR(A$,1,1)=HEX(FF):REM HEX(FF) IN 1ST BYTE OF KEY
4100 DBACKSPACE #1,1S:REM RECORDS ARE 1 SECTOR LONG
4110 DATA SAVE DC #1,A$,H(),J()
.
.
.
6000 STOP "DELETE UNSUCCESSFUL"
```

Instead of flagging deleted records, the space in the User File can be reused; however, this normally requires special techniques together with the use of FINDNEW(HERE). For information on these techniques see Chapter 12.

4.6 FINDOLD

The FINDOLD subroutine is used to locate a desired record in the User File. Following subroutine execution, the Current Sector address for the User File is set to the address of the record whose key was passed to the subroutine. For blocked records, variable Q is set to the record position within the sector. The record can then be read with a DATALOAD DC statement. The calling sequence is:

```
GOSUB' 232 (I, 0, A$)
```

"I" is the KFAM I.D. Number assigned to the file in the OPEN subroutine.

"A$" is the key of the record being sought.

FINDOLD Return Codes

Q$ = "N" if the specified key is not located in the Key File.
Q$ = "X" for an improper call.
Q$ = " " ("space") if the key was located without difficulty.

4.7 FINDNEW

The FINDNEW subroutine is used to enter a new key in the Key File and to find a location for the new record in the User File. FINDNEW enters the key passed to it in the Key File, then sets the Current Sector address for the User File to the next sequential sector available for writing a new record. For blocked records, variable Q is set to the record position within the sector. The calling sequence is:

```
GOSUB' 233 (I,0,A$,0)
```

"I" is the KFAM I.D. Number, assigned to the file in an OPEN subroutine.

"A$" is the new key to be entered in the Key File.

FINDNEW Return Codes

Q$ = "D" if the key specified is a duplicate of one already in the Key File.
Q$ = "S" if there is no space in the User File for another record, or in the Key File for another key entry, or 8 index levels have been exhausted.
Q$ = "X" for an improper call.
Q$ = " " ("space") if the key was entered without difficulty.

The following example illustrates the procedure for adding a record to a type A blocked file following FINDNEW. Note the test on Q before the DATA SAVE.

```
4100        INPUT "KEY FIELD", A$              :REM OPERATOR ENTERS KEY
4120        GOSUB '233 (1,0,A$,0)              :REM FINDNEW
4130    REM TEST COMPLETION CODE
4140        IF Q$ = "D" THEN 5010              :REM DUPLICATE KEY?
4150        IF Q$ = "S" THEN 5050              :REM FILE FULL?
4160        IF Q$<> " " THEN 5060              :REM ERROR?
4170    REM NEW BLOCK OR OLD?
4180        IF Q = 1 THEN 4220  :REM FIRST RECORD IN NEW BLOCK?
4185    REM READ EXISTING RECORDS IN BLOCK
4190        DATA LOAD DC #2, A$(),B$(),C(),D()
4200        DBACKSPACE #2, 1 S  :REM BACKSPACE AFTER DATALOAD
```

```
  10    REM ASSIGN RECORD VALUES TO PROPER ARRAY ELEMENTS
4220        A$(Q) = A$
4230        INPUT "SECOND FIELD", B$(Q)
4240        INPUT "THIRD FIELD", C(Q)
4250        INPUT "FOURTH FIELD", D(Q)
4260    REM SAVE BLOCK IN USER FILE
4270        DATA SAVE DC #2, A$(),B$(),C(),D()
  .
  .
  .
5000    REM ERROR MESSAGES
5010        STOP "KEY ALREADY EXISTS"
5050        STOP "KEY FILE OR USER FILE IS FULL"
5060        STOP "FINDNEW ERROR"
```

4.8 FINDNEW(HERE)

The FINDNEW(HERE) subroutine is a specialized routine whose primary use is in changing the keys of existing keyed records. It can only be used following the DELETE subroutine. (To get around this rule, see Chapter 12.) Once DELETE has removed the old key from the Key File, FINDNEW(HERE) enters the new key, along with the location of the deleted record, in the Key File. The Current Sector address is unchanged. For blocked records, the variable Q is set to the record position within the block.

The difference between FINDNEW and FINDNEW(HERE) is that FINDNEW make available the next available free space for the new record, whereas FINDNEW (HERE) enables the user to use the space occupied by a DELETED record.

The calling sequence is:

```
GOSUB' 234 (I,0,A$,0)
```

The FINDNEW(HERE) argument list is identical to the argument list for FINDNEW (see FINDNEW).

FINDNEW(HERE) Return Codes

Q$ =	"X" for an improper call.
Q$ =	"D" if the key specified is a duplicate of a key already in the Key File.
Q$ =	"S" if there is no space in the Key File for another entry, or if 8 index levels have been exhausted.
Q$ =	" " (space) if the subroutine executed properly.

The following example illustrates the use of FINDNEW(HERE) following DELETE:

```
5000 GOSUB '231 (1,0,"ABCD") :REM DELETE "ABCD" FROM KEY FILE
5010 IF Q$ = "X" THEN 5130
5040 IF Q$ = "N" THEN 5150
5050 GOSUB '234 (1,0,"EFGH",0) :REM INSERT "EFGH" IN KEY FILE
5060 IF Q$ = "X" THEN 5140
5070 IF Q$ = "D" THEN 5160
5075 IF Q$="S" THEN 5170
5080 DATALOAD DC #2,A$,B$,C$,N
5090 A$ = "EFGH" :REM CHANGE KEY TO "EFGH"
5100 DBACKSPACE #2, 1S
5110 DATASAVE DC #2,A$,B$,C$,N
5115 GOSUB'239(1) :REM CLOSE FILES
5120 END
5130 STOP "ERROR IN 'DELETE' CALLING SEQUENCE"
5140 STOP "ERROR IN 'FINDNEW(HERE)' CALLING SEQUENCE"
5150 STOP "KEY NOT FOUND"
5160 STOP "DUPLICATE KEY"
5170 STOP "NO SPACE"
```

4.9 FINDFIRST

The FINDFIRST subroutine sets the Current Sector address for the User File to the first record in logical key sequence. For blocked records, variable Q is set to the record position within the sector. A DATALOAD DC statement can be used after FINDFIRST to read the record. The calling sequence is:

```
GOSUB' 235 (I)
```

"I" is the KFAM I.D. Number, assigned to the file in an OPEN subroutine.

FINDFIRST Return Codes

Q$ = "N" if the User File contains no records.
Q$ = "X" for an improper call.
Q$ = " " (space) if the subroutine executed properly.

4.10 FINDLAST

The FINDLAST subroutine sets the Current Sector address for the User File to the last record in logical key sequence. For blocked records, the variable Q is set to the record position within the sector. A DATALOAD DC statement can be executed following FINDLAST to read the record. The calling sequence is:

GOSUB' 236 (I)

"I" is the KFAM I.D. Number assigned to the file in an OPEN subroutine.

FINDLAST Return Codes

Q$ = "N" for a null file.
Q$ = "X" for an improper call.
Q$ = " " (space) if the subroutine executes normally.

4.11 FINDNEXT

The FINDNEXT subroutine sets the Current Sector address for the User File to the record immediately following (in logical key sequence) the last record accessed by KFAM. For blocked records, the variable Q is set to the position of the record within the sector. A DATALOAD DC statement can be executed following FINDNEXT to read the record. FINDNEXT is useful for processing files in key sequence. The calling statement is:

GOSUB' 237 (I)

"I" is the KFAM I.D. Number assigned to the file in an OPEN subroutine.

FINDNEXT Return Codes

Q$ = "X" for an improper call.
Q$ = "E" if the previous reference was to the last record in logical key sequence.

Otherwise, Q$ = " " (space).

NOTE:

FINDNEXT cannot be executed as the first subroutine following an OPEN routine. Also, FINDNEXT cannot normally be executed immediately following any subroutine which returned an error code (Q$ other than blank). Otherwise FINDNEXT will locate the next sequential key, following any subroutine.

If FINDNEXT is executed following a FINDOLD that returned Q$ = "N" (not found), then FINDNEXT finds the next sequential record which would follow the record sought in the FINDOLD, were that record actually in the file.

CHAPTER 5
KFAM-4 SUBROUTINES

5.1 PROGRAMMING WITH THE KFAM-4 SUBROUTINES

5.1.1 Differences between KFAM-4 Subroutines and KFAM-3 Subroutines

The KFAM-4 subroutines perform the same functions as those of KFAM-3. Before using KFAM-4, the programmer should become familiar with the use of KFAM-3. Except as noted in this chapter, the elementary KFAM subroutine ogramming conventions and procedures described in Section 4.1, apply to M-4 as well as KFAM-3.

The subroutine RELEASE is added in KFAM-4 to turn off a protect flag on a record. The principal differences between the other KFAM-3 and KFAM-4 subroutines fall into four categories:

1. Two additional arguments to be supplied in the GOSUB' statements which call the subroutines.

2. Two additional return codes which indicate that the subroutine operation could not be carried out, due to a protective procedure invoked by another CPU.

3. A completely different procedure for SELECTing the Key File device address.

4. The CLOSE subroutine must be executed at the conclusion of file operations.

Additional Arguments

In the OPEN subroutine a class-of-access argument is required. Symbolized by the dummy variable C$, an argument value of "A" means that any other CPU's may open the file while this CPU has the file open. An argument

4.12 CLOSE

The CLOSE subroutine is used to close a currently open User File and its companion Key File. The KFAM I.D. Number assigned to a closed file can then be reassigned to another file in an OPEN routine. Similarly, the file numbers assigned to a User File and Key File can be reassigned in an OPEN routine once the files have been closed. The CLOSE subroutine also saves certain critical information for the KEY FILE RECOVERY utility, provided that the RECOVERY OPTION was included during BUILD SUBROUTINE MODULE execution. The calling sequence is:

```
GOSUB' 239 (I)
```

"I" is the KFAM I.D. Number assigned to the file in an OPEN routine. Following execution of the CLOSE routine, this number can no longer be used to access the User File and its associated Key File.

CLOSE Return Codes

Q$ = "X" for an improper call.
Otherwise, Q$ = " " (space).

alue of "X" means that this CPU seeks exclusive access to the file.

In general, exclusive access should not be sought, except for those operations which must be carried out on an entire file with the entire file protected from alteration by another CPU. For example, printing an end of period status report might be an appropriate use of exclusive access, when it is important that the report reflect the file status at one particular time. However, in addition to this use, exclusive access may be sought whenever maximum access speed is required.

A protect-flag argument is required for the following subroutines:

DELETE
FINDOLD
FINDNEW
FINDNEW(HERE)
FINDFIRST
FINDLAST
FINDNEXT

The dummy variable P is used to represent this argument. If an argument value of 1 is passed to the subroutine, then the protect flag is turned on for the record or block or records accessed by this subroutine call. As long as the protect flag is on for a record or block of records, that record or block cannot be accessed by any CPU other than the CPU which turned on the protect flag. All other records in the file may, however, be accessed. If rgument value of 0 is passed to the subroutine, then the protect flag is no urned on.

Once turned on, a protect flag is automatically turned off as soon as the CPU that turned on the flag executes another KFAM-4 subroutine on the same file. The subroutine RELEASE can be used if there may be a long delay before another subroutine is executed. RELEASE simply turns off the protect flag.

Additional Return Codes

As a result of the OPEN subroutine, Q$ may be returned with the value "C". This indicates access-class conflict. Either this CPU is seeking exclusive access when another CPU has the file open, or this CPU seeks access when another CPU has exclusive access.

After executing any of the subroutines, except OPEN, CLOSE, and RELEASE, Q$ may be returned with the value "B". This is the busy signal. It means that the User File record which was sought has had its protect flag turned on by another CPU. The User File's Current Sector address is unchanged.

SELECT Procedure

In KFAM-3 the user program executes a SELECT statement for the key file device address as well as the user file device address, immediately prior to calling the OPEN subroutine. The KFAM-3 subroutines themselves never have t

SELECT a device address. However, this situation is changed for KFAM-4. A KFAM-4 subroutine must SELECT a hog mode address for the key file, hog the disk during its execution, and then SELECT the non-hog mode address and leave hog mode before returning control to the user program.

The KFAM-4 subroutines select hog mode and non-hog mode by calling short subroutines that reside in the user program. These subroutines must be written by the application programmer, and included in every module which accesses a KFAM-4 subroutine.

For example, suppose that a program accesses just one KFAM file, that the Key File is at device address 320, and that file number #2 is used for the Key File. The following two subroutines must be included somewhere in the user program.

```
4000  REM SELECT HOG MODE
4010  DEFFN' 210 (T6)
4020  SELECT #2 3A0
4030  RETURN
4040  REM SELECT NON-HOG MODE
4050  DEFFN' 211 (T6)
4060  SELECT #2 320
4070  RETURN
```

Shortly after it is called, the KFAM-4 subroutine calls DEFFN'210 to select hog mode for its operations on the Key File. When the KFAM-4 subroutine is nearly complete, it calls DEFFN'211 to select non-hog mode. After selecting non-hog mode, the subroutine executes a disk statement so that the hog mode is actually released before control is passed back to the user program.

Thus, the SELECT subroutines are the reverse of the normal KFAM subroutines. In general, the user program calls a KFAM subroutine; however, these particular subroutines are written by the user, and called by the KFAM-4 subroutines.

Notice in the SELECT subroutines shown above, that the variable T6 is assigned a value by the GOSUB' statement which calls the subroutine. This variable must always appear in the DEFFN' statements of the SELECT subroutines; however, the value of this variable becomes significant only if several KFAM files are to be accessed by the user program. The variable T6 is assigned the KFAM I.D. Number when the SELECT subroutines are called by a KFAM subroutine. It is used as follows.

Suppose that there are three KFAM files (Key File/User File) to be accessed by the user program. The pertinent information is

KFAM I.D. NO.	Key File File Number	Key File Device Address
1	#2	B20
2	#4	B20
3	#6	320

The SELECT subroutines should be written as follows:

```
4000 REM SELECT HOG MODE
4010 DEFFN'210 (T6)
4020 ON T6 GOTO 4030, 4040, 4050
4030 SELECT #2 BAO: RETURN
4040 SELECT #4 BAO: RETURN
4050 SELECT #6 3AO: RETURN

4060 REM SELECT NON-HOG MODE
4070 DEFFN'211 (T6)
4080 ON T6 GOTO 4090, 4100, 4110
4090 SELECT #2 B20: RETURN
4100 SELECT #4 B20: RETURN
4110 SELECT #6 320: RETURN
```

Notice that T6, which is the KFAM I.D. number, is used to control which of the Key Files is SELECTed for hog (or non-hog) mode.

The KFAM-4 subroutines cannot operate successfully without the SELECT subroutines included in the application program.

The CLOSE Subroutine

When the KFAM-4 OPEN subroutine is executed, the CPU opening the file is assigned to a slot in the Access Table of the Key File's KDR record. It "occupies" this slot until it executes the CLOSE subroutine. If a CPU opens a file and fails to execute the CLOSE subroutine at the conclusion of its file operations, the Access Table retains the open file notation for that slot. This false notation in the Access Table prevents the file from being opened in the exclusive mode. Four such false notations, or one false "exclusive access" notation, prevent the file from being opened at all, by any CPU. It is therefore imperative that the CLOSE subroutine be executed at the conclusion of operations on a KFAM-4 file.

5.1.2 Procedural Notes for Programming with KFAM-4 Subroutines

In general the programming procedures used with KFAM-4 subroutines are not unlike those used with KFAM-3. In addition to the differences in calling sequences, return codes, and SELECT procedures, the following difference should be noted.

1. The protect flag should be set for a record if a DATA SAVE is to be executed on the record. (The protect flag is set by specifying a 1 for the dummy variable "P" in the GOSUB' argument lists of the KFAM-4 subroutines.) Updating records, adding new records, and flagging deleted records all require that a DATA SAVE DC be executed; therefore, the protect flag should be set for all these operations. Operations which only execute DATA LOAD DC on the record should not set the protect flag.

2. Application programs should not attempt to hog the disk continuously. The user file address should be a normal disk address, not a hog mode address.

3. The application program must check for a return code of Q$ = "B", indicating that the record (or block of records) sought is protected. On a Q$ = "B" condition the application program can simply reexecute the subroutine. For example,

```
     4250    GOSUB' 237 (2,1):REM FINDNEXT
     4260    IF Q$ = "B" THEN 4250: REM KEEP TRYING
```

4. In general a file should not be opened in exclusive mode, except in either of the following circumstances:

   a) The operation on the file must take place with the file status fixed as of the beginning of the operation. For example, printing a report as of the end of an accounting period.

   b) Maximum file access speed is needed. (When a file is open in exclusive mode, the KFAM-4 subroutines can search the key file without first reading and writing the KDR record. This allows subroutine execution speed to approximate that of KFAM-3.)

5. Application programs must never write trailer records of any kind into the user file. The RECOVERY OPTION should be used to provide recovery capability for the possibility of accidental Key File destruction. In general, application programs must never make any assumptions about the status of user file sectors other than those specifically returned by a subroutine. For example under KFAM-4, it is possible for the next sequential record location, after that returned by a FINDNEW, to be already occupied by a live record, written by another CPU.

6. Application programs should execute the RELEASE subroutine if the previous call set the protect flag, and there may be a long delay before the next KFAM-4 subroutine call on that file.

   You may wish to consider any keyboard entry operation as involving a long delay, and execute RELEASE prior to the keyboard entry.

Alternatively, a Special Function Key subroutine that executes RELEASE may be made available during all keyboard entry operations. The operator would then be instructed to depress the specified Special Function Key if there is any delay prior to responding.

7. The CLOSE subroutine must be executed at the conclusion of operations on a KFAM-4 file. The operator should always have available a procedure for CLOSING the file in the event of program malfunctions, or other disaster. (If the CPU power is turned off without CLOSING the file, the Access Table retains a notation for a "phantom" CPU; the RESET ACCESS TABLE utility must be run.) A Special Function key subroutine such as DEFFN' 31 might be made available to CLOSE a file at any time.

5.2 BUILD SUBROUTINE MODULE (KFAM-4)

BUILD SUBROUTINE MODULE builds a module of selected KFAM subroutines for use in an application program. It allows the programmer to include in an application program module only those subroutines and subroutine capabilities which actually are used in the application program module, and, thereby, keeps to a minimum the amount of memory occupied by KFAM-4 subroutines.

Each KFAM subroutine may be included or excluded independently of the others. After selecting the desired subroutines, the capability to operate on multiple files (two or three KFAM-4 files open at the same time) may be included or excluded for the chosen subroutines. If only one KFAM-4 file is to be open at any one time, then excluding the multiple file capability further reduces memory requirements. Finally, the RECOVERY OPTION is offered. It must be included in order for the KEY FILE RECOVERY program to execute successfully in the event of accidental Key File destruction. If the ability to use KEY FILE RECOVERY is not desired, the RECOVERY OPTION need not be included.

The OPEN subroutine, when chosen for a module, includes all the common variables needed for subroutine operation except those for FINDNEW and FINDNEW(HERE). The utility separately asks whether the variables for FINDNEW and FINDNEW(HERE) are to be included in the OPEN subroutine. These variables must be included in the OPEN subroutine, if it is to be used to OPEN a file on which, subsequently, FINDNEW or FINDNEW(HERE) is executed.

NOTE:

All subroutine modules operating on a given open KFAM file must include the same options. (Options are OPEN FOR FINDNEW, MULTIPLE FILES, RECOVERY.) For example, if RECOVERY is chosen, it must be chosen for the module that contains OPEN, any processing modules, and the module that contains CLOSE.

To illustrate how BUILD SUBROUTINE MODULE might be used, to maximi available memory, suppose that a file is to be "purged" in key sequence, deleting all obsolete records. The subroutines which are needed are:

OPEN
FINDFIRST
FINDNEXT
DELETE
CLOSE

These subroutines require 4406 bytes, approximately, if loaded at the same time. Suppose, further, that there is not enough memory available to accomplish the processing, and include all of these subroutines. Two separate modules could be built, the first to contain OPEN and FINDFIRST only, the second to contain the rest. The first of these subroutine modules would then become part of a start-up module in the application program which would open the KFAM file and perform other preliminary processing. This start-up module would then overlay the processing module, clearing the OPEN and FINDFIRST

subroutines as it does so. The processing module would contain the second group of subroutines: FINDNEXT, DELETE and CLOSE. Memory overhead at any one time, due to subroutines, is thereby reduced from 4406 bytes to

OPEN FINDFIRST	3830 bytes
FINDNEXT DELETE CLOSE	3255 bytes

Note 1:

There are two modules of KFAM-4 subroutines included with the KFAM-4 system. If desired, the programmer may simply use one of these modules rather than build a custom module with the BUILD SUBROUTINE MODULE utility. The modules are as follows:

MODULE NAME	INCLUDES
KFAM0004	All subroutines and subroutine options.
KFAM0104	All subroutines and options except: DELETE, FINDNEW, FINDNEW(HERE), RECOVERY, OPEN FOR FINDNEW.

NOTE 2:

BUILD SUBROUTINE MODULE selects hog mode for the output disk device. To execute it in non-hog mode, or to execute it at a non-multiplexed disk drive, key:

```
M$ = "X" (EXEC)
```

at KFAM-4 utilities menu, prior to accessing the utility.

Operating Instructions - BUILD SUBROUTINE MODULE KFAM-4

	DISPLAY		INSTRUCTIONS
1.		1.	From KFAM-4 subsidiary menu access its "BUILD SUBROUTINE MODULE" utility via the specified Special Function key.
2.	ENTER THE NAME OF PROGRAM TO BE GENERATED? ?--------	2.	Enter the name of the program file which is to contain the selected subroutines, maximum of 8 characters.

If a file of the same name is not already cataloged, the utility allocates just enough space for the selected subroutines.

If a file of the same name is already cataloged, that file is used for the output program and overwritten. If the file is a data file, it is changed to a program file.

CAUTION:

Before entering a name, ensure that the name entered is not the name of a valuable data file or program file. If a file already exists with the same name, its contents are destroyed by this utility.

If extra space is desired in the output file, it should be cataloged in advance as a data file. For example, DATASAVE DC OPEN T/B10, 50, "FILE"

3. ENTER THE NO. OF THE OUTPUT PROGRAM DEVICE?

1. 310	5. B10
2. 320	6. B20
3. 330	7. B30
4. 350	

3. Enter the selection number for the device address at which the selected subroutines are to be saved.

> NOTE:
>
> The utility operates in hog mode on the output disk drive unless M$ is set to "X".

ERROR MESSAGE: 1,2,3

4.
```
230 OPEN (Y OR N)?
OPEN FOR FINDNEW (Y OR N)?
231 DELETE (Y OR N)?
232 FINDOLD (Y OR N)?
233 FINDNEW (Y OR N)?
234 FINDNEW (HERE) (Y OR N)?
235 FINDFIRST (Y OR N)?
236 FINDLAST (Y OR N)?
239 CLOSE (Y OR N)?

237 FINDNEXT (Y OR N)?
238 RELEASE (Y OR N)?
MULTIPLE FILES (Y OR N)?
RECOVERY OPTION (Y OR N)?
```

4. Each of the listed prompts is displayed sequentially. For each subroutine or subroutine capability enter Y to include it in the output module; otherwise, enter N.

ERROR MESSAGE: 1

5. OK TO PROCEED? (Y OR N)

5. Enter Y to accept selected subroutines, or N to return to step 4.

ERROR MESSAGE: 1

6. PHASE 2 - BUILDING PROGRAM NAME

6. The output module is generated.

ERROR MESSAGE: 4, 5, 6, 7

7. The system returns to the KFAM subsidiary menu.

Error Messages

ERROR MESSAGE		EXPLANATION/RECOVERY
1. RE-ENTER	1.	Too many characters were entered, or an invalid character was entered in response to a "yes" (Y) or "no" (N) question. RECOVERY: Repeat the step. Re-enter the data.
2. INVALID DEVICE ADDRESS	2.	The numbers 1-7 may be used to specify a device address, according to the table of device addresses displayed. RECOVERY: Repeat the step. Re-enter the data.
3. ERR29	3.	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Repeat the step. Enter a number.
[illegible]. INVALID DELIMITER (STOP)	4.	Errors 4,5, and 6 are hardware or software errors. They should not occur. RECOVERY: Rerun the program. If the error persists, notify Wang Laboratories.
5. OUTPUT PROGRAM SPACE EXCEEDED (STOP)		
6. SYSTEM ERROR (STOP)		
7. NO ROOM ON DISK FOR OUTPUT PROGRAM (STOP)	7.	There is not room enough on the disk for the output program to be cataloged. RECOVERY: Rerun the program, with an output disk with more free space (25 sectors maximum requirement).

5.3 CALLING THE KFAM-4 SUBROUTINES

Dummy Variable Names

In defining the argument lists for the subroutines below, certain standard dummy variable names are used. These dummy names are used only to describe the general forms of the respective GOSUB' statements. In the actual program, the programmer may use any value or expression valid for use in a GOSUB' statement. Zeros in the general statement represent parameters which are not used by KFAM-4. They should be included, as zeros in the GOSUB' statement.

For example, the general statement:

```
GOSUB' 233 (I,P,A$,0)
```

may be written as:

```
GOSUB'233(I,P,K$,0)
GOSUB'233 (2,1,"A48-3029",0)
GOSUB'233(F1+1,0,STR(P1$,7,8),0)
etc.
```

The dummy variable names for KFAM-4, and their meanings, are as follows:

Dummy Variable	Meaning
I	KFAM I.D. Number (1, 2, or 3).
K	File number assigned to the Key File (#0-#6).
U	File number assigned to the User File (#0-#6).
F	Key File number (1-9), specified as the 6th character in the Key File name, as assigned in INITIALIZE KFAM FILE.
A$	The record key (alphanumeric).
N$	User File name.
P	Protect flag. If P=0, then other CPU's may access this record or block of records. If P=1, then only this CPU may access this record or block of records.

C$	Class of access desired in opening the file. "A" means any CPU may access the file. "X" means this CPU seeks exclusive access to the file.

Return Codes

Upon returning to the main line program from the subroutines, the variables Q and Q$ contain the following information:

Q returns the record position indicator for blocked files (i.e., files with more than one record per sector). The record position indicator is a numeric value which specifies the position of a desired record within a block. For example, if Q=2, the key passed to the subroutine specifies the second record in the block. For unblocked records Q is returned as 1, and may be ignored.

Q is not defined following the OPEN or CLOSE subroutines.

Q$ contains the completion return code. It indicates the result of the particular operation. The possible values of Q$, and their meanings, are as follows:

Q$ Value	Meaning
blank	The subroutine execution was successful.
D	Duplicate key (attempting to add a duplicate key to the file). The Key File is unchanged.
E	End of file (FINDNEXT only).
N	Key not found.
S	No more space, either for the User File or the Key File, or 8 levels of index have been exhausted attempting to add a record to the file. The Key File is unchanged. (FINDNEW and FINDNEW(HERE) only.)
B	Busy Signal. The user file record or block of records being accessed has been "protected" by another CPU.
C	Access Class conflict (OPEN only). Either this CPU is asking for

	exclusive access when another CPU has the file open, or this CPU is asking for access when another CPU has exclusive access.
X	Improper call to a KFAM subroutine (argument values erroneous, etc.).

If Q$ is anything other than blank, the User File Current Sector address parameter is undefined, and the value of Q is undefined.

Immediately upon return from any of the subroutines, the main line program should check Q$ for possible error indications.

The system assumes there are no programming errors in the main line program. The KFAM Subroutines can perform improperly, and can destroy a file, if the parameters supplied by the main line program are erroneous. Therefore, during the testing stage, it is recommended that the user keep a backup file so that test data can be recovered in the event that it is destroyed.

The subroutines check data errors, and the kind of errors likely to occur during normal operation, such as duplicate key, key not found, or no more space. The following errors, which are programming errors, may or may not be caught by the subroutines:

Error	Q$ Value, or ERR code
KFAM I.D. Number not an integer between 1 and 3.	X ERR 18
KFAM I.D. Number is the same as I.D. Number for a file already open.	X
File to be opened is already open.	X
Individual file numbers not integers between 0 and 6.	ERR 18 ERR 41
Individual file number is duplicate of another file number.	X
File name not in proper format, with 5th byte="F" and 6th byte a 0 (zero).	ERR 78 ERR 80
Key File number not an integer from 1 to 9.	ERR 56

File to be accessed has not been opened.	X
SELECT statements and file numbers do not actually correspond.	none
File names are not correct, or do not exist on the disk platters specified.	ERR 78 ERR 80

5.4 OPEN

The OPEN subroutine is used to open a User File and its companion Key File. OPEN must be executed prior to execution of any other KFAM subroutine. In the OPEN subroutine, a pair of DATALOAD DC OPEN statements are executed to open the named User File and its companion Key File. Specified file numbers are assigned to each file. OPEN also assigns a specified KFAM I.D. Number to the pair of files. To call the OPEN subroutine you must write two statements of the following general form:

```
SELECT #U XXX
GOSUB' 230 (I,K,U,F,N$,C$)
```

For the SELECT Statement

"#U" is the file number to be associated with the User File; "U" can be a number from 1 to 6. "#U" must be used in all subsequent DATASAVE DC or DATALOAD DC statements to reference the User File.

"XXX" is the device address of the platter on which the User File is stored.

For the GOSUB' Statement

"I" is the KFAM I.D. Number which is to be associated with the newly opened file, and must be used to reference the file in subsequent KFAM subroutines. "I" can be a number from 1 to 3.

"K" is the file number to be assigned to the Key File (see NOTE below).

"U" is the file number to be assigned to the User File (see "#U" above).

"F" is the Key File number (the sixth character in the Key File name, it may be an integer from 1 to 9, but normally it is 1).

"N$" is the name of the User File to be opened. The Key File name need not be specified; it is built from the User File name and the Key File number by KFAM itself.

"C$" is the class of access desired. If C$ = "A" then any CPU may open the file. If C$ = "X", then only this CPU may access the file.

Return Codes for OPEN

Q$ = " " (space) if the subroutine execution was O.K.

Q$ = "C" if there is an access class conflict. Either this CPU seeks exclusive access (C$ = "X") when another CPU has the file open, or another CPU has exclusive access.

Q$ = "X" for an improper call (i.e., one of the arguments in the GOSUB' 230 argument list is incorrect, or the file is already open). Note, if a file is already open or the KFAM I.D. number is already in use, OPEN returns Q$ = "X".

NOTE:

The application program must include the SELECT subroutines DEFFN'210 and DEFFN'211 to select hog mode and non-hog mode for the Key File device address. All KFAM-4 subroutines require that these subroutines be included in the application program. See Section 5.1 for information about how to write these subroutines.

5.5 DELETE

The DELETE subroutine deletes from the Key File a specified key and its associated record location pointer. The Current Sector address for the User File is set to the location of the record whose key has been deleted, and for blocked records the variable Q is set to the record position within the sector. The record itself, in the User File, is not altered or removed. Thus, although the record is not physically removed from the User File, its key entry is removed from the Key File, and the record can no longer be accessed through KFAM.

The calling sequence for DELETE is:

GOSUB' 231 (I, P, A$)

"I" is the KFAM I.D. Number, assigned to the file in an OPEN subroutine.

"P" is the protect flag option. If P=0, other CPU's may access this record or block of records. If P=1, only this CPU may access this record or block of records.

"A$" is the key of the record that is to be deleted from the file.

DELETE Return Codes

Q$ = "B" Busy Signal. The record sought is protected by another CPU.
Q$ = "N" if the key passed cannot be found in the Key File.
Q$ = "X" for an improper call.
Q$ = " " ("space") if the subroutine executed properly.

After calling a DELETE subroutine and checking for its successful completion, the application program should flag the DELETED record in the User File by changing the first character of the deleted record's key to hex FF. For unblocked files this can be done as follows:

Suppose:

```
     DIM A$15, H(4,4), J(6)
and
     DATA SAVE DC #1, A$, H(), J()
```

define a type "N" record where A$ is the key field.

The DELETE and flag operation might look like this:

```
4060 GOSUB' 231 (1, 1, A$): REM DELETE
4065 IF Q$ = "B" THEN 4060:REM BUSY TRY AGAIN
4070 IF Q$<>" " THEN 6000:REM UNSUCCESSFUL
4080 DATA LOAD DC #1, A$, H(), J()
4090 STR(A$,1,1)=HEX(FF):REM HEX(FF) IN 1ST BYTE OF KEY
4100 DBACKSPACE #1,1S:REM RECORDS ARE 1 SECTOR LONG
4110 DATA SAVE DC #1,A$,H(),J()
.
.
.
6000 STOP "DELETE UNSUCCESSFUL"
```

The space occupied by DELETED records in the User File can be reused; this normally requires special techniques together with the use of FINDNEW(HERE). For information on these techniques see Chapter 12.

5.6 FINDOLD

The FINDOLD subroutine is used to locate a desired record in the User File. Following subroutine execution, the Current Sector address for the User File is set to the sector address of the record whose key was passed. For blocked records, variable Q is set to the record position within the sector. The record can then be read with a DATALOAD DC statement. The calling sequence is:

GOSUB' 232 (I, P, A$)

"I" is the KFAM I.D. Number assigned to the file in the OPEN subroutine.

"P" is the protect flag option. If P=0, then other CPU's may access this record or block of records. If P=1, only this CPU may access this record or block of records.

"A$" is the key of the record being sought.

FINDOLD Return Codes

Q$ ="B" Busy Signal. The record sought is protected by another CPU.
Q$ = "N" if the specified key is not located in the Key File.
Q$ = "X" for an improper call.
Q$ = " " ("space") if the key was located without difficulty.

5.7 FINDNEW

The FINDNEW subroutine is used to enter a new key in the Key File and to find a location for the new record in the User File. FINDNEW enters the key passed to it in the Key File, then sets the Current Sector address for the User File to an available User File location for writing a new record. For blocked records, variable Q is set to the record position within the sector.

GOSUB' 233 (I,P,A$,0)

"I" is the KFAM I.D. Number, assigned to the file in an OPEN subroutine.

"P" is the protect flag option. If P=0, other CPU's may access this record or block of records. If P=1, only this CPU may access this record or block of records.

"A$" is the new key to be entered in the Key File.

FINDNEW Return Codes

Q$ =	"B" Busy Signal. The record (or block) sought is protected by ancther CPU.
Q$ =	"D" if the key specified is a duplicate of one already in the Key File.
Q$ =	"S" if there is no space in the User File for another record, or in the Key File for ancther key entry, or 8 index levels have been exhausted.
Q$ =	"X" for an improper call.
Q$ =	" " ("space") if the key was entered without difficulty.

NOTE:

The User File location returned by FINDNEW is unoccupied by live data, but is not necessarily at the end of all live data in the User File.

The following example illustrates the procedure for adding a record to type A blocked files following FINDNEW. Note the test on Q before the DATASAVE, and that the protect flag is set by FINDNEW.

```
4100         INPUT "KEY FIELD", A$      :REM OPERATOR ENTERS KEY
4120         GOSUB '233 (1,1,A$,0)      :REM FINDNEW
4130     REM TEST COMPLETION CODE
4135         IF Q$ = "B" THEN 4120      :REM BUSY TRY AGAIN
4140         IF Q$ = "D" THEN 5010      :REM DUPLICATE KEY?
4150         IF Q$ = "S" THEN 5050      :REM FILE FULL?
4160         IF Q$<> " " THEN 5060      :REM ERROR?
4170     REM NEW BLOCK OR OLD?
4180         IF Q = 1 THEN 4220  :REM FIRST RECORD IN NEW BLOCK?
4185     REM READ EXISTING RECORDS IN BLOCK
4190         DATA LOAD DC #2, A$(), B$(), C(), D()
4200         DBACKSPACE #2, 1 S  :REM BACKSPACE AFTER DATALOAD
4210     REM ASSIGN RECORD VALUES TO PROPER ARRAY ELEMENTS
4220         A$(Q) = A$
4230         INPUT "SECOND FIELD", B$(Q)
4240         INPUT "THIRD FIELD", C(Q)
4250         INPUT "FOURTH FIELD", D(Q)
4260     REM SAVE BLOCK IN USER FILE
4270         DATA SAVE DC #2, A$(),B$(),C(),D()

5000     REM ERROR ROUTINES
5010         STOP "KEY ALREADY IN KEY FILE"
5050         STOP "KEY FILE OR USER FILE IS FULL"
5060         STOP "FINDNEW ERROR"
```

A similar procedure must be used for type C files, for which Q represents a record location rather than a subscript.

5.8 FINDNEW(HERE)

The FINDNEW(HERE) subroutine is a special purpose subroutine which can be used to reuse the User File space occupied by DELETE'd records or to change the value of the key of an existing record. It adds a new key to the Key File, but, unlike FINDNEW, the User File location, which it associates with that key, is the User File location returned by the last KFAM subroutine call. To use FINDNEW(HERE) to reuse the User File space occupied by DELETE'd records, see Chapter 12. An illustration of the use of FINDNEW(HERE), to change the value of the key of an existing record, is shown below.

The calling sequence is:

```
GOSUB' 234 (I,P,A$,0)
```

The FINDNEW(HERE) argument list is identical to the argument list for FINDNEW (see FINDNEW).

FINDNEW (HERE) Return Codes

Q$ =	"B" Busy Signal. The record or block sought is protected by another CPU.
Q$ =	"X" for an improper call.
Q$ =	"D" if the key specified is a duplicate of a key already in the Key File.
Q$ =	"S" if there is no space in the Key File for another entry, or if 8 index levels have been exhausted.
Q$ =	" " (space) if the subroutine executed properly.

The following example illustrates the use of FINDNEW (HERE) following DELETE:

```
5000 GOSUB '231 (1,0,"ABCD") :REM DELETE "ABCD" FROM KEY FILE
5005 IF Q$ = "E" THEN 5000:REM BUSY
5010 IF Q$ = "X" THEN 5130
5040 IF Q$ = "N" THEN 5150
5050 GOSUB '234 (1,1,"EFGH",0) :REM SET "PROTECT", INSERT "EFGH" IN KEY FILE
5060 IF Q$ = "X" THEN 5140
5070 IF Q$ = "D" THEN 5160
5075 IF Q$="S" THEN 5170
5080 DATALOAD DC #2,A$,B$,C$,N
5090 A$ = "EFGH" :REM CHANGE KEY TO "EFGH"
5100 DBACKSPACE #2, 1S
5110 DATASAVE DC #2,A$,B$,C$,N
5115 GOSUB'239(1) :REM CLOSE FILES
5120 END
5130 STOP "ERROR IN 'DELETE' CALLING SEQUENCE"
5140 STOP "ERROR IN 'FINDNEW(HERE)' CALLING SEQUENCE"
5150 STOP "KEY NOT FOUND"
5160 STOP "DUPLICATE KEY"
5170 STOP "NO SPACE"
```

9 FINDFIRST

The FINDFIRST subroutine sets the Current Sector address for the User File to the first record in logical key sequence. For blocked records, variable Q is set to the record position within the sector. A DATALOAD DC statement can be used after FINDFIRST to read the record. The calling sequence is:

```
GOSUB' 235 (I,P)
```

"I" is the KFAM I.D. Number, assigned to the file in an OPEN subroutine.

"P" is the protect flag option. If P=0, other CPU's may access this record or block of records. If P=1, only this CPU may access this record or block of records.

FINDFIRST Return Codes

Q$ = "B" Busy Signal. The record sought is protected by another CPU.
Q$ = "N" if the User File contains no records.
Q$ = "X" for an improper call.
Q$ = " " (space) if the subroutine executed properly.

5.10 FINDLAST

The FINDLAST subroutine sets the Current Sector address for the User File to the last record in logical key sequence. For blocked records, the variable Q is set to the record position within the sector. A DATALOAD DC statement can be executed following FINDLAST to read the record. The calling sequence is:

```
GOSUB' 236 (I,P)
```

"I" is the KFAM I.D. Number assigned to the file in an OPEN subroutine.

"P" is the protect flag option. If P=0, other CPU's may access this record or block of records. If P=1, only this CPU may access this record or block of records.

FINDLAST Return Codes

Q$ = "B" Busy Signal. The record sought is protected by another CPU.
Q$ = "N" for a null file.
Q$ = "X" for an improper call.
Q$ = " " (space) if the subroutine executes normally.

5.11 FINDNEXT

The FINDNEXT subroutine sets the Current Sector address for the User File to the record immediately following (in logical key sequence) the last record accessed by KFAM. For blocked records, the variable Q is set to the position of the record within the sector. A DATALOAD DC statement can be executed following FINDNEXT to read the record. FINDNEXT is useful for processing files in key sequence. The calling statement is:

```
GOSUB' 237 (I,P)
```

"I" is the KFAM I.D. Number assigned to the file in an OPEN subroutine.

"P" is the protect flag option. If P=0, other CPU's may access this record or block of records. If P=1, only this CPU may access this record or block of records.

FINDNEXT Return Codes

Q$ =	"B" Busy Signal. The record sought is protected by another CPU.
Q$ =	"X" for an improper call.
Q$ =	"E" if the previous reference was to the last record in logical key sequence.

Otherwise, Q$ = " " (space).

NOTE:

FINDNEXT cannot be executed as the first subroutine following an OPEN routine. Also, FINDNEXT cannot normally be executed immediately following any subroutine which returned Q$ = "X" or "E". Otherwise FINDNEXT will locate the next sequential key, following any subroutine.

If FINDNEXT is executed after a FINDNEXT which returned Q$ = "B" (the Busy Signal), it will attempt to access the same record that it previously found to be protected.

If FINDNEXT is executed following a FINDOLD that returned Q$ = "N" (not found), FINDNEXT locates the record whose key logically follows the key passed to FINDOLD.

5.12 RELEASE

The RELEASE subroutine turns off the protect flag previously set by the calling CPU.

Any call to a KFAM-4 subroutine for a particular file turns off any protect flag for that file. RELEASE should be used only if there may be a long delay before the next KFAM-4 subroutine is called.

The calling sequence is:

```
GOSUB'238 (I)
```

"I" is the KFAM I.D. Number assigned to the file in an OPEN subroutine.

RELEASE Return Codes

Q$ = "X" for an improper call.
Q$ = " " (space) after successful execution.

5.13 CLOSE

The CLOSE subroutine is used to close a currently open User File and its companion Key File. The KFAM I.D. Number assigned to a closed file can then be reassigned to another file in an OPEN routine. Also, the file numbers assigned to a User File and Key File can be reassigned. CLOSE alters the Access Table in the Key File's KDR record to indicate that the CPU no longer has the file open. The CLOSE subroutine also saves certain critical information for the KEY FILE RECOVERY utility, provided that the RECOVERY OPTION was included during BUILD SUBROUTINE MODULE execution. The calling sequence is:

```
GOSUB' 239 (I)
```

"I" is the KFAM I.D. Number assigned to the file in an OPEN routine. Following execution of the CLOSE routine, this number can no longer be used to access the User File and its associated Key File.

CLOSE Return Codes

Q$ = "X" for an improper call.
Otherwise, Q$ = " " (space).

NOTE:

CLOSE must be executed at the conclusion of operations on a file.

CHAPTER 6
THE KFAM REORGANIZE UTILITIES (KFAM-3 AND KFAM-4)

6.1 THE REORGANIZE SUB-SYSTEM

6.1.1 Overview

The REORGANIZE SUB-SYSTEM performs the following KFAM file maintenance operations:

1. Based on an input KFAM file (Key File and User File) it constructs a new output User File which contains active records only, writte in ascending key sequence.

2. Creates a Key File based on the new output file. Optionally the new Key File may occupy the same physical space as the input Key File, overwriting the input Key File.

3. Optionally, the new output User File may be copied back to the disk area occupied by the input User File, overwriting the input file.

Unlike other KFAM maintenance utilities, the REORGANIZE SUB-SYSTEM is loaded by means of a user-written set-up program that specifies all the parameters for the reorganization. The REORGANIZE SUB-SYSTEM can, optionally, call another user program module after completing execution. Since it must be loaded via a user-written set-up module, the REORGANIZE SUB-SYSTEM does not appear on the KFAM-3 or KFAM-4 menus. However, the three modules of the utility are included on Application Support Diskette #2 for KFAM-3, and Application Support Diskette #3 for KFAM-4. Also included on each diskette is a module of KFAM subroutines used by the utility. Finally, on each diskette a COPY/VERIFY reference file is included to facilitate copying the complete utility. The names of the reference files and modules are as follows:

KFAM-3 VERSION

COPY/VERIFY Reference File Name	=	K-3RF010
REORGANIZE SUB-SYSTEM modules	=	KFAM3503
	=	KFAM3603
	=	KFAM3703
Module of Subroutines	=	KFAM0103

KFAM-4 VERSION

COPY/VERIFY Reference File Name	=	K-4RF010
REORGANIZE SUB-SYSTEM Modules	=	KFAM3504
	=	KFAM3604
	=	KFAM3704
Module of Subroutines	=	KFAM0104

6.1.2 Writing the Set-up Module

To use the REORGANIZATION SUB-SYSTEM you must write a brief set-up program which provides the operating parameters and loads the first module. The set-up program can be broken down into two parts, with a third part used only for KFAM-4.

1. Lines 1-3499 contain statements executed before the REORGANIZATION SUB-SYSTEM is loaded. These lines must clear the CRT screen, select disk file devices, and load KFAM3503 (or KFAM3504 for KFAM-4). These lines must be cleared by the LOAD DC statement. They can include additional preprocessing, if desired.

2. Lines 4200-4799 contain statements which assign reorganization parameters to specific variables. They remain as an overlay to the first reorganization module. They are executed after the first reorganization module defines its common variables and sets default values.

3. (KFAM-4 ONLY) Lines 3500-3699 must contain the subroutines DEFFN'210 (T6) to select hog mode and DEFFN'211 (T6) to select non-hog mode. These lines are not cleared; they remain as an overlay to the first module.

A skeleton of the set-up program is shown below. A line may be omitted if the default value shown is the desired value. Read all comments before writing a set-up module.

Line	Contents	Default Value	See Comment
10	REM program identification		
20	PRINT HEX(03)	-	1
50	SELECT DISK (disk address for REORGANIZATION SUB-SYSTEM disk)	-	
60	SELECT #1 input User File device address	-	
70	SELECT #2 input Key File device address	-	
80	SELECT #3 output User File device address	-	2
90	SELECT #4 output Key File device address	-	3
100	SELECT #5 user program device address	-	4
110	LOAD DC T#0, "KFAM3503" 1,3499	-	5
4210	N1$ = input User File name.	-	
4220	P1$ = input User File device address as "xyy".	-	6
4230	N2 = input Key File number.	1	7
4240	P2$ = input Key File device address as "xyy".	-	
4250	N3$ = output User File name.	-	8
4260	P3$ = output User File device address as "xyy".	-	
4270	O3$ = "C" catalog output User File if uncataloged.	C	9
	= "Y" output User File already cataloged; do not catalog it.		
	= "N" output User File is not already cataloged; catalog it.		
4280	S3 = number of sectors to allocate to output User File. This statement not needed if O3$ = "Y" (above). *If the utility catalogs the file, the default value for S3 is the number of sectors in the input User File.	*	9
4290	O6$ = "C" to copy back Output User File over Input User file when reorganization completed.	blank	10
	= blank to leave input User File intact.		
4300	N4 = output Key File number.	1	11
4310	P4$ = output Key File device address as "xyy".		
4320	O4$ = "C" catalog output Key File, if uncataloged.	C	12
	= "Y" output Key File cataloged; do not catalog it.		
	= "N" output Key File not cataloged; catalog it.		

330	S4 = number of sectors to allocate to the output Key File. Omit this if O4$ = "Y". *If the utility catalogs the file, the default value is calculated in proportion to the input Key File size times the increase or decrease in User File size.	*	12
4340	N5$ = name of program to be loaded following reorganization. = blank - no program to be loaded.	blank	13
4350	P5$ = device address of user program as "xyy".		

Additional Lines for KFAM-4 Only

Line	Contents	Default Value	See Comment
3510	DEFFN'210 (T6)	-	14
3520	SELECT #2 input Key File hog mode address		
3530	RETURN		
3540	DEFFN'211 (T6)		14
550	SELECT #2 input Key File non-hog mode address		
560	RETURN		

Comments

1. The CRT screen should be cleared prior to calling the REORGANIZATION SUB-SYSTEM. Lines 0-3 are used by the utility for messages. Lines 4-15 may be used for a user written display. For example, line 20 might be:

```
        20 PRINT HEX(030A0A0A0A); "REORGANIZE INVENTORY FILE."
```

2. The output User File device address may be the same as the input User File device address, if the two files have different names. (For KFAM-4 see comment 15.)

3. If the output Key File device address is the same as the input Key File device address, and the output Key File name is the same as the input Key File name, then the output Key File replaces the input Key File. See comment 10.

4. If the REORGANIZATION SUB-SYSTEM is to call another program when it completes execution, the device address of this program file must be selected for file number #5.

5. The last statement to be executed in the range 1-3499 must be a LOAD DC that loads module 1 of the utility and clears lines 1-3499 as it does so. If the KFAM-4 utility is being used, the module name is "KFAM3504".

6. Example:

```
      4220 P1$ = "B10"
```

7. This number is assigned during INITIALIZE KFAM FILE and appears as the 6th character in the input Key File name (normally it is 1).

8. The output user file name need not conform to the KFAM file naming conventions. This relaxation of normal KFAM requirements may be useful if the "copy back" option is chosen (line 4290), since in this case it may be desirable to use an established work file that may have any name.

9. If "C" is assigned to O3$, the output User File is cataloged by this utility, if the output file does not already exist. "C" is the default value of O3$.

   If "N" is assigned to O3$, the system ensures that the named output User File does not already exist on the disk, and catalogs the output User File.

   If the utility catalogs the output User File, it allocates to it the same number of sectors that are in the input User File, unless a different number is specified by assigning the desired number of sectors to S3.

   If "Y" is assigned to O3$, the system checks that the named output file already exists. S3 need not be assigned a value.

   The output User file must contain at least 10 sectors.

10. If O6$ is assigned the value "C", then the utility constructs the output Key File name from the input Key File name, and copies the output User File back into the input User File area, overwriting the input User File. If O6$ is assigned a blank, then the output Key File name is constructed from the output User File name, and the output file is not copied back.

11. This number is used in the construction of the output Key File name, in which it becomes the 6th character. If the constructed name is the same as the input Key File name, and the same address is specified for both input and output Key Files, then the output Key File replaces the input Key File.

12. The effect of these responses for O4$ and S4 is analogous to O3$ and S3 discussed in comment 9. However, if the utility catalogs the Key File, its size is proportional to the input Key File size times the increase or decrease in User File size.

13. If N5$ is assigned a program name, the program is loaded upon completion of the utility. The program must reside at the address SELECTed for file number #5 (line 100).

14. (KFAM-4 ONLY) Lines 3500-3699 must contain the KFAM-4 SELECT subroutines. These subroutines are discussed in detail in Chapter 5. These lines must not be cleared by the LOAD DC statement at line 110. If the programmer wants the entire utility to execute in hog mode, or non-hog mode, lines 3520 and 3550 may be omitted, leaving the subroutines to consist merely of a RETURN statement. However, the subroutines themselves must be present. (See Comment 15.)

15. ADDITIONAL PROGRAMMING NOTES FOR KFAM-4 - The REORGANIZATION SUB-SYSTEM restricts access to the input files (Key File and User File) by opening the input file in exclusive mode. However, access to the output files cannot be controlled in this manner. If the user's own conventions cannot assure the integrity of the output files during the reorganization, then hog mode addresses should be specified for file numbers #0-#4 (lines 50-90) and the subroutines (lines 3510-3560) should omit the SELECT statements at lines 3520 and 3550. When the reorganization is complete, hog mode can be deselected by loading a user program that turns off hog mode, or RESET can be keyed.

Shown below are two set-up programs, one for KFAM-3 and another for KFAM-4.

Example 6-1 A Set-Up Program to Call KFAM3503

```
10 REM EXAMPLE OF A REORGANIZATION SET-UP PROGRAM FOR KFAM-3
20     PRINT HEX(030A0A0A0A); "REORGANIZE INVENTORY FILE"
50     SELECT DISK 310 :REM REORG. SUB-SYSTEM
60     SELECT #1 B10   :REM INPUT USER FILE
70     SELECT #2 B10   :REM INPUT KEY FILE
80     SELECT #3 B10   :REM OUTPUT USER FILE
90     SELECT #4 B10   :REM OUTPUT KEY FILE
110    LOAD DC T#0, "KFAM3503" 1, 3499
4210   N1$ = "INVTF010"
4220   P1$ = "B10"
4240   P2$ = "B10"
4250   N3$ = "INVTF011"
4260   P3$ = "B10"
4310   P4$ = "B10"
```

Example 6-2 A Set-Up Program to Call KFAM3504

```
10 REM EXAMPLE OF A REORGANIZATION SET-UP PROGRAM FOR KFAM-4
20     PRINT HEX(030A0A0A0A); "REORGANIZE INVENTORY FILE"
50     SELECT DISK 310 :REM REORG. SUB-SYSTEM
60     SELECT #1 320   :REM INPUT USER FILE
70     SELECT #2 B20   :REM INPUT KEY FILE
80     SELECT #3 320   :REM OUTPUT USER FILE
90     SELECT #4 B20   :REM OUTPUT KEY FILE
100    SELECT #5 310    :REM USER PROGRAM
110    LOAD DC T#0, "KFAM3504" 1, 3499
3510   DEFFN' 210 (T6)
3520   SELECT #2 BA0
3530   RETURN
3540   DEFFN' 211 (T6)
3550   SELECT #2 B20
3560   RETURN
4210   N1$ = "INVTF040"
4220   P1$ = "320"
4240   P2$ = "B20"
4250   N3$ = "WORK"
4260   P3$ = "320"
4290   O6$ = "C" :REM COPY BACK OUTPUT USER FILE
4310   P4$ = "B20"
4340   N5$ = "START"
4350   P5$ = "310"
```

6.1.3 Utility Operation and Error Messages

The operation of the utility may be divided into three parts:

1) The User File is read sequentially, using FINDFIRST/FINDNEXT, and copied to the output file so that the records are physically in sequential order, and DELETED records are eliminated.

2) A new Key File is built, based on the keys in the output User File, using a special procedure. The new Key File, optionally, may occupy the same physical space as the old Key File.

3) If indicated by the set-up program, the output user file is copied back to the input user file, overwriting the original.

The original Key File and User File are not altered until the output User File has been written, complete with the necessary information to restore the Key File. Therefore, it is not essential to have backup copies of the User File and Key File. If the system fails during Part 1 of the reorganization, the original Key File and User File are intact. If the system fails during Part 2, both the input User File and the output User File are intact, and a Key File may be built for either one, using the Key File Recovery Utility. During Part 3, the output User File remains intact, as well as the Key File.

though backup disks are not necessary for this operation, it is good practice to make backup copies regularly, especially of the User File.

There are no operating instructions for this program, because normally no operator intervention is required. However, there are recovery procedures, for certain error conditions. These are described below:

ERROR MESSAGE	EXPLANATION/RECOVERY
1. ERR 72	Disk read error. Part 1: Input User File or Key File has an unreadable sector. Part 2: Output User File or Key File has an unreadable sector. Part 3: Output User File has an unreadable sector. RECOVERY: Part 1: Run Key File Recovery Utility. Rerun Part 2: Run Key File Recovery Utility on input User File, if input Key File is being overwritten. Rerun. Part 3: Run Key File Recovery Utility on output User File. Set up Reorganize Subroutine to reorganize output User File, giving input User File.
2. ERR 85	Disk write error. Part 1: Output User File contains a bad physical sector. Part 2: Output Key File contains a bad physical sector. Part 3: Input User File contains a bad physical sector. RECOVERY: Part 1: Replace the output disk, or recreate file to bypass the bad sector. Rerun. Part 2: Replace the disk containing the output Key File, or recreate the file to bypass the bad sector. If input and output Key File are the same, run Key File Recovery. Rerun. Part 3: Replace input disk or recreate input User File to bypass the bad sector. See recovery procedure for ERR 72, Part 3.

3.	ERR 80	Program not on disk. The four modules listed in 6.1.1 must reside on the device specified by "SELECT DISK". Correct and rerun.
4.	FILE ######## NOT FOUND ON DEVICE ###	Required KFAM file (User File or Key File) is not on designated disk. RECOVERY: Mount disk containing the designated file. Rerun.
5.	INPUT AND OUTPUT USER FILE MAY NOT BE THE SAME FILE	Both input and output User Files are designated by the same file name, on the same device. RECOVERY: Correct the file designations. Rerun.
6.	######## NOT KFAM FILE NAME	File name must have "F" in position 5, and a digit 0-9 in position 6. RECOVERY: Correct the file name. File name may be changed on disk using SCRATCH and DATASAVE DC OPEN. Rerun.
7.	INVALID KEY FILE NUMBER #	Key File number not 1-9, or not an integer. RECOVERY: Correct the Key File number. Rerun.
8.	INSUFFICIENT SPACE FOR FILE ######## ON DEVICE ###	There is not enough space on the designated disk device to catalog the file. RECOVERY: Mount an output disk with enough free space to accommodate the output User File and/or Key File. Rerun.
9.	FILE ######## ALREADY CATALOGED ON DEVICE ###	A file designated as "not cataloged" is already cataloged, or another file exists of the same name. RECOVERY: Mount a scratch disk or other disk which does not already have this file name cataloged. Rerun.

If this is a rerun, change the values of 03$ and 04$ (user set-up module) to "C", and run.

10. ERROR OPENING FILES

KFAM "OPEN" subroutine returns an error indication.

RECOVERY: If this is a rerun, set V9=0 and rerun.

11. INVALID RECORD FORMAT

Type A records: Invalid control byte or more than 38 fields per record.

RECOVERY: The program will not reorganize this file.

12. NOT BLOCKED AS SPECIFIED

Type A records: Blocking of record not the same as blocking specified in the KDR.

RECOVERY: Write a program to open the file, change V8$ in the KDR, and close the file. Run it. Then rerun the reorganization.

13. RECORD LENGTH NOT SPECIFIED CORRECTLY

Type A records: Record length not the same as specified in the KDR.

RECOVERY: Change STR(V1$,2,1) in the KDR (see 12, above). Rerun.

14. KEY FIELD OUT OF BOUNDS

Type A records: The starting position of the key and/or key length are such that the key is not wholly included within a field of the record.

RECOVERY: Change the starting position of the key, STR(V1$,4,1), or the key length, STR(V1$,5,1), in the KDR (see 12, above). Rerun.

15. NUMERIC KEY INVALID

Type A records: The key field is indicated as lying within a numeric variable.

RECOVERY: See 14, above, to change key field position. The key may not be a numeric variable. Rerun.

16. NULL FILE	There are no active records in this file. RECOVERY: Run "INITIALIZE KFAM FILE" to reorganize this file.
17. FINDFIRST ERROR	Hardware or software error. RECOVERY: Rerun. Notify Wang Laboratories if the problem persists.
18. FINDNEXT ERROR	Hardware or software error. RECOVERY: Rerun. Notify Wang Laboratories if the problem persists.
19. OUTPUT USER FILE SPACE EXCEEDED	Output User File is too small to contain all the active records from the input User File. RECOVERY: Allocate more space for the output User File, and rerun.
20. OUTPUT KEY FILE SPACE EXCEEDED	Output Key File is too small. RECOVERY: If the output Key File is the same as the input Key File, run KEY FILE RECOVERY on the input User File. Allocate more space for the output Key File, and rerun.
21. 8 LEVELS OF INDEX EXCEEDED	More than 390,625 30-byte keys, or more than 429,981,696 12-byte keys, etc. This error should not occur. RECOVERY: Notify Wang Laboratories.
22. SEQUENCE ERROR, HEX KEY = (key value)	The key contained in the input User File is not the same as the key in the input Key File. RECOVERY: Check for errors in application programs that may cause this condition. Run KEY FILE RECOVERY on input User File. Rerun.
23. INVALID KEY, HEX VALUE = (key value) KEY RETURN(EXEC) TO SKIP RECORD	The record is included as active in the input Key File, but flagged as deleted in the input User File.

	RECOVERY: See 22, above. The option is also provided to skip the record and continue.
24. MOUNT DISK CONTAINING PROGRAM ######## ON DEVICE ### KEY RETURN(EXEC) TO RESUME	The reorganization is finished and ready to load the next program, which is not found on the designated device. RECOVERY: Mount the disk containing the next program on the designated device. KEY RETURN(EXEC).
25. ACCESS NOT EXCLUSIVE	The input KFAM File is currently open by another CPU. RECOVERY: Other CPU's must close the file.

6.2 REORGANIZE KFAM FILE

6.2.1 Overview

This program reorganizes a KFAM File in place. The record which belongs first, in ascending key sequence, is switched with the record that is physically first. This process is repeated for the second record, and so forth, until the entire User File has been placed in sequential order. In the process, all DELETED records are removed. Then, the Key File is reinitialized and a new Key File is created in the space formerly occupied by the old Key File. No additional disk space is required for the User File or the Key File; a 15 sector work file is required. This program is 4 to 5 times slower than the REORGANIZATION SUB-SYSTEM utility, and therefore should be used only if the file is too large to permit simultaneous mounting of an output file as required by the REORGANIZATION SUB-SYSTEM.

Because this program destroys both the User File and the Key File, as they formerly existed, there is no possible recovery in the event of hardware or software error. For that reason, backup copies of the User File and the Key File must be made before running this program.

This program reorganizes any KFAM file, with the exception of type M records with more than 40 sectors per record. However, it should be noted that multiple-sector records require extra storage space in memory, and that this program cannot operate in a 12K system if the record length exceeds 8 sectors.

NOTE:

For KFAM-4 only, hog mode is automatically selected for the disk drives containing the User File, Key File, and Work File. To operate the utility at a non-multiplexed disk drive key:

M$ = "X"(EXEC)

at KFAM-4 utilities menu, prior to loading the utility.

6.2.2 Operating Instructions

	DISPLAY		INSTRUCTIONS
1.		1.	Make backup copies of both the User File and the Key File. If anything goes wrong during the execution of the utility, both files are destroyed.
2.		2.	Mount disk platter(s) containing the User File and the Key File.
3.		3.	To access the REORGANIZE KFAM FILE utility, depress the specified Special Function key from KFAM-3 or KFAM-4 subsidiary menu.
4.	ARE THERE BACKUP COPIES OF USER FILE AND KEY FILE? (Y OR N)	4.	Enter Y if backup copies exist. Proceed with Step 6. below. Enter N for "no" or "don't know". Proceed with Step 5.
5.	The system displays: ANY ERROR DURING THE RUNNING OF PROGRAM FILE WILL DESTROY BOTH FILFS. MAKE COPIES OF THE DISK PLATTER(S) CONTAINING THE USER FILE AND THE KEY FILE BEFORE RUNNING THIS PROGRAM. STOP	5.	Make backup copies of both the User File and the Key File. Key CONTINUE RETURN(EXEC) and go to step 4.

6.	ENTER USER FILE NAME (SSSSFJNN)	6.	Enter the name of the User File. MESSAGE: 2, 4
7.	ENTER THE NO. OF THE USER FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	7.	Enter the selection number for the device address of the User File. NOTE: Error messages and recovery procedures follow the operator instructions. MESSAGE: 2, 5
8.	The system displays: ENTER KEY FILE NUMBER (NORMAL=1)	8.	Enter the Key File Number. The Key File Number should always be 1, unless there are multiple key files for a single User File, in which case, the Key File Number can be any digit from 1 to 9. MESSAGE: 2, 3, 6
9.	The system displays: ENTER THE NUMBER OF THE KEY FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	9.	Enter the selection number for the device address of the Key File. MESSAGE: 2, 5
10.	ENTER WORK FILE NAME	10.	15 sectors are required for a work file. This work file may be a cataloged file, either a scratch file that already exists or a new file created by this program, or it may reside in the temporary work file area (if any) beyond the cataloged area of one of the disk platters.

If the work file is a file already cataloged, or if it is to be cataloged, enter the name of the work file.

If the work file is to reside in the uncataloged area of one of the disk platters, key only RETURN (EXEC).

11. ENTER THE NUMBER OF THE WORK FILE DEVICE ADDRESS

1. 310	5. B10
2. 320	6. B20
3. 330	7. B30
4. 350	

11. Enter the selection number for the work file device address.

If no name was entered for the work file, the program proceeds to Step 13, below.

MESSAGE: 2, 5, 7

12. IS WORK FILE CATALOGED? (Y OR N)

12. Enter Y if the work file has been previously cataloged.

Enter N if the work file has not been previously cataloged.

MESSAGE: 2, 8, 9, 10

13.

13. The system opens the Key File and User File and begins processing.

No operator intervention is required from this point on.

MESSAGE: 8, 11, 12, 13, 14
15, 16, 17, 18, 19

14. REORGANIZE KFAM FILE

14. This file is being reorganized. Any error from this point on effectively destroys both the User File and the Key File. Both files should be re-created from backup copies before attempting to rerun.

MESSAGE: 1, 12, 13, 20,
21, 22

15.

15. The number of records in the User File is displayed and the system returns to KFAM subsidiary menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered, or not "Y" or "N" in response to a "yes" or "no" question. RECOVERY: Repeat the step, entering the correct value.
3.	ERR29	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Reenter numeric quantity.
4.	NOT KFAM FILE NAME	The User File name must have an "F" in position 5 and a digit (0-9) in position 6. RECOVERY: Repeat Step 6 Enter correct User File name.
5.	INVALID DEVICE ADDRESS	The device address for User File, Key File, or work file was invalid. RECOVERY: Repeat the step. Enter correct device address selection number.
6.	INVALID	The Key File number may not be 0. Repeat Step 8. Enter Key File number 1-9.
7.	ERR64	Sector not on disk. The temporary work file area on the specified platter is not large enough to hold the work file (15 sectors). RECOVERY: Rerun the program from Step 4. Specify a different platter or a cataloged file for the work file.

8.	ERR80	File not found (User File, Key File, or work file). RECOVERY: LISTDCF and/or LISTDCR. Check which file is not there. Correct and rerun the program.
9.	ERR79	File already cataloged. The work file is already cataloged. RECOVERY: Rerun the program from Step 4. Pick another name for the work file, or answer "Y" to "IS WORK FILE CATALOGED?"
10.	WORK FILE TOO SMALL	The cataloged file named as a work file contains less than 15 sectors. RECOVERY: Repeat from step 10. Enter a new name for the work file.
11.	STOP ERROR OPENING FILES	File could not be opened. Possible cause: The program was stopped and restarted after processing had begun. RECOVERY: Recreate User File and Key File from backup copies. Rerun this program. If the error persists, notify Wang Laboratories, Inc.
12.	ERR72	Disk read error. See accompanying program statement for file being read: #1 = Key File #2 = User File #3 = Program File #4 = Work File #T1= Key File #T1(T9)=Key File If "REORGANIZE KFAM FILE (KFAM3203)" is displayed on the screen, the User File and Key File must be recreated from backup copies. Rerun the program. If the error persists, the file being read is permanently damaged, or there is a hardware malfunction.

13.	ERR85	Disk write error. See accompanying program statement for file being written: #1=Key File #2=User File #4=Work File #T1=Key File RECOVERY: If "REORGANIZE KFAM FILE" is displayed on the screen, the User File and Key File must be recreated from backup copies. Rerun the program. If the error persists, either the disk platter is permanently damaged, or there is a hardware malfunction.
14.	STOP MORE THAN 40 SECTORS PER RECORD	This program will not reorganize a file with a record length of more than 40 sectors. RECOVERY: This program may be modified by the user for the particular application, by dropping ISS module KFAM3103 (or KFAM3104 for KFAM-4) and coding the necessary statements in KFAM3203 (or KFAM3204 for KFAM-4) (see KFAM "Programming Techniques" - Generated Code).
15.	INVALID RECORD FORMAT (STOP)	Record type A, array-type blocking: more than one sector per block, more than 38 fields per record, or not written with correct control bytes. RECOVERY: The program will not reorganize this file.
16.	NOT BLOCKED AS SPECIFIED (STOP)	Record type A, array-type blocking: records per block specified incorrectly in INITIALIZE KFAM FILE or records not written in array format. RECOVERY: The program will not reorganize this file.
17.	RECORD LENGTH NOT SPECIFIED CORRECTLY (STOP)	Record type A, array-type blocking: record length specified in INITIALIZE KFAM FILE does not equal record length of sample record.

		RECOVERY: The program will not reorganize this file.
18.	KEY FIELD OUT OF BOUNDS (STOP)	Record type A, array-type blocking: the key must be wholly contained within one field of the record. RECOVERY: The program will not reorganize this file.
19.	NUMERIC KEY INVALID (STOP)	Record type A, array-type blocking: the key falls within a numeric field. RECOVERY: The program will not reorganize this file.
	The following errors are preceded by the general message: RESTORE BOTH USER FILE AND KEY FILE FROM BACKUP COPIES BEFORE ATTEMPTING TO RE-RUN THIS PROGRAM	The status of the User File and Key File, being partially reorganized, is not defined at this point. Both files are effectively destroyed. RECOVERY: Recreate User File and Key File from backup copies.
20. 21. 22.	PROGRAM ERROR or SEQUENCE ERROR or LAST KEY NOT FOUND	a) The keys in the Key File do not match the keys in the corresponding User File records. b) Machine error. RECOVERY: a) The applications programmer should write a small program to determine which keys do not match. Following FINDFIRST or FINDNEXT, T7$ contains the key value from the Key File. This can be compared to the corresponding key value in the User File. The non-matching keys should be corrected or deleted before the reorganization program is run. b) Rerun the program.
23.	STOP ACCESS NOT EXCLUSIVE	KFAM-4 ONLY. The User File is in use by another CPU, or a "phantom" entry exists in the ACCESS TABLE.

RECOVERY: Wait until other CPU's close the file, or if an erroneous entry is in the ACCESS TABLE run RESET ACCESS TABLE utility.

CHAPTER 7
THE ADJUST KFAM FILES UTILITIES

7.1 REALLOCATE KFAM FILE SPACE (KFAM-3 AND KFAM-4)

7.1.1 Overview

The utility programs REALLOCATE KFAM FILE SPACE and DISK COPY AND REORGANIZE can be used in conjunction with one another to lengthen or shorten KFAM Key Files and User Files. The latter program can be used alone to copy any disk file.

Non-KFAM data files, maintained with the Catalog Mode statements, keep track of the end of live data with a special trailer record written by the statement DATA SAVE DC END. When saved, this record updates the USED parameter in the disk catalog. The value of this parameter appears in the USED column of a catalog listing. The absolute end of the file area is marked by a fixed control sector whose address appears as "END" in a catalog listing.

KFAM does not use this system for keeping track of the end of live data in the User File, but it does operate within the framework of Catalog Mode files. KFAM automatically puts the DATA SAVE DC END trailer in the next to last sector of the file (the sector immediately preceding the end-of-file control sector). This is done during INITIALIZE KFAM FILE for both the Key File and the User File. During normal operations KFAM leaves the end-of-data trailer in this location.

KFAM keeps its own file boundary information in the Key File's first record, the KDR. It keeps two items of information for each file: the total number of available sectors, and the total number of sectors presently occupied by data. The first item, the total number of available sectors, can have an absolute maximum value which is two less than the total number of sectors allocated to the cataloged file. This is because the DATA SAVE END trailer and the control sector at the end of the file are always present, and can never be used for file records.

Thus, for each file, Key File and User File, there exist four values:

Two Catalog system values:

T	=	total space allocated for the file. This is the total number of sectors occupied by the file, from the starting sector through the ending sector, as recorded in the disk catalog. T = "END" - "START" + 1. T is established by DATA SAVE DC OPEN, and can only be changed by copying the file.
U	=	sectors used by the file. This is the number recorded in the disk catalog for the number of sectors used. With KFAM, this value does not reflect the number of sectors occupied by live data. It is established by the location of the DATA SAVE DC END TRAILER. This is automatically put into the sector immediately preceding the control sector, at the end of the file, by INITIALIZE KFAM FILE.

Two KFAM-maintained values (kept in the KDR record):

K	=	total number of sectors available for file records. K=U-2, since the value of U includes the two sectors of "overhead" (the control sector, and the DATA SAVE DC END trailer sector).
L	=	number of sectors occupied by live data (index records for the Key File) in a KFAM File. This value is regularly updated by the FINDNEW subroutine. The difference, K-L, is sectors which presently contain no data, but have been set aside for future expansion by KFAM, based on the user's specification of the maximum number of records the file may contain.

REALLOCATE KFAM FILE space changes the value of K, and rewrites the DATASAVE DC END trailer to adjust U, so that the relationship U-2=K is preserved. K may not be made less than L nor greater than T-2. Thus, the purpose of this program is to change the size of a file from the point of view of KFAM's internal control of file space. Of itself, this does not change the cataloged disk space, T, allccated to the file. It is one phase of a two-phase operation to change the actual size of a KFAM file. The other phase is performed by DISK COPY AND REORGANIZE which, by copying a file, can change the value of T.

REALLOCATE KFAM FILE SPACE can change the value of K and U for both a Key File and User File in a single execution of the utility. Generally, if one file size is changed, the other should be changed, proportionally. The files may be on the same disk or different disks. The program displays the "LENGTH", K, "LOW LIMIT", L, and "HIGH LIMIT", T-2, for both the user file and the key file. It then provides the option to change the length, K, of either or both.

To Shorten a KFAM File:

1. Run REALLOCATE KFAM FILE SPACE decreasing the values of K as desired.

2. Run DISK COPY AND REORGANIZE to copy the files into new files that have fewer total sectors, T.

> NOTE:
>
> To preserve RECOVERY capability when copying the User File, copy the exact number of sectors specified as "SECTORS USED".

To Lengthen a KFAM File:

1. Run DISK COPY AND REORGANIZE to copy the files into new files that have more sectors, T.

2. Run REALLOCATE KFAM FILE SPACE to increase K for each of the copied files.

> NOTE:
>
> To preserve RECOVERY capability, set the User File size to the exact number of sectors specified as "HIGH LIMIT."

For KFAM-4 only, hog mode is selected for the disks containing the User File and the Key File. To execute the utility at a non-multiplexed disk drive key

M$ = "X" (EXEC)

at KFAM-4 utilities menu, prior to loading the utility.

7.1.2 Operating Instructions REALLOCATE KFAM FILE SPACE

DISPLAY	INSTRUCTIONS
1.	1. Mount the disks containing the user file and key file. From KFAM subsidiary menu, access REALLOCATE KFAM FILE SPACE via the indicated Special Function key.

2. ENTER USER FILE NAME (SSSSFJNN)

2. Enter the name of the file.

MESSAGE: 2, 4, 5

> **NOTE:**
>
> Error messages and recovery procedures follow the operator instructions.

3. ENTER THE NO. OF THE USER FILE DEVICE ADDRESS

1. 310	5. B10
2. 320	6. B20
3. 330	7. B30
4. 350	

3. Enter the selection number for the user file device address.

MESSAGE: 2, 6

4. ENTER THE NO. OF THE KEY FILE DEVICE ADDRESS.

1. 310	5. B10
2. 320	6. B20
3. 330	7. B30
4. 350	

4. Enter the selection number for the device address of the key file.

MESSAGE: 2, 6

. ENTER NUMBER OF KEY FILE

5. Normally, enter 1.

If there is more than one key file associated with the user file, enter the number of the key file to be accessed.

MESSAGE: 2, 3, 7

6.

6. The system reads the KDR record of the specified index and displays the current space allocation. It also displays the low and high limits to which it may be changed, for both the user file and the key file.

MESSAGE: 8, 9, 10

7. DO YOU WISH TO REALLOCATE UF SPACE? (Y OR N)

7. To change the user file space allocation,
enter Y or nothing.

allocation unchanged, enter N.

If N is entered, the program proceeds to Step 10 below.

8. INPUT NEW UF SECTOR ALLOCATION

8. Enter the number of sectors to be allocated to the user file for the use of KFAM.

> NOTE:
>
> To preserve RECOVERY capability when lengthening the file, enter the number of sectors specified as "HIGH LIMIT".

To increase the physical size of a disk file, run the "Disk Copy and Reorganize" program

first; then run this program to make the increased number of sectors available to KFAM. This program does not increase the space allocated to the file on the disk. It only adjusts internal pointers so that KFAM is able to use more, or less, of that space.

MESSAGE: 2, 3, 12

9.

9. The system displays the new sector allocation.

10. DO YOU WISH TO REALLOCATE SPACE FOR KF? (Y OR N)_

10. To change the key file space allocation, enter Y or nothing.

To leave the key file space allocation unchanged, enter N.

If N is entered, the program proceeds to Step 14 below.

MESSAGE: 2, 11

11. ENTER NEW KF SECTOR ALLOCATION

11. Enter the number of sectors to be allocated to the key file for the use of KFAM.

This program only adjusts internal pointers in the KFAM file. To increase the physical size of a disk file, run "Disk Copy and Reorganize" first.

MESSAGE: 2, 3, 12

12.

12. The system displays the new sector allocation.

13.

13. The program makes the internal adjustments to the user file and the key file.

MESSAGE: 9, 13

14. DO YOU WISH TO DO ANOTHER FILE? (Y OR N)

14. To do another file, if both user file and key file are already mounted, enter Y or nothing.

To stop, or to do another file which is not already mounted, enter N.

If "Y" is entered, or RETURN(EXEC) alone is keyed, the program proceeds to Step 2 above.

If "N" is entered, the program continues with Step 15 below.

MESSAGE: 2, 11

15.

15. The system returns to KFAM subsidiary menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered. RECOVERY: Repeat the step, entering no more than the number of characters indicated on the screen.
3.	ERR29	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Reenter numeric quantity.
4.	FILE NAME MUST HAVE F IN POSITION 5	The file name entered does not conform to KFAM naming convention. RECOVERY: Repeat Step 2, entering the name of a KFAM file.
5.	FILE NAME MUST HAVE NUMBER IN POSITION 6	The file name entered does not conform to KFAM naming convention. RECOVERY: Repeat Step 2 entering the name of a KFAM file.
6.	INVALID DEVICE ADDRESS	An invalid selection number was entered. RECOVERY: Repeat the step, entering a valid selection number.
7.	INVALID	The number 0 is not valid for a key file number. RECOVERY: Repeat Step 5, entering a number from 1 through 9.
8.	ERR80	Either the user file or the key file was not found on the designated platter. RECOVERY: PRINT U1$ for the name of the user file. PRINT K1$ for the name of the key file. Execute LIST DC to determine what files are present on the disk platters. Rerun the program.

9.	ERR72	Disk read error, either a machine error or bad data on disk. RECOVERY: Recreate the KFAM file from a backup volume, and rerun the program.
10.	STOP RUN KFAM2003 FIRST	Internal pointers indicate the KEY FILE CREATION UTILITY has not been run to build the key file. RECOVERY: Run the KEY FILE CREATION UTILITY; then rerun this program.
11.	ANSWER Y OR N	The answer to a "yes" or "no" question must be Y or N, or RETURN(EXEC) alone, indicating "yes". RECOVERY: Repeat the step with the correct response.
12.	INVALID-OUT OF BOUNDS	The new length specified for the file is greater than the high limit or less than the low limit. RECOVERY: Repeat the step, entering a number which is within the limits displayed on the screen for the file (key file or user file).
13.	ERR85	Disk write error. The key file and/or user file are destroyed. RECOVERY: Recreate the KFAM files from a backup volume, and rerun this program.

NOTE:

FOR KFAM-4 ONLY

If a file (User File or Key File) is not found, the message FILE NOT FOUND is generated, and not ERR80, as with KFAM-3.

If the file is flagged as being in use, the error message "FILE BUSY" is generated.

"HARDWARE" error messages of the type "ERR XX" are intercepted by the program and the message "ERR XX LINE XXXX" is generated.

Any of the above errors cause the program to stop. To return to the menu following such a stop, key CONTINUE, (EXEC).

7.2 DISK COPY AND REORGANIZE (KFAM-3 AND KFAM-4)

7.2.1 Overview

This program copies a file from one disk to another. It can be used in conjunction with REALLOCATE KFAM FILE SPACE to copy a KFAM file and change it length. It can be used alone to copy any cataloged file to another disk, and in this way can be used to rearrange disk files.

The input disk contains the files to be copied. Files are copied one at a time with intervening operator parameter entries. Any cataloged file may be copied including program files. The utility provides for operator specification of the number of sectors in the output file. However, if the input file is a program file, or a data file with a DATASAVE DC END trailer, the output sectors may not be less than the number of used sectors in the input file. A data file without a DATASAVE DC END trailer may be copied without this restriction.

The output disk receives the copied files. It must have been initialized before running this program, using the SCRATCH DISK statement. It may contain other files written on it in Catalog Mode prior to execution of this program.

The program uses the cataloging mechanism provided by the system. Copied files begin at the next free sector. File names are entered in the index of the output disk.

This program is an addition to, but not a replacement of, existing hardware functions such as MOVE, COPY, and VERIFY.

To copy complete KFAM files, the key file and the user file must both be copied. However, since Key File and User File can reside on separate disks, this program permits rearranging these files into the most advantageous combinations.

> NOTE:
>
> For KFAM-4 only, hog mode is selected for the input disk and output disk. To execute the utility at a non-multiplexed disk drive key
>
> M$ = "X"
>
> at KFAM-4 utilities menu, prior to loading the utility.

7.2.2 Operating Instructions

DISPLAY	INSTRUCTIONS
1.	1. Mount the input and output disks.
2.	2. From KFAM-3 or KFAM-4 menu access DISK COPY/REORGANIZE via the specified Special Function key.
3. ENTER THE NO. OF THE INPUT PLATTER DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	3. Enter the selection number of the input disk device address.
4. ENTER THE NO. OF THE OUTPUT PLATTER DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	4. Enter the selection number of the output disk device address. MESSAGE: 2, 4, 5

> NOTE:
>
> Error messages and recovery procedures follow the operating instructions.

5. ENTER FILE NAME

5. Enter the name of the file to be copied.

To end the program, key RETURN(EXEC) and go to step 11.

> **NOTE:**
>
> A new input or output platter may be mounted at this point.

MESSAGE: 2, 6, 7, 14

6.

6. The system displays the input platter designation, the output platter designation, and the number of sectors available on the output platter.

7.

7. The system displays the name of the file to be copied, the number of sectors it occupies on the input platter, and the number of sectors used for program or data storage.

8. ENTER NUMBER OF SECTORS TO BE COPIED

8. Enter the number of sectors to be allocated to the file on the output platter.

MESSAGE: 2, 3, 8, 9, 10

> **NOTE:**
>
> To preserve KEY FILE RECOVERY capability when decreasing the size of User Files, specify the exact number of sectors shown as "SECTORS USED".

9.

9. The program copies the file from the input platter to the output platter.

MESSAGE: 11, 12, 13

10.		10.	The program displays the number of sectors now available on the output platter. Go to step 5.
11.	MOUNT SYSTEM DISK KEY RETURN(EXEC) TO RESUME	11.	Mount the KFAM ISS disk. Key (EXEC).
12.		12.	The system returns to the KFAM menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered. RECOVERY: Repeat the step, entering not more than the number of characters indicated on the screen.
3.	ERR29	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Reenter numeric quantity.
4.	INVALID	Platter address designation invalid. RECOVERY: Repeat the step entering a valid selection number.
5.	INPUT AND OUTPUT PLATTERS MUST BE DIFFERENT	The same platter designation was entered for both input and output. RECOVERY: Repeat from Step 3 entering different platter designations for input and output.
6.	FILE NOT FOUND	Input file not found. RECOVERY: Repeat from Step 5. Enter correct input file name.

7. STOP NO ROOM TO COPY

The number of sectors used by the input file is greater than the number of cataloged sectors available on the output platter. Therefore there is not enough room on the output platter to copy the file. (For KFAM-4 only, key (EXEC) to return to the KFAM-4 menu.)

RECOVERY:

1. Replace the output platter with another platter, with more space available.

2. Or, use MOVE END to increase the cataloged area on the output platter.
3. LIST DC may be used at this point to determine the contents of the output platter.
4. SCRATCH may be used to remove unwanted files from the output platter. This will not free any space, however. To free the space occupied by scratched files, remove the input platter and replace it with a scratch disk, use MOVE to copy the output disk to the scratch disk, and use COPY to copy the new contents of the scratch disk back to the output disk.

   To resume, begin at step 1.

8. LESS THAN SECTORS USED

This program will not copy less than the number of sectors used.

RECOVERY: Repeat Step 13. Enter a number at least as large as sectors used.

To shorten sectors used in a KFAM file, see REALLOCATE KFAM FILE SPACE.

9.	GREATER THAN AVAILABLE SPACE	The number of sectors to be copied is greater than the number of sectors available on the output platter. RECOVERY: Repeat Step 8. Enter a number not greater than available space, as shown in the screen display. To increase the size of the output cataloged area, see Error Message 7, above.
10.	ERR79	A file of the same name is already cataloged on the output platter. Two files of the same name may not be cataloged on the same platter. RECOVERY: To replace the existing file on the output platter with a new file of the same name, enter: SCRATCH T#2, N$ key: RETURN(EXEC) enter: DATASAVE DC OPEN T$#2,N$, "dummy name" key: RETURN(EXEC) repeat from Step 1 reentering the name and length of the new file to be copied. To leave the existing file on the output platter and proceed on to the next file, repeat from Step 1.
11.	ERR72	Disk read error.
12.	ERR85	RECOVERY: For either ERR 72 or ERR85, the procedure is as follows: To retry the disk read or write operation, enter RUN XXXX, where XXXX is the line number shown with the error message.

	If the error persists, either: a. There is a hardware malfunction, b. If ERR 72, the input sector is recorded in error, or c. If ERR 85, the output sector is physically no good. The presence of a bad sector on either the input or output platter can be detected by using the VERIFY command.
13. STOP DISASTER	Program error. The copy of the file is not completed. RECOVERY: Rerun from Step 1. Recopy the same file again. If ERR79 occurs, follow the Scratch and Rename Recovery procedure.
14. PROTECTED PROGRAM	An attempt is being made to copy a protected program. RECOVERY: This program will not copy a protected program.

CHAPTER 8
PRINT KEY FILE UTILITIES

8.1 PRINT KEY FILE KFAM-3

This program prints the current contents of the Key Descriptor Record (KDR) and the Key Index Records (KIR) for any KFAM-3 Key File.

Operating Instructions

DISPLAY		INSTRUCTIONS
1.	1.	Mount the disk platter containing the KFAM-3 Key File to be printed; mount paper on the printer.
2.	2.	Access PRINT KEY FILE via the appropriate Special Function ke
		from the KFAM-3 menu.
3. ENTER FILE NAME	3.	Enter the name of the User File with which this Key File is associated, or the name of the Key File itself.
4. ENTER KEY FILE #	4.	Enter the number of the Key Fil to be printed.
		The Key File Number is normally 1, but may be any digit from 1 to 9 if there are multiple Key Files for one User File.
		MESSAGE: 3

NOTE:

Error messages and recovery procedures follow the operating instructions.

5.	ENTER THE NO. FOR THE KEY FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	5.	Enter the selection number for the device address of the Key File. MESSAGE: 2, 3, 4
6.		6.	The program prints the contents of the Key File. MESSAGE: 5, 6, 7
7.		7.	The system returns to KFAM-3 menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered. RECOVERY: Repeat the step entering the correct information.
3.	ERR 29	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Reenter numeric quantity.
4.	INVALID DEVICE ADDRESS	Device address entered was invalid. RECOVERY: Repeat the step. Enter correct device address selection number.
5.	ERR80	File not found. The specified file does not exist on the specified platter. RECOVERY: Make sure the correct platter is mounted. Rerun from Step 2, entering the correct information.

6.	ERR72	Disk read error. RECOVERY: Rerun from Step 2.
7.	ERR43	Wrong file format read. RECOVERY: This program will only print a Key File created under KFAM-3.

8.2 PRINT KEY FILE KFAM-4

This program prints the current contents of any KFAM-4 Key File.

NOTE:

Hog mode is selected for the device containing the Key File. To execute the utility at a non-multiplexed disk drive key,

M$ = "X" (EXEC)

at KFAM-4 utilities menu, prior to loading the utility.

DISPLAY	INSTRUCTIONS
1.	1. From KFAM-4 menu access the PRINT KEY FILE utility via the indicated Special Function key.
2. ENTER USER FILE NAME (SSSFJNN)	2. Enter the name of the User File with which the Key File is associated. MESSAGE: 4,5
3. ENTER THE KEY FILE NUMBER (NORMAL=1)	3. Enter the Key File Number of the Key File to be printed. MESSAGE: 4,6,7

4.	ENTER THE NO. OF THE KEY FILE DEVICE ADDRESS. 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	4.	Mount the disk containing the Key File. Enter the selectio number (1-7) to choose the device address of the Key File. MESSAGE: 4,6,8
5.		5.	The program prints the contents of the Key File. MESSAGE: 1,2,3
6.		6.	The system returns to KFAM-4 menu. MESSAGE: 2

Error Messages

MESSAGE		EXPLANATION/RECOVERY
1.	ERR80	File not found. RECOVERY: Mount disk containing Key File. Rerun.
2.	ERR72	Disk read error. RECOVERY: Rerun the program. If error persists, program or Key File will have to be recreated from backup.
3.	ERR85	Disk write error. RECOVERY: Rerun the program. If error persists, the disk containing the Key File is bad.
4.	RE-ENTER	Too many characters were entered, or an invalid character was entered in response to a "yes" (Y) or "no" (N) question. RECOVERY: Repeat the step. Re-enter the data.
5.	NOT KFAM FILE NAME	The 5th character of the file name must be "F", and the 6th character must be a zero.

		RECOVERY: Repeat the step. Enter a valid KFAM file name.
6.	ERR29	Non-numeric data was entered when a numeric quantity was requested. RECOVERY: Repeat the step. Enter a number.
7.	INVALID	Key File number may not be zero. RECOVERY: Repeat the step. Enter a number 1-9.
8.	INVALID DEVICE ADDRESS	The numbers 1-7 may be used to specify a device address, according to the table displayed. RECOVERY: Repeat the step. Enter a number 1-7.

CHAPTER 9
THE RECOVERY UTILITIES

9.1 KEY FILE RECOVERY (KFAM-3 AND KFAM-4)

9.1.1 Overview

If a Key File is destroyed, the Key File Recovery utility permits it to be reconstructed from the data in the User File, provided that application programs that operate on the file adhere to the following conventions:

1) All DELETED records are flagged in the User File with HEX(FF) in the first byte of the key.

2) Programs that execute FINDNEW on the file include the RECOVERY OPTION in all subroutines, and subsequently close the file with the CLOSE subroutine. (Note that under KFAM-4, CLOSE is a system requirement, apart from the RECOVERY requirements.)

The information required to operate the utility is:

1) User File name
2) User File device address
3) Key File number (normally = 1)
4) Key File device address
5) Is the Key File already cataloged?

If the Key File already exists on the designated disk, this utility reuses that file; otherwise, it catalogs a new file with sufficient space to index the maximum number of records in the User File.

If more than one Key File exists for this one User File, it may be impossible to use this utility.

The utility uses a printer (address 215) to list duplicate keys. If no printer is available, or a different printer device address is desired, see Chapter 12.

For KFAM-4 only, the utility selects hog mode for the disk containing the Key File, initializes the Key File, then deselects and leaves hog mode. (To execute the utility at a non-multiplexed disk drive, key

M$ = "X" (EXEC)

at KFAM-4 utilities menu, prior to loading the utility.) The file is then opened in exclusive mode and the disk is not hogged.

9.1.2 Operating Instructions

	DISPLAY		INSTRUCTIONS
1.		1.	Mount the disk containing the User File, and the disk to contain the reconstructed Key File.
2.		2.	From KFAM-3 or KFAM-4 menu load KEY FILE RECOVERY via the indicated Special Function Key.
3.	ENTER USER FILE NAME (SSSSFJNN)	3.	Enter the name of the User File for which the Key File is to be reconstructed. MESSAGE: 2,4 NOTE: Error Messages and recovery procedures follow the operator instructions.
4.	ENTER THE NO. OF THE USER FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	4.	Enter the selection number (1-7) to choose the device address of the User File. MESSAGE: 2,5

5. ENTER THE KEY FILE NUMBER	5. The Key File Number should always be 1, unless there are multiple key files for a single User File, in which case the Key File Number may be any digit from 1 to 9. MESSAGE: 2,6
6. ENTER THE NO. OF THE KEY FILE DEVICE ADDRESS. 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	6. Enter the selection number (1-7) to choose the device address of the Key File. MESSAGE: 2,3,5
7. IS KEY FILE CATALOGED (Y OR N)	7. If the Key File is cataloged at the address selected in step 6, enter Y; otherwise enter N. MESSAGE: 1,2,7,8,9
8. TURN ON PRINTER KEY RETURN(EXEC) TO RESUME	8. Ready the printer. The printer is used to list duplicate keys or unreadable sectors, if any. (If no printer is available, this program must be slightly modified; see Chapter 12.) MESSAGE: 2
9.	9. The system recreates the Key File. MESSAGE: 1,10,11,12,13,14, 15,16,17,18
10.	10. The system returns to the KFAM menu.

Error Messages

ERROR MESSAGE	EXPLANATION/RECOVERY
1. ERROR ## LINE ####	This is the same as ERR ## in BASIC.

		RECOVERY: Appropriate to error type.
2.	RE-ENTER	Too many characters were entered, or the entry was invalid. RECOVERY: Repeat the step, correcting the entry.
3.	ERROR 80 LINE 6190	The User File is not mounted on the device specified. RECOVERY: Mount the disk containing the User File and rerun the program.
4.	NOT KFAM FILE NAME	The User File name must have an "F" in position 5 and a 0 in position 6. RECOVERY: Repeat step 3. Enter correct User File name.
5.	INVALID DEVICE ADDRESS	The device address for a KFAM file must be 310, B10, 320, B20, 330, B30, or 350. RECOVERY: Repeat the step. Enter correct device address.
6.	INVALID	The Key File Number may not be 0. RECOVERY: Repeat step 5. Enter a Key File Number 1-9.
7.	FILE ALREADY CATALOGED	Key File already exists. RECOVERY: Repeat from step 1. Mount new disk if necessary.
8.	FILE NOT FOUND	Key file does not exist on the specified device. RECOVERY: Repeat from step 1. Mount new disk if necessary.
9.	NO SPACE ON DISK FOR KEY FILE (STOP)	There is not sufficient space on disk to catalog the Key File. RECOVERY: Mount new disk and rerun.

10.	STOP ERROR OPENING FILES	Return code "X" from "OPEN" sub-routine. Possible cause: Th program was stopped and restarted after processing had begun. RECOVERY: Load and rerun from menu. If the error persists, notify Wang Laboratories.
11.	INVALID RECORD FORMAT (STOP)	Record type A, array-type blocking: more than one sector per block, more than 38 fields per record, or not written with correct control bytes. RECOVERY: None. "END" record invalid.
12.	NOT BLOCKED AS SPECIFIED	Recovery type A, array-type blocking: records per block specified incorrectly, or records not written in array format. RECOVERY: None. "END" record invalid.
13.	RECORD LENGTH NOT SPECIFIED (STOP)	Record type A, array-type blocking: record length specified i INITIALIZE KFAM FILE does not equal record length of sample record. RECOVERY: None. "END" record invalid.
14.	KEY FIELD OUT OF BOUNDS (STOP)	Record type A, array-type blocking: the key must be wholly contained within one field of the record. RECOVERY: None. "END" record invalid.
15.	NUMERIC KEY INVALID (STOP)	Record type A, array-type blocking: the key falls within a numeric field. RECOVERY: None. "END" record invalid.
16.	NO SPACE (STOP)	Return code "S" from FINDNEW(HERE). Not sufficient space for Key File.

	RECOVERY: Allocate more space for the Key File. Rerun.
17. INVALID POINTER (STOP)	Sector accessed is not in the User File. Probably the "END" record does not contain the necessary information to rebuild the Key File. RECOVERY: Rerun the program. If the error persists, no recovery is possible.
18. SYSTEM HANGS	Printer not turned on, not selected manually, or no device 215 in system. RECOVERY: Turn printer on and press "SELECT". If no device 215, this program will not run without modification. (See "Eliminating the Printer", Chapter 12.)

9.2 RESET ACCESS TABLE (KFAM-4 ONLY)

For KFAM-4 only there is an Access Table included in the Key File (in the [illegible]R). This table is 4 bytes long, one byte for each possible CPU accessing the file. If no CPU is accessing the file, all 4 bytes should be blank. If one or more CPU's are accessing the file, then one byte is set in the Access Table for each CPU currently accessing the file. It is set to "A" or "X" depending on whether the access is shared or exclusive.

When the file is closed, by a particular CPU, the corresponding byte in the Access Table is set back to blank. If, for any reason, such as system failure or power failure, the program is terminated without closing the file, there will remain, in the Access Table, bytes which are not set to blank. If this happens, the file cannot subsequently be opened in the exclusive mode. If a byte happens to remain set to "X" in the Access Table, the file cannot subsequently be opened in either exclusive or shared mode. Also the number of files which can be opened in the shared mode is cut down by the number of bytes in the Access Table which remain set to "A". (The programs assume that these slots represent CPU's which are currently accessing the file.)

This utility is provided to reset the Access Table to blanks, in the event of a program failure or system failure that has left the Access Table with erroneous non-blank characters. The utility also turns off any "protect flags" that may be left on. PRINT KEY FILE (KFAM-4) shows the current settings of the Access Table.

This utility should not be run if any other CPU is currently accessing the file. The utility has no way of knowing whether entries in the Access Table are "live" or "dead", and resets all Access Table bytes to blanks indiscriminately. Before running this program, the user should check to make sure that no other CPU is currently accessing the file. Otherwise there could be an unpredictable scrambling of results.

Hog mode is selected for the disk containing the Key File, while it is being read and re-written. To execute the utility at a non-multiplexed disk key

M$ = "X" (EXEC)

at KFAM-4 utilities menu, prior to loading the utility.

The User File is not accessed by this program. Only the Access Table in the KDR is altered.

Operating Instructions

DISPLAY	INSTRUCTION
1.	1. From KFAM-4 subsidiary menu access RESET ACCESS TABLE via the indicated specified Special Function Key. ERROR MESSAGE: 2
2. ENTER USER FILE NAME (SSSFJNN) RESET ACCESS TABLE	2. Enter the User File name. ERROR MESSAGE: 4,5
3. ENTER KEY FILE NUMBER (NORMAL=1)	3. Enter the Key File number. Normally this is 1, unless there are multiple Key Files indexing the same User File. ERROR MESSAGE: 4,6,7
4. ENTER THE NUMBER OF THE KEY FILE DEVICE ADDRESS. 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	4. Enter the selection number for the address at which the Key File is mounted. ERROR MESSAGE: 4,6,8
5.	5. The Access Table is reset. ERROR MESSAGE: 1,2,3

6.	DO YOU WISH TO DO ANOTHER FILE? (Y OR N)	6.	If the Access Table of another Key File must be reset, enter Y and go to step 2. Otherwise, enter N to return to KFAM-4 subsidiary menu. ERROR MESSAGE: 2

Error Messages

ERROR MESSAGE			EXPLANATION/RECOVERY
1.	ERR 80	1.	File not found. RECOVERY: Mount disk containing Key File. Rerun.
2.	ERR 72	2.	Disk read error. RECOVERY: Rerun the program. If error persists, program or Key File will have to be recreated from backup.
3.	ERR 85	3.	Disk write error. RECOVERY: Rerun the program. If error persists, the disk containing the Key File is bad.
4.	RE-ENTER	4.	Too many characters were entered, or an invalid character was entered in response to a "yes" (Y) or "no" (N) question. RECOVERY: Repeat the step. Re-enter the data.
5.	NOT KFAM FILE NAME	5.	The 5th character of the file name must be "F", and the 6th character must be a number 0-9. RECOVERY: Repeat the step. Enter a valid KFAM file name.
6.	ERR 29	6.	Non-numeric data was entered when a numeric quantity was requested. RECOVERY: Repeat the step. Enter a number.

7. INVALID	7. Key File number may not be zero. RECOVERY: Repeat the step. Enter a number 1-9.
8. INVALID DEVICE ADDRESS	8. The numbers 1-7 may be used to specify a device address, according to the table displayed. RECOVERY: Repeat the step. Enter a number 1-7.

CHAPTER 10
THE KFAM CONVERSION UTILITIES

10.1 The KFAM-3 CONVERSION UTILITIES

10.1.1 Overview

KFAM-3 includes two KFAM conversion utilities. These are CONVERT KFAM-1 to KFAM-3 and CONVERT KFAM-2 to KFAM-3. They are provided to convert a file created under one of the earlier KFAM's to the format of KFAM-3. The procedures and operating instructions for these programs are the same regardless of which one is being used.

The structure and format of the Key File is not the same for KFAM-3 as for KFAM-1 or KFAM-2. Therefore, the conversion process consists of dropping the old Key File and creating a new Key File in the KFAM-3 format.

Certain information must be preserved before the old Key File is dropped. Deleted records must be identified, so that they will not be included in the new Key File. The location of the last physical record in the User File must be determined, and the value of the last key must be displayed, to define the end of the file. The utility performs these two functions. It does this by using the KFAM subroutines of the KFAM version originally used to organize the file. It extracts the key from each record in the User File. It then executes "FINDOLD" for that key. If the key is not found, or if the pointer in the Key File points to a different location in the User File, it assumes that record is deleted. It flags each deleted record with HEX(FF) in the first byte of the key. In a printed report, it lists the location and key of each deleted record.

If the record is not deleted, the utility checks the key to see whether it violates the restrictions of KFAM-3 (first byte HEX(FF) or the entire key binary zero). It lists on the printed report, as "invalid", any key which violates these restrictions, together with the record location. It also lists

on the report the last valid key, so that it may be used to set up the new Ke
File.

Once the User File has been conditioned in this manner by the conversion utility, INITIALIZE KFAM FILE (KFAM-3 version) and KEY FILE CREATION (KFAM-3 version) utilities are run to create the new Key File. Any key that is flagged HEX(FF) in the first byte is ignored by KEY FILE CREATION, thereby creating the new Key File only from the active records in the User File.

10.1.2 Conversion Procedure

To convert a file to KFAM-3, three programs must be run, the appropriate "CONVERT" program, INITIALIZE KFAM FILE, and KEY FILE CREATION. The overall procedure is as follows:

1. Backup copies should be made of the User File and the old Key File.

2. Mount the User File and the old Key File.

   Execute the appropriate "CONVERT" program.

3. Initialize the new (KFAM-3) Key File.

   Load and execute INITIALIZE KFAM FILE.

4. Build the new Key File.

   Load and execute KEY FILE CREATION UTILITY.

The User File and Key File are now converted and can be accessed via KFAM-3.

If converting from KFAM-1, modifications may be required to user programs to run under KFAM-3. The return codes from the KFAM-1 subroutines have been changed as follows:

Subroutine	Condition	KFAM-1 Subroutines Return	KFAM-3 Subroutines Return
231 DELETE	Key not found	L, H, or N	N
232 FINDOLD	Key not found	L, H, or N	N
235 FINDFIRST	Normal	L	blank
236 FINDLAST	Normal	H	blank

All other return codes are the same as before.

KFAM-2 and KFAM-3 have identical subroutine return codes.

Operating Instructions

	DISPLAY		INSTRUCTIONS
1.		1.	Make backup copies of the User File and Key File to be converted.
2.		2.	Mount the disk platters containing the User File and Key File to be converted.
3.		3.	From KFAM-3 menu, depress the appropriate Special Function key to access CONVERT KFAM-1 to KFAM-3 or CONVERT KFAM-2 to KFAM-3.
4.	ENTER USER FILE NAME (SSSSFJNN)	4.	Enter the User File name. MESSAGE: 2, 4 NOTE: Error messages and recovery procedures follow the operating instructions.
5.	ENTER THE NO. OF THE USER FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	5.	Enter the selection number for the user file device address. MESSAGE: 2, 3, 6
6.	ENTER KEY FILE NUMBER (NORMAL=1)	6.	Enter the Key File Number. The key file number should always be 1, unless there are multiple key files for a single User File, in which case, the Key File Number may be any digi from 1 to 9. MESSAGE: 2, 3, 5

7.	ENTER THE NO. OF THE KEY FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	7.	Enter the selection number of the key file device address. MESSAGE: 2, 3, 6
8.	"KFAM FILE CONVERSION (KFAM5000)" etc.	8.	The files are opened. MESSAGE: 7, 8, 9, 10, 15
9.	TURN ON PRINTER KEY RETURN(EXEC) TO RESUME	9.	Mount paper in the printer. Key RETURN(EXEC) to resume. MESSAGE: 2
10.		10.	The system proceeds with the conversion. MESSAGE: 12, 13
11.	DO YOU WISH TO DO ANOTHER FILE? (Y OR N)	11.	To convert another file, enter Y and go to step 4. Otherwise, enter N and go to the next step. MESSAGE: 2
12.		12.	The system returns to the KFAM-3 menu.

Error Messages

	ERROR MESSAGE	EXPLANATION/RECOVERY
2.	RE-ENTER	Too many characters were entered, or an invalid character was entered in response to a "yes" (Y) or "no" (N) question. RECOVERY: Repeat the step, entering the correct value.
3.	ERR29	A non-numeric quantity was entered when a numeric quantity was requested. RECOVERY: Reenter numeric quantity.
4.	NOT KFAM FILE NAME	The User File name must have an "F" in position 5 and a zero in position 6.

		RECOVERY: Repeat Step 4. Enter correct User File name.
5.	INVALID	The Key File number may not be 0. RECOVERY: Repeat Step 6. Enter Key File number 1-9.
6.	INVALID DEVICE ADDRESS	The device address is invalid. RECOVERY: Reenter correct selection number.
7.	STOP ERROR OPENING FILES	This should not occur. Either the program is being rerun without closing the file, or there is an error in the Key File. RECOVERY: Recreate the Key File from a backup. Rerun the program from Ste 1.
8.	NOT EVEN MULTIPLE	This should not occur. The total sectors occupied by the User File is not an even multiple of the number of sectors per record. RECOVERY: Recreate the Key File from a backup copy. Rerun the program from Step 1.
9.	ERR80	Files not found. Either the User Fil or the Key File does not exist on the specified platter. RECOVERY: Rerun the program from Step 4. Enter correct information.
10.	ERR72	Disk read error. If the error persists, either the User File (#1) or the Key File (#2) is permanently damaged. RECOVERY: Rerun the program from Step 1.
11.	ERR85	Disk write error. If the error persists, the platter is physically damaged.

		RECOVERY: Recreate both the User Fi and the Key File from backup copies. Rerun the program from Step 1.
12.	System hangs	Either the printer is not turned on, or there is no device 215 in the system. RECOVERY: Press both "ON/OFF" and "SELECT" to turn on the printer. Both should be illuminated. If no printer, the program must be modified in order to run (see Chapter 12, "Eliminating the Printer").
13.	ERROR X	This should not occur. The FINDOLD subroutine reports an improper call. RECOVERY: Rerun from Step 1. If the error persists, notify Wang Laboratories, Inc.
14.	ERR 43	Wrong record format read. The Key File is not in the original KFAM format. RECOVERY: Check the system which created the Key File. Rerun from Step 3.
15.	INVALID RECORD FORMAT or NOT BLOCKED AS SPECIFIED or RECORD LENGTH NOT SPECIFIED CORRECTLY or KEY FIELD OUT OF BOUNDS or NUMERIC KEY (STOP)	Record type A array type blocking: record format or key position is invalid. RECOVERY: File cannot be converted.

10.2 THE KFAM-4 CONVERSION UTILITY

The KFAM-4 system includes a utility program to convert from KFAM-3 to KFAM-4. The structure of the Key File's key index entries is identical from KFAM-3 to KFAM-4. Only the Key File's special header record, the KDR, differs, and, therefore, only this needs to be altered to convert a KFAM-3 file to a KFAM-4 file. The utility CONVERT KFAM-3 TO KFAM-4 performs the necessary alteration of the KDR.

To convert a file from KFAM-1 or KFAM-2 to KFAM-4, it must first be converted to KFAM-3 using the KFAM-3 conversion utilities.

Application programs written for KFAM-3 will require modification to operate on KFAM-4 files. See Chapters 1, 5 and 12 for KFAM-4 programming procedures.

> NOTE:
>
> The utility selects hog mode for the disk device containing the key file to be converted. To execute the utility at a non-multiplexed disk drive key,
>
> M$ = "X" (EXEC)
>
> at KFAM-4 utility menu, prior to loading the utility.

Operating Instructions

1.	1. From the KFAM-4 menu access CONVERT KFAM-3 TO KFAM-4 via the specified Special Function Key.
ENTER USER FILE NAME (SSSSFJNN)	2. Enter the name of the User File to be converted. MESSAGE: 4,5
3. ENTER KEY FILE NUMBER (NORMAL=1)	3. Enter the Key File Number. Normally this is 1, except if there is more than one Key File for the User File. MESSAGE: 4,6,7
4. ENTER THE NO. OF THE KEY FILE DEVICE ADDRESS 1. 310 5. B10 2. 320 6. B20 3. 330 7. B30 4. 350	4. Enter the selection number (1-7) to choose the Key File device address. MESSAGE: 4,6,8
5.	5. The utility converts the Key File from KFAM-3 to KFAM-4 format.

	MESSAGE: 1,2,3
6. DO YOU WISH TO DO ANOTHER FILE ? (Y OR N)	6. Enter Y to repeat program for another file; go to step 2. Enter N to return to KFAM-4 menu.
	MESSAGE: 4

Error Messages

ERROR MESSAGE	EXPLANATION/RECOVERY
1. ERR 80	File not found. RECOVERY: Mount disk containing Key File. Rerun.
2. ERR72	Disk read error. RECOVERY: Rerun the program. If error persists, program or Key File will have to be recreated.
3. ERR85	Disk write error. RECOVERY: Rerun the program. If error persists, the disk containing the Key File is bad.
4. RE-ENTER	Too many characters were entered, or an invalid character was entered in response to a "yes" (Y) or "no" (N) question. RECOVERY: Repeat the step. Re-enter the data.
5. NOT KFAM FILE NAME	The 5th character of the file name must be "F", and the 6th character must be a number 0-9. RECOVERY: Repeat the step. Enter a valid KFAM file name.
6. ERR29	Non-numeric data was entered when a numeric quantity was requested. RECOVERY: Repeat the step. Enter a number.

	INVALID	Key File number may not be zero. RECOVERY: Repeat the step. Enter a number 1-9.
8.	INVALID DEVICE ADDRESS	The numbers 1-7 may be used to specify a device address, according to the table displayed. RECOVERY: Repeat the step. Enter a number 1-7.

CHAPTER 11
GENERAL TECHNICAL INFORMATION

11.1 KEY FILE RECORD LAYOUTS

The first sector of the key file contains the Key Descriptor Record (KDR). The remaining sectors contain Key Index Records (KIR's), as many as are necessary to index the User File. The layouts of the KDR's of KFAM-3 and KFAM-4 are different; both are given below. The layouts of the KIR's are identical for KFAM-3 and KFAM-4.

Key Descriptor Record (KDR)--KFAM-3

Variable Name	Bytes on Disk	Contents
Q2$2	3	Last data sector (last sector used for data in User File, relative to starting sector = 0, hex number).
Q3$2	3	Data sector limit (last sector available for data in User File, relative to starting sector = 0, hex number).
V5$1	2	Record number within sector, last slot used for data in User File, hex number. (First record within sector = 1.)
V8$1	2	Records per block, hex number. (Set to 1 for type M or N records.)
V0$2	3	Key File, absolute address (hex) of starting sector.
V1$8	9	Byte 1: Record type, A, C, M, or N. Byte 2: Record length (hex) if type A or C. Bytes 3, 4: Starting position of key (hex) relative to first byte of first sector of record = 0.

		Byte 5: Key length (hex). Byte 6: The number of KIE's per KIR (hex). Bytes 7, 8: Not used.
V2$2	3	Key File, last sector used (hex), relative to starting sector = 0.
V3$2	3	Key File, last sector available (hex), relative to starting sector = 0.
V6$1	2	Sectors per logical record (hex). (Set to 1 for type A or C records.)
T2$2	3	Sector address of highest level index sector (hex), relative to starting sector of Key File = 0.
T0	9	Number of index levels.
T1	9	Current Key File # (file number assigned in SELECT statement).
T2	9	Current User File # (file number assigned in SELECT statement).
V8	9	Bias for splitting KIR expressed as a percentage of the number of KIE's which can be contained in the KIR, range .2 to .8.
T4$3	4	Last record accessed, pointer: Bytes 1, 2: Relative sector within User File. Byte 3: Record number (hex) within sector.
5$30	31	Last key added to file.
T7$30	31	Last key accessed.
T2$(8)2	24	Path to last record accessed: Sector address, of KIR's, from level T0 down to level 1.
T(8)	72	Path to last record accessed. Number of KIE's within KIR, from level T0 down to level 1.
T8$1	2	Internal completion code: Same as Q$, except: Following DELETE, O.K., T8$="1". Following FINDOLD, not found, T8$ = "2". Following FINDNEW or FINDNEW (HERE), O.K., T8$ = "3". Following OPEN, O.K., T8$=letter "O". Following CLOSE, O.K. T8$ not defined.

TOTAL 233 bytes

Key Descriptor Record (KDR) (KFAM-4)

Variable Name	Bytes on Disk	Contents
Q2$2	3	Last live data sector (last sector used for data in User File, relative to starting sector = 0, hex number).
Q3$2	3	Data sector limit (last sector available for data in User File, relative to starting sector = 0, hex number).
V5$(4)1	8	Per CPU, record number within sector, last slot used for data in User File, hex number (first record within sector = 1) initialized to V8$.
V8$1	2	Records per block, hex number. (Set to 1 for type M or N records.)
V1$8	9	Byte 1: Record type, A, C, M, or N. Byte 2: Record length (hex) if type A or C. Bytes 3, 4: Starting position of key (hex) relative to first byte of first sector of record = 0. Byte 5: Key length (hex). Byte 6: Number of KIE's per KIR. Bytes 7-8: Not used.
V2$2	3	Key File, last sector used (hex), relative t starting sector = 0.
V3$2	3	Key File, last sector available (hex), relative to starting sector=0.
V6$1	2	Sectors per logical record (hex). (Set to 1 for type A or C records.)
T2$2	3	Sector address of highest level index sector (hex), relative to starting sector of Key File = 0.
T0	9	Number of index levels.
T8$(4)1	8	Per CPU, internal completion code: Same as Q$, except: Initialized to "Z" by KFAM1004, KFAM1005, or KFAM7004. Following FINDOLD, not found, = "2". Following FINDNEW, FINDNEW(HERE), or DELETE, all slots with a value of "9" or less are set to "3". Following OPEN, successful, set to letter "O". Following CLOSE, successful, set to "Z". If Q$="B", set to "9".
Q0$4	5	Access table: one byte slot per CPU. Byte is blank if this slot not used. "A" if access is shared. "X" if access is exclusive.

		The slot assigned to a particular CPU varies. It is determined by the first blank character of Q0$ at the time the particular CPU opens the particular file. This slot number also becomes the subscript for V5$(), T8$(), V4$(), and V2$().
V4$(4)2	12	Per CPU, protected sector. Hex (FFFF) if no protected sector.
V2$(4)2	12	Per CPU, data sector for FINDNEW. V5$() defines the record within the sector. The combination of V2$() and V5$() defines the last physical location assigned to a new record by this CPU via FINDNEW. The value of V2$(), per CPU, is taken from Q2$, which is the last sector address used by any CPU.
Total	82 bytes	

Key Index Record (KIR) (KFAM-3 AND KFAM-4)

Variable Name	Bytes on Disk	Contents
T9$2	3	Sector address (hex), this sector, relative to first sector of Key File = 0.
T0$(4)60	244	A 240 byte array containing KIE's. Number of KIE's per KIR can vary from 7 to 60. Unused KIE's are filled with all bytes HEX(FF). Active KIE's are packed as follows: K bytes: key 3 bytes: pointer Pointer points to next lower index level KIR or User File record if lowest level. The first two bytes of the pointer contain the sector address (hex) relative to the start of the file. The last byte contains the record number (hex) within the sector if the pointer is to a data record, and is not defined if the pointer is to a lower level KIR.
TOTAL	247 bytes	

Internal Storage under KFAM-4

Certain information that is stored in the KDR under KFAM-3 is stored internally in CPU memory under KFAM-4. It is stored in 3-element arrays for which the KFAM ID number serves as a subscript (T9=KFAM ID Number), and in some cases is stored in scalar variables for the most recently active file. The internal storage fields are as follows:

Most Recently Active File	Per KFAM I.D. Number	Contents
V0	V0(3)	CPU number assigned when the file was opened (see KDR, Q0$).
V0$2	V0$(3)2	Absolute starting sector (hex) of the Key File, or HEX(FFFF) if file not open.
T1	T1(3)	Key File # (file number assigned in SELECT statement).
T2	T2(3)	User File # (file number assigned in SELECT statement).
T4$3	T4$(3)3	Last record accessed, pointer: Bytes 1,2: Relative sector within User File. Byte 3: Record number (hex).
T7$30	T7$(3)30	Last record accessed, key.
T2$(8)2	T6$(3)16	Path to last record accessed: Sector addresses of KIR's from highest level down to level 1. Subscript of T2$() corresponds to index level. Subscript of T6$() is file I.D.
T$8	T$(3)8	Path to last record accessed: Starting byte of KIE within KIR, from highest level down to level 1 (hex). Byte within T$ corresponds to index level.
--	V3$(3)1	Access mode, "A" = shared, "X" = exclusive.
--	V8(3)	Bias for splitting KIR. Reset to .5 when the file is opened.
--	T5$(3)30	Last key added to file.

11.2 KEY FILE STRUCTURE

The structure of the Key File in KFAM-3 and KFAM-4 is the same. It is similar to the structure called a B-tree, which is discussed on pages 473-479 of THE ART OF COMPUTER PROGRAMMING: Volume 3/Sorting and Searching, by Donald E. Knuth.

The problem is to create a Key File that permits rapid access to any particular User File record, and may also be updated at any time without a major reorganization of the file. The B-tree structure, as modified, satisfies this two-fold requirement.

The structure of the Key File is best described by showing how the file is constructed. The first step, in INITIALIZE KFAM FILE, is to create one KIR record, which contains one dummy KIE with a key value of binary zero (all bytes HEX(00)). This dummy KIE serves to "prime" the system so that the same program logic can be applied to a null, or empty, file as is applied to a file containing active records. Being the lowest possible key, it also serves to mark the lower limit of the Key File. For example, FINDFIRST (see KFAM subroutines in Programming Aids Section) is done by searching for the binary zero key and then doing FINDNEXT. This dummy key can be thought of as the 0th entry in the Key File. Of itself, it represents nothing, except as the marker of the lower boundary.

In the examples below, this dummy key is designated as "000". Please note that the actual value is binary zero, HEX(000000), and not the characters "000", or HEX(303030). The characters "000" may be used as an active key, and will not conflict with the dummy key.

The unused KIE's in any KIR always have all bytes set to HEX(FF). Thus the original KIR record has the first key set to all HEX(00) and the remaining keys set to all HEX(FF).

In the examples below, these unused keys are designated as "FFF." Please note that the actual value is HEX(FFFFFF...) and not the characters "FFF," or HEX(464646).

Two items in the KDR record are essential to searching the Key File. One is the number of index levels, T0. To start with, T0 = 1, because there is only one level of index. The other item is the relative sector address of the highest level index, T2$. At the starting point, there is only the one index sector, the KIR record described above, and its sector address is always HEX(0001). (The KDR record always occupies sector HEX(0000), or the first sector of the Key File, and the initial KIR follows it, in the second sector, at relative address HEX(0001).)

The Key File is now set up to begin entering active KIE's. As new keys are added to the file, the respective KIE's are inserted in the KIR in their proper sequential order. Higher keys are moved up one position, and one HEX(FF) key is dropped off the end.

For example, if the first three keys to be inserted are 276, 913, and 198, the KIE's would be arranged as follows:

```
Start:      000, FFF, FFF, etc.
First Key:  000, 276, FFF, etc.
Second Key: 000, 276, 913, FFF, etc.
Third Key:  000, 198, 276, 913, FFF, etc.
```

Keys are inserted in the first KIR in this manner until it is filled. The number of keys per KIR depends upon the size of the key. Let us assume for this example that the first KIR has been completely filled by one dummy key plus 14 active keys:

000, 009, 147, 198, 276, 292, 589, 591, 671, 710, 730,
809, 851, 903, 913

At this point the key 796 is to be added. Since there is no room in the one KIR to add another key, the KIR is split in two. A new KIR is created, and the KIE's are divided between the old KIR and the new KIR:

```
Old KIR:  000, 009, 147, 198, 276, 292, 589, 591, FFF, etc.
New KIR:  671, 710, 730, 796, 809, 851, 903, 913, FFF, etc.
```

The new KIR occupies relative sector HEX(0002). Note that the key added, 796, is inserted in its proper sequential order, which in this case just happens to fall in the new KIR.

With more than one KIR now in the file, the concept of "level" enters in. Both KIR's so far created are on level 1, the lowest level. The lowest level is defined as the level which contains the pointers to the data records in the User File. Whenever a KIR is split, the new KIR is on the same level as the old KIR.

Rather than search the KIR's sequentially for a given key, the system searches via a tree structure. There is one and only one KIR at the highest level. Its sector address is recorded in the KDR. The search is started by reading this sector. Up to this point, the search has been complete by locating the position of the key within the one sector. But at this point, there are two KIR's on level 1, and a higher level index must be created to reference them.

Therefore a third KIR is created. It is a level 2 index. It contains two keys, 000 and 671, which are the first keys of each of the two level 1 KIR's. The pointers associated with these two keys are the relative sector addresses of the two level 1 KIR's, which happen to be, by coincidence, HEX(0001) and HEX(0002). This 2nd-level KIR is stored in relative sector HEX(0003) of the Key File, and its contents are:

```
Keys:      000, 671, FFF, etc.
Pointers:    1,   2, FFF, etc.
```

The KDR is now updated. TO = 2, to show that the index now has 2 levels. T2$ = HEX(0003), to show that the highest level index is located at relative sector HEX(0003).

Assuming that the next key to be added is 562, the search now proceeds as follows. 562 is compared to the entries in the level 2 index, to see where it falls. It is greater than or equal to 000, but less than 671. Therefore it falls in the range 000 to 670. The pointer associated with 000 in the level 2 index is HEX(0001), and therefore the level 1 index stored in relative sector HEX(0001) is read. Then 572 is inserted in its proper place in the level 1 index, as before. The system knows when it has reached level 1, because it is counting down from TO to 1 as each level is read and searched.

When the key 562 has been added, the key file structure looks like this:

Sector	Level	Keys
1	1	000, 009, 147, 198, 276, 292, 562, 589, 591, FFF, etc.
2	1	671, 710, 730, 796, 809, 851, 903, 913, FFF, etc.
3	2	000, 671, FFF, etc.

As further keys are added, the KIR's on level 1 will again become full, and again the KIR must be split to provide room for all the keys. Let us assume that keys 401, 402, 403, 404, 405, 406, and 407 are added. The first six keys will cause sector 1 to be full, and the addition of 407 will make a split necessary. Relative sector HEX(0004) will be assigned to the new KIR, and the resulting structure will look like this:

Sector	Level	Keys
1	1	000, 009, 147, 198, 276, 292, 401, 402, FFF, etc.
2	1	671, 710, 730, 796, 809, 851, 903, 913 FFF, etc.
3	2	000, 403, 671, FFF, etc.
4	1	403, 404, 405, 406, 407, 562, 589, 591, FFF, etc.

Note that no new level has been added this time. In this example, there is room in the level 2 index to reference up to 15 level-1 KIE's. Therefore at least 15 x 8, or 120 records (and probably more, up to 225) can be accessed by a two-level index search.

Once the second level index is full, it is split, the same way the original KIR was split, and a third level is created, pointing to two 2nd-level KIR's, which in turn point to the first-level KIR's. The first level KIR's always contain the pointers to the actual data records. As new levels are added, more superstructure is added, but the bulk of the Key File remains the same.

If for a given key file there is an average of 10 KIE's per KIR, the number of records which can be accessed by a given number of levels of index is as follows:

INDEX LEVELS	NUMBER OF RECORDS
1	14
2	150
3	1500
4	15,000
5	150,000
6	1,500,000
7	15,000,000
8	150,000,000

For the largest possible key (30 bytes), each KIR holds a maximum of 7 KIE's and a guaranteed average minimum of 4 KIE's. For such a file the maximum 8 levels of index access at least 114,687 records.

Perhaps the best illustration of the Key File structure for a large file could be obtained by running PRINT KEY FILE with an actual KFAM file. The structure can then be traced from the highest level index sector (T2$, in KDR) down to the level 1 pointers to the actual data record.

The general procedure for locating a key in KFAM is as follows:

1) The number of index levels (T0) and the relative sector address of the highest level index (T2$) are taken from the KDR.

2) The index sector (KIR) is read from disk.

3) A search of the KIR is made to locate the key. The search returns a pointer (T) to the key in the KIR which is equal to, or next lower than, the key being searched.

4) The relative sector address of the KIR and the pointer to the KIE

path taken to locate the particular key, where T3 is the current index level.

5) If the current index level is greater than 1, the sector address for the next lower level index is taken from the KIE found (T), and the process is repeated from Step 2, above, for the next lower level.

6) If the current index level is 1, then the search is finished. T points to a KIE on level 1, and V indicates whether the key found is equal to or lower than the key being searched. Control is returned to the particular subroutine (FINDOLD, FINDNEW, DELETE, etc.).

The general procedure for inserting a key is as follows:

1) The proper position for the key is determined by the search procedure, above.

2) If the KIR is not full, the key and its associated record pointer are inserted at location T+1 in the KIR. All KIE's from location T+1 and up are moved up one position.

3) If the KIR is full, a new KIR is created, on the same level as the old KIR. The KIE's are divided between the old KIR and the new KIR. The new key and its associated record pointer are inserted in proper sequential order in either the old KIR or the new KIR, depending on where the new key happens to fall. The next available sector address in the Key File is assigned to the new KIR.

4) If the split is not at the highest index level, the first key and the sector address of the new KIR are inserted in proper key sequence in the next highest level KIR (as determined by tables T2$() and T()). If the next highest level KIR is full, Step 3 is repeated at that level.

5) If the split is at the highest index level, a new level is created. A new KIR is created with two KIE's. The first KIE contains the binary zero key and the relative sector address of the old KIR (formerly the highest level KIR). The second KIE contains the first key and sector address of the new KIR (created by the split). The next available sector in the Key File is assigned to this new highest level index. The KDR is updated (TO and T2$) to reflect the new level.

When the KIR is split, it is not always divided equally. There is a reason for this. Consider keys which are being added sequentially. Again assume the first index sector is filled by 14 active KIE's and one dummy KIE.

```
000, 001, 002, 003, 004, 005, 006, 007, 008, 009, 010
011, 012, 013, 014
```

The next key added, 015, causes a split:

```
Old KIR:  000, 001, 002, 003, 004, 005, 006, 007, FFF, etc.
New KIR:  008, 009, 010, 011, 012, 013, 014, 015, FFF, etc.
Level 2:  000, 008, FFF, etc.
```

The next keys added, 016, 017, etc. are all added to the new KIR eventually causing it to be split:

Sector	Level	Keys
1	1	000, 001, 002, 003, 004, 005, 006, 007, FFF, etc.
2	1	008, 009, 010, 011, 012, 013, 014, 015 FFF, etc.
3	2	000, 008, 016, FFF, etc.
4	1	016, 017, 018, 019, 020, 021, 022, 023, FFF, etc.

The process continues, always adding to the latest KIR and splitting it leaving behind a residue of KIR's which are only half full. It should be clear in this case that if the split were 12/4 instead of 8/8, the process of

indexing a sequential file would leave behind a residue of KIR's each containing 12 KIE's or 80% full. This would result in better utilization of Key File space and also tend to reduce the number of index levels required to access a given file.

But a 12/4 split would be disastrous if the keys were being added at random. There would be a greater probability of new keys being added to the KIR's already containing 12 entries, because of the greater range of values represented. So the Key File could actually fall below 8 keys per sector, and a very inefficient skew distribution would be the result.

Therefore there is no particular split that is best in all cases. Because of this, a moving bias has been included in the system. As each new key is added, the program checks whether it is higher or lower than the previous key added. If it is higher, the bias is adjusted downward. If it is lower, the bias is adjusted upward. The bias is a percentage of the maximum number of KIE's which, for a particular key size, can be contained in a KIR. When a KIR must be split, the current bias percentage is multiplied by the maximum number of KIE's per KIR to give the split, i.e., the number of KIE's which go into the new KIR. The range of the bias is .2 to .8.

On the basis of past experience, the system determines the best possible split, based on the order in which keys are added sequentially, mostl sequentially, random or backwards. The bias tends to approach .2 as keys are added sequentially, and tends to stay at .5 if keys are added in random order.

The bias, V8, is initially set to .5. It is adjusted upwards or downwards by 2% of the distance to .8 or .2 as each new key is added, depending on whether the key is lower or higher than the previous key added.

In REORGANIZE KFAM FILE where it is known that keys will be added sequentially, the bias is set to .2 at the begining. It is reset to .5 following the reorganization.

In KEY FILE CREATION the bias is set to .5 initially, and reset to .5 when the program is finished, because the order of keys added when initially creating the Key File could very well be different than the order of keys added at some later time (for example, sequential vs. random). The random hypothesis is always the "safest" to start with, unless experience proves differently.

Between the creation of the Key File and the reorganization, if any, the bias is allowed to fluctuate on the basis of how keys are added. It is stored in the KDR, and preserved as a permanent record, i.e., not reset every time the program is reloaded.

In summary, for KFAM, there are two minor departures from the B-tree structure as described in Knuth: First, keys are duplicated in higher level indexes, and second, a bias is introduced for the splitting of KIR's.

11.3 KEY FILE RECOVERY INFORMATION

KEY FILE RECOVERY utilities are provided for KFAM-3 and KFAM-4 to reconstruct a Key File in the event of its accidental destruction. In

reconstructing the Key File these utilities use information saved by the CLOSE subroutine in the next-to-last sector of the User File.

At the end of a User File are two sectors of "overhead". The last sector is a control sector written by the DATA SAVE DC OPEN statement. In the next-to-last sector is a "trailer" record written by DATA SAVE END during the INITIALIZE KFAM FILE utility. Two control bytes in this trailer record mark it as a trailer record for the 2200 system; however the remaining bytes are ignored by the 2200 system logic. Some of these remaining bytes are used by KFAM to store recovery information. The information is stored each time the CLOSE subroutine is executed (provided that the RECOVERY OPTION has been chosen during BUILD SUBROUTINE MODULE).

The data saved by CLOSE in the next-to-last sector of the User File is taken from the Key File's KDR record, and is as follows:

?AM-3

Bytes	Contents
1-2	HEX(A0FD)
3-4	Q2$2 = last sector used, User File.
5	V5$1 = last record within last sector.
6	V8$1 = records per block.
7-14	V1$8 = record type, record length, starting position of key, key length, number of KIE entries per sector.
15	V6$1 = sectors per record.

Bytes	Contents
1-2	HEX(A0FD)
3-4	Q2$2 = last sector used, User File.
5-8	V5$(4)1 = per CPU, last record used in sector assigned for FINDNEW.
9	V8$1 = records per block.
10-17	V1$8 = record type, record length, starting position of key, key length, number of KIE entries per sector.
18	V6$1 = sectors per record.
19-26	V2$(4)2 = per CPU, sectors assigned for FINDNEW.

This data saved by CLOSE is written in the next-to-last sector of the User File. This should always be the DATA SAVE DC END trailer. However, if the rules for shortening and lengthening files given in Chapter 7 are not carefully adhered to, the "trailer" may end up in some other sector. This could cause the RECOVERY utility to fail in some cases.

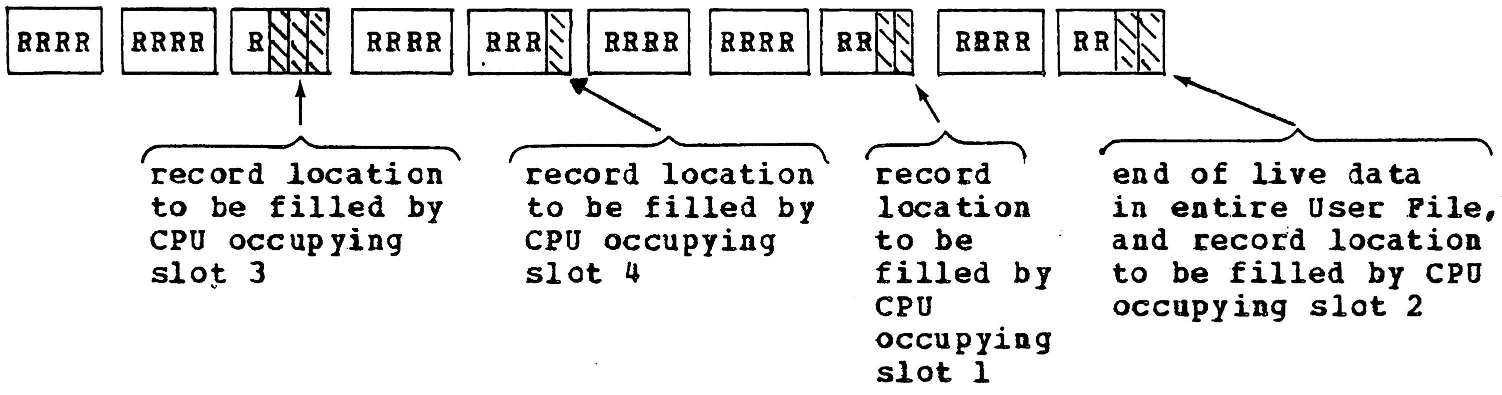
11.4 FINDNEW WITH BLOCKED FILES UNDER KFAM-4

Under KFAM-3 FINDNEW always sets the Current Sector address for the User File to the next available sector at the end of the live data in the User File. If records are blocked (type A or C), it passes back the next record location as well. With blocked files under KFAM-4, the operation of FINDNEW is more complex.

Under KFAM-4 up to four CPU's can have a KFAM file open simultaneously. When a CPU executes OPEN for a file, it is assigned one of the four slots in the KDR's Access Table. Associated with each slot in the Access Table is a relative sector location, and, for blocked files, a record number within that sector. This sector location and record number always point to the last location in the User File assigned when a CPU, occupying that Access Table slot, executed a FINDNEW. If, after OPENing a blocked file, a CPU executes FINDNEW, the location passed to it (sector and record location within the sector) will be the next available location after the last location given to a CPU occupying the same Access Table slot. This new location will be the sector following the last sector of live data in the file only if a new block must be started.

In summary, when using blocked files with KFAM-4, whenever a new block must be used, FINDNEW assigns an entire block to a particular Access Table slot. That block then becomes the exclusive property of that slot in the Access Table for the purpose of FINDNEW. It can only be filled by FINDNEW's executed by a CPU occupying that slot. The result is that all record locations up to the end of live data in the User File may not be filled at any one time.

For blocked files under KFAM-4, the User File might look like this, for example,


RRRR
RRRR
R
RRRR
RRR
RRRR
RRRR
RR
RRRR
RR
record location to be filled by CPU occupying slot 3
record location to be filled by CPU occupying slot 4
record location to be filled by CPU occupying slot 1
end of live data in entire User File, and record location to be filled by CPU occupying slot 2

where: R = record.
= unoccupied record locations.

11.5 COMPATIBILITY BETWEEN KFAM-1 AND KFAM-3

KFAM-3 is upwards - compatible with the original KFAM-1 with the following exceptions:

The structure of the Key File has been completely revised. There is a conversion program to facilitate the conversion of files organized under KFAM-1 to KFAM-3.

2. Restrictions are placed on the key. The first byte of the key may not be HEX(FF). The entire key may not have a value of binary-zero (the lowest possible value).

3. The following alterations have been made to the Return Codes in the KFAM-3 incorporable subroutines.

   a. KFAM-3 returns Q$=blank in all cases if the subroutine was executed properly. Formerly, FINDFIRST returned "L" and FINDLAST returned "H" for normal execution. This will require a program change in any user program using FINDFIRST or FINDLAST.

   b. Error codes "H" and "L" have been dropped in KFAM-3. Code "N" means "Not Found" in DELETE and FINDOLD. This will require a change to any user program testing Q$= "H" or Q$= "L" following a DELETE or FINDOLD.

   c. All other Return Codes remain as before.

CHAPTER 12
KFAM ADVANCED PROGRAMMING TECHNIQUES

12.1 ELIMINATING THE PRINTER IN KFAM-3 AND KFAM-4

Certain utilities in KFAM use a printer (device 215). The printer is used only for marginal functions, and can be eliminated with some slight modifications if the particular System does not include a printer.

The printer is used in the following modules, for the following purposes:

INITIALIZE KFAM FILE: Hard copy printout of file description.

KEY FILE CREATION: Print duplicate keys and record locations.

CONVERT KFAM-1 TO KFAM-3, CONVERT KFAM-2 TO KFAM-3: Prints deleted keys and invalid keys and their respective record locations. Prints last key. Prints record counts.

KEY FILE RECOVERY: Prints duplicate keys and unreadable sectors.

PRINT KEY FILE: Print the contents of the Key File.

PRINT KEY FILE must be eliminated entirely if there is no printer, since its sole function is to print the contents of the Key File. This function is useful when programs are being tested, but is not necessary for the running of KFAM.

INITIALIZE KFAM FILE may be run as written, but when the system asks "DO YOU WANT A HARD COPY PRINTOUT OF FILE DESCRIPTION? (Y OR N)", the operator must always enter "N" for "no".

The other utilities must be modified, though the changes, as described below, are minor.

KEY FILE CREATION

The KEY FILE CREATION uses a printer to log duplicate keys, because duplicate keys are otherwise ignored in the construction of the Key File. Without some indication that a duplicate key was encountered, and some record of where it was encountered, the data identified by the duplicate key would be lost. Because duplicate keys are not allowed in KFAM, the recovery procedure is left to the user. This utility only assumes the responsibility to log them, if they occur.

The suggested modification to it is to display a message on the screen, and stop, if a duplicate key occurs. The operator then has the option of

keying CONTINUE (EXEC) to continue, once the duplicate key and its location is manually recorded. The program changes to module KFAM2003 (or KFAM2004 for KFAM-4) to accomplish this are as follows:

```
CLEARP  5396, 5400
6194  GOSUB'248(12,0,0)
6960 GOSUB'248(7,0,4)
CLEARP 7100, 7120
7100 STOP
7105 GOTO 5770
```

Key File Recovery

The printer is used to list duplicate keys and unreadable sectors. The prompt and operator entry for "TURN ON PRINTER" can be eliminated by deleting line 7010. To display on the CRT, and stop, following a duplicate key or unreadable sector, make the following changes to KFAM9003 (or KFAM9004 for KFAM-4):

```
8285 GOSUB' 248 (7,0,4)
8345 STOP
```

This displays the duplicate key in the center of the screen (lines 7-10) erasing the fixed information there. Following the STOP, the operator can key CONTINUE (EXEC) to resume processing.

The KFAM-3 Convert Utilities

The KFAM-3 "CONVERT" utilities use the printer to log deleted records, invalid keys, and the last key, and to print record counts. It is not really necessary to log deleted records, nor is it necessary to print record counts. Since this information fits on the screen, it can be displayed.

Invalid keys are keys which violate the KFAM-3 restrictions. (The first byte of the key may not be HEX(FF). The entire key may not be binary zero, or all bytes HEX(00).) If such keys exist under KFAM-1, their values should be changed before conversion to KFAM-3. Invalid keys should not occur, but if they do, some provision should be made to log their occurrence, becaus otherwise data could be lost. The suggested procedure to handle invalid key is the same as with duplicate keys in KEY FILE CREATION: an error message is displayed on the screen, and the program stops. The operator should record, manually, the key value (hex) and the record location. Then, optionally, the operator may continue by keying CONTINUE (EXEC).

The last key is necessary in order to run KEY FILE CREATION later. Therefore, the last key must be displayed on the screen and the operator must record its value before clearing the screen.

The suggested changes to the KFAM-3 "CONVERT" utilities to eliminate the printer are:

1. No display of deleted records.

2. Display invalid key and record location and stop so that the information can be written down. Optionally continue.

3. Display record counts on the screen.

4. Display the last key. The last key should be written down before the screen is cleared.

Program changes to CONVERT KFAM-1 TO KFAM-3 (KFAM5000) to accomplish the above are as follows:

```
CLEARP  7545, 7574
CLEARP 7765, 7775
7765 D=D+1: GOTO 7795
CLEARP 7815, 7825
7815 GOSUB'248(4,0,11)
CLEARP  7935, 7940
CLEARP  7955, 7970
7935  GOSUB'248(4,0,11)
8004  STOP
```

Program changes to CONVERT KFAM-2 TO KFAM-3 (KFAM5002) to accomplish the above are as follows:

```
CLEARP 5510, 5544
CLEARP 6030, 6040
6030 D=D+1:  GOTO 6060
CLEARP 6080, 6090
6080 GOSUB' 248 (4,0,11)
CLEARP 6200, 6205
CLEARP 6220, 6235
6200 GOSUB' 248 (4, 0, 11)
6314 STOP
```

The Model 2201 Output Writer

The Model 2201 Output Writer can perform any of the functions assigned to a line printer in KFAM. The "SELECT PRINT 215" statements need merely be changed to "SELECT PRINT 211". For the listed programs, these statements occur on the following lines.

PROGRAM	LOCATION
PRINT KEY FILE KFAM-3	240
PRINT KEY FILE KFAM-4	810
KEY FILE CREATION (KFAM-3 and KFAM-4)	6194, 6960
CONVERT KFAM-1 TO KFAM-3	7545
CONVERT KFAM-2 TO KFAM-3	5510
INITIALIZE KFAM FILE KFAM-3	2710
INITIALIZE KFAM FILE KFAM-4	2860
KEY FILE RECOVERY (KFAM-3 AND KFAM-4)	8285

12.2 FILES TOO LARGE FOR ONE PLATTER IN KFAM-3 AND KFAM-4

A cataloged disk file must be wholly contained on one disk. If the User File is too large for one disk, it must be broken into two separate files. (Both files may have the same name, since they are on different disks.)

eparate Key Files must be created, one for each User File. (If both Key les are on the same disk, they may not have the same name.)

Perhaps the simplest scheme for splitting the User File is to determine a "cutoff" point. A key value is picked, somewhere in the middle, which will be the highest key in User File #1. Records with lower keys are stored in User File #1, and records with higher keys are stored in User File #2.

If each User File and its companion Key File are stored on the same platter, both User Files may have the same name, as may both Key Files. In that case, the same routines can be used to access both files, simply by changing the platter designation. For example, suppose that the User Files "FILEF1" are open on the 'F' and 'R' platter, as are the Key Files "FILEK1". Assume that these files are parts of a single inventory file, and that the part number of the last record in UF #1 (on the 'F' platter) is "9006AS-B4". Under KFAM-3 the following routine could then be used to open both files, accept an input key, determine which file the record associated with this key is in, and read the record from the appropriate file for processing.

```
1       GOTO 4000
4000    SELECT #1 320     :REM  KF #1
4010    SELECT #2 B20     :REM  KF #2
4020    SELECT #3 320     :REM  UF #1
4030    SELECT #4 B20     :REM  UF #2
4040    REM OPEN BOTH FILES
4050    GOSUB'230(1,1,3,1,"FILEF1")
4060    GOSUB'230(2,2,4,1,"FILEF1")
4070    REM NOW PROCESS
4080    INPUT "PART NUMBER", P$
4090    X=2:  REM ASSUME PART # BELONGS IN FILE #2
4100    IF P$<> "9006AS-B4" THEN 4130
4110    X=1:  REM IF PART # SMALLER THAN 9006AS-B4 IT GOES
           IN FILE #1
4120    REM FINDOLD
4130    GOSUB'232(X,0,P$):  REM SEARCH FOR KEY IN APPROPRIATE KF
4140    IF Q$<> " " THEN 6020
4150    REM GET DATA RECORD
4160    X=X+2:  REM COMPUTE UF FILE NO. BY ADDING 2 TO KFAM ID
           NUMBER
4170    DATALOAD DC#X, Data Record


4180
  .
  .     Process Data
  .
  .
5990

6000    GOTO 4080:  REM LOOP BACK TO INPUT NEXT PART NO.

6010    REM ERROR PROCEDURE
6020    PRINT "PART # NOT ON FILE"
6030    GOTO 4080
```

Notes:

1) Line numbers less than 4000 should not be used in the program (since KFAM subroutines end at line 3075), with the exception of Line 1 (GOTO 4000), which makes it possible to execute the program simply by keying RUN, EXEC.

2) Line 4130: Alpha variables can be used as valid parameters for alphanumeric arguments, and numeric expressions can be used as numeric arguments.

3) Line 4170: A numeric variable is valid as a file number in the DATALOAD DC (or DATASAVE DC) statement. A variable cannot be used for the file number in a SELECT statement, however.

4) For KFAM-4, the SELECT subroutines DEFFN' 210 and DEFFN' 211 must be included in the program, and the GOSUB' arguments must be changed to conform to KFAM-4 specifications.

12.3 REUSING DELETED SPACE WITH FINDNEW(HERE)

Immediately following a DELETE, FINDNEW(HERE) may be used to insert a new record in the space just vacated by the deleted record. This function is useful for changing a key, but is not generally useful to reuse the deleted space because a new record is not generally available immediately following a DELETE.

The user may, however, store the pointer to the deleted record in a separate file for later use. The procedures, for KFAM-3 and KFAM-4, are given below.

KFAM-3 Procedure

1. DELETE a record.

2. Test T8$. If T8$="1", then T4$ contains a valid pointer to a deleted record, and may be saved.

3. If T8$="1", save the contents of T4$ in some file or list external to KFAM. (T4$ is a 3-byte pointer containing the relative sector address (2 bytes, hex) and record number (1 byte, hex) of the deleted record.)

To reuse the space at some later time:

1. Set T8$ = "1".

2. Move the saved record pcinter to T4$.

3. Use FINDNEW(HERE) with the new record key.

4. FINDNEW(HERE) will return with the Current Sector address of the correct sector and Q = the record number within the sector.

Notes:

1. T8$ is an internal return code. T8$ = "1" indicates that the last operation was a DELETE, which was successfully executed. FINDNEW(HERE) will not be executed unless T8$ = "1".

2. T4$ always points to the record being accessed, following normal execution of any subroutine except OPEN and CLOSE. T4$ is the source field from which the disk read/write head is positioned and Q is extracted. The first two bytes of T4$ can be used as an absolute sector address by adding the starting sector (hex) of the User File.

3. T8$ and T4$ are both contained in the KDR. When more than one file is open concurrently, the KDR residing in memory is the KDR of the last file accessed and not necessarily the next file to be accessed. Therefore, when more than one file is open, care should be taken in modifying variables in the KDR. The current KDR in memory may belong to another file.

   The I.D. Number of the currently active file is in T9. If there is any question, T9 can be tested. To ensure that the proper KDR is in memory, the following statements should be executed:

```
T6 = (I.D. Number)
GOSUB 920
IF Q$ = "X" THEN (file not open)
```

The subroutine at line 920 checks T6 = T9. If they are not the same, it writes the current KDR and reads the KDR belonging to file T6, and then sets T9 = T6. If they are the same, it does nothing.

Once the proper KDR is in memory, then the values of T8$ and T4$ can be modified for the correct file.

KFAM-4 Procedure

Unlike KFAM-3, KFAM-4 does not check that FINDNEW(HERE) follows DELETE.

Under KFAM-4, the pointer to a deleted record may be saved as follows:

1. DELETE a record.
2. Test to make sure that Q$ = blank.
3. Save the contents of T4$ in some file or list external to KFAM. (See Section 11.1, "Internal Storage KFAM-4" for definition of T4$.)

To re-use the space at some later time:

1. Move the saved record pointer to T4$. (See Note 1 below.)
2. Use FINDNEW(HERE) with the new record key.
3. FINDNEW(HERE) will return with the Current Sector address set to read the correct sector and Q = the record number within the sector.

NOTE:

If the file to be accessed is not the same as the file last accessed by a KFAM subroutine, move the saved record pointer to T4$ (i), where i = this file's KFAM I.D. Number. If not sure which file was last accessed, test T9 = KFAM I.D. Number last accessed.

12.4 MULTIPLE KEY FILES PER USER FILE

KFAM does not support multiple Key Files for a single User File. Though the Key File number provides a means of identifying different Key Files for a single User File, the subroutines and utility programs are designed for operations in which there is only one Key File per User File. The Programming Department of Wang Laboratories, Inc. does not support KFAM based file access systems that attempt to maintain multiple Key Files for a single User File.

12.5 STATUS OF THE KEY DESCRIPTOR RECORD (KDR) IN KFAM-3

The Key Descriptor Record (KDR) contains vital information pertaining to a KFAM file. The contents of the KFAM-3 KDR have been described in Section 11.1, but the dynamics of the KDR, namely when it is read, when it is written, and when certain fields are updated, may be of interest to the applications programmer.

The contents of the KFAM-3 KDR can be split into the following categories:

a. Fields which are set up in INITIALIZE KFAM FILE and remain unchanged:

Q3$	Ending (relative) sector address, upper bound, User File (may be changed with REALLOCATE KFAM FILE SPACE).
V8$	Records per block, user file.
V1$	File type, Record Length, Starting position on key, Key length, Number of entries in KIR.
V3$	Ending (relative) sector address, upper bound, Key File (may be changed with REALLOCATE KFAM FILE SPACE).
V6$	Sectors per logical record or block.

b. Fields which are set up by the OPEN subroutine and remain set until the file is opened again:

V0$	Starting (absolute) sector address, Key File. This field is set at OPEN time to allow for moving the Key File to a different location on disk.
T1	Current Key File #.
T2	Current User File #.

c. Fields which are initialized in INITIALIZE KFAM FILE and changed (or subject to change) whenever a record is added to the file:

Q2$	Last (relative) sector address assigned, User File.
V5$	Record number within sector, last record of User File.

When a record is added via the FINDNEW subroutine, V5$ is incremented by 1. If V5$ exceeds V8$ (records per block), Q2$ is incremented by V6$ (sectors per block) and V5$ is set to 1. When a record is added via the FINDNEW(HERE) subroutine, Q2$ and V5$ are not changed.

V2$	Last (relative) sector address assigned, Key File. This will be updated only when the KIR is split, requiring a new sector (or sectors) for the Key File.
T2$	Relative sector address of highest level index, Key File.
TO	Number of index levels in Key File.

T2$ and TO are only updated when a new level is added to the key index.

V8	Bias percentage for KIR split.
T5$	Last key added to the file.

V8 and T5$ are updated every time a record is added to file.

d. Fields which are changed every time a record is accessed:

T4$	Pointer to record found in User File. Corresponds to positioning of disk read/write head and Q value.
T7$	Last key accessed. In the case of "key not found", this is the key value specified by the user. In the case of FINDFIRST, FINDLAST, or FINDNEXT, it is the key found in the Key File.
T2$()	Path to locate key, in terms of sector addresses of KIR's searched.

T() Path to locate key, in terms of KIE within KIR per level searched.

T2$() and T() are not defined following FINDNEW, FINDNEW(HERE), or DELETE.

T8$ Internal completion code.

The KFAM-3 KDR is resident in memory once the file is opened. It remains resident in memory, as long as the file is "current", and is written back onto disk when the file ceases to be "current".

The distinction between "open" and "current" is necessary because more than one file may be open concurrently. The "current" file is defined as the last file accessed by a KFAM-3 subroutine. Following a CLOSE of any file, no file is "current".

Regardless of how many files are open, there is only one space in memory for the KDR, that space being defined by the variables Q2$, Q3$, ..., T8$, that define the KDR. The KDR of the current file occupies these variables. When another file is specified by the user, the KDR for the current file is written onto the disk, the KDR for the new file is read into memory, and the new file becomes "current".

Therefore care should be taken, in the multi-file situation, in modifying any of the variables in the KDR. The KDR residing in memory may elong to another file. If there is any doubt, the following instructions ill invoke the subroutine which checks which file is current and switches KDR's if necessary.

```
T6 = (I.D. number of file to be accessed)
GOSUB 920
IF Q$ = "X" THEN (file not open)
```

In addition to being written every time the file ceases to be current, the KDR is also written every time a record is added to the file, either by FINDNEW or FINDNEW(HERE). In other words, the KDR is written every time that critical information is updated. This is a safety factor, so that the file will not be destroyed in the event of system failure. (However, this is not an absolute guarantee that the file cannot be destroyed. A system failure during the critical rewrite operations of FINDNEW, FINDNEW(HERE), or DELETE can cause the key index itself to become invalid. Also a hardware malfunction can make the disk unreadable. It is a good practice to make a back-up copy of the disk at regular intervals.)

The fields of the KDR which are changed with every record accessed are not critical, and therefore the KDR is not rewritten every time a record is accessed. When the contents of the KDR is printed, these fields may or may not reflect the latest status of the KDR. (In the event of system failure, they will not generally reflect the latest status of the KDR.) They are printed only because they are there, and they may or may not be meaningful.

The PRINT KEY FILE program prints the latest version of the KDR written on disk, which means the status of the KDR either the last time a record was added or the last time the file ceased to be current.

There are legitimate reasons why a user may wish to change information in the KDR. One problem which is likely to occur is that the starting position of the key or the record length is wrong, causing the Reorganization

program to fail. These fields, which are critical in reorganizing, cannot really be checked prior to reorganizing. And at the point of reorganizing, it is not generally feasible to recreate the Key File from the beginning. If such problems, or similar problems, occur, the contents of the KDR can be changed by the user, via a very simple procedure:

SELECT (Key File#, User File#)
OPEN the file
Modify the appropriate variable in the KDR
CLOSE the file

This will read in the KDR, change it, and write it back on the disk.

12.6 STATUS OF THE KEY DESCRIPTOR RECORD (KDR) KFAM-4

In KFAM-4, the KDR is not so easy to modify, via user program, as in KFAM-3, nor is it necessary or recommended to modify the KDR.

The fields which are of most interest to the user, T4$ (current pointer) and T7$ (current key), are stored internally. (See the Section 11.1 on "File Layouts" and "Internal Storage.")

In KFAM-4, the KDR serves as the communications link between multiple CPU's accessing the file. In shared mode ("A"), it is read at the start of each KFAM subroutine, updated, and rewritten at the end. In exclusive mode ("X"), it is read and written the same as in KFAM-3, except that it is written in the OPEN subroutine to indicate to other CPU's that the file is held exclusively.

There are legitimate reasons why a user may wish to change information in the KDR. One problem which is likely to occur is that the starting position of the key or the record length is wrong, causing the Reorganization program to fail. These fields, which are critical in re-organizing, cannot really be checked prior to re-organizing. At the point of re-organizing, it is not generally feasible to re-create the Key File from the beginning. If such problems, or similar problems, occur, the contents of the KDR can be changed by the user, via a very simple procedure:

```
SELECT (User File #)
OPEN the file, exclusive mode
Modify the appropriate KDR variable
CLOSE the file
(DEFFN'210, 211 to SELECT Key File #)
```

This will read in the KDR, change it, and write it back on the disk.

12.7 FILE NAMES FOR THE KFAM UTILITIES

File names for the KFAM-3 and KFAM-4 Utilities are as follows:

UTILITY		KFAM-3	KFAM-4
INITIALIZE KFAM FILE	-	KFAM1003	KFAM1004
KEY FILE CREATION	-	KFAM2003	KFAM2004
REORGANIZE KFAM FILE			
DIALOG	-	KFAM3003	KFAM3004
GENERATE CODE	-	KFAM3103	KFAM3104
MAIN PROGRAM	-	KFAM3203	KFAM3204
REALLOCATE KFAM FILE SPACE	-	KFAM4003	KFAM4004
DISK COPY/REORGANIZE	-	KFAM4103	KFAM4104
CONVERT KFAM-1 TO KFAM-3	-	KFAM5000	-
CONVERT KFAM-2 TO KFAM-3	-	KFAM5002	-
PRINT KEY FILE	-	KFAM6003	KFAM6004
BUILD SUBROUTINE MODULE	-	KFAM8003	KFAM8004
REORGANIZE SUB-SYSTEM			
MODULE 1		KFAM3503	KFAM3504
MODULE 2		KFAM3603	KFAM3604
MODULE 3		KFAM3703	KFAM3704
KEY FILE RECOVERY		KFAM4003	KFAM9004
RESET ACCESS TABLE		-	KFAM7004
CONVERT KFAM-3 TO KFAM-4		-	KFAM5004

APPENDIX A: COPYING THE SYSTEM FILES FROM CASSETTE TO DISK

If you receive this software package on tape cassette, you must copy it to disk before you can use it.

Each KFAM system requires two cassettes which are numbered one and two. A special loader program is recorded at the beginning of cassette one. This loader program must be used to copy the cassettes to disk. In addition, should you receive updates to the software package, these updates will contain the same loader program. The loader program has been specially designed to make cassette to disk copying and updating an easy automatic operation.

For initial copying, scratch disks should be mounted at both disk locations of a dual disk drive. For updating, a disk containing the files of the software system to be updated must be mounted at the removable disk location, and a scratch disk must be mounted at the fixed disk location. The disk at the removable location should contain only files that are part of the Wang software system being updated.

Operating Instructions

	DISPLAY		INSTRUCTIONS
1.		1.	If updating a file, make backup copies of the disk to be update Mount cassette number one at address 10A. Key: CLEAR (EXEC) LOAD (EXEC) RUN (EXEC)
2.	ENTER THE DESIRED DISK ADDRESSES. ? -/ 0 - 310/B10 1 - 320/B20 2 - 330/B30	2.	Enter 0, 1 or 2 to select the disk drive at which the files are to be copied (or updated).
3.	MOUNT DISK TO BE UPDATED IN REMOVABLE DRIVE. KEY RETURN (EXEC) TO RESUME?	3.	For initial creation, mount scratch disks in both disk locations at the selected drive. For updating, mount the disk to be updated at the R drive and mount a scratch disk at the F drive.

4.	DO YOU HAVE A BACK-UP COPY? (YES/NO)	4.	Enter Yes if you have already made a backup copy of the disk to be updated. Otherwise enter NO.
5.	(processing displays)	5.	The processing displays show the operation currently being performed.
6.	MOUNT THE NEXT TAPE - UNIT 10A	6.	If this message appears, mount and key (EXEC).
7.	END PROGRAM	7.	The copying or updating is complete. Both mounted disks contain complete copies of the updated (copied) files.

APPENDIX B: LOADING THE MENU MODULE

The KFAM-3 and KFAM-4 systems each have a menu module that displays all of the available utilities and provides Special Function Key access to them. This menu module is accessed in the following way:

For KFAM-3

Key:

```
          CLEAR                    (EXEC)
          SELECT DISK XYY          (EXEC)
          LOAD DC T "START050"     (EXEC)
          RUN                      (EXEC)
```

where: XYY is the disk address at which the KFAM-3 system disk is mounted.

For KFAM-4

Key:

```
          CLEAR                    (EXEC)
          SELECT DISK XYY          (EXEC)
          LOAD DC T "START065"     (EXEC)
          RUN                      (EXEC)
```

where: XYY is the disk address at which the KFAM-4 system disk is mounted.

To help us to provide you with the best manuals possible, please make your comments and suggestions concerning this publication on the form below. Then detach, fold, tape closed and mail to us. All comments and suggestions become the property of Wang Laboratories, Inc. For a reply, be sure to include your name and address. Your cooperation is appreciated.

700-4070

TITLE OF MANUAL: **KFAM 3/KFAM 4 USER MANUAL**

COMMENTS:

Fold

Fold

(Please tape. Postal regulations prohibit the use of staples.)

WANG

Fold

FIRST CLASS
PERMIT NO. 16
Tewksbury, Mass.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

– POSTAGE WILL BE PAID BY –

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE
LOWELL, MASSACHUSETTS 01851

Attention: Marketing Department

Fold

Cut along dotted line.

Printed in U.S.A.

WANG LABORATORIES (CANADA) LTD.
49 Valleybrook Drive
Don Mills, Ontario M3B 2S6
TELEPHONE (416) 449-2175
Telex: 069-66546

WANG EUROPE S.A./N.V.
250, Avenue Louise
1050 Brussels, Belgium
TELEPHONE 02/6400617
Telex: 61186

WANG DO BRASIL COMPUTADORES LTDA.
Rua Barao de Lucena No. 32
Botafogo ZC-01 20,000
Rio de Janeiro RJ, Brasil
TELEPHONE 226-4326, 266-5364
Telex: 2123296 WANG BR

WANG COMPUTERS (SO. AFRICA) PTY. LTD.
Corner of Allen Rd. & Garden St.
Bordeaux, Transvaal
Republic of South Africa
TELEPHONE (011) 48-6123
Telex: 960-86297

WANG INTERNATIONAL TRADE, INC.
836 North Street
Tewksbury, Massachusetts 01876
TELEPHONE (617) 851-4111
TWX 710-343-6769
Telex: 94-7421

WANG SKANDINAVISKA AB
Pyramidvaegen 9A
S-171 36 Solna, Sweden
TELEPHONE 08/27 27 95
Telex: 11498

WANG COMPUTER LTD.
Shindaiso Building No. 5
2-10-7 Dogenzaka Shibuya-Ku
Tokyo, Japan
TELEPHONE (03) 464-0644

WANG NEDERLAND B.V.
Damstraat 2
Utrecht, Netherlands
(030) 93-09-47
Telex: 47579

WANG PACIFIC LTD.
902-3 Wong House
26-30, Des Voeux Road, West
Hong Kong
TELEPHONE 5-435229
Telex: 74879 WANG HX

WANG INDUSTRIAL CO., LTD.
110-118 Kuang-Fu N. Road
Taipei, China
TELEPHONE 7522068, 7814181-3
Telex: 21713

WANG GESELLSCHAFT M.B.H.
Merlingengasse 7
A-1120 Vienna, Austria
TELEPHONE 85.13.54, 85.13.55
Telex: 74640 Wang a

WANG S.A./A.G.
Markusstrasse 20
CH-8042 Zurich 6, Switzerland
TELEPHONE 41-1-60 50 20
Telex: 59151

WANG COMPUTER PTY. LTD.
55 Herbert Street
St. Leonards, 2065 , Australia
TELEPHONE 439-3511
Telex: 25469

WANG ELECTRONICS LTD.
Argyle House
Joel Street
Northwood Hills
Middlesex, HA6INS
TELEPHONE Northwood 28211
Telex: 923498

WANG FRANCE S.A.R.L.
Tour Gallieni, 1
78/80 Ave. Gallieni
93170 Bagnolet, France
TELEPHONE 33.1.3602211
Telex: 680958F

WANG LABORATORIES GmbH
Moselstrasse 4
6000 Frankfurt AM Main
West Germany
TELEPHONE (0611) 252061
Telex: 04-16246

WANG DE PANAMA (CPEC) S.A.
Apartado 6425
Calle 45E, No. 9N. Bella Vista
Panama 5, Panama
TELEPHONE 69-0855, 69-0857
Telex: 3282243

WANG COMPUTER LTD.
302 Great North Road
Grey Lynn, Auckland
New Zealand
TELEPHONE Auckland 762-219
Telex: CAPENG 2826

WANG COMPUTER PTE., LTD.
Suite 1801-1808, 18th Floor
Tunas Building, 114 Anson Road
Singapore 2, Republic of Singapore
TELEPHONE 2218044, 45, 46
Telex: RS 24160 WANGSIN

WANG COMPUTER SERVICES
836 North Street
Tewksbury, Massachusetts 01876
TELEPHONE (617) 851-4111
TWX 710-343-6769
Telex: 94-7421

DATA CENTER DIVISION
20 South Avenue
Burlington, Massachusetts 01803
TELEPHONE (617) 272-8550

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE, LOWELL, MASSACHUSETTS 01851, TEL. (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

Printed in U.S.A.
700-4070
11-76-2C
Price: see current list