File and Volume Management

Bull DPS 7000

UFAS-EXTENDED User’s Guide

47 A2 04UF Rev05

File and Volume Management

Bull DPS 7000

UFAS-EXTENDED User's Guide

Subject: This manual describes the UFAS-EXTENDED product and shows how to use it under the GCOS 7 operating system, Release V7.

Special Instructions:

Software Supported: GCOS 7 – Release V7.

Software/Hardware required: Software required text

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Preface

Scope and Objectives

This manual describes UFAS-EXTENDED (Unified File Access System for Large Systems) and shows how to use it under GCOS7 on DPS7000 machines, with the latest disk subsystems.

Intended Readers

The intended readers of this manual are primarily COBOL programmers, but it may equally be used by programmers working in other languages.

To set up files under GCOS7, a knowledge of GCL (GCOS7 Command Language) is essential. This information can be obtained from the *IOF Terminal User's Reference Manual.*

Prerequisites

GCL/JCL

To use UFAS-EXTENDED files, you can enter either GCL commands or JCL statements. Throughout the text, each time a GCL command is given, its functional equivalent in JCL appears between parentheses. A Correspondence Table is provided in Appendix D.

Structure

There are eight sections in the manual. Each section begins with a summary. You should begin by reading the first section which introduces UFAS-EXTENDED and shows its context within the GCOS7 system. In Section 1, basic concepts are explained. These concepts are essential reading for anyone who wishes to acquire background information about UFAS-EXTENDED.

The next three sections describe the three UFAS-EXTENDED file organizations: sequential, relative and indexed sequential. The type of file organization to be used within a system is generally an application designer's decision. This decision is then translated into the necessary programming language to suit the file organization. Most likely, you will not need to read all three sections.

The fifth section shows how to assign and reference UFAS-EXTENDED files with GCL or JCL.

The sixth section concentrates on file design and shows you how to allocate a UFAS-EXTENDED file. Parameters to be specified may vary depending on the particular disk device you use.

The seventh section describes the use of tape files.

The eighth section gives an overview of the utilities for manipulating and maintaining files.

Use the index to locate a particular topic.

Bibliography

The most important manuals referred to in the text are:

COBOL 85 Reference Manual	47 A2 05UL
COBOL 85 User's Guide	47 A2 06UL
Data Management Utilities User's Guide	47 A2 26UF
GPL System Primitives	47 A2 34UL
UFAS Booster User's Guide	47 A2 33UF
IOF Terminal User's Reference Manual (Part 1)	47 A2 38UJ
IOF Terminal User's Reference Manual (Part 2)	47 A2 39UJ
IOF Terminal User's Reference Manual (Part 3)	47 A2 40UJ
File Migration Tool User's Guide	47 A2 32UF
File Recovery Facilities User's Guide	47 A2 37UF
JCL Reference Manual	47 A2 11UJ
JCL User's Guide	47 A2 12UJ

Other manuals referred to in the text are:

Catalog Management User's Guide	47 A2 35UF
GAC-EXTENDED User's Guide	47 A2 12UF
System Administrator's Manual	47 A2 41US
Full IDS/II Reference Manual 1	47 A2 05UD
Full IDS/II Reference Manual 2	47 A2 06UD
Full IDS/II User's Guide	47 A2 07UD
Messages and Return Codes Directory	47 A2 10UJ
SORT/MERGE Utilities User Guide	47 A2 08UF
TDS Administrator's Guide	47 A2 32UT
TDS COBOL Programmer's Guide	47 A2 33UT

Syntax Notation

The following conventions are used for presenting GCL command syntax.

ITEM	An item in upper case is a literal value, to be specified as shown. The upper case is merely a convention; in practice you can specify the item in upper or lower case.
item	An item in lower case is a non-literal. A user-supplied value is expected.

In most cases it gives the type and maximum length of the value:

`char12`	a string of up to 12 characters
`name31`	a name of up to 31 characters
`dec10`	a decimal integer value of up to 10 digits
`file78`	a file description of up to 78 characters
`volume18`	a volume description of up to 18 characters

<u>ITEM</u>	An underlined item is a default value. It is the value assumed if none is specified.
bool	A boolean value which is either 1 or 0. A boolean parameter can be specified by its keyword alone, optionally prefixed by "N". Specifying the keyword alone always sets the value to 1. Prefixing the keyword with "N" always sets it to 0.
{ }	Braces indicate a choice of items. Only one of these items can be selected. When presented horizontally, the items are separated by a vertical bar as follows: { item | item | item }
[ ]	Square brackets indicate that the enclosed item is optional. An item not enclosed in square brackets is mandatory.

( )	Parentheses indicate that a single value or a list of values can be specified. A list of values must be enclosed by parentheses, with each value separated by a comma or a space.
...	Ellipses indicate that the item concerned can be specified more than once.
+ = $ * / - .	Literal characters to be specified as shown.
- - - -	All parameters or commands below a dashed line do not appear in the help menus.

Example 1:

```
[ VOLUME = { * | () | (vol18 ...) } ]
```

This means you can specify:

- Nothing at all (VOLUME=* applies)
- VOLUME=* (the same as nothing at all)
- VOLUME=FSD001:MS/D500 for a single volume
- VOLUME=(FSD001:MS/D500,FSD002:MS/D500) for a list of volumes
- VOLUME=() for no volumes

Example 2:

```
[ ACCNTSPACE = { [+]dec5 | -dec5 } ]
```

This means you can specify:

- Nothing at all
- ACCNTSPACE=10 to increase the value by 10
- ACCNTSPACE=+10 to increase the value by 10
- ACCNTSPACE=-10 to decrease the value by 10

Example 3:

```
[ AUTOADD ={ bool | 1 } ]
```

This is a boolean parameter whose default value is one. You can specify:

- Nothing at all (AUTOADD=1 applies)
- AUTOADD=1 or simply AUTOADD
- AUTOADD=0 or simply NAUTOADD

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1. Introduction to UFAS-EXTENDED

1.1 Summary

This section covers the following topics:

- overview of UFAS-EXTENDED,
- features of UFAS-EXTENDED,
- essential concepts,
  - logical records (fixed-length and variable-length),
  - control interval (CI),
  - control intervals and address spaces,
  - layout of CIs within a file,
  - FBO disk volumes,
  - VBO disk volumes,
    disk track
    disk cylinder
  - disk address,
  - disk extent,
  - logical/physical layout,

1.2 Overview of UFAS-EXTENDED

UFAS-EXTENDED is the standard file structure for DPS 7000 systems. It is the file structure that is used for applications running under GCOS 7 since release V5.

UFAS-EXTENDED is the interface between logical data management and physical devices. It is a set of routines providing facilities for:

- creating,
- reading,
- and updating disk and tape/cartridge files known as "UFAS-EXTENDED files".

Regardless of the physical characteristics of the file media, UFAS-EXTENDED performs the following functions:

- buffer handling,
- data blocking,
- error checking,
- record locating,
- label processing.

All CIs (described later in this Section) of a UFAS-EXTENDED file are the same size.

Fewer I/O operations are performed because of the large number of buffers supported:

- up to 20,000 buffers per TDS application (18,500 for PREVIOUS files),
- up to 32,000 buffers can be shared at system level, that is, among several applications, including batch applications.

A large number of files can be simultaneously opened:

- approximately 1000 files can be shared among several TDS applications, if level of share = 5, or 3200 files if level of share = 2 (with the MI EFM2).
- approximately 500 files can be simultaneously opened for one TDS application.

1.3 UFAS-EXTENDED Features

The major UFAS-EXTENDED features are as follows:

1. UFAS-EXTENDED supports the following file organizations:

   sequential,
   relative,
   indexed sequential,
   IDS/II (Integrated Data Store).

NOTE:
File organization is the technique of arranging a collection of records in the most effective way for processing.

An IDS/II file is a database file containing several record types and logical relationships between them. Physically the file consists of a number of areas. Since IDS/II is beyond the scope of this manual, please see the relevant IDS/II Reference Manual for more information, .

2. Each file organization can be used in the various GCOS 7 environments:

   Batch,
   Transactional (TDS),
   Interactive (IOF).

3. UFAS-EXTENDED supports the access modes and verbs defined by the American National Standards Institute (ANSI) for the COBOL Language (COBOL-85).

4. Other Features are:

   multivolume files (a file spread over several volumes) and multifile volumes (more than one file per volume) on both disk and tape/cartridge,

   standard-label processing on disk, tape, and tape cartridge,

   full standard error-handling as defined for COBOL-85,

   file integrity through checkpoint/restart and journalization facilities,

   concurrent file-access from more than one program,

   static and dynamic file extension for sequential and indexed sequential files.

1.4 Essential Concepts

The following pages treat concepts which are essential in understanding and using UFAS-EXTENDED files. These concepts are as follows:

- logical records,
- control intervals (CIs),
- control intervals and files,
- physical disk characteristics.

The three first concepts only deal with the disk files. The FBO volumes are defined by the following concepts:

Data Blocks	is the smallest addressable unit for an I/O in a FBO volume. The size is 512 bytes on a FSA disk and 4096 bytes on a non-FSA disk formatted as a FBO volume.
File Blocks	is the smallest unit that the access method can handle. The file block corresponds to the CI of the UFAS files. A file block can consist of one or more data blocks.

Note that files held on tape/cartridge are dealt with separately in Section 7.

1.4.1 Logical Records

Data is transferred between UFAS-EXTENDED and user programs by means of logical records. These logical records are defined in the program and allow portions of data to be manipulated. A file is a named collection of these records.

In COBOL, for example, the I-O processing done by verbs such as READ, WRITE, and REWRITE causes records to be moved to and from a record-description area.

In FORTRAN, the record description is the list of variables associated with the I/O statement.

Records can be of fixed or variable length. This is discussed below.

Figure 1-1 shows how the logical record is the unit of transfer between a program and UFAS-EXTENDED.

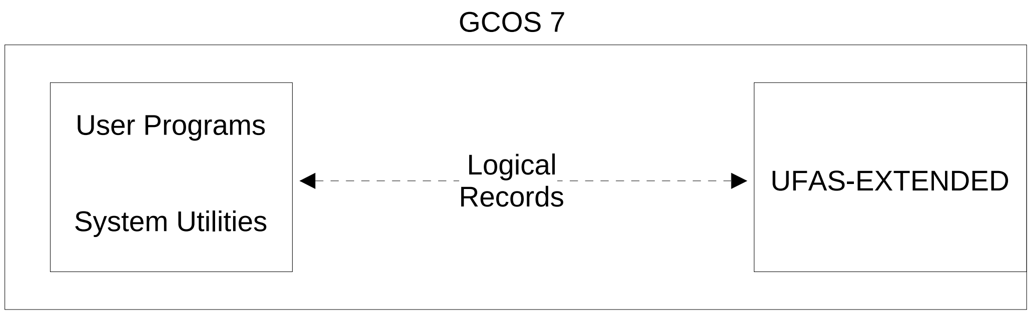

Figure 1-1. Logical Record as Unit of Transfer

Fixed-Length and Variable-Length Records

Records can be fixed length or variable length. (Fixed length or variable length is declared as one of the file attributes at file creation time.)

An example of the use of fixed-length records might be in a payroll application, where there is one record for each employee. The record could have the form:

EMPLOYEE NAME	HOME ADDRESS	SOCIAL SECURITY N°.	EMPLOYEE NUMBER	INCOME TAXE CODE

Each employee record contains the same amount of information, therefore each record is of the same length.

An example of the use of variable-length records might be a sales file in which there is one record per customer per year. Each customer could theoretically place an order each week. However, in practice the total number of orders in a year never exceeds twenty. The design of the record might be:

CUSTOMER NUMBER	SALES AREA	YEAR	ORDER N°.1	ORDER N°.2		ORDER N°.20

Suppose the average number of orders placed by each customer is 5. It would be wasteful for each record to contain space for 20 entries (since only 25% of the space would be used). It is more efficient to use variable-length records, so that each record will occupy only the necessary amount of space (plus a small amount of control information, managed by UFAS-EXTENDED).

Under UFAS-EXTENDED, all file organizations support variable-length records.

Note that when variable-length records are used, the maximum record length for the file is declared at file-allocation time.

1.4.2 Control Intervals (CIs)

One of the most important concepts in UFAS-EXTENDED is the Control Interval (CI). A CI is the unit of transfer to and from disk. Each CI contains one or more records, (a minimum of 2 records for indexed sequential files), according to the size declared by the user. UFAS-EXTENDED CIs correspond to IDS/II pages. The main characteristics of CIs are:

- All CIs are the same size (data CIs, index CIs or label CIs),
- Records cannot be split across CIs; a CI contains an integral number of records, up to a maximum of 255,
- The maximum record length cannot exceed the declared CI size,
- The maximum size of a CI is 32,256 bytes (32K - 512),
- The declared CI size for Fixed Block Organization (FBO) disk subsystems corresponds to an integral number of blocks (described later in this Section). In the case of Variable Block Organization (VBO) disk subsystems, the CI size cannot be larger than one track and CIs do not overflow tracks.
- The size of a CI is always a multiple of 512 bytes; you can specify any size for a CI (up to 5 digits long), but UFAS-EXTENDED always rounds the figure up to a multiple of 512. Table 6-1 gives you the recommended filling capacity of a CI for each type of disk drive.
- The maximum number of CIs in a file is limited to 16,777,215 (2**24 - 1)

Further information about CIs is contained in the sections specific to each type of file organization.

Figure 1-2 shows how the CI is the unit of transfer between UFAS-EXTENDED and the storage media.

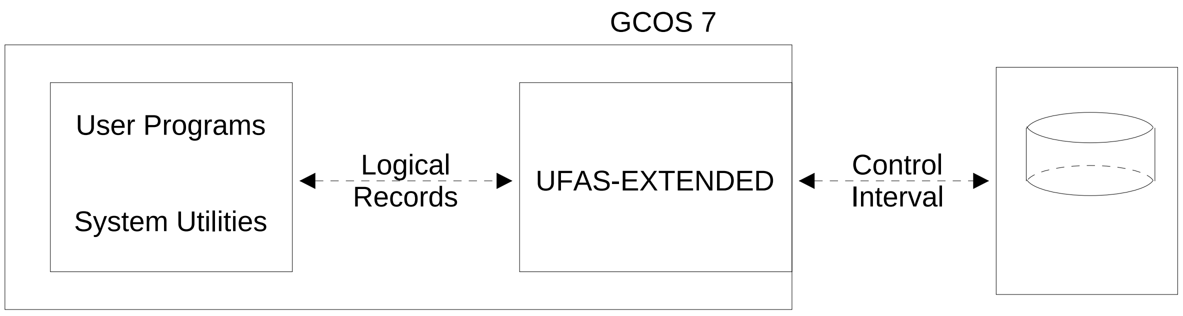

Figure 1-2. Control Interval as Unit of Transfer

1.4.3 Control Intervals and Address Spaces

Read on if you wish to learn more about CIs and the physical characteristics of disk volumes. The relationship between the logical layout of the file and the physical layout of the file is discussed. Note that the discussion applies only to disk files; tape files are discussed in Section 7.

Layout of CIs Within a File

A file is a structured amount of space, consisting of several address spaces used to group data of the same category. The layout of CIs within a file depends upon the file organization. Figure 1-3 shows the logical layout of CIs for sequential and relative files.

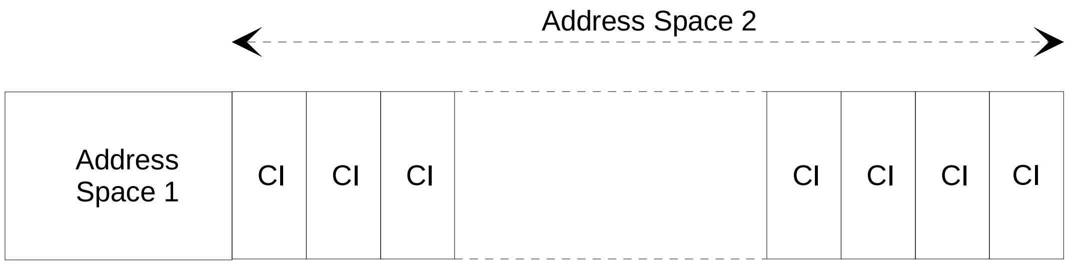

Figure 1-3. CI Layout in Sequential and Relative Files

- Address space 1 contains control information such as the description of the other address spaces and any user labels. This control information is used and managed by UFAS-EXTENDED, and is always located at the beginning of the first track used by the file. The address space 1 always occupies one track on a VBO disk. For FBO volumes, address space 1 occupies a minimum of 16 Kbytes.
- Address space 2 contains the data CIs.

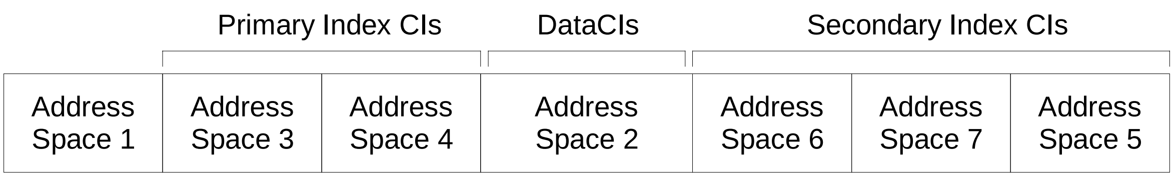

Figure 1-4. CI Layout in an Indexed Sequential File

- Address space 1 contains control information such as the description of the other address spaces and any user labels. This control information is used and maintained by UFAS-EXTENDED. Address space 1 always occupies one disk track (VBO), or the first sixteen Kbytes of the file (FBO volumes).
- Address space 2 contains the data CIs,
- Address spaces 3 and 4 contain the primary index CIs, and address spaces 5, 6 and 7 contain the secondary index CIs.

  The terms primary index and secondary index are defined later in Section 4.

To see how the logical layout described above is mapped onto disks, it is first necessary to describe briefly the physical characteristics of disks.

1.4.4 Different Types of Disk Volumes

A disk volume is a fixed number of plates mounted one above the other on a common spindle.

Each plate has two recording surfaces, top and bottom (except the upper surface of the top disk and the lower surface of the bottom disk, which are protective covers and are not used for data storage).

The physical disk volume is different from the logical volume. The logical volume determines the place reservation of the file. There are two types of logical volume:

- FBO (Fixed Block Organization), used since the GCOS 7-V5 release.
- VBO (Variable Block Organization), as used in earlier releases.

There are two different physical architectures:

- The FSA (Fixed Sector Architecture) disks with FBO organization (MS/FSA device class).
- The non-FSA or CKD disks (device class: MS/500 or MS/B10),which can be formatted by the VOLPREP into VBO or FBO volumes.

1.4.4.1 FBO Disk Volumes

FBO disk volumes are either FSA (MS/FSA) disks or non-FSA disks formatted as FBO format (MS/B10 or MS/D55). These volumes are organized in fixed length data blocks.

The size of a data block is 512 bytes on the FSA disks and 4096 bytes on the non-FSA, FBO formatted. The size of the CIs (file blocks) is a multiple of 512.

CIs are physically mapped onto the data blocks so that volume space is not wasted. A CI always occupies an integral number of data blocks.

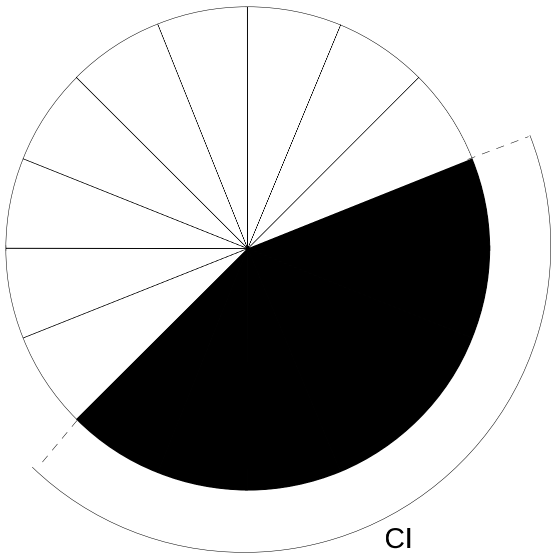

Figure 1-5. Mapping a CI to a Data Block

In Figure 1-5, a particular CI is mapped onto 7 data blocks, that is 3584 (512 x 7) bytes.

1.4.4.2 VBO Disk Volumes

The VBO disk volumes are organized in tracks and cylinders. They are located on the non-FSA disks using the VBO format (MS/B10 or MS/D500).

Disk Track

Each recording surface is divided into a number of concentric bands, known as tracks, on which data is recorded. A track is the area covered by one read/write head during one revolution of the disk. Figure 1-6 illustrates a single track on a recording surface.

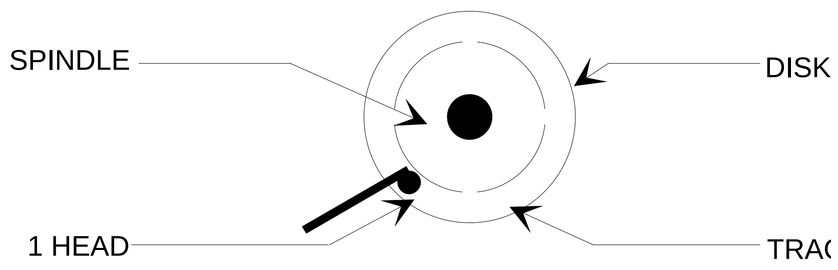

Figure 1-6. Disk Track

Disk Cylinder

The tracks in the same relative position on each recording surface logically form a cylinder. For example, the outermost tracks (one from each recording surface) form one cylinder. Figure 1-7 illustrates cylinders.

Disk Address

A location on a disk volume is specified as:

- a data block address on FBO volumes,
- a cylinder track address on VBO volumes.

Cylinders are numbered consecutively from the outermost (cylinder 000) to the innermost.

Tracks are numbered according to the recording surface on which they occur. All tracks on the first recording surface (the lower surface of the top disk) are numbered 00; all tracks on the second recording surface (the upper surface of the second disk) are numbered 01, and so on down to the last surface.

Figure 1-7 illustrates the physical layout and addressing system for disk volumes.

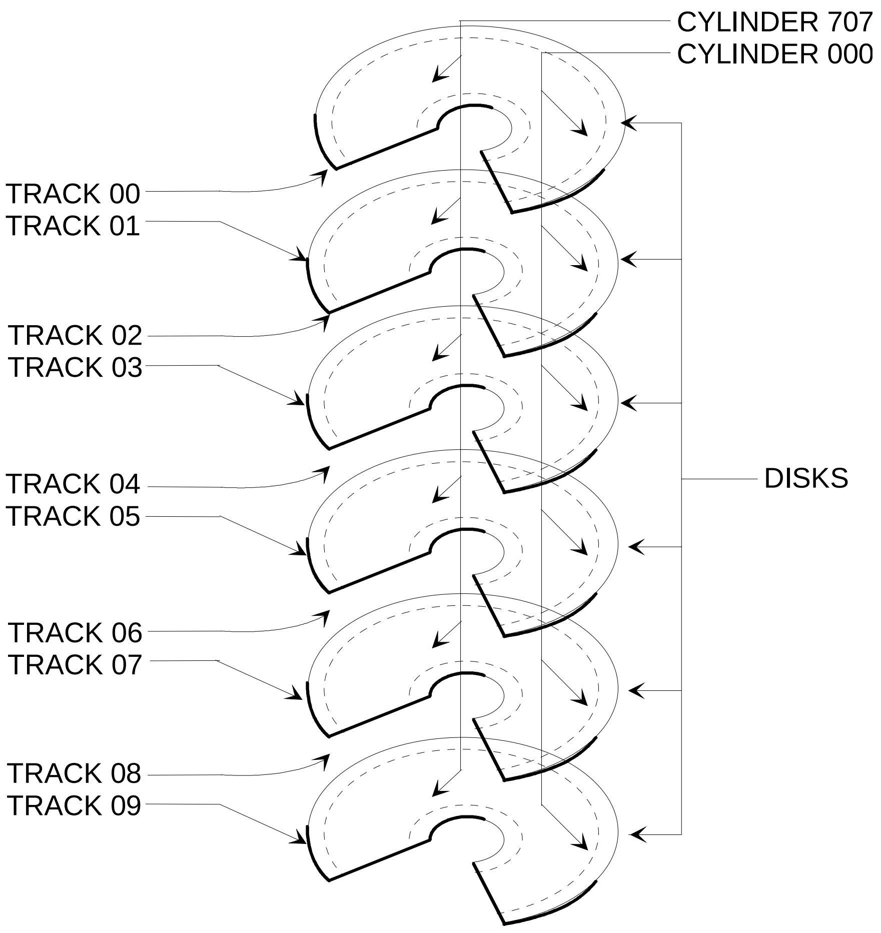

Figure 1-7. Physical Layout of a VBO Disk Volume

Disk Extents

A disk file can occupy one or more extents. An extent is a group of contiguous tracks in the case of VBO volumes or in the case of FBO volumes contiguous data blocks in the same disk volume.

Figure 1-8 illustrates the relationship between disk volumes, files and extents, where:

- file A is a single-extent, single-volume file.
- file B is a multi-extent, single-volume file.
- file C is a multi-extent, multi-volume file.

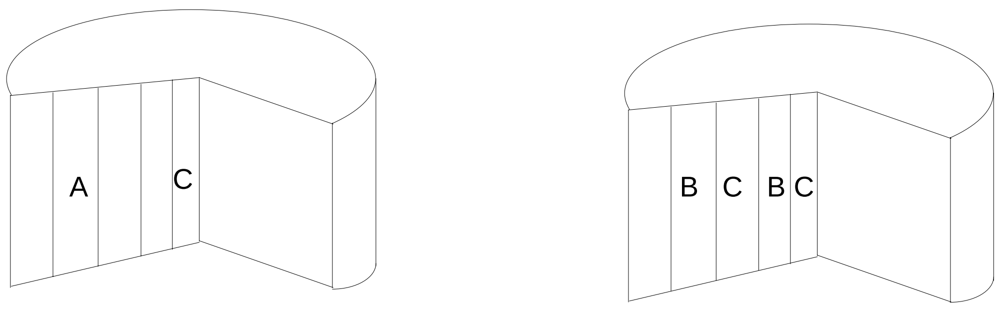

Figure 1-8. Files, Volumes, and Extents

Logical/Physical Layout

Figure 1-9 shows a single file which consists of 4 extents. Extents 1 and 2 are located on volume X, and extents 3 and 4 are located on volume Y.

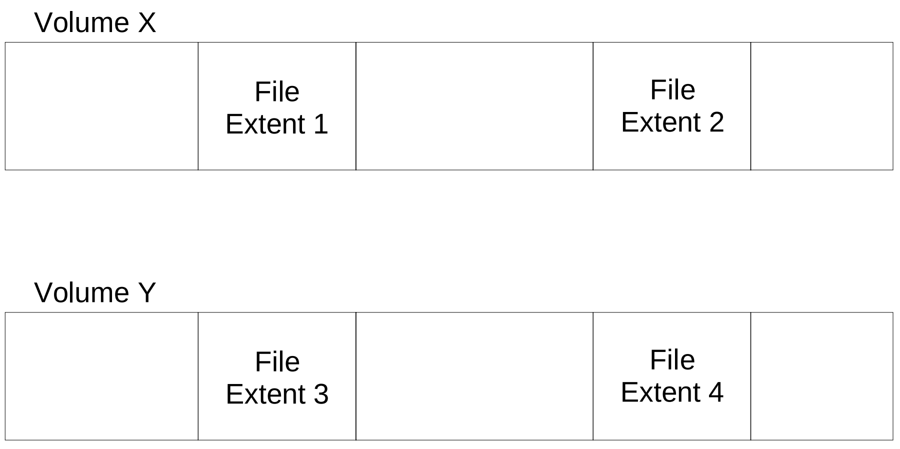

Figure 1-9. Physical Layout of a File

Figure 1-10 shows the relationship between the physical layout and the logical layout of the file.

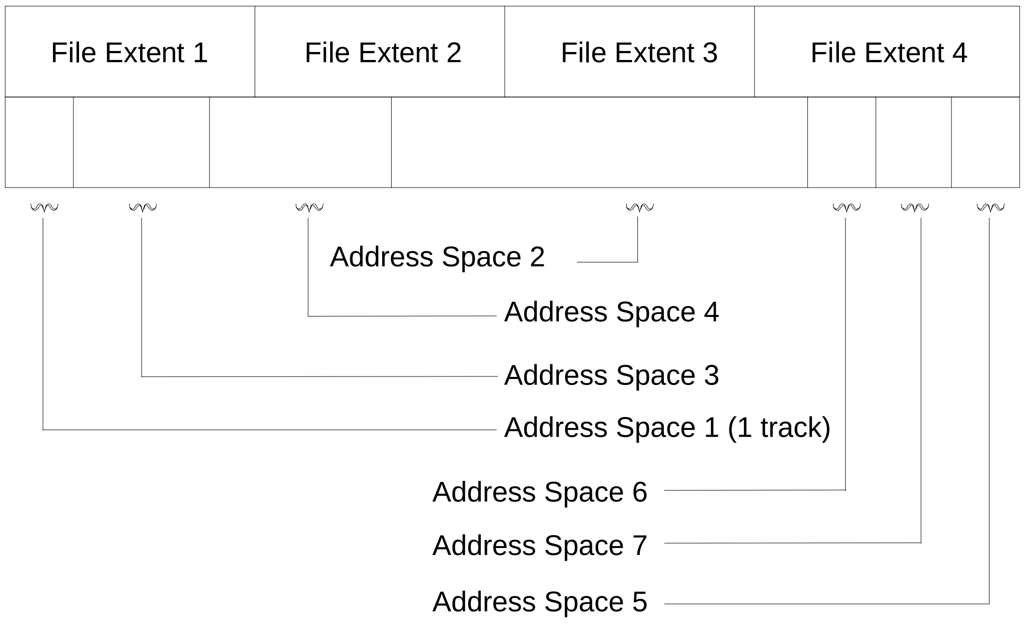

Figure 1-10. Logical/Physical Layout of a File

- Address-space boundaries are independent of extent boundaries,
- Address spaces are logically addressed using CI numbers; this means that UFAS-EXTENDED files can be transferred to a different set of extents without any special reprocessing,
- You can move UFAS-EXTENDED files between disks with different physical characteristics (block, number of tracks per cylinder, track capacity) without any loss of coherence.

Disk-file design and space allocation are described later in Section 6.

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2. Sequential Organization

2.1 Summary

This section covers the following topics:

- sequential-file concepts,
- types of open mode,
- sequential-access mode,
- using a sequential file for the first time,
- format of a data CI in a sequential file.

2.2 Brief Review of Sequential Organization

A sequential file can be stored on disk or tape.

Access to the records it contains can only be sequential. To retrieve record n, you must first read down to and including record (n - 1). After record n has been read, the next READ statement will read record (n + 1).

NOTE:

In GPL, however, you can access the nth record directly in a sequential disk file, using this as start point for subsequents READs.

You can write record n only after you have written record (n - 1).

Figure 2-1 shows a logical picture of records in a sequential file.

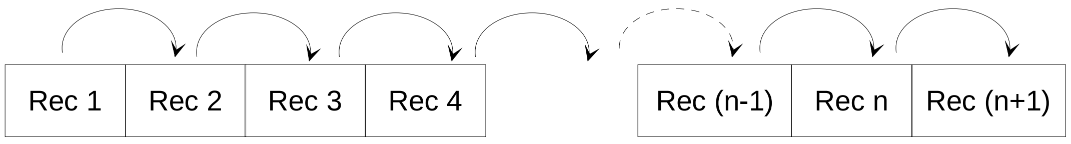


Figure 2-1. Layout of Records in a Sequential File

A program using a sequential file must have its organization declared as SEQUENTIAL (ORGANIZATION IS SEQUENTIAL in COBOL). This is the default value if you omit an ORGANIZATION IS clause.

2.3 Types of Open Mode

When you open a file, you must state an open mode, for example in the COBOL OPEN statement. The declared open mode determines which verbs you can use to access the file. You can open a sequential file in four modes:

INPUT

OUTPUT

I-O

EXTEND (GPL equivalent APPEND)

Figure 2-2 shows the ways of opening a sequential file and the verbs used to access such a file.

COBOL VERB / COBOL OPEN MODE	READ	WRITE	REWRITE
INPUT	X		
OUTPUT		X	
I-O*	X		X
EXTEND		X	

*I-O can be applied only to disk files

Figure 2-2. Accessing a Sequential File

- Opening a file in OUTPUT mode deletes any previous contents of the file; this mode should normally be used only when you wish to create a new sequential file,
- EXTEND mode causes the WRITE verb to append extra records to the end of the file; in all other respects EXTEND mode is equivalent to OUTPUT mode,
- In I-O mode, a REWRITE must be preceded by a READ of the record to be updated. Do not try to change the length of variable-length records.

MULTIVOLUME FILES

(described later in Section 5)

Where space is allocated for a file on more than one volume, volumes are switched automatically in the OUTPUT, EXTEND, INPUT and I-O open modes as follows:

OUTPUT or EXTEND open modes:

The current volume is released and subsequent write operations continue at the first allocated extent on the next volume. Note that the first volume must remain on line because it contains the control information which is required or updated by UFAS-EXTENDED. The volume switch will occur only when all the allocated space on the current volume is completely used up.

INPUT and I-O open modes:

After the last record in the last extent of the current volume has been read, the next record to be read will be the first record on the first extent allocated to the file on the next volume.

2.4 Type of Access Mode in COBOL-85

You can access a sequential file in only one access mode:

ACCESS MODE IS SEQUENTIAL

In COBOL the access-mode clause must state SEQUENTIAL. This is the default value.

2.5 Using a Sequential File for the First Time

When you first access a newly allocated sequential file, you should open it in OUTPUT mode and place records in it. If the file is on disk, it is in fact possible to open in I-O mode, but this is not advised. You can use such utilities as LOAD_FILE (JCL equivalent CREATE), SORT_FILE (JCL equivalent SORT), and MERGE_FILE (JCL equivalent MERGE) as well as COBOL programs.

2.6 Format of a Data CI in a Sequential File

The following information will give you a better understanding of how space requirements are calculated (described later in Section 6). There is no user programming required to maintain, or take into account, the control fields shown. UFAS-EXTENDED does all the necessary processing.

Neither fixed-length nor variable-length records are ever split over two CIs and the size of a CI is always a multiple of 512. Therefore, there may be unused space in a CI. UFAS-EXTENDED always rounds up the size of a CI (CISIZE parameter) given by the user to a multiple of 512. Table 6-1 gives you the CI sizes that are recommended for each type of disk drive.

Each stored record has a 4-byte header which contains the record length. A user program cannot access this header. The unit of data transfer between UFAS-EXTENDED and programs remains the logical record, containing only user-declared data fields. Each programming language handles the length of each variable record differently, for example, in COBOL the DEPENDING ON clause is used.

Figure 2-3 shows the format of a CI for a sequentially organized file for fixed-length records and Figure 2-4 shows the same for variable-length records.

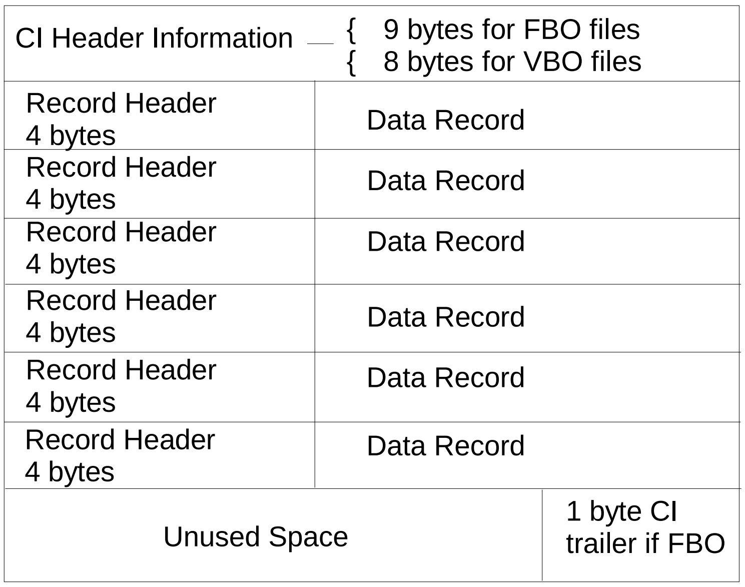


Figure 2-3. Format of a data CI in a Sequential File (Fixed-Length Records)

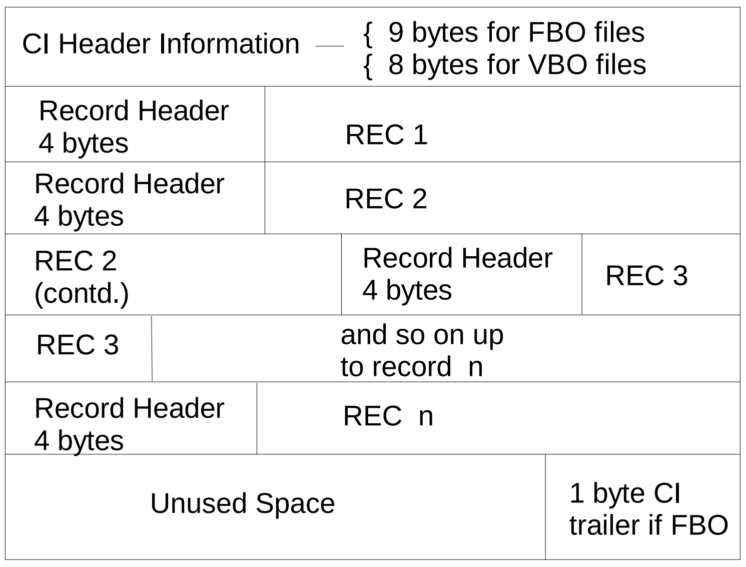


Figure 2-4. Format of a Data CI in a Sequential File (Variable-Length Records)

❑

3. Relative Organization

3.1 Summary

This section covers the following topics:

- relative-file concepts,
- types of open mode,
- types of access mode,
- sequential-access mode,
- random-access mode,
- dynamic-access mode,
- using a relative file for the first time,
- format of a data CI in a relative file,
- example of an application,
- advantages and disadvantages.

3.2 Brief Review of Relative Organization

A relative file must reside on disk. A record in a relative file can be accessed directly by its unique record number. To read record n, you do not need to read through records 1 to (n - 1). Similarly, in OUTPUT, to write record m, you do not need to write records 1 to (m - 1).

Figure 3-1 shows a logical picture of records in a relative file.

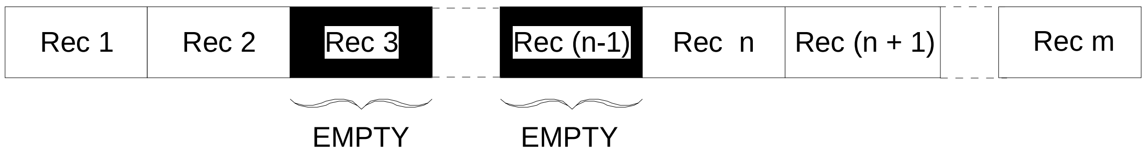


Figure 3-1. Relative File Record Layout

A relative file consists of a series of record positions or slots each of which is identified by a relative record number (RRN). Each record position, which can contain one logical record, can be accessed directly via its RRN.

The RRNs are 1, 2, 3,... The maximum record number depends on the size of the file. If a file is built to hold 1240 records, then the highest RRN is 1240.

When a relative file is first allocated, it consists of empty record positions. Any attempt to retrieve a record directly from an empty position causes an error.

When the nth record is directly accessed, the record positions 1 to (n - 1) may be empty. In Figure 3-1, record positions 3 and (n - 1) are empty.

You can establish the RRN either by loading the file sequentially or by converting a key field into an RRN. Appendix A gives some examples of randomizing algorithms for key fields.

A program using a relative file must have its organization declared as RELATIVE (ORGANIZATION IS RELATIVE in COBOL).

3.3 Types of Open Mode

When you open a file, you must state an open mode. You can open a relative file in four modes:

INPUT

OUTPUT

I-O

EXTEND (GPL equivalent APPEND)

The choice of open mode depends on the access mode declared for the file. The various combinations are described in the following sections.

3.4 Types of Access Mode in COBOL

You can access a relative file in three access modes:

```
               { SEQUENTIAL }
ACCESS MODE IS { RANDOM     }
               { DYNAMIC    }
```

3.4.1 Sequential-Access Mode in COBOL-85

Sequential-access mode allows the program to carry out standard sequential processing. The open modes are discussed below.

INPUT mode:

When you open a file in INPUT mode, then the first record read is RRN 1, then RRN 2 and so on (unless you use the START verb to specify the first record). Empty record positions are skipped. For example, if record position 4 is empty, the records read in sequential order are 1,2,3,5,6...

The data name given in the START verb must be the data item that is specified in the RELATIVE KEY phrase of the associated SELECT clause.

OUTPUT mode:

Opening a file in OUTPUT mode deletes any previous contents of the file. The first record is written into record position 1, then record position 2, and so on. This is used only when you wish to initially load a relative file.

I-O mode:

The REWRITE and DELETE verbs must be preceded by a READ verb when access is sequential. Since the maximum record size is reserved for each record position, a record written using the REWRITE verb may be of a different length than the one being overwritten.

EXTEND mode:

The EXTEND phrase can be used only in COBOL-85.

Figure 3-2 shows the COBOL verbs available to the programmer when ACCESS MODE IS SEQUENTIAL.

COBOL VERB / OBOL OPEN MODE	READ	WRITE	REWRITE	DELETE	START (RRN)
INPUT	X				X
OUTPUT		X			
I-O	X		X	X	X
EXTEND		X			

Figure 3-2. Sequential Access to a Relative File

3.4.2 Random-Access Mode in COBOL-85

In random-access mode, each file access must reference a valid RRN specifying the record position required. The value given in the RELATIVE KEY IS phrase indicates the record to be accessed.

Figure 3-3 shows the COBOL verbs available to the programmer when ACCESS MODE IS RANDOM.

VERB / OPEN MODE	READ (RRN)	WRITE (RRN)	REWRITE (RRN)	DELETE (RRN)
INPUT	X			
OUTPUT		X		
I-O	X	X	X	X

Figure 3-3. Relative File Random Access

The difference between WRITE and REWRITE in I-O mode is that a WRITE statement loads an empty location but REWRITE overwrites an existing valid record in the file. Since the maximum record size is reserved for each record position, a record written using the REWRITE verb may be of a different length than the one being overwritten.

3.4.3 Dynamic-Access Mode in COBOL-85

In dynamic-access mode, you can combine sequential access with random access. Using the COBOL verb START, you indicate at what record location in the file sequential access is to begin. Verbs which do not specify an RRN are taken as sequential, whereas those with a valid RRN are used for random access (see above, in this Section).

Figure 3-4 shows the COBOL verbs available when ACCESS MODE is dynamic.

VERB / OPEN MODE	READ [RRN]	WRITE [RRN]	REWRITE [RRN]	DELETE [RRN]	START [RRN]
INPUT	X				X
OUTPUT		X			
I-O	X	X	X	X	X

Figure 3-4. Relative File Dynamic Access

If a relative file is to be referenced by a START verb, the RELATIVE KEY phrase must be specified for that file in the FILE-CONTROL entry.

3.5 Using a Relative File for the First Time

When you first access a new relative file, you must open it either in OUTPUT mode or in I-O mode. You can use the LOAD_FILE command (JCL equivalent CREATE) as described in Section 8.

3.6 Format of a Data CI in a Relative File

The following information will help you understand how space requirements are calculated (described later in Section 6). There is no user programming required to maintain or take into account the control fields shown. UFAS-EXTENDED does all the necessary processing. Figure 3-5 shows the CI format for fixed-length records and Figure 3-6 shows the CI format for variable-length records.

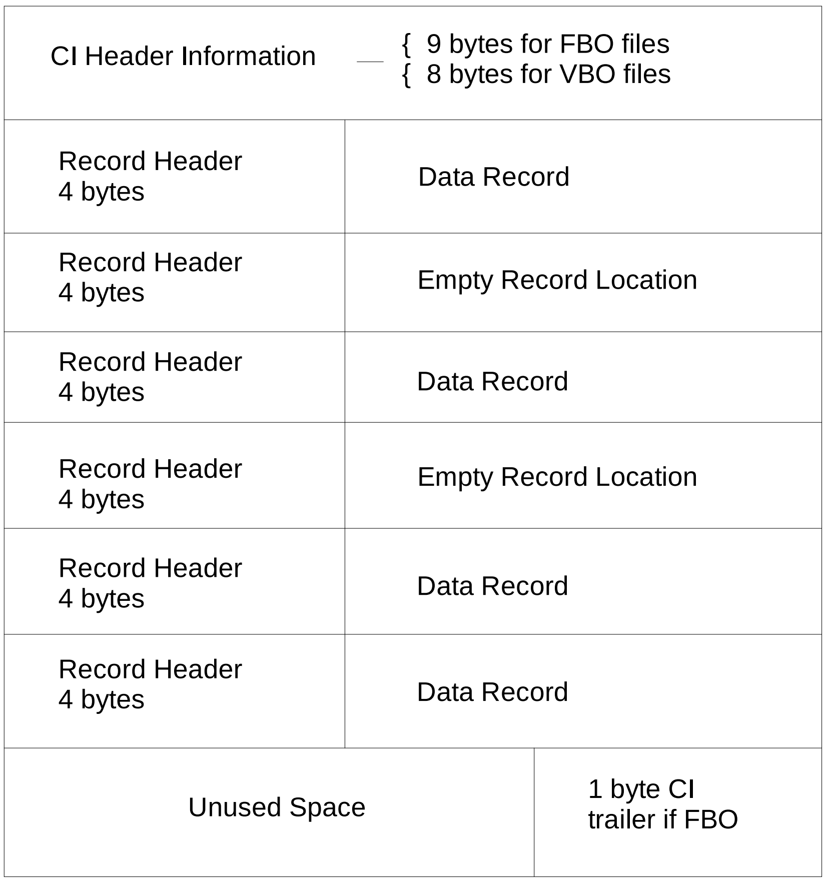


Figure 3-5. Relative File Data CI Format (fixed length records)

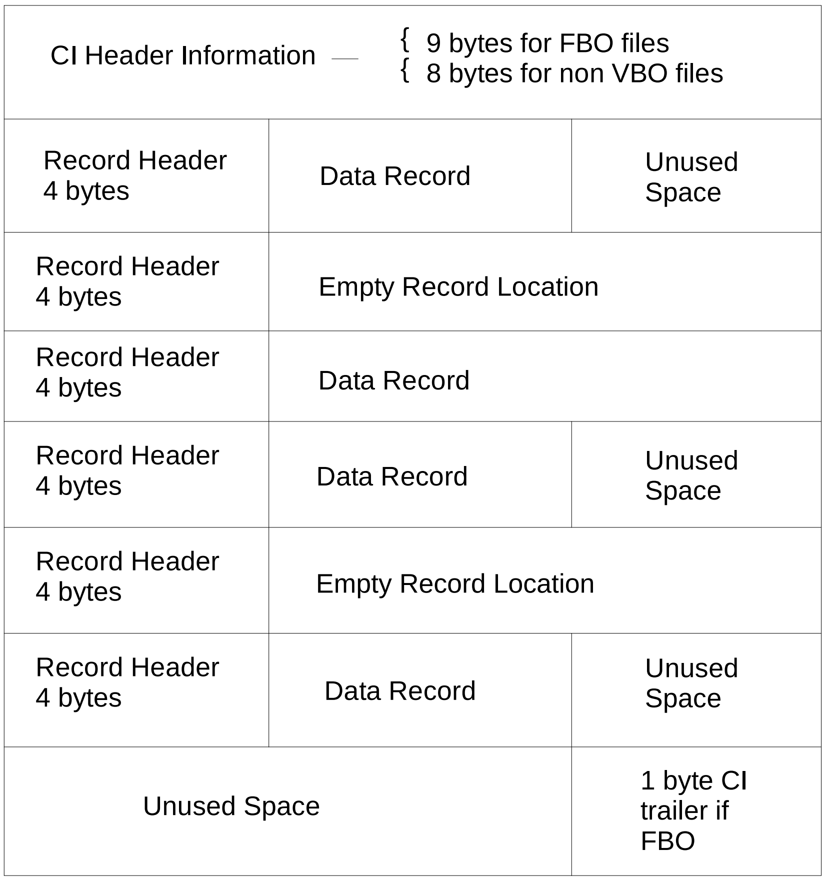


Figure 3-6. Relative File Data CI Format (variable length records)

In either case, a record is never split over 2 CIs and the size of a CI is always a multiple of 512. There may, therefore, be unused space in a CI. UFAS-EXTENDED always rounds up the size of a CI (CISIZE parameter) given by the user to a multiple of 512. Table 6-1 gives you the CI sizes recommended for each type of disk drive.

Note that each record location has a 4-byte record header. This header contains information on whether the record location is empty or not.

For variable-length records, the maximum record length is reserved for each record position. Therefore, no file space is saved by choosing variable record format for a relative file. However, there may be other advantages for the programmer to code the application using variable-length instead of fixed-length records.

For full details on space calculations, see Section 6.

3.7 Example of an Application

A user has a file where each record details a spare part. There are 5,000 spare parts. The file is to be used on-line as part of a stock control system.

When the file was designed, each spare part was given a number, from 1 to 5,000. The numbers are published in a catalog used by customers when ordering.

Figure 3-7 shows the ordering procedure.

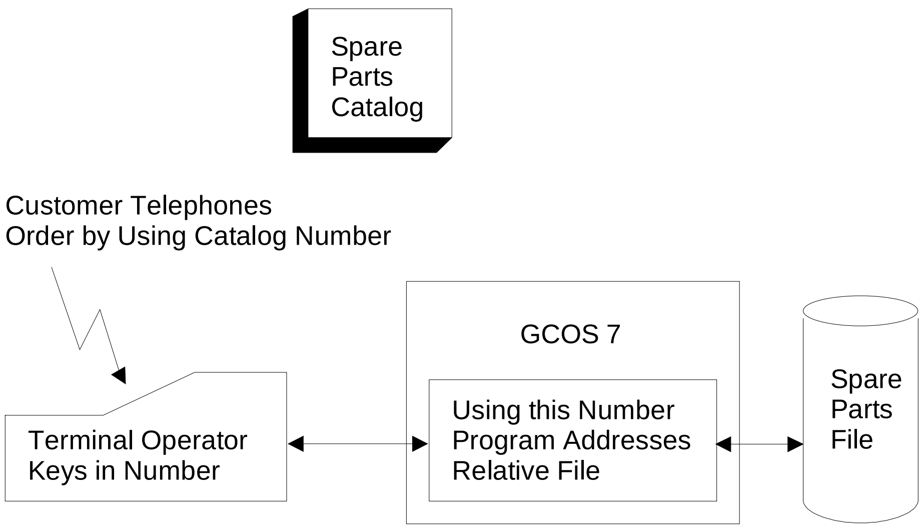

Spare Parts Catalog
Customer Telephones Order by Using Catalog Number
Terminal Operator Keys in Number
GCOS 7
Using this Number Program Addresses Relative File
Spare Parts File

Figure 3-7. Relative File Application

A file record might have the format:

PART DESCRIPTION	CURRENT STOCK	MINIMUM ORDER	UNIT PRICE	RE-ORDER LEVEL	AVAILABILITY DATE

The user program updates records based on the order value. (The same program will probably also record the order for billing and shipment.)

Hence, the order is always made using the latest information on stock level and current price.

The on-line user program would access the file in RANDOM mode. The file would be opened in I-O mode, to allow changes.

If the parts had been numbered in such a way that all parts belonging to a subassembly were in consecutive record locations, then the user program might operate in DYNAMIC mode so that a sequential listing of a part of the file could be made at the terminal.

Each evening, or perhaps once a week, when the on-line operation is not active, a program might be run which inspects every record in the file in order to compile a report for replenishing stock items which are at or below the reorder level. Here access to the file is sequential.

However, even in batch mode, you may find it more efficient to address the file directly than to perform sequential processing. If a job is run every day to update a file and if, say, only 2% of the records are accessed in the run, then direct access is more efficient (in the case above, only 100 records are accessed) rather than sequential (up to possibly 5000 record accesses). Note that this choice can be made only if the user program can be supplied with the locations (RRNs) of the records to be updated.

4. Indexed Sequential Organization

4.1 Summary

This section covers the following topics:

- indexed-sequential-file concepts,
- types of open mode,
- types of access mode,
  - sequential access,
  - random access,
  - dynamic access,
- using an indexed sequential file for the first time,
- adding records,
- deleting records,
- secondary keys,
- creating secondary indexes,
- updating secondary indexes,
- structure of a UFAS-EXTENDED indexed sequential file,
  - address space 1
  - address space 2
  - address space 3
  - address space 4
  - address space 5
  - address space 6
  - address space 7
- primary-index handling,
- secondary-index handling,
- structure of primary and secondary indexes,
- allowing for free space,
- inserting records,
  - simple insertion,
  - insertion requiring CI compaction,
  - insertion requiring CI splitting,
  - reorganization of index CIs.
- format of a data CI in an indexed sequential file,
- example of an application.

4.2 Brief Review of Indexed Sequential Organization

An indexed sequential file can reside only on a disk. Each record in an indexed sequential file is identified by a value called a key. There are two kinds of key: primary keys and secondary keys.

The primary key is the main key by which a set of records is organized or accessed. It must be present as a data field within the record and each record may have only one primary key. Two different records cannot have the same primary key value.

A secondary key is any key, other than the primary key, used to access data. You can specify up to 15 secondary keys, but they must be present as data fields within the record. Several different records may have the same secondary key value (DUPLICATES are allowed), but split keys are not permitted.

Records can be read using the primary or secondary keys. To write a new record or to update an existing record, the primary key must be used. Figure 4-1 shows a logical picture of records and their keys in an indexed sequential file.

FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5
	Primary KEY		Secondary KEY	

Figure 4-1. Indexed Sequential Record Keys

For each key, its length and its location within the record must be the same for all records in the file. The location of the key (that is, its offset from the beginning of the record) is defined by the user at file-allocation time. Each key is uniquely identified by its location and its length; this means that no two keys can have the same location and the same length. This topic is further discussed in Section 6. Although any two keys must be distinct, it is permissible for them to have the same KEYLOC (position of the byte of each key in the record).

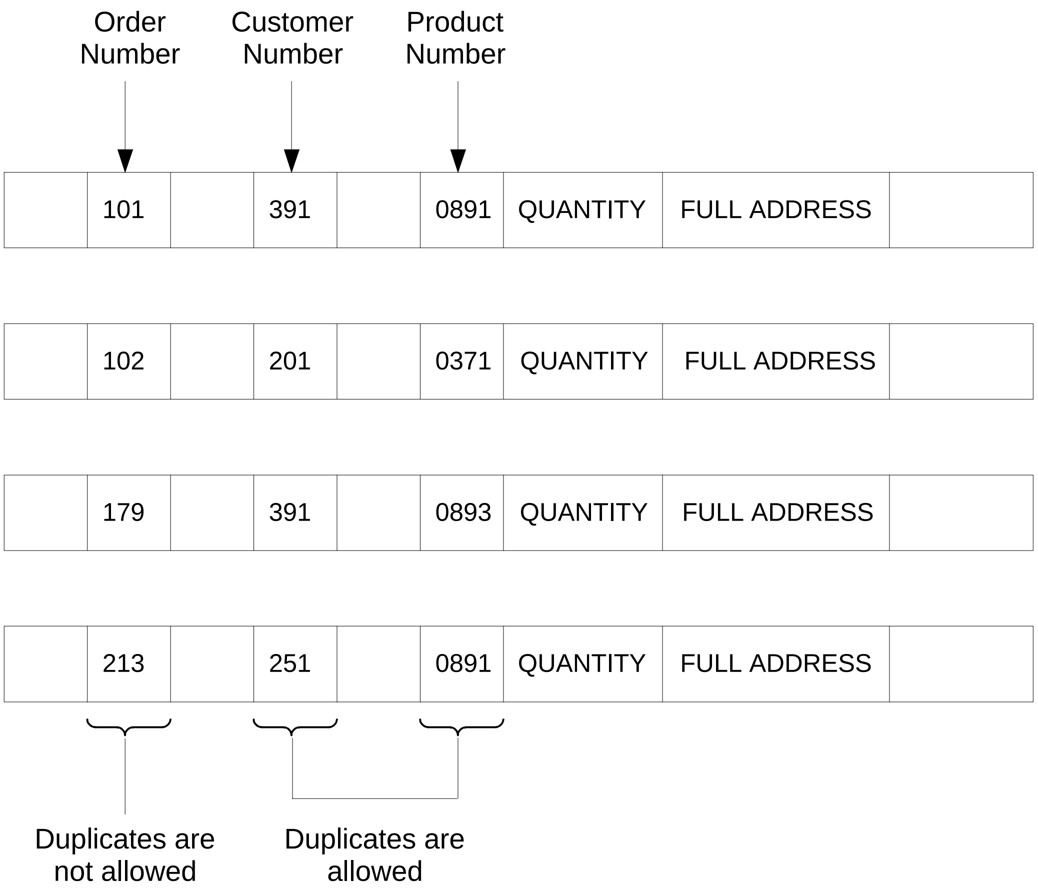
The key can exist anywhere in the record, subject to the restriction that for variable-length records the defined key fields must always be present. If a file contains variable-length records and the highest-key location is byte m and its length is n bytes, then the minimum length of the record for the file is (m - 1) + n.

CAUTION:
The maximum key length is 251 bytes. It is not possible to have a key split into several parts.

As shown in Figure 1-4, an indexed sequential file has index areas, in addition to data records. These indexes provide the path between the user-supplied key value and the address of the record to be accessed. In other words, these indexes are used to locate records in a data file. UFAS-EXTENDED maintains these indexes.

In the following example, an order file has:

primary key	= order number
secondary key	= customer number
secondary key	= product number



- Customer number 391 has 2 orders (101 and 179) for two different products (891 and 893).
- Product 891 has been ordered by 2 different customers (391 and 251).

Indexes are used in two different ways:

Sequential access:	the order file may be accessed sequentially, that is, in order number sequence,
Random access:	individual records in the file are accessed on the basis of a given value for a key; for example, retrieve all the orders of a customer whose customer number is 391.

A program using an indexed sequential file must have its organization declared as INDEXED (ORGANIZATION IS INDEXED).

4.3 Types of Open Mode

When you open a file, you must state an open mode. You can open an index sequential file in four modes:

INPUT

OUTPUT

I-O

EXTEND (GPL equivalent APPEND)

EXTEND open mode is a recent feature of UFAS-EXTENDED and is available only in COBOL-85.

The choice of open mode depends on the access mode declared for the file. The various combinations are described below.

4.4 Types of Access Mode in COBOL-85

You can access an indexed sequential file in three modes:

```
               { SEQUENTIAL }
ACCESS MODE IS { RANDOM     }
               { DYNAMIC    }
```

4.4.1 Sequential-Access Mode in COBOL-85

Choose this mode to process all the records of the file. You can open a file for INPUT, OUTPUT, or I-O mode.

INPUT and I-O mode:

- Records are read by a program in ascending order by primary-key or secondary-key value. When records are being read using a secondary key where duplicates (non unique keys) are allowed, duplicate records are read in the same order as they were written.
- Use the START verb to specify the logical position within the file at which processing begins.

I-O only:

When using the REWRITE verb, which must be preceded by a READ, you must not change the primary-key value.

OUTPUT mode:

- Opening a file in OUTPUT mode deletes the previous contents of the file.
- Open a file for OUTPUT to populate the file; this can be done by a utility such as the LOAD FILE (JCL equivalent CREATE) command (described later in Section 8), or by a COBOL program.
- Records written by the program must be in ascending order of primary key.

EXTEND mode:

- Available only in COBOL-85.
- Records must be written in ascending order of primary key.

Figure 4-2 shows the COBOL verbs available when ACCESS MODE IS SEQUENTIAL.

COBOL VERB / COBOL OPEN MODE	READ	WRITE	REWRITE	DELETE	START (KEY)
INPUT	X				X
OUTPUT		X			
I-O	X		X	X	X
EXTEND		X			

Figure 4-2. Sequential Access to an Indexed Sequential File

4.4.2 Random-Access Mode in COBOL-85

Random access is performed by a key value. To read a record, the user program supplies the key value (primary key value or secondary key value, if any) of the required record. To write a record to a file, the program uses the value of the record's primary-key field to place a record in the file.

Note that all primary-key values used in a file must be unique.

Figure 4-3 shows the COBOL verbs available when ACCESS MODE IS RANDOM.

COBOL VERB / COBOL OPEN MODE	READ (KEY)	WRITE (KEY)	REWRITE (KEY)	DELETE (KEY)
INPUT	X			
OUTPUT		X		
I-O	X	X	X	X

Figure 4-3. Random Access to an Indexed Sequential File

In I-O mode:

- WRITE is used to add a new record to a file, that is, a new primary-key value.
- REWRITE is used to overwrite an existing record (having the same record length and the same primary-key value).

4.4.3 Dynamic-Access Mode in COBOL-85

In dynamic-access mode, you can mix sequential with random access in the same program. Using the COBOL verb START, indicate the record location in the file at which sequential access is to begin. Verbs without key values are taken as sequential, whereas those with key values are processed for random access as described in paragraph 4.4.2.

Figure 4-4 shows the COBOL verbs available when ACCESS MODE IS DYNAMIC.

COBOL VERB / COBOL OPEN MODE	READ (KEY)	WRITE (KEY)	REWRITE (KEY)	DELETE (KEY)	START (KEY)
INPUT	X				X
OUTPUT		X			
I-O	X	X	X	X	X

Figure 4-4. Dynamic Access to an Indexed Sequential File

Note that the meaning of a WRITE verb in dynamic-access mode depends on how you open a file.

CAUTION:

When you open the file in OUTPUT or EXTEND mode:

Records written by WRITE statements must be in ascending order of primary key. This is particularly important when you open the file in EXTEND mode.

When you open the file in I-O mode:

The primary-key value of the record written need not be greater than the primary-key values of records written by previous WRITE statements (you do not have to write records in ascending order of primary key).

4.5 Using an Indexed Sequential File for the First Time

When you first access a new indexed sequential file, you must open it either in OUTPUT mode or in I-O mode. You can use a utility such as the LOAD FILE (JCL equivalent CREATE) command as described in Section 8.

It is recommended that you open the file in OUTPUT mode; if any secondary keys are associated with this file, then run the SORT_INDEX utility (JCL equivalent SORTIDX) after the file is loaded. In this case, use the APPLY NO-SORTED-INDEX clause in a COBOL step.

4.6 Adding Records

You may add records with new primary-key values to the file, provided that there is space available. Primary key values in the additional records may be greater than the highest value or lower than the lowest value already present in the file. The new values can, of course, also lie between the existing high and low values. When designing a file, be sure to allocate sufficient file space for later expansion. See "Choosing Free Space" in Section 6.

4.7 Deleting Records

When you delete records, the space freed can be re-used during later insertions into the file. For further details, see this later in Section ("Insertion Requiring CI Compaction").

4.8 Secondary Keys

Up to 15 secondary keys can also be used; duplicate key values are allowed for secondary keys. In a TDS application, there must not be more than 2 or 3 secondary keys. Avoid specifying meaningless duplicates (KEY = SPACE or ZERO).

4.8.1 Creating Secondary Indexes

Although there are two ways of creating secondary indexes, it is recommended that you use the first of those below.

- It is assumed that the records to be loaded are already sorted in primary key order. When you wish to load the file (first time use), you can use:
  - either the LOAD_FILE command (JCL equivalent CREATE),
  - or a COBOL program (using WRITE verbs) with the APPLY NO-SORTED-INDEX ON clause and the ALTERNATE RECORD KEY in the SELECT clause.

    After records are initially loaded in an indexed sequential file, use the SORT_INDEX (SRTIDX) command (JCL equivalent SORTIDX) to sort and load the secondary indexes.

- UFAS-EXTENDED builds secondary indexes automatically when the file is:
  - updated (open in I-O mode),
  - created by a COBOL program without using the APPLY NO-SORTED-INDEX clause (open in OUTPUT mode),
  - loaded with the LOAD_FILE command and the parameter ORDER=0 (JCL equivalent FILELOAD=NORDER in CREATE).

    This means that a newly inserted record is immediately available from its primary key or from any secondary keys.

    The simplified format for SRTIDX is as follows:

    ```
    SRTIDX [ OUTFILE = ] (outfile-file-description)
    ```

    For example,

    ```
    S: SRTIDX (SD3.IQS.CUSTOMERS)
    ```

    where SD3.IQS.CUSTOMERS is the file whose secondary indexes are to be created. The keys stored in the secondary index are sorted into ascending order.

For further information about this utility, see the *IOF Terminal User's Reference Manual* or the *Data Management Utilities User's Guide* for the equivalent JCL utility SORTIDX.

Secondary indexes will be built automatically if a COBOL program loads a file by using the WRITE verb when there is no APPLY NO-SORTED-INDEX ON clause in the I-O-CONTROL Section of the ENVIRONMENT DIVISION. The same is true if the program opens the file in I-O mode. Note that in these circumstances any duplicate records will be written in the order in which they are provided (and not sorted on the primary key as they would be with SORTIDX).

For performance reasons, it is recommended that you use the APPLY NO-SORTED-INDEX ON clause when a file is being initially loaded by a COBOL program in OUTPUT or EXTEND mode. THE APPLY NO-SORTED-INDEX ON clause is effective **only when the file is opened in output mode**.

For more information on the APPLY NO-SORTED-INDEX ON clause, see the *COBOL-85 Reference Manual*.

4.8.2 Updating Secondary Indexes

Secondary indexes are updated automatically as the records are updated, according to ANSI COBOL standards; therefore, no user action is required.

4.9 Structure of a UFAS-Extended Indexed Sequential File

It is useful to know about the structure of an indexed sequential file because this knowledge will help you interpret the information given by the LIST_FILE command (JCL equivalent FILLIST). For instance, if you find that there have been a lot of CI splits for a particular file, it is time to redefine the file with a larger free space allocation and rebuild it.

As shown in Figure 1-4, an indexed sequential file consists of up to 7 address spaces. These are further detailed in Figure 4-5. Address spaces 3, 4, 5, 6 and 7 are specific to indexed sequential files.

4.9.1 Address Space 1

This address space contains CIs control information for UFAS-EXTENDED. Address space 1 always occupies at least the first blocks (16 Kbytes) of an FBO file , or the first track of a VBO file.

4.9.2 Address Space 2

This address space contains user data structured in logical records in the CIs.

4.9.3 Address Space 3

This address space contains a part of the index used to access the data through the primary key for an indexed sequential file. It contains that part of the index (high-level index) that does not point to data CIs. It can be empty for a small file using a single level index.

4.9.4 Address Space 4

This address space contains the part of the index used to access data through the primary key for an indexed sequential file. Address space 4 contains that part of the index (low-level index) that points to data CIs.

4.9.5 Address Space 5

This address space contains the lowest part of the indexes that are used to access the data through secondary keys. It is also known as the dense index. An index is said to be dense because it contains an entry for every stored record in the indexed file. For each secondary index, there is one entry at this level for each record in the data area.

For example, if we have 100 records in the file and 3 secondary keys per record, the number of entries will be 100 x 3 = 300.

Address space 5 exists only for indexed sequential files with secondary keys.

4.9.6 Address Space 6

For each secondary key that has been specified for the file, there is an index with the same structure as the primary index.

Address Space 6 contains the high-level index associated with each secondary key. It does the same job for secondary indexes as address space 3 does for primary indexes. It exists only for indexed sequential files with secondary keys.

4.9.7 Address Space 7

Address space 7 contains the low-level index associated with each secondary key. It does the same job for secondary indexes as address space 4 does for primary indexes.

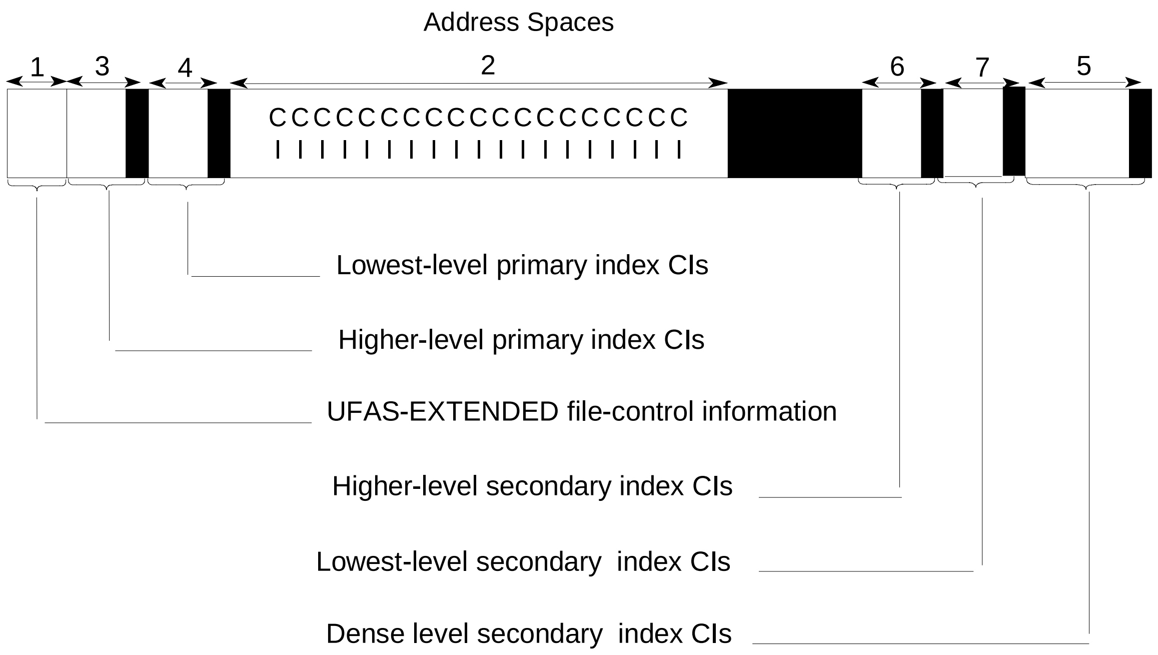

Address Spaces
1
3
4
2
6
7
5
CCCCCCCCCCCCCCCCCCC
Lowest-level primary index CIs
Higher-level primary index CIs
UFAS-EXTENDED file-control information
Higher-level secondary index CIs
Lowest-level secondary index CIs
Dense level secondary index CIs

Figure 4-5. Detailed Layout of an Indexed Sequential File

4.9.8 Primary-Index Handling

A primary index generally comprises several levels. In a single-level index, and at the lowest level of a multi-level index, an entry points directly to an individual data CI. At the higher levels of a multi-level index, an entry points to an index CI at the next lower level; a multi-level index is used where the size of a file is such that it would give rise to excessive search time using a single-level index.

Figure 4-6 shows two index address spaces, higher (address space 3), and lower (address space 4) and the data address space (address space 2).

Within each address space reserved for the indexes, the index entries are contained within CIs.

The size of a CI in all address spaces, including address space 2, is the same.

The primary index takes into account the order of the records. It consists of only one entry per data CI corresponding to its record with the highest key value. The ascending key sequence allows UFAS-EXTENDED to locate keys that are not included in the index.

- UFAS-EXTENDED builds as many levels of higher index as necessary and at each level only one CI is inspected for record access.
- Each index entry records the highest primary-key value present in the CI to which it refers. Hence, in Figure 4-6, using a 3-character key, the highest primary-key value present in the 17th data CI is EAP.

Assume that the record with the key named JFO is to be retrieved. UFAS-EXTENDED begins at the highest level of index. Within the highest index CI (RST), UFAS-EXTENDED starts its search from the JKA entry which points to the index CI (JKA) in address space 4. This is the lowest-level index. Within this index CI, UFAS-EXTENDED finds the index entry JKA which points to the 18th data CI. UFAS-EXTENDED concludes that the record key JFO, if it is present, is in the 18th CI.

4.9.9 Secondary-Index Handling

You can specify up to 15 secondary keys for a file. For performance reasons, the number of secondary keys used in a transactional environment should be small. The indexes for these keys are held in address spaces 5, 6 and 7, as shown in Figure 4-5.

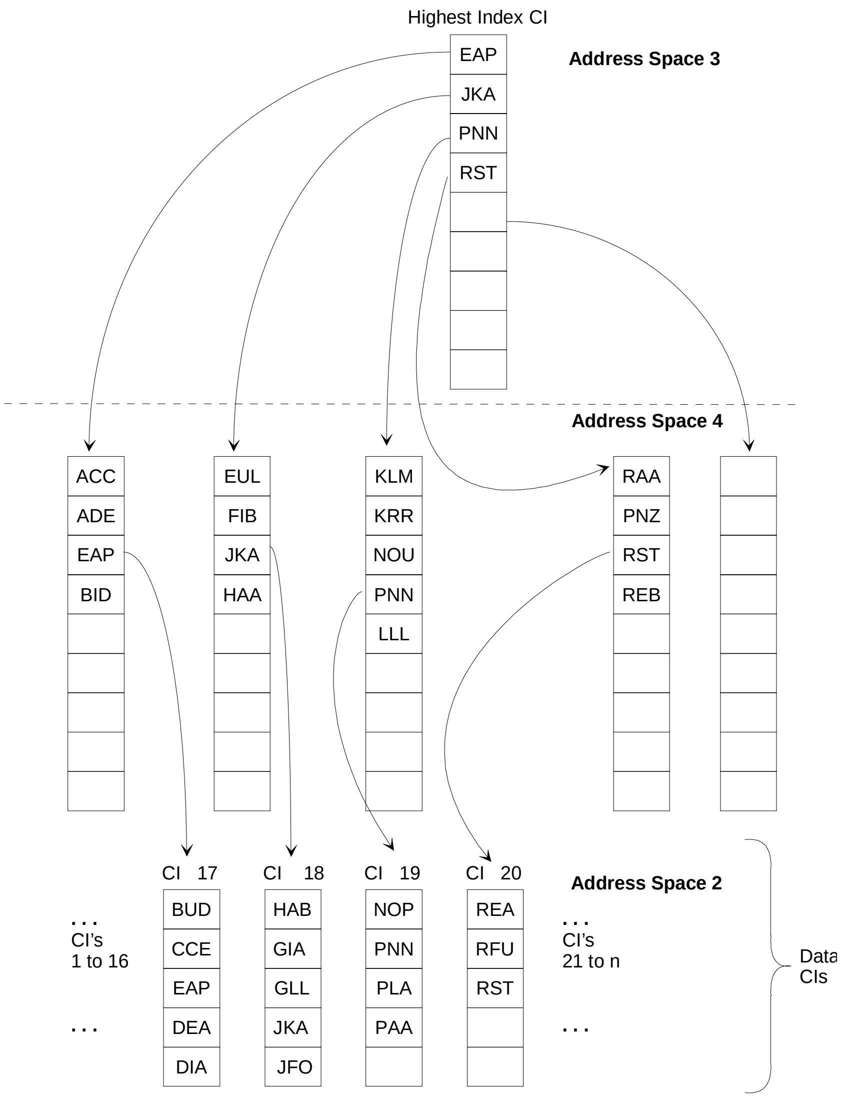


Figure 4-6. UFAS-EXTENDED Indexed File Structure (without secondary keys)

4.9.10 Structure of a Primary and Secondary Index

Figure 4-7 shows how two secondary indexes access the data area through address space 5. To keep matters simple, this example shows only 5 entries per index CI; usually there are many more entries per CI.

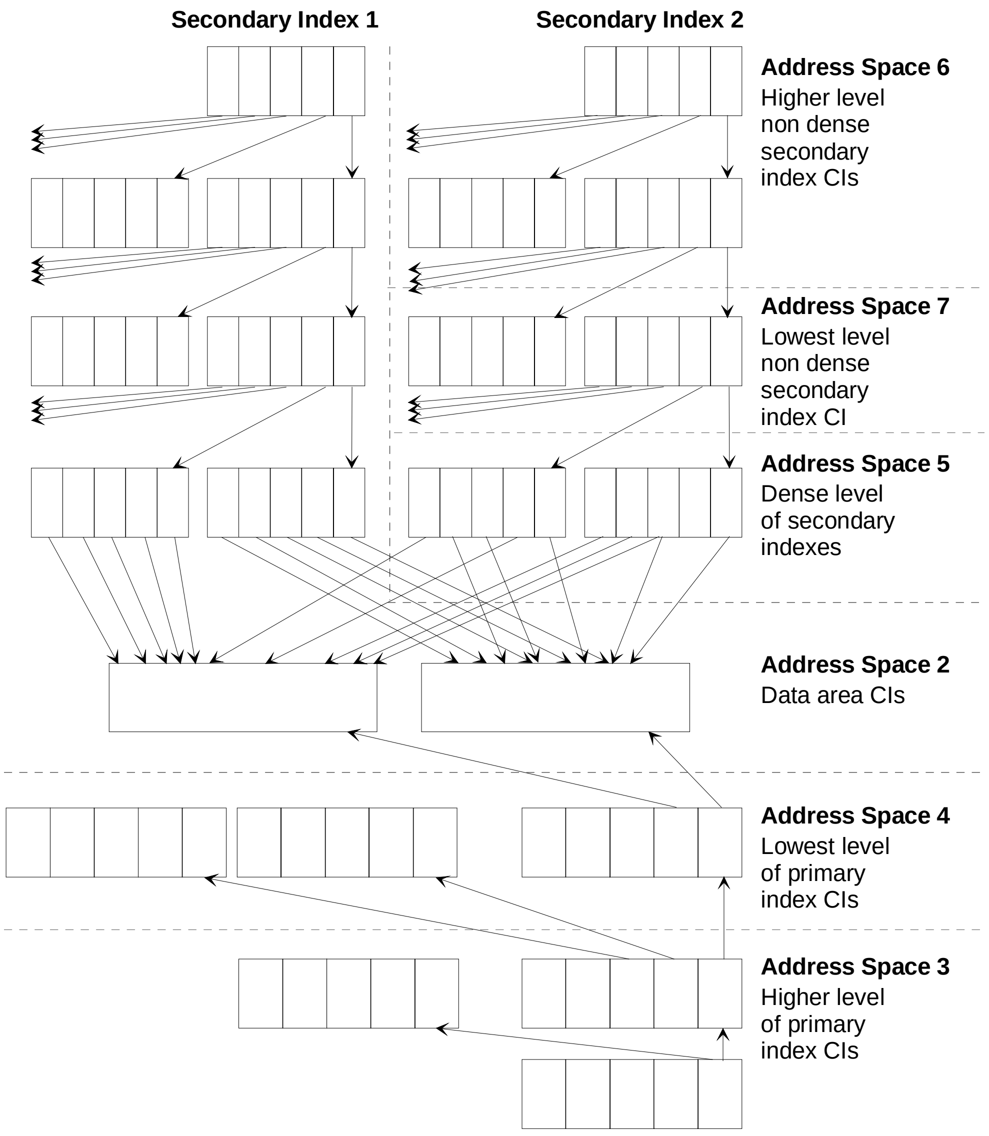

Secondary Index 1
Secondary Index 2
Address Space 6
Higher level non dense secondary index CIs
Address Space 7
Lowest level non dense secondary index CI
Address Space 5
Dense level of secondary indexes
Address Space 2
Data area CIs
Address Space 4
Lowest level of primary index CIs
Address Space 3
Higher level of primary index CIs

Figure 4-7. Primary and Secondary Index Structure

4.10 Allowing for Free Space

At allocation time, you can specify the amount of space to be left empty in a CI by using the CIFSP parameter in the BUILD FILE command (JCL equivalent PREALLOC) as described in Section 6. When you load the file for the first time in OUTPUT mode, space will be left empty according to the CIFSP parameter in order to allow for later record insertions.

Figure 4-8 shows free space left in CIs after the initial loading of the file.

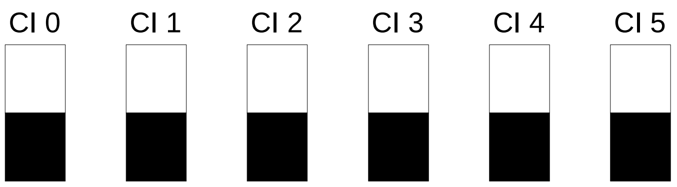


Figure 4-8. Free Space in an Indexed Sequential File

The shaded areas represent free space.

4.11 Inserting Records

Within the space allocated to the file, UFAS-EXTENDED automatically makes new CIs available to the file as necessary. When a record is to be inserted into a CI, UFAS-EXTENDED reads the current CI in which the record should be inserted (on the basis of the primary key). Some of the insertion mechanisms are described in the following sections.

4.11.1 Simple Insertion

This occurs when enough space is present in the CI without moving records within the CI. See Figure 4-9.

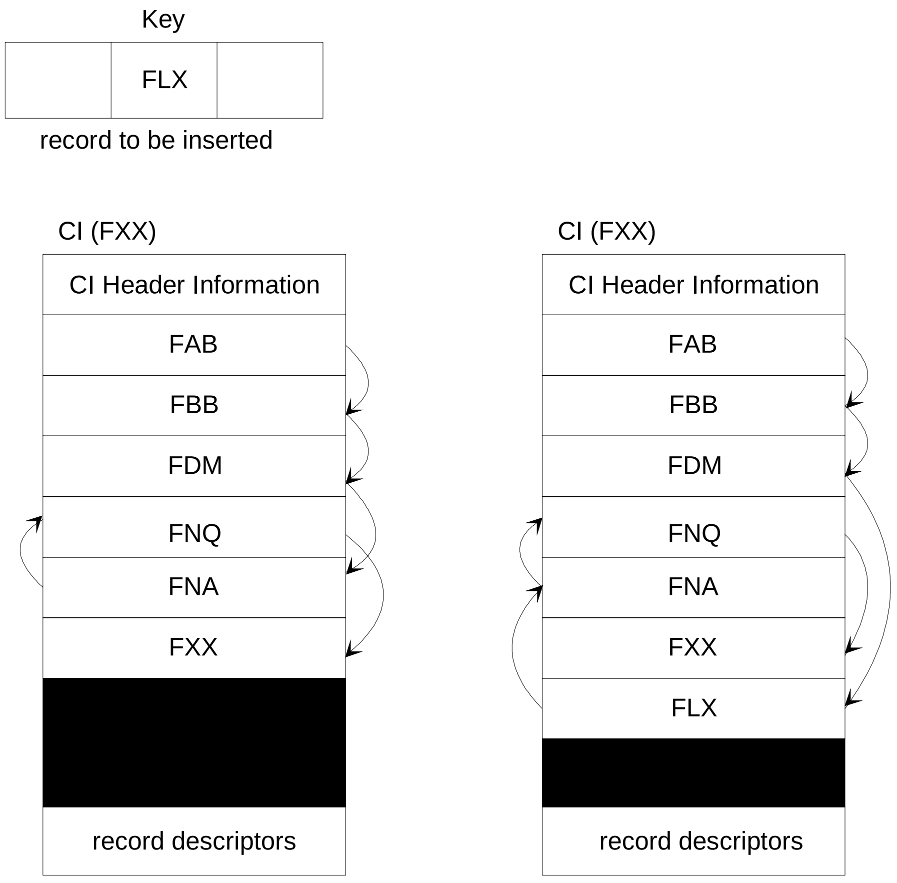


Figure 4-9. Simple Insertion

Each record in the CI contains a pointer to the next higher record by key value within the CI. Note that the physical sequence of records within the CI is not the same as the key sequence. These pointers allow logical chaining of the CIs.
For an explanation of the "record descriptors", see Section 4.

4.11.2 Insertion Requiring CI Compaction

This applies when enough space is present in the CI, but UFAS-EXTENDED must compact the records in the CI in order to retrieve space made available as a result of record deletion.

The records remain in the same order as before they were compacted. See Figure 4-10. (Links between records are not shown.)

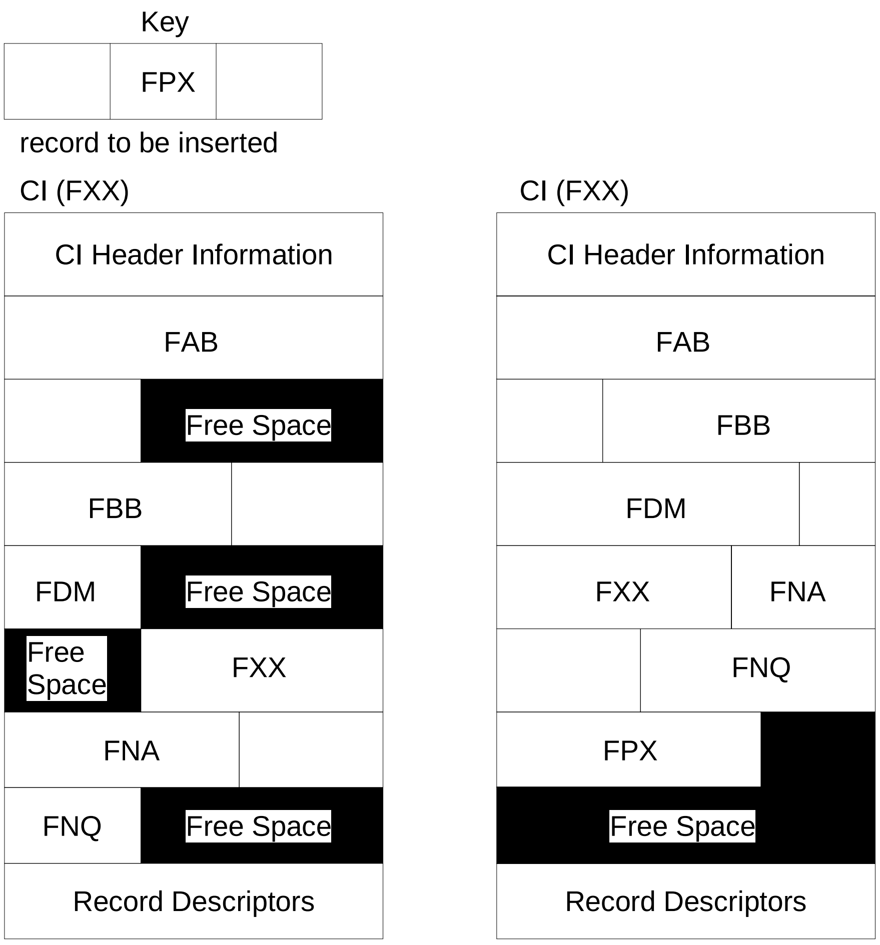


Figure 4-10. Insertion Requiring CI Compaction

CIs containing variable-length records often need to be compacted.

UFAS-EXTENDED compacts the records in the CI so that all free space is collected at the end. During the compaction, the new record is inserted. Because the Cls are compacted and not reorganized as in earlier releases of UFAS, the costs associated with the updating of address space 5 are avoided.

4.11.3 Insertion Requiring CI Splitting

This occurs when the appropriate CI does not contain enough space. This means that UFAS-EXTENDED must find another CI. See Figure 4-11.

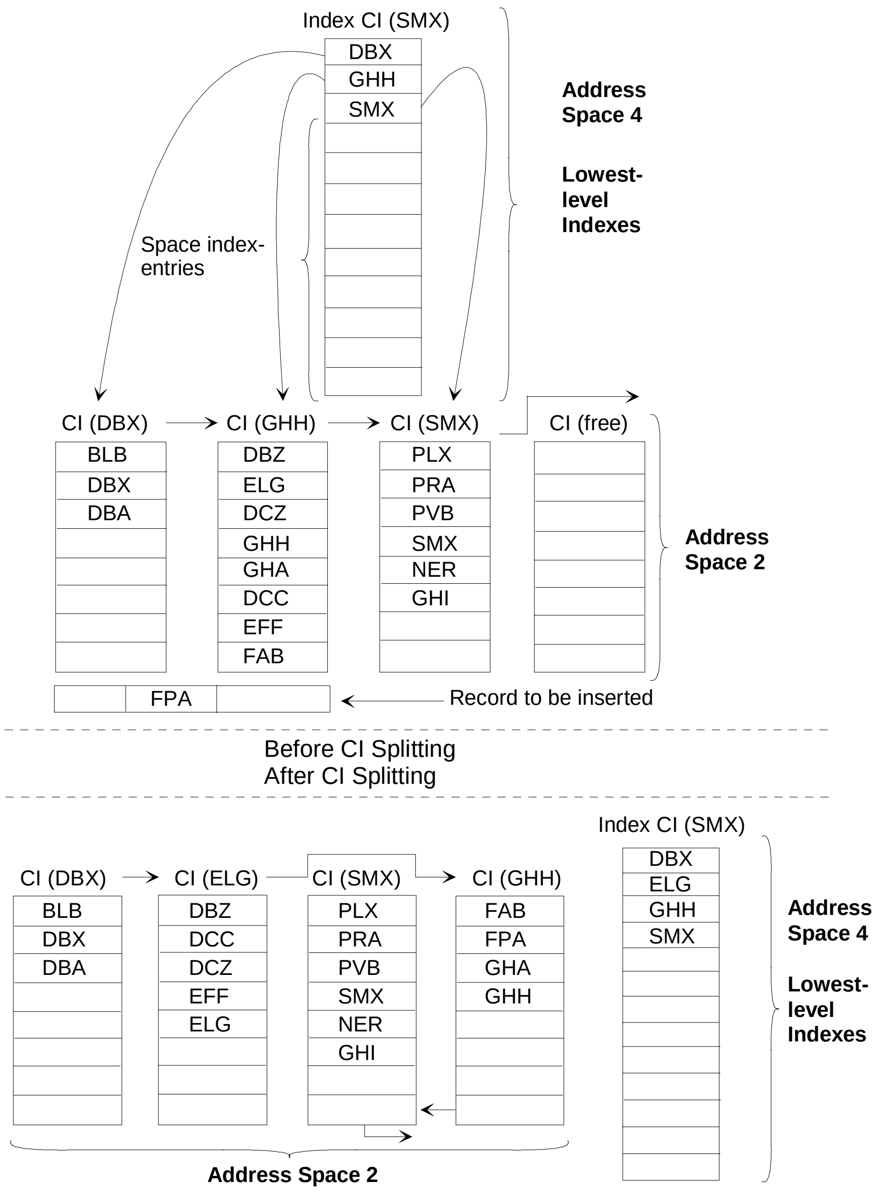


Figure 4-11. Insertion Requiring CI Splitting

Figure 4-11 shows what is known as CI splitting. UFAS-EXTENDED splits the CI called GHH. After this CI is split, records DBZ, DCC, DCZ, EFF, and ELG, remain in the old CI (now called CI (ELG)), but the new record FPA is inserted into the new CI (GHH) along with records GHH, GHA, and FAB.

Note that there are links between each CI to allow sequential access to take place.

UFAS-EXTENDED automatically manages the spare entries in index CIs; normally there are many more entries per index CI than appear in this example.

CAUTION:
If a file with secondary indexes using the Deferred Update mechanism is split, the mechanism is no longer taken into account and return code WDNAV is issued; instead, the Before Journal takes effect automatically.

4.11.4 Insertion Requiring Reorganization of Index CIs

In the previous paragraph, where we described an insertion causing a CI to be split, we assumed that there was at least one spare index entry in the lowest level index in question. When there is no spare index entry, UFAS-EXTENDED uses more complex mechanisms to insert a record.

The content of the low-level index CI is split into two index CIs. During this splitting operation, no data record is moved; only index CIs are affected. As a result of this splitting, an index entry is made in the high-level index (address space 3 or 6). This entry, in turn, can lead to a reorganization of the high-level indexes.

Figure 4-12 shows how a record identified by key 1210 is to be inserted into the data CI 13, but CI 13 is full; hence the CI needs to be split, but there is no free entry in address space 4.

In the right-hand column of Figure 4-12, the index CI (1786) is split and there is room for the index entry 1100. Next the data CI (13) is split; records whose keys are 1000, 1020, and 1100 are placed in the new data CI (nn) and record 1214 remains in the data CI (13) where the new record 1210 is also placed.

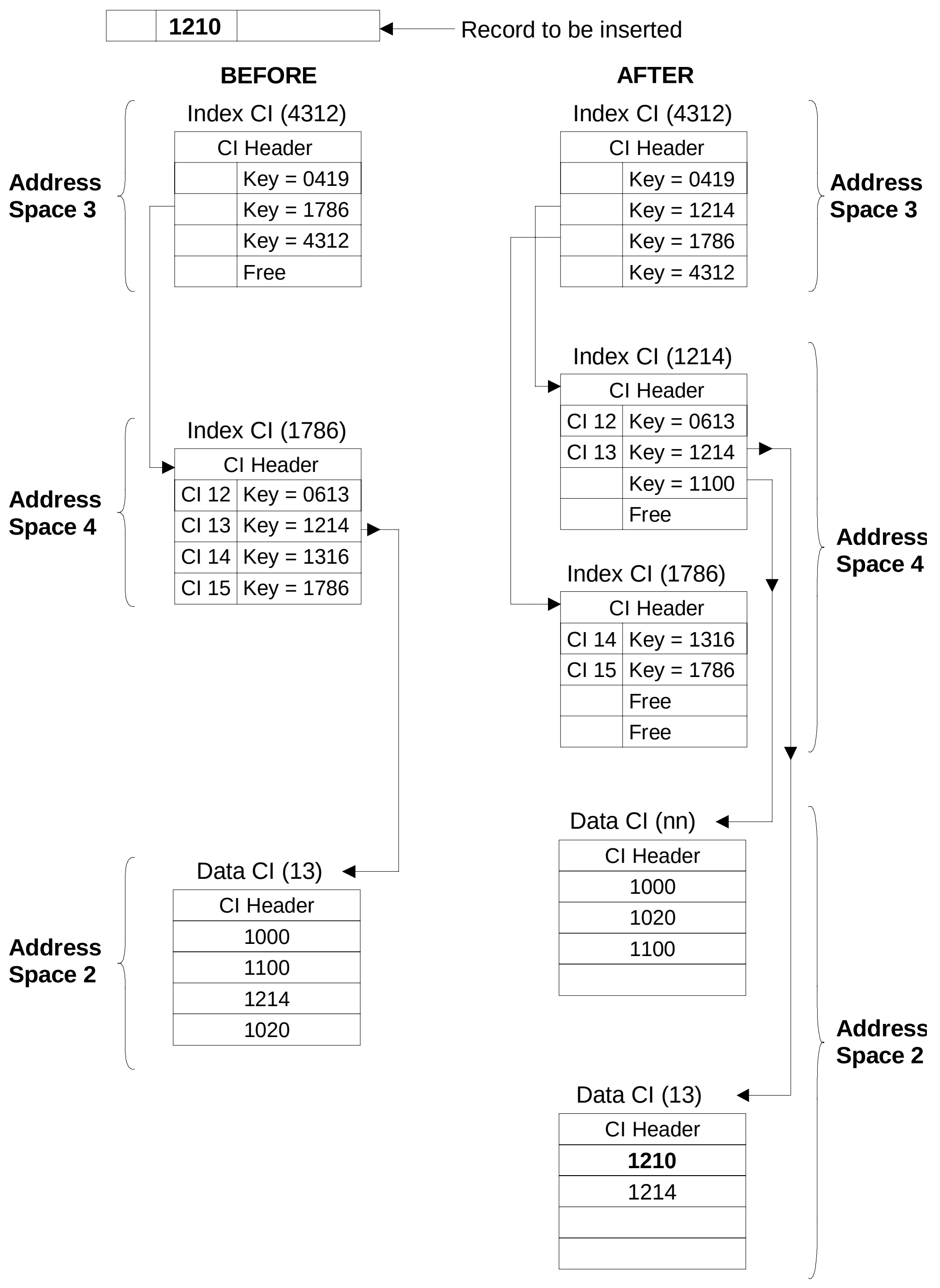
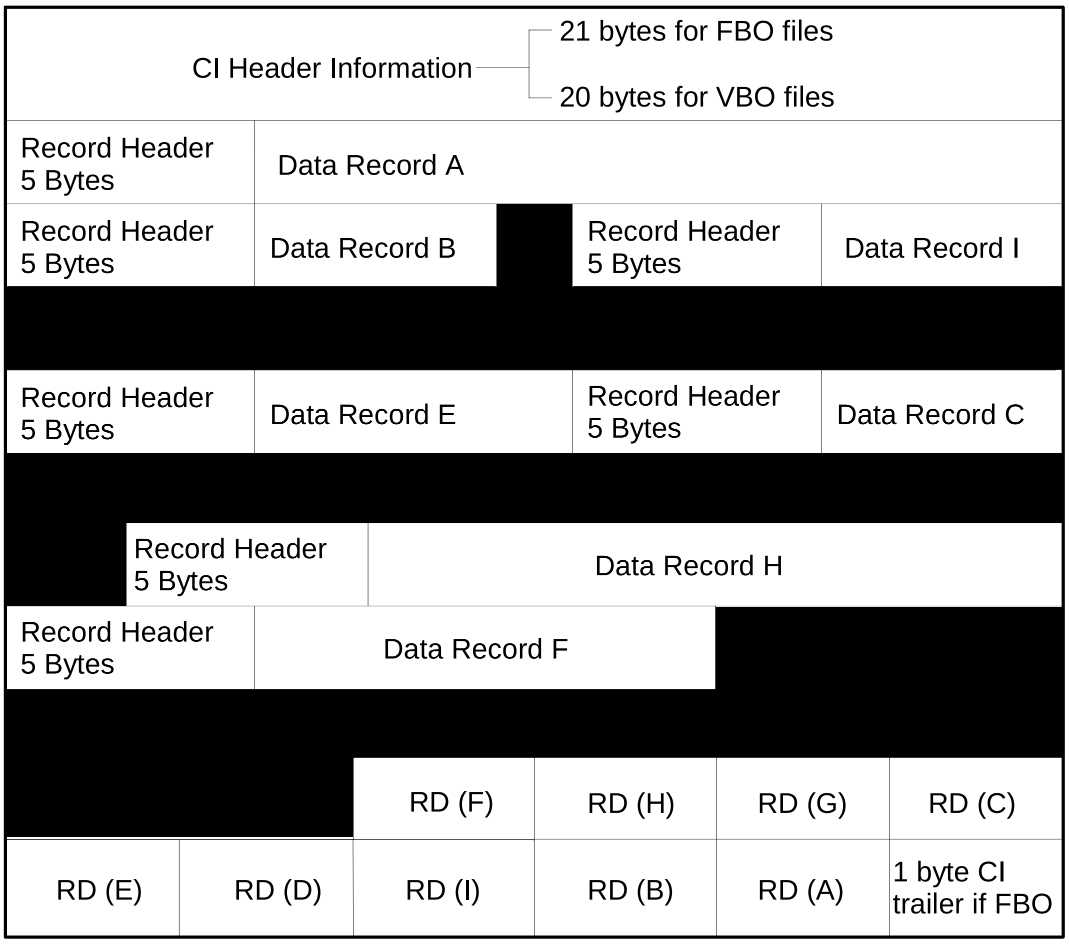


Figure 4-12. Insertion Requiring Reorganization of Index CIs

4.12 Format of a Data Ci In an Indexed Sequential File

You may find the following information useful for calculating file space. No user programming is required to maintain, or take into account, the control fields shown in Figure 4-13. UFAS-EXTENDED does all the necessary processing.

CI Format (fixed-length or variable-length records)



Each record descriptor (RD) is 2 bytes long.

Each record header is 5 bytes long.

■ Indicates unused space, including any space occupied by logically deleted records which are not yet physical deleted

Figure 4-13. Data CI Format in an Indexed Sequential File

Comments on Figure 4-13

- The maximum number of records allowed in a CI is 255.
- The size of a data CI for an indexed sequential file must be large enough to accommodate at least 2 records.
- There is one record descriptor for each active or deleted record in the CI. In Figure 4-13, records D and G are marked for deletion. When records in a CI are marked for deletion, they are not physically removed immediately; thus the associated record descriptors may or may not be empty (See "Insertion Requiring CI Compaction" above.)
- The record descriptors point to the records (an offset from the CI header).
- The CI size will be a multiple of 512 bytes. You can specify a CI of any size (up to five digits long), but UFAS-EXTENDED always rounds this figure up to a multiple of 512. Table 6-1 gives you the recommended CI sizes for each non-FSA disk drive. Table 6-2 gives you the recommended CI sizes for files being allocated on FSA disks.
- For full details concerning space calculation, see Section 6.

4.13 Example of an Application

A large organization maintains a personnel file where there is one record for each employee. The record format is:

Employee Name	Home Address	Social Security Number	Next-of-kin Name & Address	Date of Birth	Date of Hire	Qualification level

This file is to be accessed non-sequentially. Therefore, choose either relative or indexed sequential file organization. If you choose relative, each employee will have to be allocated an RRN. This would be very inflexible because old RRNs remain in the file as people leave or retire. In addition, new employees would have to receive a new number (for security reasons, old numbers could not be re-used).

Instead, you can build an indexed sequential file using a unique number, for example, the employee's social security number. Thus you need not invent a new classification system, and space previously occupied by deleted records can be re-used by new key values automatically.

❑

5. File Assignment, Buffer Management, and File Integrity

5.1 Summary

This section covers the following topics:

- GCL commands/JCL statements,
- user-program reference,
- file-assignment parameter group ASGi,
- types of volume:
  - resident,
  - work,
  - named,
- multivolume files:
  - partial/extensible processing of multivolume files,
- managing multivolume devices (MOUNT),
- sharing devices between files (POOL),
- file sharing,
- overriding rules,
- file-define parameter group DEFi,
- manipulating buffers:
  - POOLSIZE,
  - BUFPOOL,
  - NBBUF,
  - tuning buffers,
  - JOR statistics,
- journalization:
  - Before Journal,
  - After Journal,
- file integrity,
  - file creation,
  - file opening,
- file extension,
- permanent I-O errors.

5.2 GCL Commands

GCL commands are used to assign and allocate UFAS-EXTENDED files in the IOF environment.

You can use the following parameters of the GCL command EXEC PG to reference UFAS-EXTENDED files:

ASGi	assigns a file to a program (described in Section 5),
ALCi	declares space requirements for a temporary or permanent disk file (described in Section 6). In certain commands, like COPY_FILE and COMPARE_FILE, you can allocate a file dynamically by specifying the DYNALC and ALLOCATE parameters.
DEFi	provides file attributes for the assigned files (described in Section 6). These attributes can also be introduced through the INDEF and OUTDEF parameters of a file management utility.

GCL Keywords:

POOL	optimizes device usage (described in Section 5),
POOLSIZE	defines the maximum size of the UFAS-EXTENDED buffer pool. (described in Section 5).

These statements are discussed here as they apply to UFAS-EXTENDED files. For a complete description, see the *IOF Terminal User’s Reference Manual*.

5.3 JCL Statements

JCL statements are used to assign and allocate UFAS-EXTENDED files in the batch and TDS environments.

The files, and the manner in which they are to be used, are specified in the job description. JCL statements which can reference UFAS-EXTENDED files are:

ASSIGN	assigns a file to a program,
ALLOCATE	declares space requirements for a temporary or new permanent disk file,
DEFINE	provides file attributes and file usage information, such as the number of buffers allocated to a file (NBBUF parameter),
POOL	optimizes device usage,
SIZE	declares the declared working set and the memory area shared by buffers (POOLSIZE parameter).

These statements are discussed in this manual as they apply to UFAS-EXTENDED files. For a complete description, see the *JCL Reference Manual*.

In addition to these JCL statements, there is in the CREATE utility, for example, the OUTALC parameter for dynamically allocating a file. The INDEF and OUTDEF parameters provide file attributes to be used by UFAS-EXTENDED. All these parameters are covered in the *Data Management Utilities User’s Guide*.

5.4 User-Program Reference

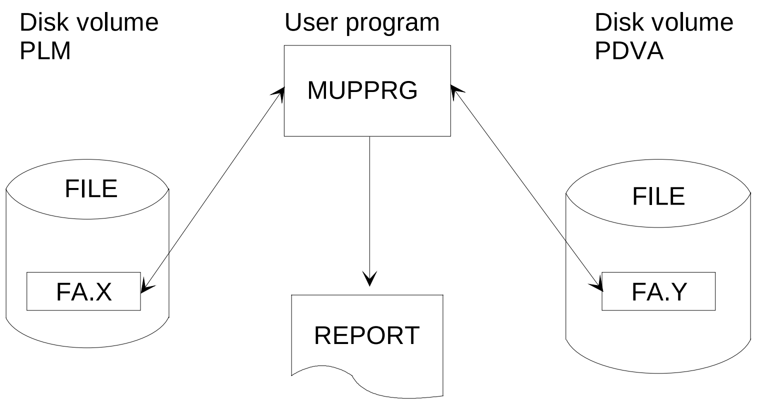
COBOL programs are independent of the physical attributes of the files they use. A COBOL program references an "internal-file-name" with which the real file is associated at run time (see the next section on file assignment). The program describes only the logical characteristics of the file to be processed. Examples of such attributes are:

- record length
- record format (fixed or variable)
- file organization (sequential, relative or indexed)
- access mode.
- open mode

In some programming languages, the programmer can declare the number of buffers or the block size, etc. However, for GCOS7, it is good practice to declare this information in the GCL or JCL and not in the program. If this advice is followed, the file characteristics can be altered without changing and re-compiling the program. As it will be discussed later in this Section, the values defined in the label override the JCL statements/GCL commands, which, in turn, override the values declared in the program.

5.5 File-Assignment Parameter Group ASGi in the GCL Command EXEC_PG

For each internal-file-name (FILEi) used in a program, there must be a file-assignment parameter group introduced through ASGi.



```
EXEC_PG MUPPRG
        LIB = MY.LMLIB
        FILE1 = IFB
        ASG1 = FA.X:PLM:MS/D500
        FILE2 = IFA
        ASG2 = FA.Y
        FILE3 = FX2
        ASG3 = SYS.OUT;
```

Figure 5-1. Using the File Assignment Parameter Group

The program MUPPRG accesses two disk files, FA.Y on disk volume PDVA and FA.X on disk volume PLM. A report is produced through the standard SYSOUT mechanism.

The file FA.X is permanent, uncataloged, and therefore has probably been allocated (and loaded) in a previous job. It is assumed that the file FA.Y is cataloged; thus it is unnecessary to specify the device class or the media. Similarly, if the file FA.Y is a resident or a temporary file, the device class or media need not be specified. If it is cataloged, it has been made known to the catalog in a previous program or job through the BUILD_FILE, or CREATE_FILE, or MODIFY FILE_STATUS commands. The media on which the file resides will be found by GCOS7 in the catalog.

Figure 5-1 shows a simple form of the file-assignment parameter group ASGi. Figure 5-2 gives the complete syntax of the parameter group ASGi as it applies to UFAS-EXTENDED files.

```
EXEC_PG    program-name
           FILEi = internal-file-name
           ASGi = (external-file-name

           [          { WRITE    } ]
           [          { READ     } ]
           [ ACCESS = { SPREAD   } ]
           [          { SPWRITE  } ]
           [          { RECOVERY } ]
           [          { ALLREAD  } ]

           [         { NORMAL   } ]
           [ SHARE = { ONEWRITE } ]
           [         { MONITOR  } ]

           [         {          } ]
           [ NBEFN = {dec3 |ALL } ]
           [         {          } ]

           [            {           } ]
           [ FIRSTVOL = { dec3 |EOF } ]
           [            {           } ]

           [           {           } ]
           [ LASTVOL = { dec3 |EOF } ]
           [           {           } ]

           [       { DEASSIGN } ]
           [ END = { PASS     } ]
           [       { LEAVE    } ]
           [       { UNLOAD   } ]

           [         { DEASSIGN } ]
           [ ABEND = { PASS     } ]
           [         { LEAVE    } ]
           [         { UNLOAD   } ]

           [ MOUNT = dec3 ]

           [        { NO    } ]
           [ POOL = { FIRST } ]
           [        { NEXT  } ]


           [ DEFER = bool ]



           [ OPTIONAL = bool ]
```

Figure 5-2. Parameters for Assigning a file (1/2)

```
[ CATNOW = { bool  } ]


[           { ddd      } ]
[ EXPDATE = { yy/dd    } ]
[           { yy/mm/dd } ]

[           { 6250 } ]
[ DENSITY = {      } ]
[           { 1600 } ]


[ VOLWR = { bool |0  } ] ) ;
```

Figure 5-2 Parameters for Assigning a file (2/2)

For an explanation of these parameters, see the *IOF Terminal User's Reference Manual.*

For cataloged files, the minimum information required by a file-assignment parameter group ASGi, is the name by which the file is referenced in the program, that is, the internal-file-name (FILEi parameter of the EXEC_PG command) and the external-file-name (ASGi parameter).

For uncataloged files, the minimum information required is as follows:

- the internal-file-name,
- the external-file-name,
- the disk or tape cartridge volume where the file resides,
- the device class.

Volume and device class need not be specified if the file is RESIDENT.

5.6 Types of Volume

There are 3 types of volume:

- resident
- work
- named

Each type is described in the following sub-sections.

5.6.1 Resident Volume

When a GCOS7 session begins, the operator can name certain disk volumes as RESIDENT. These disks are kept on-line for the whole session. If no volume name and no device class is specified at assignment time (see the ASGi parameter group in sub-section 5.5), the system assumes that the file is either cataloged or allocated on these resident volumes; see Figure 5-3.

```
COMM   'THE NEXT GCL STATEMENT REFERS TO A PREVIOUSLY
        ALLOCATED FILE ON A RESIDENT DISK VOLUME OR A
        CATALOGED FILE';


EXEC_PG MYPROGRAM
        FILE1 = IFLQ
        ASG1 = PY.RMSX;


COMM   'THE NEXT STATEMENT REFERS TO A TEMPORARY FILE
        ON A RESIDENT DISK VOLUME';


EXEC_PG MYPG
        FILE1 = INLBNB
        ASG1 = TFX.P$TEMPRY;
```

Figure 5-3. Using Resident Volumes

5.6.2 Work Volume

The second type is a WORK volume. Whereas a RESIDENT volume must be a disk, a WORK volume must be a tape or a cartridge. A WORK volume is a tape prepared by a utility such as the PREPARE_TAPE (PRPTP) (JCL equivalent VOLPREP) command.

When the user specifies a WORK volume, the operator will be instructed to mount a WORK volume for the job at execution time. To write to a work tape, a program must know whether the tape file is permanent (default) or temporary ($TEMPRY).

If a temporary file is written, the volume remains a WORK tape. However, if a permanent file is written, the tape volume loses its WORK status to become a normal named volume; see Figure 5-4.

```
COMM  'THE FOLLOWING FILE ASSIGNMENT PARAMETER GROUP ASGi
       REFERENCES A TEMPORARY FILE ON A WORK TAPE. AT THE
       END OF THIS PROGRAM THE TAPE WILL STILL HAVE THE
       ATTRIBUTE WORK';


       EXEC_PG MYPROGRAM
               FILE1 = INITX
               ASG1 = (FIT.PM:WORK:MT/T9$TEMPRY);


COMM  'THE NEXT STATEMENT ESTABLISHES A NEW PERMANENT FILE
       ON A WORK VOLUME';


       EXEC_PG MYPG
               FILE1 = INQLP
               ASG1 = (FIT.PM:WORK:MT:T9 EXPDATE=240);


COMM  'NOTE IN THIS EXAMPLE TWO ASGi PARAMETER GROUPS USING
       THE SAME FILENAME FIT.PM.THIS IS ACCEPTED BY GCOS 7
       SINCE THE STATUS OF THE FILES IS DIFFERENT;I.E.,
       TEMPORARY UNCATALOGED AND PERMANENT UNCATALOGED. THE
       NEXT TIME THE USER USES THE PERMANENT FILE FIT.PM,
       HE MUST SUPPLY THE PROPER VOLUME NAME (THE VOLUME
       NAME OF THE WORK TAPE WHICH IS DISPLAYED IN THE JOB
       OCCURRENCE REPORT)';
```

Figure 5-4. Using a Work Volume

Work tapes are also used when a tape file overruns the supplied volumes. See "Multivolume Files" later in this Section.

5.6.3 Named Volume

The third and most usual type of volume declaration is the volume name. Each standard disk and tape volume has a name. This name, stored on the volume label, can be set up by the following commands:

PREPARE DISK (PRPD)	labels and formats a disk volume
PREPARE TAPE (PRPTP)	labels and formats a tape volume

For a complete explanation of these commands, see the *IOF Terminal User’s Reference Manual (Part 2).*

The JCL equivalent for formatting disk and tape volumes is the VOLPREP utility.

```
COMM  ’THE FOLLOWING THREE FILE ASSIGNMENT PARAMETER GROUP
       ASGi REFER TO UNCATALOGED FILES ON NAMED VOLUMES’;


       EXEC_PG MYPROG
               FILE1 = BINB
               ASG1 = LM.PL:BD41:MS/D500
               FILE2 = BINC
               ASG2 = GHAC:1487D:MT/T9$TEMPRY
               FILE3 = FRED
               ASG3 = XA.BPLQ:TXAMB:MT/T9;


COMM  ’NOTE THAT NAMED VOLUMES MAY CONTAIN TEMPORARY OR
       PERMANENT FILES THROUGH IT WILL PROBABLY BE AN
       INSTALLATION POLICY TO PLACE TEMPORARY TAPE FILES ON
       WORK VOLUMES’;
```

Figure 5-5. Using a named volume

5.7 Multivolume Files

A single file may be spread across several volumes. All the volumes for the file must be of exactly the same type (all disk and same disk type, or all tape). For information on multivolume files and types of OPEN mode, see section 2.

For a multivolume file, always supply volume names, via ASGi parameters, in the order they were specified when the file was first allocated on disk or first written on tape.

The maximum number of volumes allowed for a single file is 10 for a non-cataloged file.

```
COMM  'THE NEXT STATEMENT ASSIGNS A MULTIVOLUME FILE NAMED
       MST.PLN';

       EXEC_PG MYPG
               FILE1 = FILA
               ASG1 = (MST.PLN:11451/11452/11453:MS/D500);


COMM  'THE NEXT STATEMENT ASSIGNS A MULTIVOLUME TAPE FILE WHICH
       IS TO BE WRITTEN ON WORK TAPES';

       EXEC_PG MYPROGRAM
               FILE1 = FILB
               ASG1 = (N.MSTPLN:WORK:MT/T9 EXPDATE = 340);

COMM  'EXPDATE ENSURES THAT THE FILE N.MSTPLN WILL BE RETAINED
       FOR 340 DAYS.';
```

Figure 5-6. Using a Multivolume Uncataloged Disk or Tape File

Figure 5-7 shows the form of the above example for a cataloged disk file.

```
EXEC_PG MYPROGRAM
                        FILE1 = FILA
                        ASG1 = MST.PLN;
```

Figure 5-7. Using a Multivolume Cataloged File

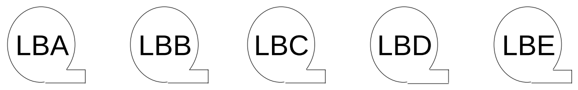
Multivolume files can be temporary or permanent. If you specify that the file is on a WORK volume, then the system will automatically use as many WORK volumes as required. The sequence in which they are used will be listed in the Job Occurrence Report, and these names will then have to be used in subsequent references to the file (if the file is not temporary).
Work tapes may also be used if you do not supply enough volumes for a file opened in OUTPUT or EXTEND mode. On reaching the end of the last volume specified, the system asks the operator to mount a work volume. The operator can refuse the request, in which case the program is aborted.

5.7.1 Partial/Extensible Processing of Multivolume Files

This facility is available only for sequential disk or tape/cartridge files.

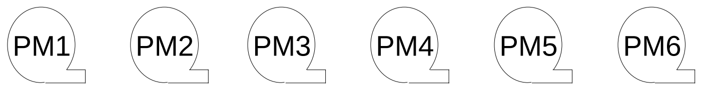
Suppose that you know that a program requires records only from a subset of the volumes of a file. GCOS7 allows you to supply this subset of all the volumes. The advantage is that the preceding volumes are not read unnecessarily. Similarly, when you open a file in EXTEND open mode, you need specify only the volume-name list starting at the last volume containing records. Figure 5-8 applies to tape files only. For UFAS disk files, the first volume in the list must always be the first volume of the file.

File FNAL.A



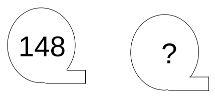
Program reads records only within volumes LBC and LBD. Does not read to end-of-file, so LBE is not needed

File HMQC.41



PM4 is the last volume currently used. This file is opened in EXTENDED mode and any future expansion will occur on reserved volumes PM5 and later, PM6.

File NCU.BX



File NCU.BX. opened in EXTENDED mode, is to grow using work volumes. Currently, only one volume, 148, accomodates the file.
If the files FNAL.A, HMQC.41 and NCU.BX are cataloged, the above example becomes:

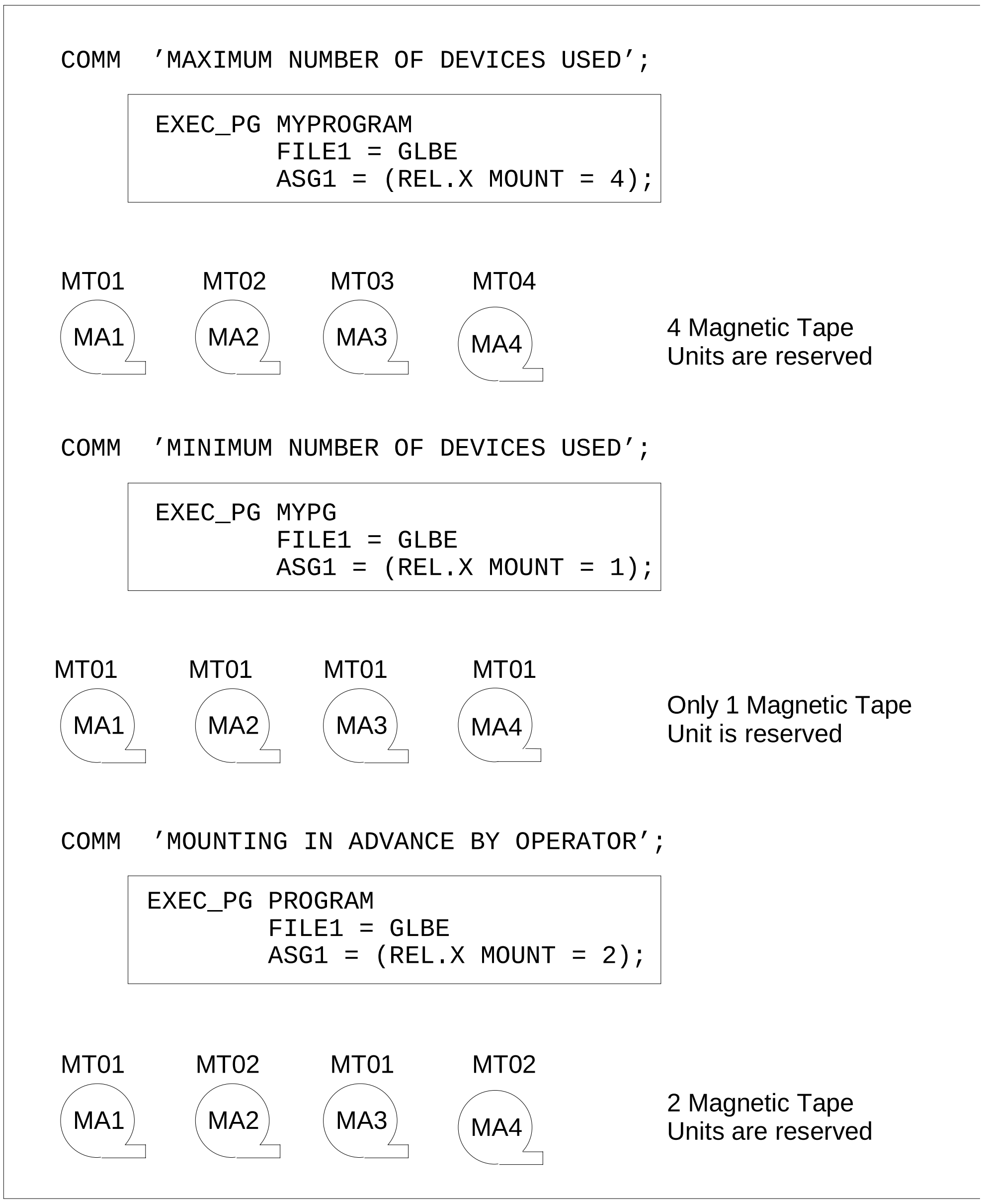
```
EXEC_PG GROFIL
        LIB = MY.LIB:MSD:MS/D500
        FILE1 = FLA
        ASG1 = (FNAL.A FIRSTVOL = 3 LASTVOL = 4)

        FILE2 = FLB
        ASG2 = (HMQC.41 FIRSTVOL = 4)

        FILE3 = FLC
        ASG3 = NCU.BX;
```

Figure 5-8. Partial/Extensible Processing of Multivolume Tape Files

5.7.2 Managing Multivolume Devices (MOUNT)

This facility is available only for sequential disk or tape/cartridge files.

Disk files:	In the examples shown so far, all of the volumes of a multivolume file will be placed on-line simultaneously. Therefore a file-assignment parameter group ASGi referencing 5 volumes will use 5 devices.
	The following remark applies only to non-fixed disks. To reduce the number of devices, use the MOUNT parameter (for sequential files only) in the file-assignment parameter group ASGi. MOUNT specifies the maximum number of devices to be used at any one time for the file. The default value, for disk files, is the number of volumes.
Tape Files:	To specify the maximum number of tape drives to accommodate the file, use MOUNT. The most effective values are MOUNT=1 and MOUNT= 2. The default value is MOUNT = 1 for tape files.
	If MOUNT = 1, then only one tape drive will be reserved for the file. After a volume is used, the volume will be replaced by the next volume in sequence. Although minimizing device reservation, this technique halts the program while the operator changes volumes, unless premounting is used on another device.
	If MOUNT = 2, only two tape devices are used for the file. However, in this case the operator can mount each volume in advance and volume switching is not delayed by operator intervention. See Figure 5-9.



```
COMM  'MAXIMUM NUMBER OF DEVICES USED';

 EXEC_PG MYPROGRAM
         FILE1 = GLBE
         ASG1 = (REL.X MOUNT = 4);
```

MT01
MA1
MT02
MA2
MT03
MA3
MT04
MA4
4 Magnetic Tape Units are reserved

```
COMM  'MINIMUM NUMBER OF DEVICES USED';

 EXEC_PG MYPG
         FILE1 = GLBE
         ASG1 = (REL.X MOUNT = 1);
```

MT01
MA1
MT01
MA2
MT01
MA3
MT01
MA4
Only 1 Magnetic Tape Unit is reserved

```
COMM  'MOUNTING IN ADVANCE BY OPERATOR';

EXEC_PG PROGRAM
        FILE1 = GLBE
        ASG1 = (REL.X MOUNT = 2);
```

MT01
MA1
MT02
MA2
MT01
MA3
MT02
MA4
2 Magnetic Tape Units are reserved

Figure 5-9. Managing Multivolume Devices

The use of MOUNT applies to cataloged and permanent uncataloged and temporary tape files (described later in sub-section 7.2).

When the programmer specifies that a file is on a WORK volume and the file is multivolume, GCOS7 operates as if MOUNT = 1 is specified.
The MOUNT value continues to have effect when a file overflows onto WORK volumes.

5.8 Sharing Devices between Files (POOL)

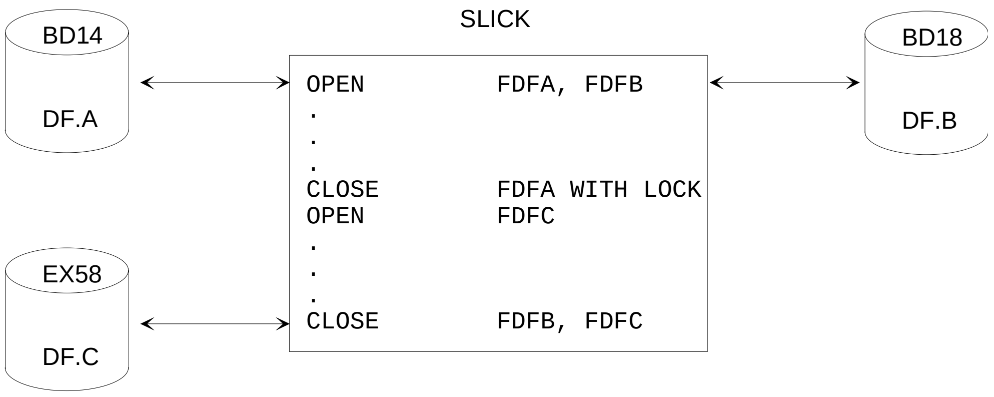
The MOUNT parameter optimizes device use for a single file which is multivolume. A second form of device management concerns the sharing of devices between files.

In the examples shown so far, all the files referred to by the file-assignment parameter group ASGi must be on-line when the program starts executing. Therefore, in Figure 5-8 a total of 6 tape drives must be available. Yet in that example it may be that the file FNAL.A is completely processed before processing begins on file HMQC.41. Therefore, it would be better to use the same drives for both files.

This can be done by specifying a device pool in the POOL parameter of the EXEC_G command and the POOL parameter of the file-assignment parameter group ASGi. Both are described in the *IOF Terminal User’s Reference Manual (Part 2).*

The device-pool technique depends on the logic of the processing program. When the program has finished processing a file, the program must signal to GCOS7 that the file can be de-assigned, causing the devices used to become available. In COBOL this is done by specifying WITH LOCK in the CLOSE verb.

The program SLICK uses 3 disk files, DF.A, DF.B and DF.C. The file DF.A is processed before the processing of DF.C begins.



```
OPEN          FDFA, FDFB
.
.
.
CLOSE         FDFA WITH LOCK
OPEN          FDFC
.
.
.
CLOSE         FDFB, FDFC
```

```
EXEC_PG SLICK
        LIB = AX.LIB
        POOL = 1*MS/D500
        FILE1 = FDFA
        ASG1 = (DF.A POOL = FIRST)
        FILE2 = FDFA
        ASG2 = DF.B
        FILE3 = FDFC
        ASG3 = (DF.C POOL = NEXT);
```

Figure 5-10. Pool Device

In Figure 5-10, a device pool consisting of one MS/D500 disk drive is defined. There are two files to be placed on pool devices - DF.A and DF.C (the POOL parameter). Only one file with POOL is to be loaded when the program is started - DF.A (the FIRST parameter). The file DF.C is not mounted and does not require a disk drive, until the program opens the file (at which point the single-pool device will be available). The result is that only two disk drives are used by the program.

Note that the device used by file DF.B is not a member of the pool (no POOL in ASG2).

In one program, there cannot be more than one pool for each type of device.

In the above example, only one device is pooled. In general a device pool may contain more than one device. So if either or both disk files DF.A and DF.C were on two volumes, then the pool parameter would be:

```
POOL 2*MS/D500
```

You can specify a device pool for disk and tape device types. The files may be temporary or permanent. The use of MOUNT with device pools is not restricted.

For complete details on the POOL parameter, see the *IOF Terminal User's Reference Manual (Part 2)*. The POOL parameter specified at file assignment is explained in the same manual.

5.9 File Sharing

Sharing means that a file being accessed by a program can be accessed by other concurrently running programs. File sharing applies only to disk files.

The SHARE parameter specifies the sharing conditions applicable to a file. You can use the SHARE parameter to specify the maximum permitted level of concurrent file access.

For cataloged files you need specify only the ACCESS values. The sharing mode is held in the catalog as part of the file attributes.

Two cases of shared access illustrated in Figures 5-11 and 5-12 are handled through the file-assignment parameter group ASGi.

```
EXEC_PG  MYPG

         FILE1 = IFA
         ASG1 = (XP.ML
                 SHARE = NORMAL
                 ACCESS = READ)...;
```

```
EXEC_PG  MY

         FILE1 = MX
         ASG1 = (XP.ML
                 SHARE = NORMAL
                 ACCESS = READ)...;
```

Figure 5-11. Sharing a File with Another Step

The file XP.ML is referenced by both steps.

Some cases of file sharing are treated below:

NORMAL	Many concurrent readers or one writer per file. Sharing is controlled at the file level. This is the default value.
ONEWRITE	Many readers <u>and</u> one concurrent writer per file. Sharing is controlled at the file level.

DANGER:
Do not use SHARE = FREE, (that is, totally free file sharing) for UFAS-EXTENDED files.

If a cataloged file has an associated parameter which specifies a different value for SHARE from that specified in the catalog, then the catalog value will override the value given at assignment time, and the program will be given exclusive access to the file (that is, ACCESS = READ becomes ACCESS = SPREAD, and ACCESS=WRITE becomes ACCESS=SPWRITE). Do not use this feature to avoid sharing a file with other programs, but use ACCESS=SPREAD or ACCESS=SPWRITE where appropriate.

Figure 5-12 shows the keyword values for ACCESS and SHARE with their

Keyword Values		Type of Sharing Requested
ACCESS	SHARE	
WRITE	NORMAL	Exclusive Use (default value).
SPWRITE	NORMAL	Exclusive Use.
READ	NORMAL	Read a file while several jobs read the file.
SPREAD	NORMAL	Exclusive Read.
READ	ONEWRITE	Read a file while several jobs read the file and one job writes to the file.
SPREAD	ONEWRITE	Exclusive Read.
WRITE	ONEWRITE	Write to a file while several jobs read the file.
SPWRITE	ONEWRITE	Exclusive Use..

Figure 5-12. ACCESS and SHARE Values

Figure 5-12 shows the types of sharing that the user may request. Whether sharing is granted, depends on the current use of the file.

For example, a file already assigned with the values:

```
ACCESS = READ
```
and
```
SHARE = ONEWRITE
```

may be shared with another job which specifies:

```
ACCESS = WRITE
```
and
```
SHARE = ONEWRITE
```

GCOS7 does NOT check that the organization of the file supports the mode of sharing that you requested. Observe the following guidelines.

- you cannot share a file opened in OUTPUT mode, (opening a file in OUTPUT means that a file is being initially loaded),
- you can share indexed sequential files in ONEWRITE. It is important to note that when a CI split occurs, the whole file is not locked. This means that there should be fewer access conflicts. During the CI split, there can be several readers.

File Assignment/sharing with END = PASS

When a file is assigned with END = PASS, the file cannot be assigned to another job that also passes the file with END = PASS until the file is released by the first job. This restriction prevents deadlock occurring between the jobs.

	Requested ACCESS/SHARE Modes							
Current ACCESS/ SHARE Modes	WRITE/ NORMAL	SPWRITE/ NORMAL	READ/ NORMAL	SPREAD/ NORMAL	READ/ ONEWRITE	SPREAD/ ONEWRITE	WRITE/ ONEWRITE	SPWRITE/ ONEWRITE
WRITE/ NORMAL								
SPWRITE/ NORMAL								
READ/ NORMAL			READ NORMAL	SPREAD * NORMAL	READ NORMAL	SPREAD * NORMAL		
SPREAD/ NORMAL			SPREAD * NORMAL	SPREAD * NORMAL	SPREAD * NORMAL	SPREAD * NORMAL		
READ/ ONEWRITE			READ NORMAL	SPREAD * NORMAL	READ ONEWRITE	SPREAD * NORMAL	WRITE ONEWRITE	SPWRITE * ONEWRITE
SPREAD/ ONEWRITE			SPREAD * NORMAL	SPREAD * NORMAL	SPREAD * ONEWRITE	SPREAD* ONEWRITE	SPWRITE * ONEWRITE	SPWRITE * ONEWRITE
WRITE/ ONEWRITE					WRITE ONEWRITE	SPWRITE * ONEWRITE		
SPWRITE/ ONEWRITE					SPWRITE * ONEWRITE	SPWRITE * ONEWRITE		

Figure 5-13. File-Sharing Rules

Blank entries mean that sharing is denied. Entries marked * mean that sharing is permitted only to a request from the same step.

5.10 Overriding Rules

CAUTION:
Avoid giving contradictory values for the various file attributes. Values are tested, for example that the file opened does not have a record size different from that declared in the program. In COBOL 85, there are further checks and ANY mismatch between program and file may lead to an abort with return code OVRVIOL.

When a program opens a file, sufficient information must be available to UFAS-EXTENDED for file processing. Such attributes as the CI size (block size on tape files), record size, record format, number of buffers, must be declared or provided by default. The sources of this information are as follows:

- The existing file label. No label information is available when:
  - you write an output file to tape; see sub-section 7.7,
  - you allocate a disk file in the same program using the file-allocation parameter group ALCi; see Section 6.

  For an existing disk or input tape file, any values declared in the label will override all other values supplied from the program or through the GCL or JCL.
- The file-allocation parameter group ALCi (JCL statement ALLOCATE) and the file-define parameter group DEFi (JCL statement DEFINE), which may be associated with a file-assignment parameter group ASGi file reference (JCL statement ASSIGN).

  Any values declared in the GCL or JCL, (for example, number of buffers, or CISIZE) will override any equivalent value in the program; the file-define parameter group DEFi is described in sub-sections 5.11 and 6.8.4.
- Attributes from the executing program; the user program provides a complete set of attributes (usually by default).

Outlined below are the general overriding rules for the define parameters.

General Overriding Rule 1:

Rule 1 applies if the file concerned already exists.

(1) File label (including the VTOC - Volume Table of Contents for a disk file),
(2) Catalog (for a cataloged file),
(3) Define parameters,
(4) File definition value (for example, the FD in a COBOL program, or the utility's implicit value if you are using a system utility).

In Rule 1, (1) overrides (2) which overrides (3) which overrides (4), but see the warning above.

The FPARAM parameter allows you to force the define parameter values which you enter to override the corresponding values in the file label.

- If FPARAM = 0 (the default value), then for an existing file, the file label overrides the define parameters.
- If FPARAM = 1, then the define parameters override the file label (for an existing file). Use this facility only in special cases, for example, the file is non-standard and/or the file is being reloaded to conform to the characteristics given via the define parameters.
- FPARAM cannot be used to override the catalog entry information for a cataloged file.

General Overriding Rule 2:

Rule 2 applies if the file concerned does not exist. Therefore it applies to files being dynamically created, for example through use of the parameter group ALCi (JCL equivalent ALLOCATE).

(1) Define parameters,

(2) Default file attributes (automatically provided by the COBOL program or by a utility),

(3) File definition value (FD).

In Rule 2, (1) overrides (2), which overrides (3), but see the warning above.

There are no default values for the parameters within the file-define parameter group DEFi (JCL equivalent DEFINE). If you do not enter a value for a file-define parameter, an effective value will still be derived using the above rules. For example, the following file attributes are chosen automatically if they are not given in the DEFi parameter group (JCL equivalent DEFINE):

- CISIZE is set to 2048 bytes (If the CREATE_FILE or CREATE_FILESET commands are being used, CISIZE is set to 3584 bytes for MS/D500 and MS/B10 disk devices),
- CIFSP = 0.

The CIFSP parameter can be specified in the DEFi parameter group (JCL equivalent DEFINE) to modify the amount of free space to be defined for a file which is dynamically allocated. For more information on how to leave free space in a file, see sub-section 6.7.2.

5.11 Using the File-Define Parameter Group DEFi

As explained in the previous sub-section, file attributes defined in the catalog override those defined in the parameter group DEFi. Thus it is recommended that you define file attributes in the catalog whenever possible.

If the DEFi parameter is present in the EXEC_PG command (JCL equivalent DEFINE), it is associated (via the internal-file-name) with a file-assignment parameter group ASGi (JCL equivalent ASSIGN).

```
 EXEC_PG MYPROGRAM
         FILE1 = TFX
         ASG1 = JC.JHB ...
         DEF1 = (file-define parameters);
```

Use the DEFi parameter (JCL equivalent DEFINE) to perform the following tasks:

- to specify execution parameters effective only for the current job, for example, the number of buffers,
- to describe file attributes when:
  - a new disk file is being built (file-allocation parameter group ALCi),
  - an output tape is written,
  - an unlabeled tape file is being read.
- to process non-standard tape file formats.

See below for the format of the file-define parameter group DEFi as applicable to buffers (the full syntax is given in sub-section 6.8.4). Note that, although it is possible to specify the type of journalization with DEFi, you are strongly advised to do this in the catalog.

```
EXEC_PG MYPROG
        FILEi = ifn
        ASGi = efn
        DEFi = ( [BUFPOOL = name4]
                 [NBBUF = dec3] )
```

Note that there are no default values in the file-define parameter group DEFi. The file-define parameters supplement or override declarations of the program. This topic was discussed in sub-section 5.10.

For a complete explanation of these parameters, see the *IOF Terminal User's Reference Manual, Part 2* and the *JCL Reference Manual*.

5.12 Buffer Management

This sub-section presents an overview of buffer management which should help you to understand what is going on behind the scene when a program executes. Luckily, the average programmer operates at a fairly abstract level, divorced from the need to know about buffer addressing. The real drudgery of buffer management is performed by UFAS-EXTENDED and other software modules with which it interfaces, for example, the Virtual Memory Manager (VMM).

The use of buffers involves working with large quantities of data in main memory so that the number of disk accesses can be reduced.

When a CI is requested, it is temporarily held in an area of main storage, known as a buffer. A good analogy for understanding buffers is to think of them as parking lots for holding file information in main memory. Whenever possible, COBOL READ and WRITE statements read from and write to buffers in memory.

If a required CI is already in a buffer, no read operation from disk needs to be performed. Management of buffers consists in minimizing the number of I/O operations. You can control the declared buffers through the following three parameters:

POOLSIZE	specified in the EXEC_PG command (JCL equivalent: SIZE statement)
BUFPOOL	Specified in the DEFi parameter group, (JCL equivalent: DEFINE)
NBBUF	Specified in the DEFi parameter group, (JCL equivalent: DEFINE)

```
EXEC_PG MYPROG
    [SIZE=dec8]                                    } program level
    [POOLSIZE = dec8]...                           }

    FILE1 = ifn1                                   }
    ASG1 = efn1                                    }
    DEF1 = ([BUFPOOL = name4 NBBUF = dec3])        }file level
    FILE2 = ifn2                                   }
    ASG2 = efn2                                    }
    DEF2 = ([BUFPOOL = name4 NBBUF = dec3].  ..);  }
```

The use of large buffer pools is no longer restricted to TDS applications: a new functionality is provided for heavy batch steps. See the examples in Section 5.12.4 for full details.

The following sections describe the use of buffers as they apply to TDS, batch, and IOF applications.

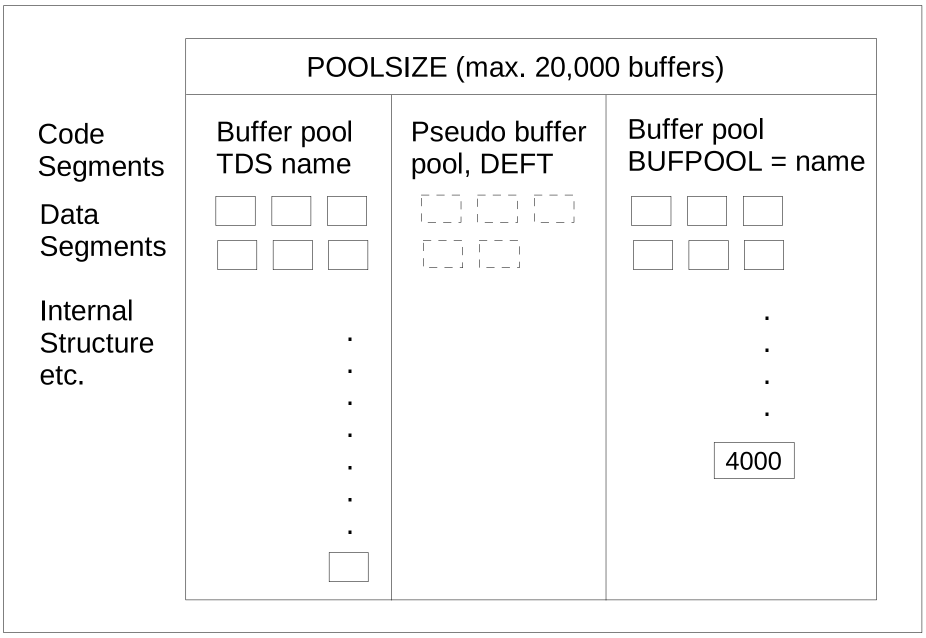


Figure 5-14. Layout of Buffer Space

Note that it is the ICA attribute of the dimension which guarantees that a step will have a specified amount of memory available to it. The MINMEM option in the JCL statement SIZE is no longer meaningful with ARM. Within the total amount of buffer space allocated through use of the POOLSIZE parameter in the JCL statement SIZE, the following are set up:

- a pseudo buffer pool, named DEFT (buffers cannot be shared among the files),
- a buffer pool with the same name as the TDS application.
- in appropriate cases, a non-TDS buffer pool with name given by BUFPOOL = name in the DEFINE statement.

Note that the number of buffers in a job is limited to 20,000. For TDS applications, buffers are assigned in the main buffer pool, TDS name, using the RESERVE AREAS CLAUSE. For batch and IOF applications, use the NBBUF parameter of the JCL statement DEFINE to assign buffers in the other pools. The number of buffers in a pool should correspond to the total of NBBUF for all the files attached to the pool.

In the pseudo buffer pool (represented by the broken rectangles), five buffers are shown.

5.12.1 Declaring the Size of the Overall Buffer Space (POOLSIZE)

The maximum total amount of main memory reserved for buffers is specified in the POOLSIZE parameter. Use this parameter to specify in kilobytes the amount of main memory in which UFAS-EXTENDED creates and manipulates buffers during program execution. It must be emphasized that you should specify a much higher value than the default value (27 Kbytes).

It is recommended that you allocate the total buffer space required (POOLSIZE) in multiples of 4 Kbytes.

If several buffer pools are declared (described in the next sub-section), then the POOLSIZE value is the total amount of memory occupied by all the buffer pools.

TDS APPLICATIONS ONLY:

It is recommended that for all TDS applications (including TDS controlled and non-controlled files), a portion of memory be reserved for all buffer pools including the pseudo buffer pool known as DEFT.

- Plan on reserving from 20 to 50% or even more of the total memory size for the allocation of buffers, depending on the type of machine.
- Share the portion of memory reserved for buffers among the different TDS applications, depending on such factors as the importance of the application and the number of simultaneities and files.
- Estimate the number of buffers which the buffer pool may hold (developed in sub-section 5.12.3).
- Adjust the Declared Working Set.

When you increase the value of POOLSIZE, you should correspondingly increase the declared working set (DWS). Both parameters are specified in the JCL statement SIZE.

- Adjust the number of buffers to the POOLSIZE value.

The relationship between the POOLSIZE value and the number of buffers is further developed in sub-section 5.12.3.

BATCH/IOF APPLICATIONS ONLY:

Use the following formula to calculate an approximate value of the POOLSIZE parameter:

```
POOLSIZE = (Average nbpg * 4 Kbytes) * NBBUF
```

where nbpg is the number of pages needed to hold a CI, that is:

$$\text{nbpg} = \frac{\text{CISIZE}}{4096} \quad \text{rounded up to a multiple of 4 bytes.}$$

Assume that this formula produces the result of 400 Kbytes for POOLSIZE. Then you can specify this parameter as follows:

```
EXEC PG MYPROGRAM
SIZE = 500
POOLSIZE = 400;
```

5.12.2 Defining a Buffer Pool (BUFPOOL)

Buffer pools reduce the amount of storage allocated to buffers by sharing buffer space among several files. When a buffer is needed, it is taken from a pool of available buffers. When UFAS-EXTENDED receives a request to read a certain CI, it looks to see if one of its existing buffers already contains that CI. If no buffer contains it, then UFAS-EXTENDED finds from its pool of buffers one that is not currently in use and loads the contents of the requested CI into it.

Use of buffer pools is recommended whenever possible, particularly in applications which access many files randomly.

To name a buffer pool, specify the BUFPOOL parameter in the file-define parameter group DEFi (JCL equivalent DEFINE).

TDS APPLICATIONS ONLY:

A large UFAS-EXTENDED buffer pool can result in substantial performance improvements:

- up to 50% reduction in the number of I/O operations,
- improved response times.

By default, a TDS application has available:

- one buffer pool for all the TDS-controlled files, whose name corresponds to that of the TDS application,

- a pseudo buffer pool which is automatically provided for the non-controlled files.

The disadvantage of using the DEFT pseudo buffer pool is that the buffers are not shared among the non-controlled files such as H_CTLN.

In TDS applications, the use of a single buffer pool (tdsname) is normally recommended. However, do not include in the common buffer pool files which are accessed:

- in sequential mode: these files require only a few buffers (two if they are declared sequential, otherwise about 10 buffers),
- in direct mode if they have only a few CIs: such files should be placed together in a specific buffer pool for which the number of buffers is equal to the total number of CIs.

A second buffer pool can also be used for input files containing tables such as the name and address of customers or the product details in a stock application. Another possible use concerns indexed sequential files accessed sequentially (to avoid saturation of the main buffer pool).

You must specify in the DEFi parameter group (JCL equivalent DEFINE) for each file in a buffer pool:

- the name of the buffer pool (BUFPOOL),
- the number of buffers (NBBUF).

If you omit one of these values, then the default values are as follows:

- the buffer pool is named according to the TDS application (tds-name),
- the number of buffers declared in the "RESERVE n AREAS" clause will apply.

Note that the number of buffers specified in the "RESERVE n AREAS" clause is the default value for all the buffer pools in a TDS application.

BATCH/IOF APPLICATIONS ONLY:

You can define no buffer pools, or one, or several, although the use of more than one buffer pool is appropriate only in very rare cases. It is particularly advantageous to specify a buffer pool for a step randomly accessing more than five files. If a buffer pool is being used, do not include sequential files in it. Use the LMC mechanism instead.

5.12.3 Defining the Number of Buffers (RESERVE AREAS/NBBUF)

When you open a file, UFAS-EXTENDED allocates a number of buffers to accommodate the CIs transferred from disk. NBBUF specifies the number of buffers per file. You specify this parameter in the file-define parameter group DEFi described earlier, or in the JCL equivalent DEFINE.

The minimum number of buffers, for all types of access on all types of organization, is 1 per file.

The default values for NBBUF are as follows:

- a file accessed in non-sequential access mode has 1 buffer (NBBUF = 1)
- a file accessed in sequential access mode has 2 buffers (NBBUF = 2)
- an indexed sequential file accessed directly has 1 buffer. Additional buffers are reserved for CI splitting.
- an IDS/II area has 4 buffers.

In dynamic-access mode, UFAS-EXTENDED keeps its buffers in memory as long as possible.

You may specify a number of buffers:

- either for each individual file,
- or at the level of the buffer pool in which files share buffers.

Whenever possible, it is recommended that you use a buffer pool and that you specify the same NBBUF value for each file belonging to the same buffer pool.

TDS APPLICATIONS ONLY:

Choose the number of buffers (specified in the RESERVE AREAS clause) so that the size of the memory reserved for buffers (POOLSIZE) is effectively used. The maximum number of buffers per TDS application is 20,000. Up to 32,000 buffers may be defined for the whole system.

Specify an estimated value, such as:

```
Number of Buffers =  POOLSIZE divided by (No. of pages * 4 Kbytes)
```

For example, if the CISIZE is 6 Kbytes, then 2 pages are required because each page occupies 4 Kbytes. Note that the:

```
No. of pages =  CISIZE divided by 4096 rounded up
to a multiple of 4 Kbytes.
```

You can refine your estimate by comparing the figure given for USED SIZE and POOLSIZE in the JOR. If USED SIZE is less than POOLSIZE, then increase the number of buffers up to the maximum specified in the RESERVE AREAS clause; otherwise decrease the value of the POOLSIZE parameter and the declared-working-set.

If you are using two or more buffer pools, specify the same number of buffers (NBBUF value in the DEFINE statements) for each file belonging to the same buffer pool (see the second TDS example in the next sub-section).

BATCH/IOF APPLICATIONS ONLY:

The default values for the buffer parameters mean that each file is allocated 1 or 2 buffers so that:

```
POOLSIZE >= (no. of pages * number of buffers)
```

You can override the default NBBUF values by specifying a value in the NBBUF parameter within the file-define parameter group DEFi (JCL equivalent DEFINE).

It is a good general rule that NBBUF for each file should be not less than 6 plus the number of secondary indexes. Using this rule for sequential files with several secondary indexes, instead of the normally recommended 100 buffers, will result in greatly improved performance.

In the first IOF and batch example, the number of buffers per file is defined on a file-by-file basis through use of the NBBUF parameter.

5.12.4 Examples of Buffer Usage

FIRST TDS EXAMPLE: - One buffer pool matching the name of the TDS application, in this case TSIC.

It is assumed that 1,000 buffers are specified in the "RESERVE n AREAS" clause.

```
$JOB TDS-EX  USER=BULL1;
$JOBLIB SM,TSIC.SMLIB;
STEP TSIC,FILE=(TSIC.LMLIB),REPEAT
DUMP=NO;
SIZE 4500 POOLSIZE=4000;
ASSIGN IFN1 EFN1;
ASSIGN IFN2 EFN2;
ASSIGN IFN3 EFN3;
ASSIGN IFN4 EFN4;
ASSIGN IFN5 EFN5;
ASSIGN IFN6 EFN6;
ASSIGN IFN7 EFN7;
ASSIGN IFN8 EFN8;
ASSIGN IFN9 EFN9;
ASSIGN IFN10 EFN10;
.............................................................
.............................................................
ASSIGN IFN50 EFN50;
ASSIGN IFN51 EFN51;
.............................................................
.............................................................
ASSIGN IFN70 EFN70;
ASG DBUGFILE,TSIC.DEBUG,FILESTAT=CAT,SHARE=DIR;
ASG BLIB,.FORM.BIN,SHARE=DIR,ACCESS=READ;
$ASG H_BJRNL DVC=MS/D500 MD=FSD99 FILESTAT=TEMPRY;
ASG H_FORM,.FORM.OBJET,FILESTAT=CAT
SHARE=MONITOR,ACCESS=READ;
$DEFINE H_CTLM ,JOURNAL=BEFORE;
ENDSTEP;
$ENDJOB;
```

The average CISIZE is estimated at 3,584 bytes. If the declared POOLSIZE value for these buffers is 4,000 Kbytes, then the required number of buffers is:

```
4000 Kbytes divided by 4 Kbytes = 1000 buffers.
```

NOTE:
The 4000 Kbytes includes the space occupied by the buffers of the non-controlled files.

SECOND TDS EXAMPLE: Using two or more Buffer Pools.

In addition to the main buffer pool (in this case named TSIC), a second buffer pool named PARA is used by two files.

It is assumed that 1,000 buffers are specified in the "RESERVE n AREAS" clause.

```
$JOB TDS-EX  USER=BULL2;
$JOBLIB SM,TSIC.SMLIB,TSIC.TEST;
STEP TSIC,FILE=(TSIC.LMLIB),REPEAT
DUMP=NO;
SIZE 5000 POOLSIZE=4400;
ASSIGN IFN1 PARAM1;
DEFINE IFN1  NBBUF=100 BUFPOOL=PARA;
ASSIGN IFN2 PARAM2;
DEFINE IFN2  NBBUF=100 BUFPOOL=PARA;
ASSIGN IFN4 EFN4;
ASSIGN IFN5 EFN5;
ASSIGN IFN6 EFN6;
ASSIGN IFN7 EFN7;
ASSIGN IFN8 EFN8;
ASSIGN IFN9 EFN9;
ASSIGN IFN10 EFN10;
.............................................................
.............................................................
ASSIGN IFN50 EFN50;
ASSIGN IFN51 EFN51;
.............................................................
.............................................................
ASSIGN IFN70 EFN70;
ASG DBUGFILE,TSIC.DEBUG,FILESTAT=CAT,SHARE=DIR;
ASG BLIB,.FORM.BIN,SHARE=DIR,ACCESS=READ;
$ASG H_BJRNL DVC=MS/D500 MD=FSD99 FILESTAT=TEMPRY;
ASG H_FORM,.FORM.OBJET,FILESTAT=CAT
SHARE=MONITOR,ACCESS=READ;
$DEFINE H_CTLM ,JOURNAL=BEFORE;
$DEFINE H_CTLN ,BUFPOOL=TSIC;
ENDSTEP;
$ENDJOB;
```

The average buffer size for the files belonging to the default buffer pool (TSIC) is estimated at 3,584 bytes.

The two files belonging to the buffer pool PARA have a total number of 100 buffers (the size of the CI is 2048 bytes).The contents of these files will reside in memory because the buffer pool to which they belong may contain the 100 buffers.

The global size (POOLSIZE) declared for the buffer pool is 4400 Kbytes. From this figure must be taken the 400 Kbytes for the PARAM1 and PARAM2 files, whose 100 buffers are contained in the buffer pool named PARA.. (The amount of space set aside for these buffers is calculated by multiplying 100 by 4 Kbytes=400 Kbytes.)

The remaining 4000 Kbytes are occupied by the buffer pool TSIC. The number of buffers is calculated as follows:

```
4000 Kbytes divided by 4 Kbytes = 1000 buffers.
```

Note that the non-controlled file H_CTLN is declared in the main buffer pool TSIC (DEFINE H_CTLN BUFPOOL=TSIC).

FIRST IOF EXAMPLE: No Buffer Pool is Specified

```
EXEC_PG PG=LMNAME LIB=.LMLIB
SIZE 700 POOLSIZE=1320
FILE1=IFN1 ASG1= EFN1
DEF1=(IFN1 NBBUF=200)
FILE2=IFN2 ASG2= EFN2
DEF2=(IFN2 NBBUF=30)
FILE3=IFN3 ASG3= EFN3
DEF3=(IFN3 NBBUF=50);
```

When no buffer pool is specified, the pool size is computed as follows.

For each file compute (BUFFER SIZE * NBBUF) and add up the size obtained for each file.

In this example, a total of 280 buffers is declared.

Assume that the files have the following CISIZE values:

File	CISIZE
EFN1	2048
EFN2	3584
EFN3	6144

Then the POOLSIZE to be specified is:

```
EFN1  200 * (2048 rounded up to a multiple of 4 Kbytes)
                                  = (200 * 4 Kbytes) =  800 Kbytes
EFN2  30 * (3584 rounded up to a multiple of 4 Kbytes)
                                  = (30 * 4 Kbytes) =  120 Kbytes
EFN3  50 * (6144 rounded up to a multiple of 4 Kbytes)
                                  = (50 * 8 Kbytes) =  400 Kbytes

Total size occupied                                 = 1320 Kbytes
```

SECOND IOF EXAMPLE: A buffer pool is specified for an IOF application accessing more than 5 or 6 files.

```
EXEC_PG PG=LMNAME LIB=.LMLIB
SIZE 500 POOLSIZE=4000
FILE1=IFN1 ASG1= EFN1
DEF1=(IFN1 NBBUF=1000 BUFPOOL=PL01)
FILE2=IFN2 ASG2= EFN2
DEF2=(IFN2 NBBUF=1000 BUFPOOL=PL01)
FILE3=IFN3 ASG3= EFN3
DEF3=(IFN3 NBBUF=1000 BUFPOOL=PL01)
FILE4=IFN4 ASG4= EFN4
DEF4=(IFN4 NBBUF=1000 BUFPOOL=PL01)
FILE5=IFN5 ASG5= EFN5
DEF5=(IFN5 NBBUF=1000 BUFPOOL=PL01)
FILE6=IFN6 ASG6= SEQFILE;
```

Calculating the POOLSIZE in an IOF application having one buffer pool.

In this example, 1000 buffers are declared in a pool named PL01. The file SEQFILE is a sequential file and does not belong to this pool.

Assume that the files have the following CISIZE values:

File	CISIZE
EFN1	2048
EFN2	3584
EFN3	6144
EFN4	6144
EFN5	3584
EFN6	2048

If the average buffer size is 4 Kbytes, then the POOLSIZE to be specified is:

```
(1000 * 4 Kbytes) = 4 Mbytes
```

The values specified in the following two examples for a batch application are equally valid for an IOF application; instead of specifying JCL statements, you must specify the equivalent GCL commands.

FIRST BATCH EXAMPLE: No buffer pool is present.

```
$JOB B-EXPLS USER=BULL7 HOLD HOLDOUT;
STEP LMNAME .LM;
SIZE 700 POOLSIZE=600;
ASSIGN IFN1 EFN1;
DEFINE IFN1 NBBUF=20;
ASSIGN IFN2 EFN2;
DEFINE IFN2 NBBUF=30;
ASSIGN IFN3 EFN3;
DEFINE IFN3 NBBUF=50;
ENDSTEP;
$ENDJOB;
```

You follow the same procedure as that described in the first IOF example.

In this example, 100 buffers are declared. Assume that the files have the following CISIZE values:

File	CISIZE
EFN1	2048
EFN2	3584
EFN3	6144

The POOLSIZE value to be specified is 600 Kbytes which is calculated as follows:

```
EFN1    20 * (2048 rounded up to a multiple of 4 Kbytes)
                                  (20 * 4 Kbytes) =  80 Kbytes
EFN2    30 * (3584 rounded up to a multiple of 4 Kbytes)
                                  (30 * 4 Kbytes) = 120 Kbytes
EFN3    50 * (6144 rounded up to a multiple of 4 Kbytes)
                                  (50 * 8 Kbytes) = 400 Kbytes

Total                                             = 600 Kbytes
```

SECOND BATCH EXAMPLE: A buffer pool is specified for a batch application accessing more than 5 or 6 files.

```
$JOB B-EXPLS USER=BULL7;
STEP LMNAME .LM;
SIZE 500 POOLSIZE=400;
ASSIGN IFN1 EFN1;
DEFINE IFN1 NBBUF=100 BUFPOOL=PL01;
ASSIGN IFN2 EFN2;
DEFINE IFN2 NBBUF=100 BUFPOOL=PL01;
ASSIGN IFN3 EFN3;
DEFINE IFN3 NBBUF=100 BUFPOOL=PL01;
ASSIGN IFN4 EFN4;
DEFINE IFN4 NBBUF=100 BUFPOOL=PL01;
ASSIGN IFN5 EFN5;
DEFINE IFN5 NBBUF=100 BUFPOOL=PL01;
ASSIGN IFN6 EFN6;
DEFINE IFN6 NBBUF=100 BUFPOOL=PL01;
ASSIGN IFN7 SEQFILE;
ENDSTEP;
$ENDJOB;
```

In this example 100 buffers are declared in a buffer pool named PL01.
The file SEQFILE is a sequential file and does not belong to the buffer pool.

The total amount of memory reserved for buffers (POOLSIZE) is equal to the NBBUF value multiplied by the number of pages.

Assume that the files have the following CISIZE values:

File	CISIZE
EFN1	2048
EFN2	3584
EFN3	6144
EFN4	6144
EFN5	3584
EFN6	2048

If the average CISIZE is 3584, then the POOLSIZE value to be specified is:

```
100 * (3584 rounded up to a multiple of 4 Kbytes)
                                        = (100 * 4 Kbytes)
                                        = 400 Kbytes
```

Note that the POOLSIZE value (400 Kbytes) includes the space needed by the two buffers of the sequential file.

NOTES:

1. When different NBBUF values are specified for files belonging to the same buffer pool, only the highest NBBUF value is taken into account; hence the convention for specifying the highest NBBUF value for all such files.
2. If all the files belonging to the same buffer pool have the same CISIZE, the average buffer size is equal to:

   CISIZE rounded up to a multiple of 4 Kbytes.

For heavy BATCH applications: up to 4000 buffers may be specified for a BATCH step. Note that up to 32000 buffers are available for the whole system (including all the TDS and BATCH applications). This functionality may be used for heavy steps randomly accessing UFAS files. It should drastically decrease the number of physical IOs.

The following recommendations must be strictly respected to avoid aborts:

Do not launch such BATCH steps while TDS applications are running to avoid TDS or BATCH aborts with RC=SYSOV when more than 32,000 buffers are needed.

Specify for the BATCH step a POOLSIZE and a DWS large enough to avoid aborts with RC=CMWSOV. Gather within the same large BUFFER POOL all the UFAS files which are not accessed in sequential mode.

POOL SIZE COMPUTATION FOR HEAVY BATCH APPLICATIONS.

The computation of the POOLSIZE will depend on:

- the number of buffers declared for the buffer pool(s): up to 4000 buffers.
- the average buffer size.

NOTE:

For heavy batch steps running during the night, with a low multi-level and large memory available, it is better to compute the POOLSIZE taking into account the maximum CISIZE rather than the average.

FIRST EXAMPLE: GENERAL CASE.

```
JOB B-EXPLS USER=BULL7
STEP LMNAME .LM ;
SIZE 45000 POOLSIZE=16000;
ASSIGN IFN1 EFN1;
DEFINE IFN1 NBBUF= 4000 BUFPOOL=PL01;
ASSIGN IFN2 EFN2;
DEFINE IFN2 NBBUF= 4000 BUFPOOL=PL01;
ASSIGN IFN3 EFN3;
DEFINE IFN3 NBBUF= 4000 BUFPOOL=PL01;
ASSIGN IFN4 EFN4;
DEFINE IFN4 NBBUF= 4000 BUFPOOL=PL01;
ASSIGN IFN5 EFN5;
DEFINE IFN5 NBBUF= 4000 BUFPOOL=PL01;
ASSIGN IFN6 EFN6;
DEFINE IFN6 NBBUF= 4000 BUFPOOL=PL01;
ASSIGN IFN7 SEQFILE;
ENDSTEP;
ENDJOB;
```

In this example, 4000 buffers are specified for the six first files which are accessed randomly. These files belong to the same buffer pool called PL01. The seventh file, being sequential, does not belong to the buffer pool called PL01. It has only two buffers, allocated implicitly.

If all the files have the same CISIZE of 4096 bytes, then the buffer pool size will be:

```
         (4000 * 4K) = 16000 Kbytes.
```

SECOND BATCH EXAMPLE: TWO BUFFERS POOLS ARE SPECIFIED.

It may be useful to declare a second buffer pool, in order to gather together files having a specific behaviour.

For example, small files having only a few CIs and accessed very often may be resident in memory.

```
JOB B-EXPLS USER=BULL7
STEP LMNAME .LM ;
SIZE 60000 POOLSIZE=20000;
ASSIGN IFN1 EFN1;
DEFINE IFN1 NBBUF= 3000  BUFPOOL=PL01;
ASSIGN IFN2 EFN2;
DEFINE IFN2 NBBUF= 3000  BUFPOOL=PL01;
ASSIGN IFN3 EFN3;
DEFINE IFN3 NBBUF= 3000  BUFPOOL=PL01;
ASSIGN IFN4 EFN4;
DEFINE IFN4 NBBUF= 3000  BUFPOOL=PL01;
ASSIGN IFN5 EFN5;
DEFINE IFN5 NBBUF= 3000  BUFPOOL=PL01;
ASSIGN IFN6 EFN6;
DEFINE IFN6 NBBUF= 1000  BUFPOOL=PL02;
ASSIGN IFN7 EFN7;
DEFINE IFN7 NBBUF= 1000  BUFPOOL=PL02;
ENDSTEP;
ENDJOB;
```

In this example, 4000 buffers have been declared in two pools named PL01 with 3000 buffers, and PL02 with 1000 buffers.

POOL SIZE COMPUTATION WHEN SEVERAL BUFFER POOLS ARE SPECIFIED.

The pool size to be specified is the total amount of the memory dedicated to each buffer pool.

If the average buffer size in PL01 is estimated to be 4K, and the average buffer size in PL02 is estimated to be 8K, then the POOLSIZE to be specified will be :

```
      ( 3000 * 4K ) + ( 1000 * 8K ) = 20000K
        ( for PL01 )    ( for PL02 )
```

5.12.5 Tuning Buffers

To avoid wasting resources, you can modify an application's buffer parameters. The greater the number of buffers you specify, the fewer the disk I/O operations. The optimum setting for the buffer-related parameters can only be determined accurately by testing with different values. The maximum total size of the area reserved for buffers (POOLSIZE) and the number of buffers defined for the pool have a major impact on the performance of an application, in particular, TDS applications. Use the JOR statistics (described in the next sub-section) to verify how efficient the processing is and then tune the necessary parameters accordingly.

At the end of each step, the following information is printed in the JOR:

- for each UFAS-EXTENDED file and for all the files belonging to the same buffer pool:
  - GETCICOUNT, the total number of CI accesses including label, index and data CIs.
  - HITCOUNT, the number of buffers reused from the buffer pool (no I/O operation required).
- for the whole step:
  - Number of buffers deleted (SEGDL)
  - Number of buffers created (SEGCR)

To make the best use of buffers, UFAS-EXTENDED may create a buffer, re-activate an existing buffer ("remember" buffer), or delete a buffer. For further information on how UFAS-EXTENDED handles buffers, see Appendix E.

You can observe how the values affecting buffers work in practice by studying the JOR statistics.

By adjusting the number of buffers in direct relation to the size of the area reserved (POOLSIZE), it is possible to achieve the most efficient buffer use, in other words the highest hit ratio. A hit is the number of CI accesses involving no physical I/O operation. The hit ratio is the number of existing CIs accessed in the buffer pool to the total number of CIs accessed (buffer pool and physical I/O operations).

Tune application programs as follows:

- Choose the NBBUF value for each file, or for the whole buffer pool, so that the maximum number of buffers already allocated to the buffer pool is reused.
- The hit ratio is defined as:
- HITCOUNT divided by GETCICOUNT
  - Choose the POOLSIZE value in relation to the NBBUF value. Adding more buffers can significantly reduce disk access times. The trade-off is that you must specify a large enough POOLSIZE value. Normally, USED SIZE is slightly less than POOLSIZE.

Creation/Deletion of Buffers Within a Step

Buffer Creation

New buffers continue to be created until either the maximum number of buffers (given in the RESERVE AREAS clause), or the maximum total amount of main memory reserved for buffers (POOLSIZE) is reached. When one of these limits is reached, UFAS-EXTENDED uses a previously created buffer, provided the existing buffers are not busy, or are not used for DEFERRED UPDATES. Otherwise UFAS-EXTENDED will delete one or more of the existing buffers to make space available for new buffer(s).

The SEGCR counter indicates the number of buffers which are created for the step. This number also includes about 5 control structures created at file opening time.

Buffer Deletion

A buffer is deleted:

- when no existing buffer of the same size as the requested one can be re-used,
- when files are closed,
- at a checkpoint,
- at the end of the step (normal or abnormal termination).

The SEGDL counter indicates the number of deleted buffers. Note that SEGDL does not include the deletion of the control structures.

When the value for POOLSIZE and the number of buffers are correctly set, ensure that the number of buffers created (given by the SEGCR counter in the JOR) is close to the number of buffers defined in the RESERVE AREAS clause. The most efficient operation is when:

```
SEGCR divided by number of buffers
```

is approaching 1 for a batch step and is the lowest value for a TDS application. To optimize this ratio, ensure that as many CISIZE values as possible have the same size. However, in a TDS application, it is recommended that UFAS-EXTENDED files have up to 3 or 4 different CISIZE values.

5.12.6 UFAS-EXTENDED Statistics as Presented in the JOR

This sub-section explains the statistics that may appear in the JOR. To ensure that the buffer pool is being properly used, it is important to check these statistics.

```
>>> IFN=<internal file name>
    REWRITECNT=a   DELETECNT=b       WRITECNT=c    READCNT=d

>>> EFN=<external file name>
    GETCICOUNT=e   HITCOUNT=f        IOCOUNT=g

==> POOL=<pool name>
    NBFILES=h      NBBUF=i           GETCICOUNT=j
                                     HITCOUNT=k

>>> XUFAS   STEP   STATISTICS         STEP=<step name>
    POOLSIZE=l     USED SIZE=m        NBPOOLS=n
    AVAIL CI=p     FREE CI=q          TOTAL CI=r
    SEGCR=s        SEGDL=t

    READIOCT=u     WRITEIOCT=v
```

File Statistics are displayed for both the internal and external file names.

For each internal file name, IFN statistics give the number of logical records:

- rewritten
- deleted,
- written,
- read.

REWRITECNT	indicates the number of records rewritten to the internal file in question.
DELETECNT	indicates the number of records deleted from the internal file

WRITECNT	indicates the number of records written to the internal file
READCNT	indicates the number of records read in the internal file

IMPORTANT:
In COBOL 85, if you rewrite a record with a length different from the length of the existing record in the file, the rewrite operation is treated as a record deletion followed by a record insertion. Consequently, the number of records deleted from and written to the file is reflected in the DELETECNT and WRITECNT counters, and not in the REWRITECNT counter.

IFN statistics are not displayed for IDS areas because IDS uses specific verbs such as SEARCH and STORE.

For each external file name, EFN statistics give three counters concerning the number of all CIs accessed.

GETCICOUNT	is the total number of accesses to CIs which are either located on disks or found in the buffer pool.
HITCOUNT	is the number of accesses to CIs already allocated to the buffer pool.
IOCOUNT	is the number of physical I/O requests (each I/O request involves one CI).

Buffer Pool Statistics (POOL) give:

pool name	(in the case of a TDS application, this usually corresponds to the name of the TDS application),
NBFILES	is the maximum number of files that have been simultaneously opened in a given pool.
NBBUF	is the maximum number of buffers declared for the pool. NBBUF is meaningless for the pseudo buffer pool containing non-controlled files in TDS.
GETCICOUNT	is the total number of accesses to CIs (data, index, and label CIs).
HITCOUNT	is the number of CIs accessed without an I/O operation.

The remaining counters appear at **step** level:

POOLSIZE	is the declared amount of memory dedicated to buffers in the step. The value of POOLSIZE is expressed in bytes.
USED SIZE	is the size of the POOLSIZE that has actually been used. USED SIZE should be slightly less than the POOLSIZE. The value of USED SIZE is expressed in bytes.
NBPOOLS	is the maximum number of simultaneously opened pools.
AVAIL CI	indicates the number of entries available at system level when the step is completed.
FREE CI	indicates the number of entries which are not active (i.e., available entries + entries not active but reserved) at step termination.
TOTAL CI	indicates the maximum number of active entries used at system level by all the jobs in execution.
SEGCR	is the number of buffers (including control structures) that have been created.
SEGDL	is the number of buffers that have been deleted.
READIOCT	is the number of read I/O operations performed (see Note below).
WRITEIOCT	is the number of write I/O operations performed (see Note below).

NOTE:

The sum of the number of READIOCT and WRITEIOCT values is usually equal to the accumulated value of IOCOUNT which appears at file level. In the case of a TDS abort and subsequent restart, the IOCOUNT value may not correspond exactly to the sum of READIOCT and WRITEIOCT.

Example of File Statistics

```
>>> IFN=FILUP

    REWRITECNT=0   DELETECNT=1   WRITECNT=92   READCNT=608

>>> EFN=TDS1.FILUP

    GETCICOUNT=1242   HITCOUNT=1068   IOCOUNT=270
```

For the file TDS1.FILUP (whose IFN is FILUP):

- no record has been updated,
- one record has been deleted,
- 92 new records have been written,
- 608 records have been read.

These operations involved 1,242 CI accesses of which 1,068 required no physical I/O operation, because the requested CIs were already in memory; 270 I/O operations were done for this file.

Note that:

GETCICOUNT = HITCOUNT + number of physical READ I/O operations

IOCOUNT = physical READ I/O operations + physical WRITE I/O operations.

Example of Buffer Pool Statistics

Here is the printout of the POOL statistics, followed by an explanation.

```
==> POOL=TDS1

    NBFILES=34   NBBUF=500   GETCICOUNT=10225   HITCOUNT=7951

==> POOL=DEFT

    NBFILES=1   NBBUF=MEANINGLESS   GETCICOUNT=11   HITCOUNT=8
```

In this example,

- 34 TDS controlled files have been simultaneously opened in the TDS application named TDS1.
- the number of buffers shared among these files was 500 (RESERVE AREAS clause),
- the total number of accesses to CIs (data, index, and label CIs) performed for all the TDS-controlled files was 10,225.
- out of the 10,225 CI accesses, 7,951 of the required CIs were already located in the buffer pool, that is, 7951 buffers were re-activated.

One non-controlled file (the minimum) caused 11 CIs to be accessed, of which 8 were already located in the buffer pool, thus reducing the number of physical I/O operations.

Example of Step Statistics

```
>>>XUFAS      STEP STATISTICS        STEP = TDS1
  POOLSIZE = 3072000  USED SIZE = 2339288  NBPOOLS   =    2
  AVAIL CI =     110  FREE CI   =    1215  TOTAL CI  = 1005
  SEGCR    =     572  SEGDL     =     567

  READIOCT =    2243  WRITEIOCT =    1438
```

In this example, for the transactional application called TDS1, the defined POOLSIZE is 3,072,000 bytes, and reflects the $SIZE statement where POOLSIZE=3,000 (Kbytes) has been specified.

The actual size used by the buffers was 2,339,288 bytes (DEFT pool included).

Two pools have been used. Note that TDS usually creates a pool, whose name is the TDS name, for the controlled files, and the default pool called DEFT for the non-controlled files. The DEFT pool is always created for a TDS application.

110 buffer entries are available for any job when it is activated. 1215 buffer entries are available and not reserved by any job. A total of 1005 buffer entries have been created.

In this TDS1 step, 572 buffers (segments) have been created (control structures are included), whereas 567 have been deleted.

2,243 physical READ operations and 1,438 physical WRITE operations were performed on all the UFAS-EXTENDED files.

5.13 Journalization

The following two sub-sections explain some of the journalization techniques supported for UFAS-EXTENDED files. For maximum protection, use the JOURNAL = BOTH option. This involves extra I/O operations. If the file is cataloged, it is preferable to define the journal entry in the catalog. For more details, refer to the *File Recovery Facilities User's Guide*.

5.13.1 Before Journal

GCOS7 copies each data CI before it is changed by the processing program and places it in the Before Journal.

You request this system facility either through the catalog, or through the file-define parameter group DEFi (JCL equivalent DEFINE), for example,

```
EXEC_PG MYPROGRAM
        FILE = INOU
        ASGI = JC.FDB
        DEF1 = (JOURNAL = BEFORE);
```

If the program aborts, these "before" images may be used to restore (rollback) the file's contents. Figure 5-15 summarizes Journal support for UFAS-EXTENDED files.

	Open Mode		
File Organization	OUTPUT	EXTEND (APPEND)	I-O
Sequential tape	No	No	-
Sequential disk	No	No	Yes
Relative	Yes*	Yes*	Yes
Indexed Sequential	No	Yes**	Yes

Figure 5-15. Using the Before Journal

The APPEND open mode is the GPL equivalent of the EXTEND open mode in COBOL.

The asterisk (*) indicates that such a file can be journalized only in direct-access mode. In the EXTEND/APPEND column, only GPL files can be journalized in direct-access mode.

The asterisks (**) indicates that sequential file can only be opened in EXTEND mode in COBOL-85.

The symbol (-) indicates that this open mode is not applicable.

When the Before Journal is not specified, the only way to guarantee file recovery is by taking checkpoints.

5.13.2 After Journal

GCOS7 copies each logical record, after it has been updated, and writes it to the After Journal on the disk specified. If a software error or a volume failure occurs, the "after" images may be used to restore (rollforward) the file's contents.

Athough it is recommended that journal entries be defined in the catalog, you can specify them through the file-define parameter group DEFi, for example,

```
EXEC_PG MYPROGRAM
        FILE = INOU
        ASG1 = JC.FDB
        DEF1 = (JOURNAL = AFTER);
```

	Open Mode		
File Organization	OUTPUT	EXTEND (APPEND)	I-O
Sequential tape	No	No	-
Sequential disk	No	No	Yes
Relative	No	No	Yes
Indexed Sequential	No	Yes*	Yes

Figure 5-16. Using the After Journal

The asterisk (*) indicates that an indexed sequential file can be opened in EXTEND mode only in COBOL-85.

The symbol (-) indicates that this open mode is not applicable.

The APPEND open mode is the GPL equivalent of the EXTEND open mode in COBOL.

In a TDS application, it can be preferable to use the After Journal with the Deferred Update mechanism instead of the Before Journal since this reduces I/O overheads and thus improves response times. However, if CI splitting occurs while the Deferred Update mechanism is in use, the return code WDNAV will be sent.

5.14 File Integrity

UFAS-EXTENDED protects files against aborts, system crashes and persistent I-O errors. UFAS-EXTENDED takes action to avoid leaving files unstable and, where this is not possible, the user is warned with a return code.

An unstable file is a file that is not closed properly, and as a result, the header or trailer labels have not been written properly. An unstable index means that either there are records with no index path to them, or there are index entries that do not point to any records.

5.14.1 File Creation

When you open a file in OUTPUT:

- you create new records for the file and any previous records are deleted. Only the records written to the file between the opening and closing of the file are considered the new contents of the file.

The only way to ensure file recovery is by using the checkpoint mechanism. You cannot use the Before or the After Journal at file creation time.

When you open a file in EXTEND mode (GPL equivalent is APPEND):

- it is the same as opening it in OUTPUT mode except that, at opening time, new records are written after the last record.

After a GCOS7 crash, you may be asked at restart time to reply to the REPEAT FROM CHECKPOINT question for a file:

- If you answer YES, the file is restored to the state it was in at the time the last checkpoint was taken and the step continues until the program ends.
- If you answer NO, the file remains unstable.

In the event of an abort, at the time of the last checkpoint you are asked to reply to the REPEAT FROM CHECKPOINT question for a file:

- If you answer YES, the file is restored to the state it was in at the time the last checkpoint was taken and the step continues until the program ends.
- If you answer NO, the file is closed and remains in the state it was in at the time of the abort.

5.14.1.1 Files without Secondary Keys

If a user program aborts, or if the operator issues a CANCEL_JOB command, the file is closed as it was at abort time.

If a system crashes, the file is not closed, but is left in an unstable state. Any attempt to reopen the file other than in OUTPUT mode, will return the DATANAV return code.

5.14.1.2 Files with Secondary Keys

The recommended procedure for creating secondary keys is described in subsection 4.8.1.

For files with secondary keys, primary keys are created first, then secondary keys are created. When the user program uses the COBOL clause APPLY NO-SORTED-INDEX ON, the secondary keys are not built at file creation time, in which case you must use the SORT_INDEX (JCL equivalent SORTIDX) command to sort and load the secondary indexes later. In GPL, when a file is opened in OUTPUT mode, secondary indexes are never created.

If an abort or a crash occurs when secondary indexes are being created, the secondary keys are left unstable. Any attempt to open the file (other than in INPUT or OUTPUT mode, or while SORT_INDEX is executing) will return the SCIDXNAV return code. If you open the file in INPUT mode, any attempted access via secondary keys will also return the SCIDXNAV return code.

5.14.2 File Processing

5.14.2.1 INPUT Open Mode

Journalized file:	If the file is unstable, it can be read (INPUT open mode) only through use of the file recovery utilities.
Non-journalized file:	A stable or an unstable file can be opened in INPUT open mode and read in sequential access mode only. In the case of an unstable file, this open mode will be useful for restoring the file.

Trying to read a file in direct access mode through unstable paths, however, will be denied and:

- the return code FLNAV (file is not available) will be returned if the primary index is unstable,
- or the return code SCIDXNAV (secondary index is not available) will be returned if the secondary index is unstable.

5.14.2.2 EXTEND Mode

In COBOL-85, you may also use the Before Journal and the After Journal for the sequential indexed files (refer to figures 5.15 & 5.16) in EXTEND mode (GPL equivalent APPEND).

5.14.2.3 Files Without Secondary Keys

If an abort occurs while UFAS-EXTENDED is splitting a CI, the split will be terminated before the abort occurs. The file is then closed and is left in a stable state.

If the system crashes, the file is not closed, but is left unstable.

There are 3 cases to consider:

File Not Protected by Journalization

Any attempt to reopen the file, will be accepted.

If you reopen the file in INPUT open mode,

Its indexes are considered as damaged and any key access will be denied, causing the return code FLNAV to be returned.

If you reopen the file in I-O open mode,

The file is automatically salvaged by the UFAS-EXTENDED File Salvager; this salvaging can detect whether a CI was being split at the time of the crash and will restore the file consistency as at that point.

NOTE:

In batch mode, when the Before Journal is not used and records are inserted after a checkpoint, but before a system crash, the return code DUPKEY will be returned if the program tries to insert these records again after a warm restart. The records will not be inserted and the processing will continue normally. This return code is ignored.

File Protected by the Before Journal

Such instability can be avoided by using the Before Journal with such files. If you are using the Before Journal, the Before images are rewritten automatically at warm restart; therefore no salvaging is required.

File Protected by Deferred Updates and the After Journal

Such instability can be avoided by using the After Journal and Deferred Updates (used only in a TDS application). The After Journal protects against all kinds of incidents by keeping an image of each record after it has been updated. As an alternative to the Before Journal, you can use the Deferred Update option. Deferred Update means that all updates are not written immediately to the files. If an incident occurs, the program discards the updates.

5.14.2.4 Files With Secondary Keys

If an abort occurs while UFAS-EXTENDED is splitting a CI, the split will be completed before the abort occurs. The file is then closed and left in a stable state. Moreover, the whole set of accesses needed to complete an update request is protected in the same way as splitting so that secondary indexes remain consistent with primary indexes and data.

If a system crash occurs, the file is not closed but is left in an unstable state. Its primary and secondary indexes are damaged.

There are 3 cases to consider:

1 **File Not Protected by Journalization**

The salvaging mechanism is different according to the type of index.

Primary indexes are salvaged automatically as discussed in sub-section 5.14.2.3.

You must rebuild secondary indexes by using the SORT_INDEX (JCL equivalent SORTIDX) utility. In this case, the UFAS-EXTENDED salvager issues a message in the JOR requesting that you run the GCL utility SORT_INDEX against the file. If you attempt to access the file via a secondary key before using the SORT_INDEX (SRTIDX) utility (JCL equivalent SORTIDX), your attempt will be rejected and the return code SCIDXNAV will be returned.

2 **File Protected by the Before Journal**

If the file was protected by Before Journal, it is automatically reopened in input-output mode at system restart; the purpose being to rollback the data part and the dense level of secondary indexes to their last stable state. It is important to note that, in this context, the other index levels are not rollbacked, having not been journalized. This means that a possibility of index/data incoherence may occur, specially when splittings occured before the system crash. This is the reason why it is recommended to execute the SORTIDX utility after the rollback phase to restore the coherency. If it is not achieved, programms accessing such files in read access mode may get some ADDROUT return codes when trying to access records implied by the incoherency situation.

3 **File Protected by Deferred Updates and the After Journal (TDS applications only)**

As for files without secondary keys above.

NOTE:
Secondary-index salvaging is not automatic and is more time consuming than primary-index salvaging.

5.14.3 File Extension

UFAS-EXTENDED supports file extension, both dynamic and static, for sequential and indexed sequential files.

A relative file does not support static file extension. However, a relative file that is accessed sequentially can be dynamically extended only in OUTPUT or EXTEND (COBOL-85 only) open mode. The GPL equivalent of EXTEND is APPEND. When a relative file is opened in APPEND mode, extra space is usually allocated from the end of the relative file, but in GPL you can specify the record address from which you wish to extend the relative file.

Dynamic Extension:

If during a run the allocated space is filled and more space is required, the file will be extended if you specify the INCRSIZE parameter in the BUILD_FILE (JCL equivalent PREALLOC) or CREATE FILE (JCL equivalent FILALLOC) command that is described later in Section 6.

If you wish to change the value of the INCRSIZE parameter for a cataloged file, use the MODIFY_FILE (JCL equivalent FILMODIF) command that is also described in Section 6.

Static Extension:

Use the MODIFY_FILE_SPACE (MDFSP) command (described later in Section 6). The JCL equivalent is the PREALLOC statement with the EXTEND parameter.

In both cases a file is extended only if there is enough space on the disk to accommodate the extension.

If a crash occurs during file extension, UFAS-EXTENDED can resume automatically and complete the extension when you reopen the file.

5.14.4 Permanent I-O Errors

If the After Journal is specified, you can restore the file from a previously saved copy of the file through the use of the RESTORE_FILE (JCL equivalent FILREST) command; then use the static rollforward utility to roll forward the file. For more details on the ROLLFWD utility, refer to the *File Recovery Facilities User’s Guide*.

If the After Journal is not specified, you can restore the file only from a previously saved copy, using the RESTORE_FILE (JCL equivalent FILREST) command.

6. Designing and Allocating UFAS-EXTENDED Disk Files

6.1 Summary

This section covers the following topics:

- what happens when you allocate a file,
- CISIZE,
  - recommended filling capacity for CIs,
  - storage capacity for the different disk devices,
- choosing the initial size (SIZE),
- choosing the increment size (INCRSIZE),
- simulating how a file is allocated (CREATE_FILE),
- calculating space requirements for:
  - a sequential file,
  - a relative file,
- detailed design guidelines for indexed sequential files,
  - choosing CISIZE,
  - choosing Free Space (CIFSP),
  - mass insertion,
- calculating file space for an indexed sequential file:
  - without secondary indexes,
  - with secondary indexes,
- file-allocation commands/DMU utilities.

6.2 Preliminary Remarks

In the previous section we looked at some of the most important aspects of UFAS-EXTENDED. What we are going to discuss here is of equal importance since we will be seeing how to design and allocate space for UFAS-EXTENDED disk files. Further information is provided in Appendix E.

First, you need to understand the reasons behind the GCL or JCL statements that you type in at your terminal to be really confident and competent in allocating UFAS-EXTENDED files.

The GCL commands for allocating UFAS-EXTENDED files are described towards the end of Section 6. You will find a complete description of the JCL statements in the JCL Reference Manual and the utilities are covered in the *Data Management Utilities (DMU) User's Guide*.

You can allocate files only on disk volumes that have been prepared (labeled and formatted) with the following commands:

PREPARE DISK (PRPD) (JCL equivalent VOLPREP),

PREPARE VOLUME (PRPV) JCL equivalent VOLPREP (See Table 8-2).

For a description of these commands, see the *IOF Terminal User's Reference Manual (Part 2)*, the *JCL Reference Manual*, and the *DMU User's Guide*.

Before records can be written to a disk file, you must allocate file space and ensure that the file's attributes are known to the system.

There are several methods of allocating a disk file:

- using the GCL command BUILD_FILE (BF) (JCL equivalent PREALLOC) described later in this Section,
- using the GCL command CREATE_FILE (CRF) (JCL equivalent FILALLOC) described later in this Section (you can simulate how a file is to be allocated),
- using the file-allocation parameter group ALCi with its associated parameter group (JCL equivalent ALLOCATE) described later in this Section,
- using the GCL parameter DYNALC (JCL equivalent OUTALC) in the file management utilities.

6.3 What Happens when you Allocate a File

This sub-section explains background information that will help you understand why files are allocated the way they are.

The execution of a file allocation command such as BUILD_FILE (JCL equivalent PREALLOC) reserves space for a disk file, and creates the necessary file labels which contain details of the file organization.

It is recommended that you allocate a file on an FSA disk in units of blocks, 100KB, or records (for a description of the UNIT parameter, see later in this Section). The values CYL and TRACK are maintained for reasons of compatibility with existing GCL/JCL. At allocation time, an FBO disk file is always allocated in blocks, no matter what allocation unit was specified (cylinder, record, block, or quantum of 100KB). The corresponding values for the units of cylinder and track are:

- 1 cylinder = 1 000 Kbytes,
- 1 track = 50 Kbytes.

UFAS-EXTENDED reserves space on FSA disks in units of blocks and on non-FSA disks in units of disk tracks or cylinders (described in Section 1). Blocks, disk tracks, or cylinders are allocated to the VBO disk file as a series of one or more extents.

An extent is a group of one or more contiguous blocks (tracks or cylinders for VBO files). On any one volume, you may allocate a file up to 16 extents (the default value is 5 extents). However, you can limit the number of extents to one for example, with the MAXEXT keyword in the BUILD_FILE command.

If you specify the size in CIs (UNIT = CI for VBO files, UNIT=BLOCK for FBO files),

- the BUILD_FILE (JCL equivalent PREALLOC) command calculates the number of tracks in the case of VBO disk files (based on the CISIZE) and allocates the file:
  - in blocks for FBO files,
  - in tracks for VBO files.

  The maximum number of CIs in a file is:

  16 777 215 (2**24 - 1)

If you specify the size in units of records (UNIT = RECORD),

- the BUILD_FILE (JCL equivalent PREALLOC) command calculates the number of tracks (or blocks) based on the RECSIZE and CISIZE and allocates the file accordingly.

If you specify the size in units of tracks (UNIT = TRACK), or cylinders (UNIT = CYL),

- the BUILD_FILE (JCL equivalent PREALLOC) command allocates the file as a number of blocks for FBO files and as a number of tracks or cylinders for VBO files. You should specify TRACK or CYLINDER in the UNIT parameter only for files being allocated on VBO disk volumes.

The effect of leaving free space in an UFAS-EXTENDED indexed sequential file being allocated in units of records (UNIT=RECORD) is covered later in this Section.

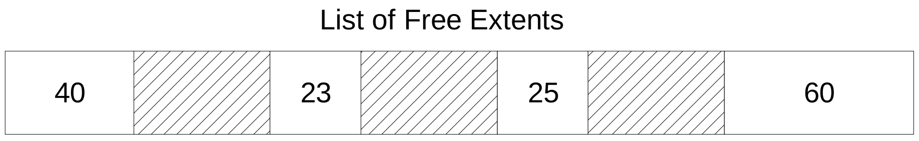
Where a multivolume file is to be allocated, you can specify the amount of space to be taken on each volume (SPLIT) as well as the position at which the allocation is to start.

The start address can be identified by:

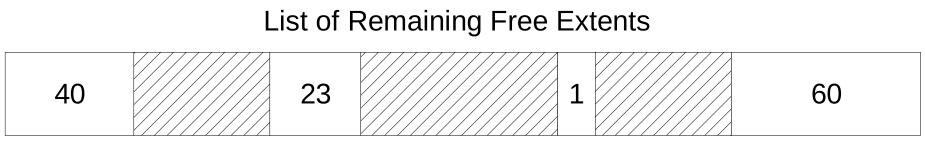
- blocks for FBO disk files,
- cylinder and addresses for VBO disk files.

When you specify the SPLIT parameter, only one extent may be allocated per volume. You cannot use the SPLIT parameter when UNIT = CI or UNIT = RECORD.

UFAS-EXTENDED allocates space by scanning the list of available free-space extents.
UFAS-EXTENDED chooses the smallest extent of those greater than or equal to the space required, if any.



For example, if the extents were 40, 23, 25, and 60 cylinders, a request for 24 would be allocated on the 25-cylinder extent, leaving unused extents of 40, 23, 1, and 60 cylinders.



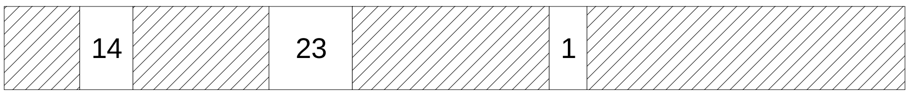
If the space that you request is larger than the largest available free extent, UFAS-EXTENDED allocates the largest extent. UFAS-EXTENDED then chooses the remaining space still required:

either by searching for the smallest of the extents that are large enough,

or by choosing the largest, and then searching for space for the remainder.

Thus, if you request 86 cylinders with the above space list (60+40), UFAS-EXTENDED allocates the 60- and 26-cylinder extents.

List of Remaining Free Extents



6.3.1 Choosing the CI Size (CISIZE)

It is important to choose the size of a CI carefully.The CISIZE parameter specifies the CI size in bytes. The size of a CI is always a multiple of 512. UFAS-EXTENDED always rounds up the size of a CI that you specify to a multiple of 512 if the size specified is not already such a multiple. Table 6-1 gives you the CI sizes that are recommended for each VBO disk drive. These CI sizes make the best use of disk space, but in TDS applications, the most important factor may be the response time, related to the number of index levels.

The larger the CISIZE, the larger the buffer(s) needed to process the file and the longer the processing time needed to split a CI. The advantage of specifying a large CISIZE is two-fold: fewer CI splitting operations will occur and there will be fewer I/O operations. Note that the buffer size = CISIZE when VERSION = CURRENT, or (CISIZE + 32) when VERSION = PREVIOUS, in both cases rounded up to a multiple of 4 Kbytes.

When you write variable-length records to a file, the number of records placed in a CI will depend on the cumulative total of record-lengths that fit in a CI. A record is never split over 2 CIs.

6.3.2 Recommended CI Sizes by Space Occupied

Table 6-1 shows the recommended CISIZE values for files being allocated on VBO disk volumes.

Table 6-1. Recommended CISIZE values

MS/B10			MS/D500		
CISIZE	CIs per Track	CIs per Cylinder	CISIZE	Data CIs per Track	Data CIs per Cylinder
32256	1 (81%)	15	28672	1 (98%)	24
19456	2 (98%)	30	14336	2 (98%)	48
12800	3 (96%)	45	9216	3 (95%)	72
9216	4 (93%)	60	6656	4 (91%)	96
7168	5 (90%)	75	5120	5 (88%)	120
6144	6 (93%)	90	4096	6 (84%)	144
5120	7 (90%)	105	3584	7 (86%)	168
4096	8 (83%)	120	3072	8 (84%)	192
3584	9 (79%)	135	2560	10 (88%)	240
3072	11 (85%)	165	2048	12 (84%)	288
2560	13 (81%)	195	1536	15 (79%)	360
2048	15 (78%)	225	1024	21 (74%)	504
1536	19 (69%)	285	512	34 (60%)	816
1024	26 (54%)	390			
512	40 (42%)	600			

VBO disk drives are divided into classes as follows:

Device Class Name	Disk Unit Family
MS/B10	1 Gigabyte disk drive
MS/D500	MSU1007

The CISIZE values shown in Table 6-1 make the best use of the available disk space. The file designer must also take into account other criteria such as the memory cost of buffers for a given CISIZE. Buffers are discussed in Section 5. For files accessed in TDS applications, the number of index levels is the most important factor.
The percentages in the 2nd column show the efficiency of track space used compared with the maximum track capacity.
From V5, data is accessed in fixed-sized memory units known as pages. A page can contain only one CI. Because it is important that the actual I/O transfers be done in efficient sizes, you can calculate the number of pages required by using the following formula:

`CISIZE divided by 4096` (rounded up to a multiple of 4 Kbytes)

For instance, a CI whose size is 4 096 requires a buffer capable of holding 1 page.

6.3.3 Disk-Storage Capacity

Table 6-2 shows the disk-storage capacity for FSA disk volumes.

Table 6-2. Number of CIs per FSA Disk Volume

CISIZE (in bytes)	Volume Capacity			
	FSA 320 MB	FSA 660 MB	LSS V1 1600 MB	LSS V2 2500 MB
512	628400	1302800	2669600	4154100
1024	314200	651400	1334800	2077050
1536	209466	434266	889866	1384700
2048	157100	325700	667400	1038525
2560	125680	260560	533920	830820
3072	104733	217133	444933	692350
3584	89771	186114	381371	593442
4096	78550	162850	333700	519262
4608	69822	144755	296622	461566
5120	62840	130280	266960	415410
5632	57127	118436	242690	377645
6144	52366	108566	222466	346175
6656	48338	100215	205353	319546
7168	44885	93057	190685	296721
7680	41893	86853	177973	276940
8192	39 275	81425	166850	259631
8704	36 964	76635	157035	244358
9216	34 911	72377	148311	230783
9728	33 073	68568	140505	218636
10240	31 420	65140	133480	207705
12288	26183	54283	111233	173087
14336	22442	46528	95342	148360
16384	19637	40712	83425	129815
18432	17455	36188	74155	115391
20480	15710	32570	66740	103852
22528	14281	29609	60672	94411
24576	13091	27141	55616	86543
26624	12084	25053	51338	79886
28672	11221	23264	47671	74180
30720	10473	21713	44493	69235
32256	9974	20679	42374	65938

Dividing the CISIZE into the capacity of the volume gives the maximum number of CIs which can be allocated on the volume for the particular CISIZE chosen. For example, by dividing 320 megabytes by 4 096, it is possible to fit a maximum of 78 550 CIs on a 320 Megabyte volume.

Table 6-3 shows disk-storage capacity and the total number of cylinders that you may allocate on a non-FSA disk volume.

Table 6-3. Storage Capacity of Non-FSA Disk Volumes

	Non-FSA Disk Volume	
	MS/D500	MS/B10
Cylinders per volume	707	1730
Additional Cylinders for Adternate Tracks	2	5
Tracks per Cylinder	24	15
Total Number of Tracks (excluding alternates)	16968	25950
Bytes per Track available to the User	29013	39381
Bytes per Cylinder	696312	590715
Total Capacity (Megabytes, approx)	500	1000

Tables 6-4 and 6-5 compare the capacity obtained when you allocate with a given CI size on volumes of the same type, but where the first is formatted in FBO with 4 Kbyte data blocks, whereas the second is formatted in VBO.

It is assumed that the whole volume is available (no DSMGT area) and that the file is mono-extent (on FBO volumes, CIs can still be split over two consecutive tracks).

Table 6-4. Comparative Capacity of VBO and FBO MS/D500 Volumes

MS/D500			
CISIZE	Number of CI's		Percentage difference
	VBO	FBO	
512	576912	101808	-82,35%
1024	356328	101808	-71,43%
1536	254220	101808	-60,00%
2048	203616	101808	-50,00%
2560	169680	101808	-40,00%
3072	135744	101808	-25,00%
3584*	118776	101808	-14,29%
4096	101808	101808	0,00%
4608	84840	50904	-40,00%
5120	84840	50904	-40,00%
5632	67872	50904	-25,00%
6144	67872	50904	-25,00%
6156	67872	50904	-25,00%
6656	67872	50904	-25,00%
7168	50904	50904	0,00%
7680	50904	50904	0,00%
8192	50904	50904	0,00%
8704	50904	33936	-33,33%
9216	50904	33936	-33,33%
9728	50904	33936	0,00%
to	33936	33936	0,00%
12288	33936	33936	0,00%
12800	33936	25452	-25,00%
to	33936	25452	-25,00%
14336	33936	25452	-25,00%
14848	16968	25452	50,00%
to	16968	25452	50,00%
16384	16968	25452	50,00%
16896	16968	20361	20,00%
to	16968	20361	20,00%
20480	16968	20361	20,00%
20992	16968	16968	0,00%
to	16968	16968	0,00%
24576	16968	16968	0,00%
25088	16968	14544	-14,29%
to	16968	14544	-14,29%
28672	16968	14544	-14,29%
29184	0	12726	-
to	0	12726	"
32256	0	12726	-

* FILALLOC default value

Table 6-5. Comparative Capacity of VBO and FBO MS/B10 Volumes

MS/B10			
CISIZE	Number of CI's		Percentage difference
	VBO	FBO	
512	1038000	207600	-80,0%
1024	674700	207600	-69.23%
1536	493050	207600	-57.89%
2048	389250	207600	-46.67%
2560	337350	207600	-38.46%
3072	285450	207600	-27.27%
3584*	233550	207600	-11.11%
4096	207600	207600	0.00%
4608	181650	103800	-42.86%
5120	181650	103800	-42.86%
5632	155700	103800	-33.33%
6144	155700	103800	-33.33%
6156	155700	103800	-33.33%
6656	129750	103800	-20.00%
7168	129750	103800	-20.00%
7680	103800	103800	0.00%
8192	103800	103800	0.00%
8704	103800	69200	-33.33%
9216	103800	69200	-33.33%
9728	77850	69200	-11.11%
12288	77850	69200	-11.11%
12800	77850	51900	-33.33%
13312	51900	51900	0.00%
16384	51900	51900	0.00%
16896	51900	41520	-20.00%
19456	51900	41520	-20.00%
19968	25950	41520	60.00%
20480	25950	41520	60.00%
20992	25950	34600	33.33%
24576	25950	34600	33.33%
25088	25950	29657	14.29%
28672	25950	29657	14.29%
29184	25950	25950	0.00%
32256	25950	25950	0.00%

* FILALLOC default value

6.3.4 Choosing the Initial Size (SIZE)

The SIZE parameter specifies the total amount of space to be allocated to a file. You can use this parameter in the BUILD_FILE (JCL equivalent PREALLOC) command, CREATE_FILE (JCL equivalent FILALLOC) command, the file-allocation parameter group ALCi (JCL equivalent ALLOCATE), and the DYNALC parameter (JCL equivalent OUTALC).

If you give a value for SIZE, this implies that the allocation is to be done in global mode. Global means that you give the total amount of space to be allocated and GCOS7 decides how to spread this over the volume(s) concerned.

In global mode, the volume(s) concerned are specified via the FILE parameter of the GCL commands BUILD_FILE and CREATE_FILE or one of the JCL statements PREALLOC, FILALLOC, or OUTALC .

The alternative to global mode is split mode (requested via the SPLIT parameter of the BUILD_FILE command). Split mode means that you choose the amount of space to be allocated on each volume. In addition, you can optionally specify the disk address(es) at which allocation is to start. In split mode, the volume(s) concerned and the amount of space on each are given via the SPLIT parameter.

Because you can extend indexed sequential files and sequential files (explained in the next sub-section), do not allocate more space than needed for the first creation. However, in the case of TDS applications, frequent file extensions are costly.

SIZE must be:

- less than 32 768 tracks if UNIT = 100KB, TRACK, or CYL,
- less than 16 777 216 if UNIT = BLOCK or CI,
- less than 2 130 706 306 if UNIT = RECORD.

6.3.5 Choosing the Increment Size (INCRSIZE)

The INCRSIZE parameter specifies the amount of space by which a file is automatically extended when it becomes full. INCRSIZE is measured in blocks, units of 100 Kbytes, cylinders, tracks, CIs, or records, depending on the unit specified by the UNIT parameter. For files being allocated on FSA disks, it is recommended that BLOCK or 100KB be specified in the UNIT parameter (described later in this Section).

The INCRSIZE parameter can be specified in the BUILD_FILE (JCL equivalent PREALLOC) command, CREATE_FILE (JCL equivalent FILALLOC) command, or the file-allocation parameter group ALCi (JCL equivalent ALLOCATE). The value declared does not override a non-zero value already declared in the catalog, or subsequently set by MODIFY_FILE (CATMODIF). In cases of conflict, the catalog value of INCRSIZE is always used.

The default value for INCRSIZE is 0, which means no automatic increment and the maximum value is 32 767.

The value of INCRSIZE should be large enough to avoid too many extensions. Ideally the file space will have been correctly estimated at the outset but, if an extension is necessary, the file space increment should be large enough (20 to 30% of the value specified in the SIZE parameter at the time of creation).

For static extension, use the SIZE parameter of the MODIFY_FILE_SPACE command (described later in this Section), or the JCL statement PREALLOC with the EXTEND parameter.

6.4 Simulating File Allocation

Instead of actually allocating a file, you can simulate its allocation by using the CREATE_FILE command (syntax is given later in this Section). This utility is quick and easy. You start with rough estimates, for example an estimate of the file size, and then refine each estimate in turn. No longer do you have to spend your time trying to calculate how many CIs are occupied by the address space 1 information or by the indexes in the case of an indexed sequential file. If you are working in line mode, ensure that the IMMED parameter is set to 0 so that you can modify the characteristics of the model file by supplying appropriate commands. If you do not specify the characteristics of the file that you wish to allocate, default values are applied for the following parameters:

- FILEFORM
- FILEORG
- RECFORM
- CISIZE
- RECSIZE
- UNIT
- SIZE
- INCRSIZE

To display the current characteristics of the file to be allocated, you then use the REPORT command. This utility gives the number of blocks, quanta of 100 Kbytes, cylinders (or tracks in the case of non-FSA disks). For a description of the REPORT command, see the *IOF Terminal User's Reference Manual.*

6.5 Calculating Space Requirements fir a Sequential File

You should be familiar with sequential-file concepts before proceeding. These concepts are described in Section 2.

User-supplied values for the calculation are RECSIZE (defined in the user program), CISIZE (chosen by the file designer) and the number of records that the file is to hold.

For a sequential file, the value that you enter for CISIZE must be within the following limits:

- must be greater than or equal to RECSIZE + 12 for VBO files (RECSIZE + 14 for FBO files),
- cannot exceed one track for a file being allocated on a VBO disk volume.

6.5.1 Fixed-Length Records

If you know the number of records in the file to be allocated, then an easy method of allocating the file is to set UNIT=RECORD in the BUILD_FILE command, and UFAS-EXTENDED automatically allocates the file. Otherwise you will need to use the CREATE_FILE utility or do the following calculations.

First calculate the number of records in a CI:

- Number of records per CI =
- (CISIZE - CI Header) divided by (RECSIZE + 4) rounded down
- To take account of the CI header information, subtract from the CISIZE:
  - 10 for files being allocated on FSA disks,
  - 8 for files being allocated on non-FSA disks.
  - add 4 to the size of the record to take account of the record-header information that occupies 4 bytes, (see Figure 2-3).

Then find number of CIs required:

Number of CIs =

(number of records) divided by (number of records per CI), rounded up

If you allocate file space by using the BUILD_FILE command and UNIT = CI, then SIZE = number of CIs will suffice.

In the case of a non-FSA disk volume, calculate the number of tracks required (and possibly from this the number of cylinders) by using the following formula:

Tracks = (number of CIs) divided by (CIs-per-track) plus 1, rounded up

The 1 extra track is that required for address space 1. If allocation is done in CIs, or in records, then this is automatically added, but you must take it into account if UNIT=TRACK or CYL. To find out the number of CIs per track, see Table 6-1.

Example of allocating an FBO disk file

A file PK.LOP of 2 349 records, each 220 bytes in length, is to be allocated on an MS/FSA volume.

A simulation of the file's allocation (described later in this Section) indicates that 90 blocks are required.

```
CREATE_FILE  PK.LOP:VOL1:MS/FSA
             FILESTAT = CAT
             UFAS     = SEQ
             UNIT     = BLOCK
             SIZE     = 90
             CISIZE   = 6144
             RECFORM  = F
             RECSIZE  = 220;
```

Example of allocating a VBO disk file

A file PC.WTM of 3 000 records, each 90 bytes in length, is to be allocated on an MS/D500 volume BD18. The CISIZE is to be 4 096.

An easy method of allocating the file is to specify in the BUILD_FILE command UNIT=RECORD, SIZE=3000. Then UFAS-EXTENDED automatically calculates the number of tracks required.

Otherwise you need to use the CREATE_FILE utility or do the following calculations.

- Number of records per CI = (4096 - 8) divided by (90 + 4) = 43 records per CI
- Number of data CIs = 3000 divided by 43 = 70 CIs

With a CISIZE of 4096, there are 6 CIs per MS/D500 track (Table 6-1).

Tracks = (70 divided by 6) plus 1 = 13 tracks

The BUILD_FILE command is:

```
BUILD_FILE PC.WTM:BD18:MS/D500
           FILESTAT = CAT
           UFAS     = SEQ
           UNIT     = CI   ( or UNIT = TRACK  or UNIT = CYL
           SIZE     = 70        SIZE = 13        SIZE = 1  )
           CISIZE   = 4096
           RECSIZE  = 90;
```

Table 6-3 gives 24 tracks per cylinder for an MS/D500 disk drive. Therefore 1 cylinder will cater for 13 tracks.

Further examples of allocating files using the BUILD_FILE command are given later in this Section.

6.5.2 Variable-Length Records

Using the same notation as for fixed-length records but with an average record length (arl) instead of RECSIZE:

- Number of records per CI = (CISIZE - CI Header) divided by (arl + 4), rounded down.
- Number of CIs = (number of records) divided by (number of records per CI), rounded up
- Tracks = (number of CIs) divided by (CIs-per-track) plus 1, rounded up

Example of allocating an FBO disk file

Assume you wish to allocate a file PK.RIT of 2,000 variable-length records whose average length is 25 bytes and maximum length is 98 bytes. You wish to allocate the file on an MS/FSA volume PKT. The CISIZE is 3584.

- Number of records per CI = (3584-10) divided by (25+4) = 123.24
- = 123 records per CI

Number of data CIs = 2000 divided by 123 = 16.23 = 17 CIs

To take into account the space occupied by address space 1, add 5 to give 22 CIs in all. Note that you can modify this estimate through use of the CREATE_FILE command (described earlier in this Section).

```
CRF  PK.RIT:PKT:MS/FSA
     FILESTAT = CAT
     UFAS     = SEQ
     UNIT     = BLOCK
     SIZE     = 22
     CISIZE   = 3584
     RECFORM  = V
     RECSIZE  = 98;
```

Example of allocating a VBO disk file

Assume you wish to allocate a file, PC.VWT of 4500 variable-length records whose average length is 40 bytes and maximum length is 120 bytes. You wish to allocate the file on an MS/D500 volume MX42. The CISIZE chosen is 1536.

- Number of records per CI = (1536 - 8) divided by (40 + 4)
- = 34 records per data CI

Note that, if you wish to allocate file space in units of records (UNIT=RECORD with SIZE=4500), then specify 120, instead of 40 for the record size.

Number of CIs = 4500 divided by 34 = 133 CIs

With a CISIZE of 1536, there are 15 CIs per MS/D500 track (See Table 6-1)

Tracks = (133 divided by 15) + 1 = 9.86, rounded up = 10 tracks.

giving:

```
BUILD_FILE  PC.VWT:MX42:MS/D500

FILESTAT = CAT
UFAS     = SEQ
UNIT     = CI       ( or UNIT = TRACK    or UNIT = CYL
SIZE     = 133           SIZE = 10          SIZE = 1    )
CISIZE   = 1536
RECSIZE  = 120
RECFORM  = V;
```

6.6 Calculating Space Requirements for a Relative File

You should be familiar with the relative-file concepts before proceeding. These concepts are described in Section 3.

User-supplied values for the calculation are RECSIZE (defined in the user program), CISIZE (chosen by the file designer) and the number of records that the file is to hold.

The calculations for a relative file are the same for both fixed-length and variable-length records.

For a relative file, the value you enter for CISIZE must be within the following limits:

- must be greater than or equal to RECSIZE + 12 for a VBO file (RECSIZE + 14 for an FBO file),
- cannot exceed one track for a VBO file.

An easy method of allocating a file is to specify in the BUILD_FILE command UNIT=RECORD, SIZE=number of records. Then UFAS-EXTENDED automatically calculates the number of blocks/tracks required. Otherwise you need to use the REPORT command of CREATE_FILE or do the following calculations.

1. Calculate the number of records in a CI:

   Number of records per CI = (CISIZE - CI Header) divided by (RECSIZE + 4), rounded down

   Take account of the CI header information, subtract from the CISIZE:

   10 for FBO files,
   8 for VBO files.

(Add 4 to the size of the record to allow for the record-header that occupies 4 bytes. See Figures 3-5 and 3-6.)

1. Find the number of CIs required:

   Number of CIs = (number of records) divided by (number of records per CI), rounded up

2. For VBO volumes, you may compute the number of tracks:

   Tracks = (number of CIs) divided by (CIs-per-track), plus 1, rounded up

(One track is added to cater for address space 1.)

Example of allocating an FBO file

A file POR.CL of 4,510 records, each 112 bytes in length is allocated on an MS/FSA disk volume RR1. The CISIZE chosen is 4608 and the unit of allocation chosen is blocks.

- Number of records per CI = (4608 - 10) divided by (112 + 4)
- = 39 records per CI
- Number of CIs = 4510 divided by 39 = 116 CIs rounded up

To allow for address space 1, add a few extra CIs, say 5, which gives 121. Specify 121 in the SIZE parameter. Note that you can modify your estimate by simulating a file allocation (described earlier in this Section).

```
CRF  POR.CL:RR1:MS/FSA
     FILESTAT = CAT
     UFAS = RELATIVE
     UNIT = CI
     SIZE = 121
     CISIZE = 4608
     RECSIZE = 112;
```

Example of allocating a VBO file

A file CLX.AA of 2080 records, RECSIZE = 134 is allocated on an MS/D500 disk volume 26P. The CISIZE chosen is 2560.

- Number of records per CI = (2560 - 8) divided by (134 + 4) = 18 records per CI.
- Number of CIs = 2080 divided by 18 = 116 CIs rounded up.

With a CISIZE of 2560, there are 10 CIs per MS/D500 track (Table 6-1)

tracks = 116 divided by 10, plus 1 = 13 tracks rounded up.

giving:

```
BF CLX.AA:26P:MS/D500
   FILESTAT = CAT
   UFAS     = RELATIVE
   UNIT     = CI      or  ( UNIT = TRACK     or UNIT = CYL
   SIZE     = 116           SIZE = 13           SIZE = 1  )
   CISIZE   = 2560
   RECSIZE  = 134;
```

Table 6-3 gives 24 tracks per cylinder for an MS/D500 disk drive. Therefore 1 cylinder will cater for 13 tracks. This means that 11 tracks are not used when you allocate in units of cylinders. To avoid this situation, it is better to allocate in unit of tracks.

As described earlier in Section 3, you do the same calculations for variable-length records as for fixed-length records.

Further examples of allocating files are given later in this Section 6.

6.7 Design Guidelines for Indexed Sequential Files

Before reading this sub-section, make sure that you are familiar with indexed sequential file organization (described in Section 4).

Indexed sequential file design can be difficult to grasp, so go more slowly through this sub-section.

At allocation time, the user supplies the following parameters:

CISIZE =	Size of a the file-allocation parameter group ALCi CI (data, index, label) (unit = bytes)
CIFSP =	Free space left in a CI (unit = percentage)
SIZE =	Initial space for the file being allocated on:
	for FBO files (UNIT = BLOCK, 100KB, CYL, or RECORD),
	for VBO files (UNIT = CI, TRACK, CYL, or RECORD).

A default value of zero is provided for CIFSP. If you wish to extend the file incrementally (that is, by predefined increments), specify the INCRSIZE parameter in the BUILD_FILE, CREATE_FILE command, or the file-allocation parameter group ALCi. The JCL equivalents are the PREALLOC statement, the FILALLOC utility and the OUTALC parameter group or the ALLOCATE statement.

An important factor affecting file access is the access mode.

> The performance of a randomly accessed indexed sequential file is the same throughout its life. Performance depends on the blocking factor, where:
>
> blocking factor = (CISIZE - CI Header) divided by (RECSIZE + 7) and must be >= 2

(The blocking factor is the number of records per CI). For this reason, most attention will be concentrated on performance in direct-access mode.

As shown in Figure 4-13, the CI header is 21 bytes long (+ 1 byte for CI Trailer) for FBO files and 20 bytes long for VBO files.

You add 7 to the RECSIZE because each record header is 5 bytes long and each record descriptor is 2 bytes long. See Figure 4-13.

6.7.1 Choosing the CISIZE for an Indexed Sequential File

The choice of a CISIZE is determined by the type of application you wish to run. In the case of TDS applications, choose a CISIZE which produces only 2 index levels. Use the following formulas to calculate the number of entries per index for:

- a primary key:

  no. of Entries per Index CI = (CISIZE - 10) divided by (KEYSIZE + 4)

- a secondary key:

  no. of Entries per Index CI = (CISIZE - 10) divided by (KEYSIZE + 8)

To avoid having more than 2 index levels, ensure that the number of entries per index is greater than the square root of the number of CIs in the file. If this condition is not true, increase the CISIZE value to reduce the number of data CIs and index CIs.

Ensure that the CISIZE is large enough to accommodate at least 2 records. The value you enter for CISIZE must be within the following limits:

- must be greater than or equal to

  2 * (RECSIZE + 7) + CI Header,

- cannot exceed one track for a VBO disk file.

A CISIZE that is about 4 Kbytes is an efficient value. A good rule is to limit the blocking factor as follows:

blocking factor = (CISIZE - CI Header) divided by (RECSIZE + 7)
subject to the limitation: 10 <= blocking factor <= 255

Tables 6-1 and 6-2 relate the CISIZE value to the number of pages required.

6.7.2 Choosing Free Space (CIFSP)

At file allocation time, the CIFSP parameter allows you to specify the percentage of free space to be left within each CI when the file is initially loaded. This free space allows records to be inserted into the CI subsequently without causing CI splitting. However, the specified free space must be large enough to hold at least one record or an integral number of records. For example, if there are 10 records per CI, then you can specify 20% free space to account for the subsequent insertion of 2 records.

Note that the CIFSP parameter in the DEFi parameter group (JCL equivalent DEFINE) is used only at time of file allocation.

If you create a file sequentially and use it without insertions, set the value of CIFSP in the BUILD_FILE command (JCL equivalent PREALLOC) to 0. If insertions to the file are randomly distributed, an efficient value for free space is:

```
CIFSP = 20
```

If insertions into the file are concentrated locally, you do not need distributed free-space and hence you need not specify the CIFSP parameter.

EXAMPLE:

At initial loading time, a file allocated with 20 % free space (CIFSP = 20). This means that the file is full at 80 % capacity.

After insertion I-O mode, this file is 90 % filled with records and has 10 % free space.

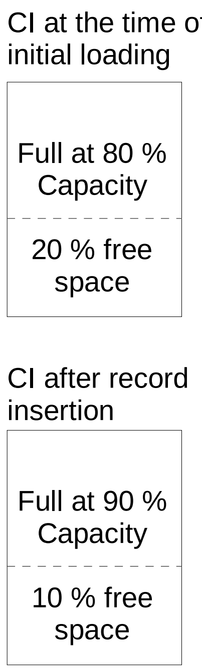


Figure 6-1. Using CIFSP

❑

The maximum free space is obtained when only one record is loaded in each CI. You may request this by specifying a value of 100 for CIFSP. Alternatively, you can calculate the percentage of free space that gives one record loaded per CI; any value between this and 100 is equivalent to specifying 100.

The default value is 0.
The maximum value is 100.

In the case of a volatile file, you may find the CIFSP parameter useful for reducing the high splitting rate.

When you wish to allocate a file in units of records (UNIT= RECORD), the number of records specified in the SIZE parameter corresponds to the number of records which will be initially loaded. If you specify a value in the CIFSP parameter, UFAS-EXTENDED automatically calculates the required amount of free space to be left in the CI for the subsequent insertion of further records. For example, if the following parameters are specified:

```
UNIT = RECORD
SIZE = 1000
CIFSP = 20
```

UFAS-EXTENDED allocates a file for holding 1,000 records and in addition leaves 20% free space in the CI.

For other units of allocation, the requested size is allocated.

6.7.3 Mass Insertion

UFAS-EXTENDED uses this mode only when it is adding records to the end or to the beginning of a file that is opened in I-O mode. The end of a file means that the key value of the records to be added in ascending order is higher than the highest key value of the records already in the file. The beginning of the file means that the key value of the records to be added in descending order is lower than the lowest key value of the records already in the file. When UFAS-EXTENDED adds a large number of records in sequential (ascending or descending) order, full CIs are created.

In this mode, UFAS-EXTENDED does not split each full CI into two CIs, each approximately half full. Instead, it leaves the original CI almost full and creates a new CI that is almost empty.

IMPORTANT:

Note that you can no longer use the CIFSP parameter in the file-define parameter group (DEFi) (JCL equivalent DEFINE) to control the split ratio in the case of mass insertion.

6.7.4 Files With Secondary Keys

In general, avoid using secondary indexes. In a TDS application, do not specify more than 3 secondary keys.

6.7.5 Calculating Space Requirements

To avoid calculating space requirements, you can use the CREATE_FILE command to simulate a file allocation. This utility was described earlier in this Section.

In the following sub-sections, the CREATE_FILE (JCL equivalent FILALLOC) command and the BUILD_FILE command (JCL equivalent PREALLOC) are used to explain how to allocate a file, but you could also use the file-allocation parameter group ALCi (JCL equivalent ALLOCATE), or the DYNALC parameter (JCL equivalent OUTALC).

Before you use the BUILD_FILE command with UNIT = CI or with UNIT = RECORD, decide on the size of:

- the CI size (CISIZE) in bytes,
- the record size (RECSIZE) in bytes,
- the number of records in the file,
- the keysize in bytes.

When you wish to allocate a file in units of CIs, calculate the total number of CIs for the SIZE parameter in the BUILD_FILE (JCL equivalent PREALLOC) command. Follow a similar procedure if UNIT = TRACK, or UNIT = CYL, except that you must calculate the SIZE parameter in the appropriate units.

The CI must be large enough to hold at least 2 records. The maximum number of records per data CI is 255.

For calculations with variable-length records, use the average record length, but the maximum record length is given as the RECSIZE parameter in the BUILD_FILE command.

The format of a CI is shown in Figure 4-13.

All rounding up or down is to the next integer value, except CISIZE which UFAS-EXTENDED always rounds up to the next multiple of 512, unless such a multiple of 512 is specified.

6.7.5.1 File Without Secondary Indexes

The unit of allocation (UNIT =) in the BUILD_FILE command (JCL equivalent PREALLOC), CREATE_FILE (JCL equivalent FILALLOC) command or the file-allocation parameter group ALCi (JCL equivalent ALLOCATE) determines how you calculate space for indexed sequential files.

In the case of FBO files, it is best to use the new units of allocation: either BLOCK, or a quantum of 100 Kbytes (100KB). These units of allocation can be used only for an FBO file. With RECORD as the unit of allocation, you simply enter the number of records in the SIZE parameter. However, with CI, or CYL, or TRACK as the unit of allocation, you must do some calculations unless you have decided to use the REPORT option in the CREATE_FILE command. These cases are described separately below.

UNIT = RECORD

Enter the number of records in the SIZE parameter of the BUILD_FILE command (JCL equivalent PREALLOC).

UNIT = CI

This means that the SIZE parameter of the BUILD_FILE command is quoted in CIs. Therefore the user must calculate the number of CIs required for the file. To do this, and to use the BUILD_FILE command, you must know the following:

The number of records to be loaded into the file.

RECSIZE	The size of the record in bytes. For a file with variable-length records, use the average length of the records for these calculations.
CISIZE	The size of the data, label, and index CIs in bytes.
KEYSIZE	The length of the key field in bytes.

You can allocate a VBO file in the previous UFAS format with VERSION = PREVIOUS in the PREALLOC statement only. For further details, see Appendix F.

An easy method of allocating a file is to specify in the BUILD_FILE command:

```
UNIT = RECORD, SIZE = number of records.
```

Then UFAS-EXTENDED automatically calculates the number of:

- blocks required for an FBO disk file,
- tracks required for a VBO disk file.

Otherwise, if you allocate space in units of CIs, use the REPORT command of CREATE_FILE or do the following calculations.

Use the following formula to determine:

1. The number of records per CI

   (CISIZE - CI Header) divided by (RECSIZE + 7), rounded down
   (Subject to a minimum of 2 and a maximum of 255 records per CI.)

   Subtract from the CISIZE:

   22 for FBO files,
   20 for VBO files.

2. The number of data CIs in the file

   (total number of records) divided by (number of records per CI), rounded up

You can now use the BUILD_FILE (JCL equivalent PREALLOC) command without needing to know how much disk space will be allocated for the file because this is done automatically by UFAS-EXTENDED.

Example of allocating an FBO disk file

Assume you wish to allocate a file called ED.BRT on an FSA disk volume using UNIT=BLOCK.

User-supplied information:

- number of records = 7,436
- RECSIZE = 230 bytes
- CISIZE = 3584
- KEYSIZE = 15 bytes
- KEYLOC = 6

Number of records per CI = (3584 - 22) divided by (230 + 7) = 15

Number of CIs = 7436 divided by 15 = 496 CIs rounded up

After simulating the file allocation through use of the CREATE_FILE command, a file size of 505 should be specified. The data occupies 496 blocks and 9 extra blocks are required for control space information including the space occupied by the primary index. In all 505 blocks must be specified in order to fit 7436 records in the file.

```
CRF  ED.BRT:Vol8:MS/FSA
     EXPDATE = 450
     FILESTAT = CAT
     UFAS = INDEXED
     UNIT = BLOCK
     SIZE = 505
     CISIZE = 3584
     RECSIZE = 230
     KEYLOC = 6
     KEYSIZE = 15;
```

Example of allocating a VBO disk file

Suppose you wish to allocate a file called JC.EXM on an MS/D500 disk drive using UNIT = CI.

User-supplied information:

number of records	= 5060 records	
RECSIZE	= 200 bytes	
CISIZE	= 4096 bytes	(With a CISIZE of 4096, Table 6-1 shows that for an MS/D500, there are 6 data CIs per track).
KEYSIZE	= 10 bytes	
KEYLOC	= 5	

To use the BUILD_FILE (JCL equivalent PREALLOC) command, find the number of data CIs required as follows:

Number of records per CI:
(4096 - 20) divided by (200 + 7) = 19.69 = 19 records rounded down

Number of CIs
5060 divided by 19 = 267 data CIs rounded up

The 267 data CIs are stored in address space 2. You need take no action for address spaces 1, 3, and 4, this aspect being managed internally by UFAS-EXTENDED.

You may now use the BUILD_FILE (JCL equivalent PREALLOC) as follows:

```
BUILD_FILE JC.EXM:TNDA:MS/D500
         EXPDATE = 199
         FILESTAT = CAT
         UFAS = INDEXED
         UNIT = CI       or (UNIT = RECORD      SIZE = 5060)
         SIZE = 267
         CISIZE = 4096
         RECSIZE = 200
         KEYLOC = 5
         KEYSIZE = 10;
```

UNIT = CYL (or UNIT = TRACK)

Both these units of allocation should be used only for files being allocated on non-FSA disks.

Where you have a fixed amount of space to allocate for the file and are interested in how many records will fit in this space, you would allocate using cylinder or track.

Unlike allocation by CI or record, which are easy to use, allocation by cylinder or track has a drawback. To allocate by track or cylinder, you must know how many tracks or cylinders are to be allocated. To calculate the number of tracks or cylinders for the different address spaces, it is best to simulate a file allocation by using the CREATE_FILE command that is described earlier in this Section.

If the unit of allocation is the cylinder, then the number of cylinders to be allocated is given by:

(number of tracks) divided by (number of tracks per cylinder), rounded up

User-supplied information:

The number of tracks in the SIZE parameter of the BUILD_FILE (JCL equivalent PREALLOC) command,

RECSIZE	the size of the records in bytes; where the file consists of variable-length records, UFAS-EXTENDED takes the maximum value specified in this parameter,
CISIZE	the size of the data CI in bytes,
KEYSIZE	the length, in bytes, of the key field.
KEYLOC	the location of the start position of the record key in the record, expressed as the position of its leftmost byte (first byte of record has position 1).

EXAMPLE:

Suppose that you wish to allocate a file called JC.EXN on an MS/D500 disk drive using UNIT = TRACK. User-supplied information:

Number of tracks	= 95 tracks
RECSIZE	200 bytes
CISIZE	5120 bytes
KEYSIZE	20 bytes
KEYLOC	53

❑

Table 6-1 shows that with a CISIZE of 5120, there are 5 data CIs per track on an MS/D500.

You can now use the BUILD_FILE command as follows:

```
BF FILE   =  JC.EXN:TNDA:MS/D500
FILESTAT  =  CAT
EXPDATE   =  199
UFAS      =  INDEXED
UNIT      =  TRACK
SIZE      =  95
CISIZE    =  5120
RECSIZE   =  200
KEYSIZE   =  20
KEYLOC    =  53;
```

You can find out the number of records in the file by using the CREATE_FILE (JCL equivalent FILALLOC). The amount of space allocated to each address space is given by the LIST_FILE command. It is possible to find out the number of records by multiplying the number of CIs by the number of records per CI.

6.7.5.2 File With Secondary Indexes

Secondary indexes are placed in address spaces 5, 6, and 7. Allocating space for these address areas is similar to that for address spaces 2, 3, and 4 respectively, except that you must take account of several secondary indexes. As with indexed sequential files without secondary indexes, the unit of allocation may be blocks, or a quantum of 100 Kbytes for FBO files, but you can also choose records. However, cylinders, tracks, and CIs should be used only for VBO disk files.

With RECORD as the unit of allocation, you simply enter the number of records in the SIZE parameter. With CYL or TRACK as the unit of allocation, you must do some calculations. These cases are described separately below.

UNIT = RECORD

An easy way of allocating space for a file is to enter the number of records in the SIZE parameter of the BUILD_FILE command (JCL equivalent PREALLOC).

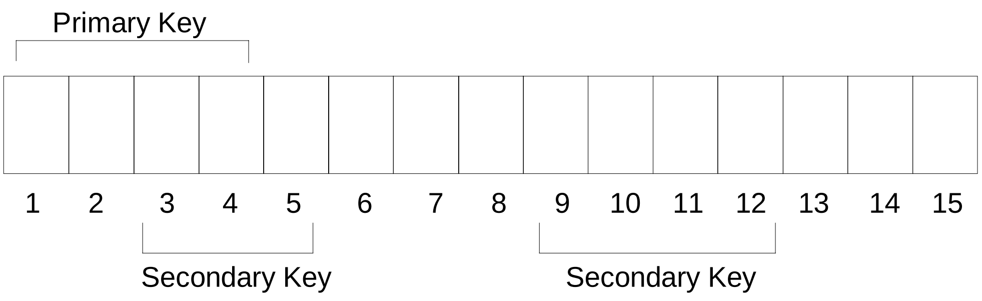
UNIT = CI

To use the BUILD_FILE (JCL equivalent PREALLOC) command correctly, you must have the following information:

Number of records to be loaded into the file,

RECSIZE	the number of bytes in each data record; for variable-length records, use the average record length for these calculations,
CISIZE	the number of bytes in a CI,
KEYSIZE(i)	size of each key, in bytes; KEYSIZE(0) is the keysize of the primary key in bytes,
	KEYSIZE(1) to KEYSIZE(15) are the sizes of up to 15 secondary indexes,
KEYLOC(i)	position of the first byte of each key in the record.
SECIDX	(keyloc:keysize [:DUPREC] ...)

Explanation of KEYSIZE and KEYLOC:



```
KEYSIZE (0) = 4    KEYLOC (0) = 1
KEYSIZE (1) = 3    KEYLOC (1) = 3
KEYSIZE (2) = 4    KEYLOC (2) = 9
```

To use the SECIDX parameter of the BUILD_FILE command, specify SECIDX as follows.
```
SECIDX = (9:4)
```

This means that the secondary key starts at byte 9 and is 4 bytes long. If you enter :DUPREC after the key length, then duplicates are allowed. A duplicate is 2 or more records with identical secondary key values. If you do not enter :DUPREC, then by default duplicates are not allowed.

The maximum length of a secondary key is 251 bytes.

As a secondary key field cannot extend beyond the end of the record, the value of KEYSIZE must satisfy the following conditions:

(KEYLOC + KEYSIZE) <= (RECSIZE + 1)

A secondary key field cannot start at the same position as the primary key nor at the same position as another secondary key. As long as this restriction is observed, key fields may overlap each other.

To use the BUILD_FILE command, you must calculate the number of data CIs to be loaded into the file to satisfy the SIZE parameter as follows:

Number of records per CI
(CISIZE - CI Header) divided by (RECSIZE + 7), rounded down

For files being allocated on FSA disks, the CI header is 22 bytes long and for files being allocated on non-FSA disks, the CI header is 20 bytes long.

Number of CIs
(number of records) divided by (number of records per CI), rounded up

NOTE:
See Appendix C, for the hexadecimal layout of address spaces in an indexed sequential file.

Example of allocating an FBO disk file

Assume you wish to allocate a file called PK.NEY on an FSA disk volume, using UNIT=BLOCK.

User-supplied information:

No of records	= 3115
RECSIZE	= 108 bytes
CISIZE	= 4096 bytes
KEYSIZE (0)	= 14-byte primary key
KEYLOC (0)	= 4
KEYSIZE (1)	= 6-byte secondary key
KEYLOC (1)	= 19
KEYSIZE (2)	= 39-byte secondary key
KEYLOC (2)	= 30
KEYSIZE (3)	= 17-byte secondary key
KEYLOC (3)	= 74
KEYSIZE (4)	= 9-byte secondary key
KEYLOC (4)	= 95

1. Calculate the number of data CIs to be loaded into the file.

   Number of records per CI = (4096-22) divided by (108+7) = 35 records, rounded down

   Number of data CIs = 3115 divided by 35 = 89

2. Simulate the file allocation through use of the CREATE_FILE command (described earlier in this Section). Make a rough estimate of the size of the file taking into account the extra blocks required for the address space 1 and the primary/secondary indexes.

   Then refine this estimate by modifying the values you give in the SIZE parameter of the CREATE_FILE command. In this case, at least 214 blocks are required in order to fit 3,115 records into the file.

3. Allocate the file when the file characteristics seem appropriate.

```
CRF PK.NEY:VOL44:MS/FSA
    FILESTAT = CAT
    EXPDATE = 210
    UFAS = INDEXED
    UNIT = BLOCK
    SIZE = 214
    CISIZE = 4096
    RECSIZE = 108
    RECFORM = F
    KEYLOC = 4
    KEYSIZE = 14
    SECIDX = (19:6  30:39  74:17  95:9);
```

Example of allocating a VBO disk file

Suppose you wish to allocate a file called JC.EXO on an MS/B10 disk drive, using UNIT = CI.

User-supplied information:

- number of records = 2915 records
- RECSIZE = 200 bytes
- CISIZE = 3584 bytes;

- KEYSIZE(0) = 20-byte primary key
- KEYLOC(0) = 5

The SECIDX parameter must be specified when secondary keys are to be defined.

KEYSIZE(1) = 10-byte secondary key
KEYLOC(1) = 30

KEYSIZE(2) = 50-byte secondary key
KEYLOC(2) = 45

KEYSIZE(3) = 40-byte secondary key and a duplicate key is required
KEYLOC(3) = 96

KEYSIZE(4) = 30-byte secondary key and a duplicate key is required
KEYLOC(4) = 138

Because the number of records is provided, you can allocate the file space in units of records; otherwise you need to do the following calculations if you decide to allocate the file space in units of CIs.

To use the BUILD_FILE (JCL equivalent PREALLOC) command, you must first find the number of data CIs required:

- Number of records per CI
- (3584 - 20) divided by (200 + 7) = 17.21 = 17 records per data CI, rounded down
- Number of CIs
- 2915 divided by 17 = 172 data CIs in the file, rounded up

Use the BUILD_FILE (JCL equivalent PREALLOC) command as follows:

```
BF JC.EXO:TNDA:MS/B10
          FILESTAT = CAT
          EXPDATE = 199
          UFAS = INDEXED
          UNIT = CI         OR UNIT = RECORD     SIZE = 2915
          SIZE = 172
          CISIZE = 3584
          RECSIZE = 200
          KEYLOC = 5
          KEYSIZE = 20
          SECIDX = (30:10 45:50 96:40:DUPREC 138:30:DUPREC);
```

You can find out the number of records in the file by using the CREATE_FILE (JCL equivalent FILALLOC). The amount of space allocated to each address space is given by the LIST_FILE command. It is possible to find out the number of records by multiplying the number of CI by the number of records per CI.

UNIT = CYL (or UNIT = TRACK)

Both these units of allocation should be used only for files being allocated on non-FSA disks.

Where you have a fixed amount of space to allocate for the file, you would allocate using cylinder or track.

Unlike allocation by CI or record, which are easy to use, allocation by cylinder or track means that you must know how many tracks or cylinders to allocate. To calculate the number of tracks or cylinders for the different address spaces, it is best to simulate a file allocation by using the CREATE_FILE command that is described later in this Section.

To display the current characteristics of the file to be allocated, you use the REPORT command. Depending on the results, you decide whether or not to allocate the file. For a description of the REPORT command, see the *IOF Terminal User's Reference Manual.*

If the unit of allocation is the cylinder, then the number of cylinders to be allocated is given by:

(number of tracks) divided by (number of tracks per cylinder), rounded up

EXAMPLE:

Suppose you wish to allocate a file called JC.EXP on an MS/D500 disk drive, using UNIT = TRACK.

❑

User-supplied information:

- Number of Tracks = 95
- RECSIZE = 200 bytes
- CISIZE = 6656 bytes
- KEYSIZE(0) = 20-bytes primary key
- KEYLOC(0) = 5

The SECIDX parameter must be specified when secondary keys are to be defined.

KEYSIZE(1) = 10-byte secondary key
KEYLOC(1) = 30

KEYSIZE(2) = 50-byte secondary key
KEYLOC(2) = 45

KEYSIZE(3) = 40-byte secondary key and a duplicate key is required.
KEYLOC(3) = 96

KEYSIZE(4) = 30-byte secondary key and a duplicate key is required.
KEYLOC(4) = 138

To find out the number of CIs per track, see Table 6-1. For an MS/B10 disk drive with a CISIZE of 6656, there are 5 data CIs per track.

Use the BUILD_FILE command as follows:

```
BF JC.EXP:TNDA:MS/B10
          EXPDATE = 199
          FILESTAT = CAT
          UFAS = INDEXED
          UNIT = TRACK  (or UNIT = RECORD  SIZE = 7360 *
          SIZE = 95         UNIT = CYL     SIZE = 2 cylinders)
          CISIZE = 6656
          RECSIZE = 200
          RECFORM = F
          KEYLOC = 5
          KEYSIZE = 20
          SECIDX = (30:10 45:50 96:40:DUPREC 138:30:DUPREC);
```

You can find out the number of records in the file by using the CREATE_FILE (JCL equivalent FILALLOC) command. The amount of space allocated to each address space is given by the LIST_FILE command. It is possible to find out the number of records by multiplying the number of CIs in address space 2 by the number of records per CI.

* This figure was calculated through use of the CREATE_FILE command.

6.8 File Allocation Commands

The following sub-sections provide the syntax for GCL commands that are most commonly used at file allocation time. A number of examples is provided after each GCL command. The parameters are described in the *IOF Terminal User's Reference Manual (Part 2)*.

A JCL --> GCL Correspondence Table and a GCL --> JCL Correspondence Table are provided in Appendix D. JCL statements are described in the JCL Reference Manual and the utilities are described in the *Data Management Utilities User's Guide*.

6.8.1 BUILD_FILE

Allocates space for a disk file and creates labels that describe the file's characteristics. The BUILD_FILE command creates the necessary file labels that are set up to contain details of the file organization.

Important points:

The recommended units of allocation for files being allocated on FSA disks are BLOCK and 100 KBytes.

However, to make the transition to FBO volume devices easier, the previous allocation units (CI, RECORD, CYL, and TRACK) can still be specified.

If you specify CI in the UNIT parameter, a CI will be transformed into a number of blocks at allocation time.

If you specify CYL in the UNIT parameter, a cylinder will be transformed into 1,000 Kbytes at allocation time.

If you specify TRACK in the UNIT parameter, a track will be transformed into 50 Kbytes at allocation time.

This suggests that it is best to specify BLOCK or 100KB for FBO files.

Syntax:

```
{ BUILD_FILE }
{            }
{ BF         }

          FILE = file78

                        { CAT             }
                        { CAT{1|2|3|4|5} }
          [ FILESTAT = {                  } ]
                        { UNCAT           }
                        { TEMPRY          }

                       { ddd      }
          [ EXPDATE = { yy/ddd   } ]
                       { yy/mm/dd }

          [ UFAS =  SEQ  ]
- - - - - - - - - - - - - - - - - - - - - -
          [ UNIT = { CYL | BLOCK | 100KB | RECORD | TRACK | CI } ]
          [ SIZE = dec10 ]
          [ SPLIT = (split-criteria) ]
          [ SPLITDVC = device-class ]
          [ INCRSIZE = dec5 ]
          [ MAXEXT = { 5 | dec2 } ]
          [ CISIZE = dec5 ]
          [ RECSIZE = dec5 ]
          [ KEYLOC = dec5 ]
          [ KEYSIZE = dec3 ]
          [ CIFSP = { 0 | dec3 } ]
          [ COLLATE = { EBCDIC | ASCII | BCD } ]
          [ SECIDX = (ddddd:dd[:DUPREC]...)]
          [ DDLIB1 = lib78 ]
          [ AREA = name30 ]
          [ INDEX = name30 ]
          [ SCHEMA = name30 ]
          [ RECFORM = { F | FB | V | VB | U } ]
          [ SILENT = { bool | 0 } ]
```

6.8.1.1 Examples of File Allocation Using BUILD_FILE

In the following examples, all the files are allocated in the UFAS-EXTENDED format. Do not hesitate to simulate a file's allocation through use of the CREATE_FILE command (described earlier in this Section).

Examples of Allocating Sequential Files

```
BF  PK.ALI:PAN:MS:FSA
    FILESTAT = CAT
    UFAS = SEQ
    UNIT = BLOCK
    SIZE = 287
    CISIZE = 3584
    RECSIZE = 228
    RECFORM = V;
```

Build a cataloged sequential file named PK.ALI on volume named PAN. The unit of allocation is BLOCK. The file SIZE is 287 blocks. The CISIZE is 3584. The RECSIZE is 228. The record format is variable.

```
BF PK.CT:VOL 11:MS/FSA
   FILESTAT = CAT
   UFAS = SEQ
   UNIT = 100KB
   SIZE =5
   CISIZE = 4096
   RECSIZE = 154;
```

This command allocates a cataloged file in units of 100KB. The total amount of space required is 500KB. The record format, by default, is fixed and each record is 154 bytes long.

```
BF LP.PJM$RES
   FILESTAT = UNCAT
   UFAS = SEQ
   UNIT = CI
   SIZE = 600
   CISIZE = 1000
   RECSIZE = 190;
```

This command allocates a resident file. Space is reserved for 600 data CIs. Because 1000 is not a multiple of 512, UFAS-EXTENDED rounds up the CI size to the next multiple of 512; that is, 1024 bytes. The record format, by default, is fixed and each record will be 190 bytes. Each data CI will hold 5 records; therefore, the total capacity of the file is 5 x 600 =3,000 records.

```
BF FILE = F2:V9:MS/D500
   FILESTAT = UNCAT
   UFAS = SEQ
   SIZE = 1
   CISIZE = 2048
   RECSIZE = 100;
```

Build an uncataloged UFAS-EXTENDED sequential file named F2 on the volume named V9; by default, the unit of allocation is CYL, the file is 1 cylinder, the CI size is 2048 bytes, the record size is 100 bytes.

```
BF POW.LM$RES
   UFAS = SEQ
   SIZE = 5000
   UNIT = RECORD
   INCRSIZE = 1000
   CISIZE = 2048
   RECSIZE = 60;
```

Build a UFAS-EXTENDED sequential file named POW.LM on resident volumes; the file size is 5000 records, the increment size is 1000 records, the CI size is 2048 bytes, the record size is 60 bytes.

```
BF JKL.MY
   UFAS = SEQ
   SPLIT = (V8:4 V9:6 V6:7)

   SPLITDVC = MS/D500

   INCRSIZE = 2
   CISIZE = 1024
   RECSIZE = 200
   RECFORM = F;
```

4 cylinders are to be allocated on the volume V8, 6 cylinders on V9, and 7 cylinders on V6. V8,V9,V6 are MS/D500 disk volumes. The increment size is 2 cylinders, the CI size is 1024 bytes, the record size is 200 bytes, record format is fixed. By default, the file is cataloged.

Example of Allocating an FBO Relative file

```
BF PK.LOY:V44:MS/FSA
   EXPDATE = 340
   UNIT = BLOCK
   SIZE = 30
   UFAS = RELATIVE
   CISIZE = 19456
   RECSIZE = 88
   FILESTAT = CAT;
```

A relative file named PK.LOY is allocated on an FSA disk, volume V44. The CISIZE is 19456. The RECSIZE is 88. A file allocation simulated by the CREATE_FILE command shows that this file can hold 6119 records.

Example of Allocating a VBO Relative File

```
BF MPTSP.DD
   EXPDATE = 300
   UNIT = CYL
   SPLIT = (D18A:10
D18B:10)
   SPLITDVC = MS/D500
   UFAS = RELATIVE
   CISIZE = 1024
   RECSIZE = 52
   FILESTAT = CAT;
```

In this example, the relative file MPTSP.DD is allocated on two volumes, D18A and D18B; each volume will contain 10 cylinders. The file is split evenly between the two disks, hence reducing head movement in random access. The file has a retention period of 300 days.

Example of Allocating Indexed Sequential Files

```
BF LM.TOR1:LU5:MS/FSA
   FILESTAT = CAT
   UFAS = INDEXED
   UNIT = BLOCK
   SIZE = 198
   CISIZE = 4096
   RECSIZE = 211
   RECFORM = F
   KEYLOC = 1
   KEYSIZE = 16
   CIFSP = 12;
```

An indexed sequential file, LM.TOR1 is allocated on an FSA disk volume LU5. The file is allocated in units of blocks. A file simulation indicates that 198 blocks are required. The CISIZE is 4096. No secondary keys are requested. Each CI will be left with 12% free space. As there are 18 records per CI, this means that it will be possible to subsequently insert 2 records in each CI.

```
BF PC.UIX:TNDA:MS/D500
   FILESTAT = CAT
   UFAS = INDEXED
   UNIT = CI
   SIZE = 26352
   CISIZE = 3072
   RECSIZE = 211
   KEYLOC = 10
   KEYSIZE = 21
   CIFSP = 22;
```

In this example, an indexed sequential file, PC.UIX, is allocated on MS/D500 volume TNDA. 26,352 data CIs are requested. UFAS-EXTENDED automatically adds the space for the header track (address space 1) and index area. The records are fixed length 211 bytes, and contain a 21-byte key starting at position 10. No secondary keys are required. The user has requested that each CI be 3072 bytes long. When the file is opened and loaded sequentially, each CI will be left with 22% free space. This free space will reduce the frequency of splitting to accommodate later insertions.

In this example, you must specify 22% free space in the CIFSP parameter to allow for the subsequent insertion of 3 records.

No. of records per Cl = (3072 - 20) divided by (211 + 7) = 14 records

Hence one record requires the following amount of space:

100 divided by 14 = 7.15%

and three records require 22%.

The following example shows how a file DEPT1.MY is created in an autoattachable catalog. For further details including file generations, see the *Catalog Management User's Guide* and the *IOF Terminal Reference User's Manual (Part 1).*

```
CREATE_DIR
       NAME = DEPT1;
```

The system administrator creates Master Directory DEPT1 under the root in the Site Catalog.

```
CREATE_CATALOG
    NAME = DEPT1.CATALOG
    VOLUME = K141:MS/D500
    NBOBJECT = 10;
```

An automatically attachable catalog is created using the CREATE_CATALOG command. Once the catalog has been created, the system knows that all cataloged objects whose names begin with DEPT1 are to be created or retrieved in DPT1.CATALOG.

```
BF FILE = DPT1.MY
   UFAS = INDEXED
   SPLIT = (BD14:10 BD15:10)
   SPLITDVC = MS/D500
   CISIZE = 512
   RECSIZE = 115
   KEYLOC = 25
   KEYSIZE = 30;
```

A cataloged indexed sequential file DPT1.MY is to be allocated on two MS/D500 volumes, each containing 10 cylinders.
The CI size in 512 bytes. The records size in 115. The primary key starts at byte 25 and is 30 bytes long.

```
BF F1:V7:MS/D500
   FILESTAT = UNCAT
   UFAS = INDEXED
   SIZE = 4
   CISIZE = 4096
   KEYLOC = 25
   KEYSIZE = 30
   RECSIZE = 120;
```

Build the file named F1 on the MS/D500 volume named V7. It is to be an uncataloged UFAS-EXTENDED indexed sequential file. The file size is 4 cylinders. The CI size is 4096 bytes. The key field starts at byte 25. The primary key is 30 bytes long. The logical record is 120 bytes long. No secondary keys are required

```
BF PHK.JK
   UFAS = INDEXED
   SPLIT = (V1:2 V2:3 V3:5)
   SPLITDVC = MS/D500

   INCRSIZE = 2
   CISIZE = 1024
   RECSIZE = 100
   RECFORM = V
   KEYLOC = 12
   KEYSIZE = 8
   SECIDX = (8:4 30:8:DUPREC);
```

2 cylinders are to be allocated on volume V1, 3 cylinders on V2, and 5 cylinders on V3. V1, V2, V3 are MS/D500 disk volumes. The increment size is 2 cylinders. The CI size is 1024 bytes. The record format is variable. The key field starts at byte 12. The key is 8 bytes long. There are two secondary keys: one starts in byte 8 and is 4 bytes long the second starts in byte 30 and is 8 bytes long. Duplicate values are permitted with the second secondary key but not with the first.

6.8.2 CREATE_FILE

The CREATE_FILE command (JCL equivalent FILALLOC) allocates space for a disk file, optionally using an existing file as a model. As described in earlier in this Section, you can use the CREATE_FILE command to simulate a file allocation. File simulation using this command is also described earlier in this Section.

Specify BLOCK and 100 KB in the UNIT parameter only for FBO files. (These are the recommended UNIT parameter values for such disk files).

Syntax:

```
{ CREATE_FILE }
{             }
{ CRF         }

          { FILE    }
          {         } = file78
          { OUTFILE }

            { LIKE   }
          [ {        } = ( input-file-description ) ]
            { INFILE }

          [ IMMED = { bool | 0 } ]

                       { CAT             }
                       { CAT{1|2|3|4|5}  }
          [ FILESTAT = {                 } ]
                       { UNCAT           }
                       { TEMPRY          }

                      { ddd      }
          [ EXPDATE = { yy/ddd   } ]
                      { yy/mm/dd }

          [ MORE = { bool | 0 } ]
- - - - - - - - - - - - - - - - - - - -
          [ UNIT = { CYL | BLOCK | 100KB | TRACK } ]

          [ SIZE = dec8 ]

          [ INCRSIZE = dec5 ]

          [ SILENT = { bool | 0 } ]

          [ PRTFILE = file78 ]

          [ COMFILE = file78 ]

          [ COMMAND = char255 ]

          [ REPEAT = bool ]
```

Example	**Comment**

`CRF A.MYF:DK1:MS/FSA`
`    LIKE = B.MYF`
`    IMMED;`
	Create a cataloged file on the FSA volume named DK1. The file characteristics will be like those of the B.MYF file and the allocation is done without user dialog. Note that the file will be cataloged (by default FILESTAT = CAT)

`CRF F2:V1:MS/D500`
`    LIKE = F1:V3:MS/D500`
`    IMMED = 1`
`    FILESTAT = UNCAT;`
	Create the uncataloged file named F2 on the MS/D500 volume named V1.
	The file named F1 is used as a model.
	Creation is immediate, so you are not given the opportunity to change the file characteristics.

`CRF FILE = F9:V9:MS/M500`
`    FILESTAT = UNCAT;`
	Create the uncataloged file named F9. There is no model file. Therefore the default characteristics apply initially.
	<u>Default characteristics:</u>
	The file organization is sequential.
	The CISIZE is 3584.
	The record format is fixed.
	The increment size is 1 cylinder.
	The unit of allocation is in cylinders.
	The record size is 200 bytes.
	You may modify these characteristics by using the appropriate command(s) while you are in the CREATE_FILE domain (before actually creating the file).

`CRF FILE`
`=P2.F6:V8:MS/D500`
`    LIKE = P2.F5`
`    FILESTAT = CAT`
`    IMMED = 1;`
	The cataloged file named P2.F6 is created on the MS/D500 volume named V8 and placed in the appropriate catalog. The cataloged file named P2.F5 is used as a model. Creation is immediate.

```
CRF FILE
=P2.F6:V8:MS/D500
    LIKE = P2.F5
    FILESTAT = CAT;
```

As the previous example, except that the creation is not immediate. You will enter the CREATE_FILE domain and you can modify the file characteristics by using the appropriate commands as described below

```
CRF FILE =
MINE6:VV:MS/D500
    LIKE = P2.F5
    FILESTAT = UNCAT;
```

As the previous example, except that the file will be named MINE6, it will be uncataloged, and will reside on the MS/D500 volume named VV.

```
CRF FILE = XYZ$RES
    COMFILE = X.CRMF
    FILESTAT = UNCAT;
```

Create an uncataloged file without a model, using parameters read from the file X.CRMF.

In the previous example, you can enter the following commands in the COMFILE or in the COMMAND string:

- CATALOG (CAT) modifies or defines the file-catalog attributes,
- CHANGE (CH) modifies or defines file attributes,
- CREATE (CR) creates the resulting file,
- DELSIDX (DSX) deletes one or all secondary keys,
- FILTYPE (FT) overrides or modifies the file organization and form,
- LISTIDX (LSX) lists one or all secondary keys,
- NUMSIDX (NSX) renumbers the secondary keys,
- QUIT (Q) leaves the utility,
- REPORT (RP) displays the characteristics of the file to be created,
- SECIDX (SX) defines or modifies a secondary key,

or you can enter these commands at your terminal as in the following example:

```
CRF .MYFILE$RES
     LIKE = P1.YOUFILE
     EXPDATE = 365;
```

(create a cataloged file, valid for one year with a dialog at the user’s terminal).

All the above commands are described in the *IOF Terminal User’s Reference Manual.*

6.8.3 The File-Allocation Parameter Group ALCi

The file-allocation parameter group ALCi (JCL equivalent ALLOCATE) allocates space for disk files. The file-allocation parameter group ALCi is associated, through the internal-file-name, with a file-assignment parameter group ASGi in the same program. ALCi is normally used for temporary files, unless the default file-allocation parameters are not suitable for the file. You cannot use ALCi to allocate space for IDS/II files.

Format:

```
EXEC_PR MYPROG

      FILEi = ifn
      ASGi  = efn
      ALCi  = ( [ SIZE = dec10 ]
(

          [ INCRSIZE = dec5 ]

          [ UNIT = { CYL | BLOCK | 100KB | RECORD } ]

          [ CHECK = { bool | 0 } ]
)
```

Specify BLOCK and 100KB in the UNIT parameter for FBO files only. (These are the recommended UNIT parameter values for such disk files).

For an explanation of these parameters, see the *IOF Terminal User’s Reference Manual.*

The following information is supplied by the file-assignment parameter group ASGi (described in Section 5):

- whether the file is temporary ($TEMPRY) or permanent,
- where the space is to be allocated (resident disk volume ($RES) or non-resident volume),
- the expiration date (EXPDATE).

The program supplies the following attributes:

- file is UFAS (in COBOL, ORGANIZATION IS UFF); (note that UFF is the COBOL default),
- logical-record length,
- record format; fixed or variable (in COBOL FLR and VLR),
- for an indexed sequential file, KEYSIZE and KEYLOC; in COBOL the RECORD KEY IS clause specifies the record key that is the primary key for the file.

The following file attributes are chosen automatically if they are not given in the file-define parameter group DEFi (described above).

- CISIZE is set to 2048 bytes,
- CIFSP = 0.

The space calculations are the same as those already described for BUILD_FILE. Because UNIT=CI and UNIT=RECORD are not available in ALCi (JCL equivalent ALLOCATE), the calculation must result in a value of:

- blocks,
- 100KB units,
- cylinders,
- tracks.

Examples **Comment**

```
EXEC_PG PROG 1
     FILE = inf1
     ASG1 = X$TEMPRY
     ALC1 = (SIZE = 10);
```

Automatic file allocation for a temporary file; by default, the unit of allocation is CYL.

```
EXEC_PG APROG
     FILE1 = OUTFILE
     ASG1 = A:VOL2:MS/D500
     ALC1 = CHECK;
```

Default automatic allocation parameters; abort if file already exists.

```
EXEC_PG MYP
     FILE1 = DMFILE
     ASG1 =
(ZABC:BO12:MS/D500
             EXPDATE = 30)
     ALC1 = (SIZE = 10
             INCRSIZE = 10).
```

An uncataloged disk file is assigned to internal file name DMFILE. If the file does not exist, it is allocated with an expiration date of 30 days from the current date. Because CATNOW is not specified, the file will be uncataloged.

```
EXEC_PG PG = PL24
     LIB = P2.F3
     FILE 1 = F1
     ASG1 = WKF$TEMPRY
     ALC1 = (SIZE = 10);
```

Execute the load module LP24 which is stored in the cataloged library P2.F3. Assign the temporary file WKF to the internal file F1. WKF will be dynamically created with a size of 10 units.

6.8.4 The File-Define Parameter Group DEFi

The file-define parameter group DEFi (JCL equivalent DEFINE):

- Overrides and complements file parameters provided in user programs,
- Complements the file description in the file label,
- Provides for buffer management,
- Requests journalization.

Syntax:

```
EXEC_PG MYPROG
      FILEi = ifn
      ASGi = efn
      DEFi = (  [ FILEFORM = { UFAS } ]

                [ FILEORG = { SEQ | RELATIVE | INDEXED } ]

                [ BLKSIZE = dec5 ]

                [ RECSIZE = dec5 ]

                [ RECFORM = { F | V | U | FB | VB } ]

                [ NBBUF = dec4 ]

                [ SYSOUT = bool ]

                [ DATAFORM = { SARF | SSF | DOF | ASA } ]

                [ ERROPT = { SKIP | ABORT | IGNORE | RETCODE } ]

                [ BUFPOOL = name4 ]

                [ CISIZE = dec5 ]

                [ BPB = dec3 ]

                [ CKPTLIM = { NO | EOV | dec8 } ]

                [ FPARAM = bool ]

                [ COMPACT = bool ]

                [ TRUNCSSF = bool ]

                [ CONVERT = bool ]

                [ BSN = bool ]

                [ disk-file-specific-parameters ]

)
```

where disk-file-specific-parameters are:

```
[ JOURNAL = { BEFORE | AFTER | NONE | BOTH } ]

[ COLLATE = { BCD | ASCII | EBCDIC } ]

[ WRCHECK = bool ]

[ READLOCK = { NORMAL | EXCL | STAT } ]

[ LOCKMARK = bool ]

[ ADDRFORM = { LRRR | LRRRR | TTRDD | SFRA } ]

[ KEYLOC = dec5 ]

[ KEYSIZE = dec3 ]

[ CIFSP = dec3 ]

[ LTRKSIZE = dec3 ]
```

As mentioned in Section 5, the file-define parameters are used to define/modify file characteristics and/or processing options. In Section 5, you are shown how to use some of these file-define parameters.

For a complete explanation of these parameters, see Part 2 of the *IOF Terminal User's Reference Manual*.

Examples / **Comment**

```
EXEC_PG TULLOW
  POOLSIZE = 100
  SIZE = 150
  FILE1 = ifn1
  ASG1 = CORJ1
  DEF1 = (NBBUF = 20
          FILEORG = INDEXED
          BUFPOOL = B5)
```

Assign the file named CORJ1 to the internal file named ifn1.
This indexed sequential file has 20 buffers defined that it shares in the buffer pool named B5.

```
FILE2 = ifn2
ASG2 = CORJ2
DEF2 = (NBBUF = 20
        FILEORG = INDEXED
        BUFPOOL = B5)
```

Assign the file named CORJ2 to the internal file named ifn2.
This indexed sequential file has 20 buffers defined that it shares in the buffer pool named B5.

```
FILE3 = ifn3
ASG3 = CORJ3
```

Assign the file named CORJ3 to the internal file named ifn3.

```
DEF3 = (NBBUF = 20
        FILEORG = INDEXED
        BUFPOOL = B5)
```

This indexed sequential file has 20 buffers defined that it shares in the buffer pool named B5.

```
FILE4 = ifn4
ASG4 = CORJ4
DEF4 = (NBBUF = 20
        FILEORG = INDEXED
        BUFPOOL = B5)
```

Assign the file named CORJ4 to the internal file named ifn4.
This indexed sequential file has 20 buffers defined that it shares in the buffer pool named B5.

```
FILE5 = ifn5
ASG5 = CORJ5
DEF5 = (NBBUF = 20
        FILEORG = INDEXED
        BUFPOOL = B5)
```

Assign the file named CORJ5 to the internal file named ifn5
This indexed sequential file has 20 buffers defined that it shares in the buffer pool named B5.

```
FILE6 = ifn6
ASG6 = CORJ6
DEF6 = (NBBUF = 20
        FILEORG = INDEXED
        BUFPOOL = B5)
```

Assign the file named CORJ6 to the internal file named ifn6
This indexed sequential file has 20 buffers defined that it shares in the buffer pool named B5.

```
FILE7 = OUT
ASG7 = OUTF
ALC7 = (SIZE = 10
        UNIT = CYL
        INCRSIZE = 2);
```

Assign the file named OUTF to the internal file named OUT.
10 cylinders are to be allocated and the increment size is 2 cylinders.
The OUTF file does not belong to the buffer pool.

6.8.5 LIST_FILE

The LIST_FILE command (JCL equivalent FILLIST) lists the label, catalog and usage information for a disk, or tape file. The listed information is presented in six sections. Each section may be requested or omitted.

Syntax:

```
{ LIST_FILE }
{           }
{ LSF       }

          { FILE   }
          {        } = ( input-file-description )
          { INFILE }

          [ CONTROL = { bool | 0 } ]

          [ ORG = { bool | 0 } ]

          [ SPACE = { bool | 0 } ]

          [ USAGE = { bool | 0 } ]

          [ SUBFILES = { bool | 0 } ]

          [ SAVINFO = { bool | 0 } ]

          [ ALL = { bool | 0 } ]

          [ CATONLY { bool | 0 } ]

          [ SILENT = { bool | 0 } ]

          [ PRTFILE = file78 ]
```

For a description of these parameters, see Part 2 of the *IOF Terminal User’s Reference Manual.*

6.8.6 LIST_FILE_SPACE

The LIST_FILE_SPACE command (JCL equivalent FILLIST) lists information about the extents of a file.

Syntax:

```
{ LIST_FILE_SPACE }
{                 }
{ LSFSP           }

          { FILE   }
          {        } = file78
          { INFILE }

          [ SILENT = { bool | 0 } ]

          [ PRTFILE = file78 ]
```

For a description of these parameters, see the Part 2 of the *IOF Terminal User's Reference Manual*.

Examples	**Comment**
`LSFSP A.MYFILE;`	List allocation of a cataloged file
`LSFSP F3:X:MS/D500;`	List allocation of an uncataloged file.

`LSFSP A.MYFILE`
`      PRTFILE = A.OUT;`
	List allocation of a cataloged file; report is stored in A.OUT, errors appear at the terminal.

`LSFSP A.MYFILE`
`      SILENT`
`      PRTFILE = A.OUT;`
	Same as the previous example, but errors are reported in A.OUT and not at the terminal.

6.8.7 MODIFY_FILE

The MODIFY_FILE command (JCL equivalent FILMODIF) modifies the characteristics of a file. Specify BLOCK in the UNIT parameter for FBO files only. (BLOCK is the recommended value for such disk files).

Syntax:

```
{ MODIFY_FILE }
{             }
{ MDF         }

          FILE = file78

          [ NEWNAME = file44 ]

                      { ddd       }
          [ EXPDATE = { yy/ddd    } ]
                      { yy/mm/dd }

          [ UNIT = { BLOCK | CYL | TRACK } ]

          [ INCRSIZE = dec5 ]

                    { NORMAL   }
                    { ONEWRITE }
                    { MONITOR  }
          [ SHARE = {          } ]
                    { DIR      }
                    { FREE     }
                    { UNSPEC   }

                      { NORMAL   }
                      { ONEWRITE }
          [ DUALSHR = {          } ]
                      { FREE     }
                      { NONE     }

                      { NO      }
                      { BEFORE  }
          [ JOURNAL = { AFTER   } ]
                      { BOTH    }
                      { PRIVATE }

          [ SLOCK = { IO | IN | AP | IA | OFF } ]
          [ UNLOCK = bool ]
          [ SYMGEN = name5 ]
          [ CLEARMD = bool ]
          [ FIRSTVOL = dec2 ]
          [ LASTVOL = dec2 ]
          [ VOLSET = name6 ]
          [ CLRVSET = bool ]
          [ MOUNT = dec1 ]
          [ SILENT = { bool | 0 } ]
          [ FORCE = bool ]
          [ IOC = { DEFAULT | BYPASS | FORCE } ]
          [ LOGSUBF = bool ]
```

For a complete explanation of these parameters, see Part 2 of the *IOF Terminal User's Reference Manual.*

Examples	**Comment**

`MDF A.BC`
`NEWNAME = A.XC`
`EXPDATE = 365`
	Change name and expiration date.

`MDF PROJ.F3`
`SHARE = ONEWRITE`
`DUALSHR = NORMAL;`
	Change sharing conditions.

6.8.8 MODIFY_FILE_SPACE

The MODIFY_FILE_SPACE command (JCL equivalent FILMODIF) extends the existing space allocated to a file. This command cannot be used with relative files. For further information on file extension, see Section 5. For dynamic extension, see under Choosing the Increment Size earlier in this Section. Specify BLOCK and 100KB in the UNIT parameter for FBO files only. (These are the recommended values for such disk files).

Syntax:

```
{ MODIFY_FILE_SPACE }
{                   }
{ MDFSP             }

          NAME = file44

                       { CAT              }
          [ FILESTAT = { CAT{1|2|3|4|5} } ]
                       { UNCAT            }

          [ VOL = { volume24 | RESIDENT } ]

          [ SPLITDVC = device-class ]

- - - - - - - - - - - - - - - - - - - -

          [ UNIT = { CYL | BLOCK | 100KB | TRACK | SECTOR } ]

          [ SIZE = dec8 ]

          [ SPLIT = ( split-criteria ) ]

          [ REPEAT = bool ]

          [ SILENT = { bool | 0 } ]

          [ MAXEXT = { 16 | dec2 } ]
```

For an explanation of these parameters, see Part 2 of the *IOF Terminal User's Manual.*

Examples	Comment
`MDFSP A.B.C. SIZE = 30;`	Extend a cataloged file by 30 blocks on the last currently used volume that is registered in the catalog. The last volume must contain the end of the file.

`MDFSP F1 UNCAT 30`
`VOL2:MS/FSA;`
	Extend an uncataloged file by 30 blocks on the FSA volume named VOL2.
	VOL2 must contain the end of the file.

`MDFSP MF UNCAT`
`  SPLIT = (VOL2:15 VOL3:10)`
`  SPLITDVC = MS/D500;`
	Extend an uncataloged file by 15 cylinders on volume VOL2 and 10 on volume VOL3.
	VOL2 must contain the end of the file.

`MDFSP P1.F4`
`   FILESTAT = CAT SIZE = 300`
`   VOL = V4:MS/FSA`
	Extend the cataloged file named P1.F4 which is implemented on volume V9 by 300 blocks (where UNIT = BLOCK).
	If V4 does not contain the end-of-file, then the system will retrieve the V9 name from the catalog and access the file organization information. Extension will start on V9 and will continue on V4 only if there is not enough free space on V9.

`MDFSP NAME = MYFILE`
`      FILESTAT = UNCAT`
`      SPLIT = (V3:2 V6:4)`
`      SPLITDVC = MS/D500;`
	Extend the uncataloged file named MYFILE by 6 cylinders. The extension consists of two cylinders on the volume named V3 and 4 cylinders on the volume V6. V3 and V6 are MD/D500 volumes. Note that V3 must contain the end of file (before the current extension).

`MDFSP NAME = MYFILE`
`      SIZE = 2`
`      FILESTAT = UNCAT;`
	Extend the uncataloged file named MYFILE by 2 cylinders. MYFILE resides on a resident volume and will be extended on this volume, and on other resident volume(s) of the same device class (if this is necessary).

❑

7. Magnetic Tape and Cartridge Tape Files

7.1 Summary

The cartridge tape unit introduced in Release V5 has the same characteristics as those of a magnetic tape unit. Section 7 discusses only the standard GCOS7/EBCDIC tape format. This is the native format (LABEL = NATIVE in JCL).

- types of tape file,
- labels,
- types of tape volume,
- types of record (fixed-length and variable-length),
- blocking of variable-length records,
- blocking of fixed-length records,
- choosing the block size,
- creating a cataloged magnetic tape or cartridge tape file,
- referencing tape files,
- minimum length of a physical record.

7.2 Types of Tape File

A tape file can be a permanent cataloged or permanent uncataloged file, or a temporary file.

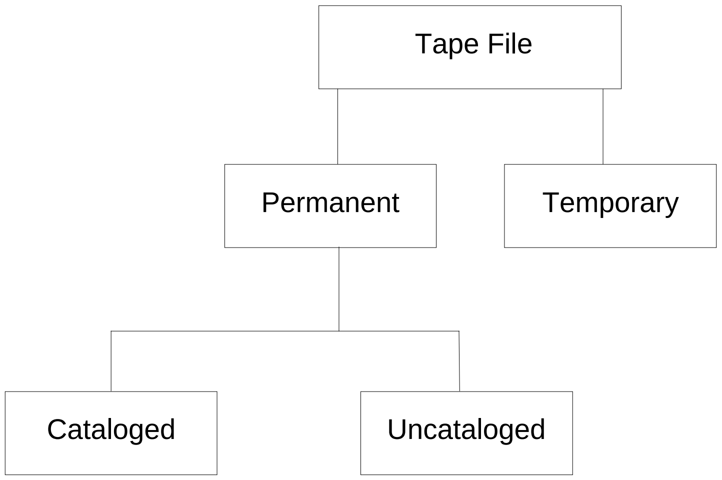


Figure 7-1. Types of Tape File

Files may be mono-volume or multi-volume.

Tape volumes may be multifile.

Tape volumes are either private or WORK. This aspect of tape handling has already been covered in Section 5. You can give tape files expiration dates.

7.3 Tape Labels

A label is a series of records placed before and after the actual data to be processed. A standard GCOS7/EBCDIC tape file is recorded with labels that contain information about the volume and file attributes:

- the volume name,
- the volume sequence number (for multivolume files); this is the relative number of the given volume (media list) in the set of volumes containing the whole file,
- the recording technique and recording density,
- the external-file-name,

the blocksize	(BLKSIZE =)
the size of the logical record	(RECSIZE =)
the record format	(RECFORM =)

You can obtain this type of information for a tape file by using the LIST_FILE (JCL equivalent FILLIST) command. For a complete description of the volume label and formats, see Appendix B.

The file designer needs to know how much space on a tape will be required to accommodate a given number of records. When programs are coded, the unit of transfer between the program and the file is the logical record, but information recorded on tape is in the form of blocks, (sometimes called physical records). A block contains one or more logical records, and optionally, control information that is not visible to the user program.

7.4 File Attributes

The following sections describe the attributes of a magnetic tape file.

7.4.1 Record Size (RECSIZE)

Supplies the size of the logical record. For COBOL programs it need not be coded since COBOL requires that the program-declared value be maintained for the file. Hence, if you omit this parameter in the file-define parameter group DEFi (JCL equivalent DEFINE), the value is taken from the program.

For magnetic tape files, the **minimum** record size is 18 bytes. This limit refers to the number of bytes written (paragraph 7.8). For variable-length record files, the record size corresponds to the value of the longest record in the file.

7.4.2 Block Size (BLKSIZE)

Supplies the block size with which the file is to be written. If the program declares a value (in COBOL the clause BLOCK CONTAINS), then it is overridden by the value in the file-define parameter group DEFi (described earlier in paragraph 6.8.4).

Note that when RECFORM = V or VB, the BLKSIZE value must be equal to or greater than (RECSIZE + 4).

7.4.3 Record Format (RECFORM)

The five record formats available on tape are as follows:

fixed length	(RECFORM = F),
fixed length blocked	(RECFORM = FB),
variable length	(RECFORM = V),
variable length blocked	(RECFORM = VB),
undefined length	(RECFORM = U).

RECFORM defines the record format. For COBOL, the record format (fixed or variable) must be the same as that declared or implied in the program. Whether the format chosen is blocked or unblocked is not relevant.

In FORTRAN, only fixed length (blocked or unblocked) is allowed.

EXAMPLE:

A program writes 90-byte records to a tape file. The records are fixed length and there will be 10 to a block.

```
EXEC PG  MYPROGRAM
         FILE1 = TFIXT
         ASG1  = (CMQ.PC EXPDATE = 20)
         DEF1  = (BLKSIZE = 900, RECFORM = FB);
```

The RECSIZE value will be supplied from the program.

❑

7.4.3.1 Fixed-Length Records

With fixed-length records (Figure 7-2), all the logical records in the file are the same length. If they are blocked, that is, there is more than one logical record in each block, then all the blocks of the file will contain the same number of records and therefore all blocks will be the same length. The one exception is the last block of the file which will be shorter than the others if there are not enough records to fill it.

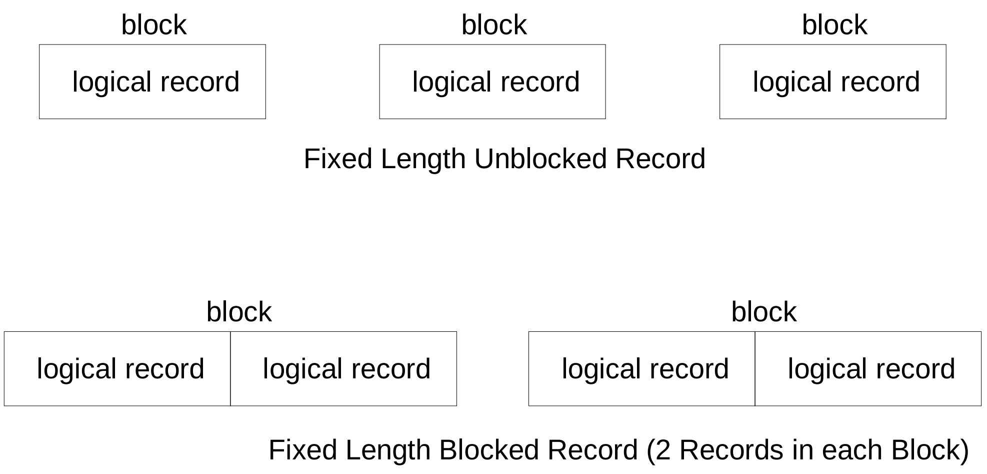


Figure 7-2. Fixed-Length Records: Blocked and Unblocked

Note that when RECFORM = F or FB, the BLKSIZE value must be an integral multiple of RECSIZE.

7.4.3.2 Variable-Length Records

Variable-length records may have any length up to a user-specified maximum. They can also be blocked. The maximum block size is user-specified and must be large enough to accommodate at least one record of maximum length. Blocks (or physical records) vary in length, thus making efficient use of the available space.

Each logical record has an associated **RDW (Record Descriptor Word).** This is a 4-byte control element that is provided and maintained for the record by GCOS7. The RDW contains the length of the record.

Each block for both blocked and **unblocked files has an associated BDW** (Block Descriptor Word). This 4-byte control element is provided and maintained for each block by GCOS7. The BDW contains the length of the block.

Note that the BDW and RDW are not accessible from user programs. The unit of transfer to and from the executing program is the **logical record**, containing data fields. Each programming language determines the length of each logical record in its own manner.

Figure 7-3 shows a series of variable-length records. Assume a program writes records A, B, ... etc., and that the maximum record length is 125 bytes (record C).

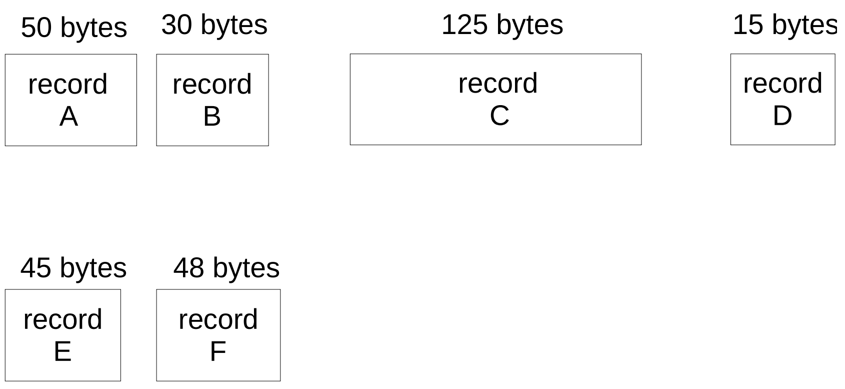


Figure 7-3. Variable-Length Records

Therefore, the file attributes are:

```
RECSIZE = 125
BLKSIZE = 129
RECFORM = V
```

RECSIZE is 125 because the maximum record length in the file is 125 bytes.

BLKSIZE is 129 because the maximum record length (125) is added to the RDW (4 bytes).

RECFORM is V because the format of the file records is variable length, unblocked.

Figure 7-4 shows how these records are written to the file.

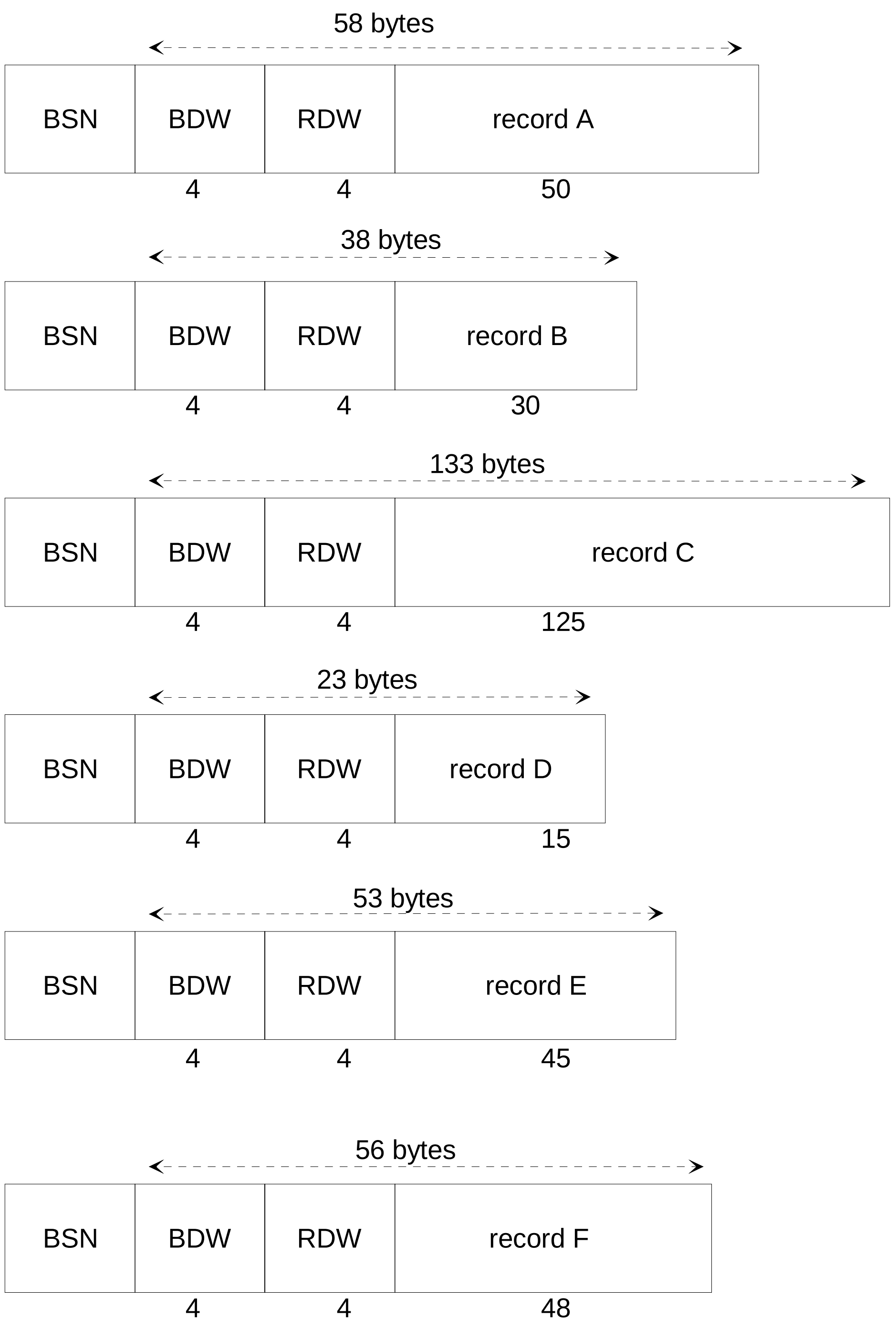


Figure 7-4. Variable-Length Unblocked Records

BSN: Block Serial Numbers are generated and managed by GCOS7.

- BSN = 0 means that no block serial numbers are to be on the tape.
- BSN = 1 means that block serial numbers are to be on the tape.

The six logical records introduced in Figure 7-3 are written as six separate physical records each containing an RDW and BDW. The maximum physical length written (record C) is 133 bytes, (that is, 4 bytes greater than that specified by BLKSIZE). This is because the value given to BLKSIZE excludes the BDW in the same manner as RECSIZE excludes the RDW.

If you wish to block this variable-length record file, the RECFORM parameter must take the form VB, as follows:

```
RECSIZE = 125
BLKSIZE = 129
RECFORM = VB
```

Figure 7-5 shows the physical records that are written.

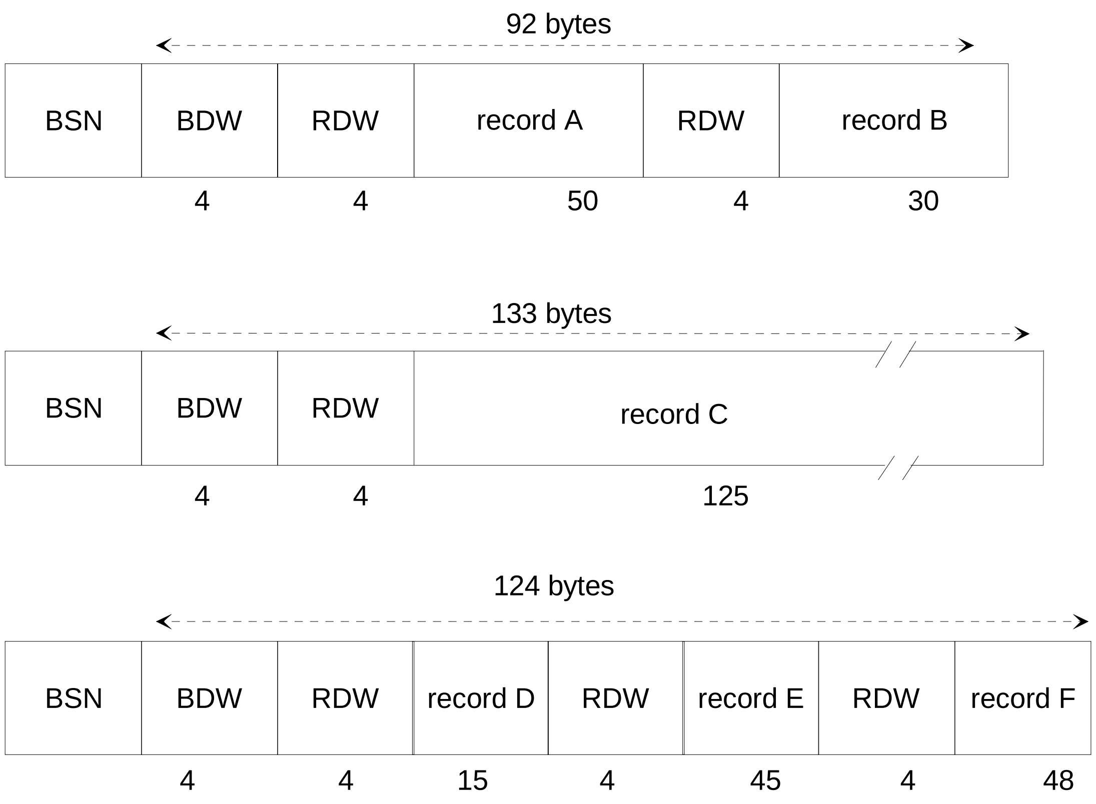


Figure 7-5. Variable-Length Blocked Records

The six logical records are written as three separate physical records. The logical records are blocked up to the maximum block size specified, (that is, 129 plus the BDW).

Blocks contain variable numbers of records and vary in length.

7.5 Choosing the Block Size

The choice of block size depends on:

- whether the blocks are fixed length or not
- how much memory is available for buffers.

The value of BLKSIZE depends on RECFORM and RECSIZE as follows:

- if RECFORM = F, BLKSIZE must be equal to RECSIZE,
- if RECFORM = FB, BLKSIZE must be a multiple of RECSIZE,
- if RECFORM = V, BLKSIZE must be equal to RECSIZE + 4,
- if RECFORM = VB, BLKSIZE must be a multiple of RECSIZE + 4,
- if RECFORM = U, BLKSIZE must be equal to the maximum record size.

Each block is separated by a gap to allow for the start/stop motion of the tape drive. The data capacity of a tape reel is greater for a large block size than for a small one.

Reel capacity can be calculated only for fixed-length and fixed-length blocked files. For variable-length and variable-length blocked files, you must calculate the capacity assuming an average block size.

These reel-capacity calculations must take the following into account:

- the recording density to be used,
- the size of the gap between each physical record,
- the length of the tape.

You can find these values in the various Operator Guides (see Preface) that are available for each type of drive.

The formula for calculating the capacity is:

```
Number of Blocks =
             Length of Tape-Header and Trailer Sections
         -------------------------------------------------
         (Bytes per Block/Density) + Length of Inter Block Gap
```

In this calculation you must also take account of BSNs (Block Serial Numbers). BSNs occur only on tape and are 4 bytes long. GCOS7, by default, writes BSNs with each block and expects BSNs to be present on input files. If a file on output is not to have BSNs, then the parameter BSN must be set to zero in the file-define parameter group DEFi associated with the file-assignment parameter group ASGi.

7.6 Creating a Magnetic-Tape or a Cartridge-Tape File

You can create a file only on tape volumes which have been prepared (labeled) with the following commands:

- `PREPARE TAPE (PRPTP)`
- `PREPARE VOLUME (PRPV) (only in interactive mode).`

The JCL equivalent is the VOLPREP utility that is described in the *Data Management Utilities User’s Guide.*

To create a cataloged tape file, use the CREATE MT FILE (CRMTF) command (JCL equivalent PREALLOC).

To create an uncataloged tape file, use the file-allocation parameter groups ASGi and DEFi (paragraph 7.7). In JCL, you use the ASSIGN and DEFINE statements.

The rest of this section shows you how to create a cataloged magnetic tape/cartridge tape file.

Syntax:

```
{ CREATE_TAPE_FILE }
{ CREATE_MT_FILE   }
{ CREATE_CT_FILE   }
{ CRTPF            }
{ CRMTF            }
{ CRCTF            }

          FILE = file78

          [ BLKSIZE = dec5]

          [ RECSIZE = dec5]

          [ WORKMT = { bool | 0 } ]

          [ RECFORM = { FB | F | VB | V | U } ]

          [ COMPACT = { bool | 0 } ]

                      { ddd      }
          [ EXPDATE = { yy/ddd   } ]
                      { yy/mm/dd }

          [ NBSN = { bool | 0 } ]

          [ MOUNT = { 1 | dec1 } ]
          [ ANSI = { bool | 0 } ]

          [ END = UNLOAD]

          [ SILENT = { bool | 0 } ]

- - - - - - - - - - - - - - - - - - - -

          [ REPEAT = { bool |0 } ]

          [ CATALOG = { 1 | 2 | 3 | 4 | 5 } ]
```

For an explanation of the parameters, see the *IOF Terminal User's Reference Manual.*

To learn more about label and volume formats, see Appendix B.

Examples	**Comment**

`CRTPF F.TRA:V2:MT/T9`
`      BLKSIZE = 4000`
`      RECSIZE = 1000`
`      ANSI;`
	Create an ANSI file

`CRMTF F.SRC:VN:VT/T9`
`      BLKSIZE = 2000`
`      RECSIZE = 2000`
`      RECFORM = F`
`      COMPACT`
`      EXPDATE = 10/08/95;`
	Create a UFAS-EXTENDED file with expiry date and compact recording of blank characters.

`CRCTF X.WK`
`      WORKMT;`
	Create file X.WK; when the file X.WK is first used, it will be allocated on a work tape.

`CRMTF P1.`
 	
`FILE7:MYTAPE:MT/T9/D1600`
`      BLKSIZE = 4096`
`      RECSIZE = 128`
`      EXPDATE = 100;`
	Create the cataloged tape file named P1.FILE7 on the 9-track 1600 BPI tape volume named MYTAPE.
	The block size is 4096 bytes, the record size is 128 bytes, and the expiry date is 100 days after today. By default, the record format (RECFORM) is fixed blocked (FB).

7.7 Referencing Tape Files

To specify a GCOS7/EBCDIC tape file for input, use the file-assignment parameter ASGi with its associated parameter group (see Section 5). The JCL equivalent is ASSIGN. The label information supplies the BLKSIZE value (which will override any declared in the user program). The record length and record format from the label will be checked against the program declared values for consistency. The program must declare that the file is of sequential organization.

Note that in COBOL it is not necessary to declare explicitly that the file is of type UFF or LEVEL-64 because no distinction is made for tape files.

For output tape-files, there is no label information concerning the file attributes. Therefore, they must be declared through the program and/or through the file-define parameter DEFi with its associate parameter group. The format of this parameter, as it applies to the processing of output-tape files.

Syntax:

```
(          [ FILEFORM = { UFAS | ANSI | NSTD } ]

           [ FILEORG = { SEQ | RELATIVE | INDEXED } ]

           [ BLKSIZE = dec5 ]

           [ RECSIZE = dec5 ]

           [ RECFORM = { F | V | U | FB | VB | FS | FBS } ]

           [ NBBUF = dec4 ]

           [ SYSOUT = bool ]

           [ DATAFORM = { SARF | SSF | DOF | ASA } ]

           [ ERROPT = { SKIP | ABORT | IGNORE | RETCODE } ]

           [ BUFPOOL = name4 ]

           [ CISIZE = dec5 ]

           [ BPB = dec3 ]

           [ CKPTLIM = { NO | EOV | dec8 } ]

           [ FPARAM = bool ]

           [ COMPACT = bool ]
```

```
          [ TRUNCSSF = bool ]

          [ CONVERT = bool ]

          [ BSN = bool ]

          [ tape-file-specific-parameters ]
)
```

where tape-file-specific-parameters are:

```
          [ FUNCMASK = hexa8 ]

          [ DATACODE = { BCD | ASCII | EBCDIC } ]

          [ BLKOFF = dec3 ]
```

NOTE:

Only those parameters that are of interest are shown for the file-define parameter group DEFi. For full details of DEFi, see the *IOF Terminal User's Reference Manual*. The JCL equivalent is the DEFINE statement that is described in the *JCL Reference Manual*.

7.8 Minimum Length of a Physical Record

On a magnetic tape, the length of a physical record is at least 18 bytes. This physical record includes the BSN, if present, and BDW and RDW if the RECFORM = V or VB. Therefore, the minimum length of the logical record as defined by RECSIZE or through the user program is:

18	bytes if the file is fixed length (blocked or unblocked) without BSNs.
14	bytes if the file is fixed length (blocked or unblocked) with BSNs.
10	bytes if the file is variable length (blocked or unblocked) without BSNs.
6	bytes if the file is variable length (blocked or unblocked) with BSNs.

7.9 Compacted Data On Tape

The sequential access method allows the compaction of data on tape by deleting repetitive spaces. The COMPACT attribute must be supplied at tape file creation through the DEFINE statement.

The following restrictions are applied to the compacted file:

- The blocksize given by the user must be at least equal to the maximum record size + 4 bytes for the record header, + 1 byte control character per 128 characters of data.
- The record size before and after compaction must not be greater than 32 Kbytes - 1 (otherwise the compaction fails with return code TSEQL 24, RECSZERR).
- Only variable record format is allowed.

8. File Manipulation and Maintenance

8.1 Summary

This section covers the following topics:

- sorting and merging files,
- loading files,

  converting a file from the UFAS file format to the UFAS-EXTENDED file format,
- manipulating the contents of files,

  converting VBO files to FBO format,

  using the Data Services Language (DSL),
- list of file-level utilities,
- list of volume-level utilities.

8.2 Sorting and Merging Files

You can sort and merge UFAS-EXTENDED disk and tape files by using SORT_FILE and MERGE_FILE. These utilities are described in the *IOF Terminal User's Reference Manual.* The JCL equivalents are the SORT and MERGE utilities which are described in the SORT/MERGE User Guide.

8.3 Load_File

This utility loads a file (JCL equivalent CREATE). The input file and the output file may be a UFAS or a UFAS-EXTENDED disk file, or a tape file. The output file, for our purposes, will be UFAS-EXTENDED.

Syntax:

```
{ LOAD_FILE }
{           }
{ LDF       }

          { FILE    }
          {         } = ( output-file-description )
          { OUTFILE }

          INFILE = ( input-file-description )

                     { CAT             }
                     { CAT{1|2|3|4|5} }
          [ DYNALC = {                 } ]
                     { UNCAT           }
                     { TEMPRY          }

            { ALLOCATE }
          [ {          } = ( file-allocation-parameters ) ]
            { OUTALC   }

            { DEF    }
          [ {        } = ( file-define-parameters ) ]
            { OUTDEF }

          [ INDEF = ( file-define-parameters ) ]


            { DSLFILE }
          [ {         } = { file78 | ::TN } ]
            { COMFILE }

          [ START = dec8 ]

          [ INCR = dec8 ]

          [ HALT = dec8 ]

          [ APPEND = { bool | 0 } ]

          [ ORDER = bool ]
          [ PADCHAR = { char1 | hexa2 } ]

          [ KEYLOC = dec5 ]

          [ TAPEND = { 1 | dec3 } ]

          [ SILENT = { bool | 0 } ]

- - - - - - - - - - - - - - - - - - - - -
          [ PRINT = { ALPHA | HEXA | BOTH } ]

          [ PRTFILE = file78 ]

          [ TITLE = char114 ]

          [ REPEAT = bool ]

          [ FMEDIA = { bool | 0 ]

          [ IMPORT =  bool ]

          [ EXPORT =  bool ]
```

For an explanation of the parameters, see the *IOF Terminal User's Reference Manual.*

Examples	**Comment**
`LDF (MYFILE ACCESS = SPWRITE EXPDATE = 94/07/31) INFILE = FRAN DYNALC = CAT;`	Load and dynamically allocate file MYFILE with expiry date and exclusive access.
`LDF FILE = P1.F1 INFILE =MYDATA:V1:MS/D500`	Load the cataloged file named P1.F1 with data from the uncataloged file named MYDATA which resides on the MS/D500 volume named V1.
`LDF FILE = P1.F1:V2MS/D500 INFILE = MYDATA:V1:MS/D500 DYNALC = CAT ALLOCATE = (SIZE = 5 UNIT = CYL);`	As the previous example, except that the file P1.F1 is to be dynamically created on the MS/D500 volume named V2. Its size will be 5 cylinders.
`LDF FILE2:V3:MS/D500 INFILE = MYDAT1:V7:MS/D500;`	Load the uncataloged file named FILE2 which resides on the MS/D500 volume named V3 with data from the uncataloged file named MYDAT1 which resides on the MS/D500 volume named V7.

8.3.1 Converting UFAS Files to the UFAS-EXTENDED File Format

You can use the LOAD_FILE command (JCL equivalent CREATE) to convert a UFAS file to the UFAS-EXTENDED file format.

Proceed as follows:

If you use the DYNALC parameter in the LOAD_FILE command, you can combine steps 1 and 2 (See the first example below).

1. allocate a new UFAS-EXTENDED file using the BUILD_FILE command,
2. use the LOAD_FILE command to move logical records from the UFAS file to the UFAS-EXTENDED file,
3. delete the old UFAS file,
4. rename the UFAS-EXTENDED file to the same name as that in the UFAS version (use the MODIFY_FILE command with the NEWNAME parameter; see Table 8-1).

NOTE:
If there are many files to be converted, use the LOAD_FILESET command with a star (*).

Examples	**Comment**

`LDFST (DUP* ACCESS =`
`SPWRITE`
`      EXPDATE = 365`
`      INSET   = ORG*`
`      DYNALC  = CAT;`
	Load and allocate files DUP* with expiry date and exclusive access from ORG*files.

`LDFST P1.**:V1:MS/D500`
`      INSET  = P2`
`      DYNALC = CAT;`
	Load the fileset P1.** with data from the fileset P2.**
	The member files of P1.** are dynamicaly created on the volume named V1. The files will be created as cataloged files.

`LDFST`
`FILESET = **:V2:MS/D500`
`INSET`
`=**:V3:MS/D500$UNCAT`
`DYNALC  = UNCAT;`
	All uncataloged files on V3 are loaded into the correspondingly named files on V2
	Dynamic allocation takes place on V2.
	There are multi-volume files on V3.

8.3.2 Converting VBO files to FBO format

A file migration tool in the IOF (Interactive Operator Facility) domain enables you to migrate files from VBO to FBO format. The MAINTAIN_MIGRATION (MNMIG) tool can only be used interactively, and you must have SYSADMIN rights. It helps you to produce a JCL program that is used to migrate files either directly or indirectly to a target FBO volume.

Full details are given in the File Migration Tool User's Guide.

8.4 Data Services Language (DSL)

This language, which is available with the SORT_FILE (JCL equivalent SORT), MERGE_FILE (JCL equivalent MERGE), COMPARE_FILE (JCL equivalent COMPARE), LOAD_FILE (JCL equivalent CREATE) and PRINT_FILE (JCL equivalent PRINT) commands allows you to:

- select/omit records from the input file,
- re-order data fields within each record,
- change the length of records,
- declare the key fields for SORT FILE/MERGE FILE,
- sum duplicate-key records for SORT FILE/MERGE FILE.

For further information on the DSL for SORT_FILE and MERGE_FILE, see the *SORT/MERGE Utilities User's Guide*.

For further information on the DSL for COMPARE_FILE, LOAD_FILE and PRINT_FILE commands, see the *Data Management Utilities (DMU) User's Guide.*

8.5 File-Level Utilities

Table 8-1 shows the set of file-level utilities available for UFAS-EXTENDED disk and tape files.

Table 8-1. File-Level Utilities (1/2)

GCL Commands	Function
BUILD_FILE (BF)	Allocates space for a disk file.
CLEAR_FILE (CLRF)	Logically erases the contents of a file without deallocating it.
COMPARE_FILE (CMPF)	Logically compares the contents of two sorted files.
COMPARE_FILESET (CMPFST)	Logically compares the contents of each sorted file of a fileset to a sorted reference file.
COPY_FILE (CPF)	Copies the contents of a file into another file of identical type.
COPY_FILESET (CPFST)	Copies the contents of a set of files into another set of files of identical types.
CREATE_CT_FILE (CRCTF)	Creates a cataloged cartridge file.
CREATE_MT_FILE (CRMTF)	Creates a cataloged tape file.
CREATE_FILE (CRF)	Allocates space for a disk file, possibly by referencing an existing file to be used as a model. Can be used to simulate a file allocation.
CREATE_FILESET (CRFST)	Allocates space for a set of disk files, possibly by referencing an existing file to be used as a model.
DELETE_FILE (DLF)	Deallocates a disk or a cataloged tape file and erases its entry in the catalog.
DELETE_FILESET (DLFST)	Deallocates a fileset.
EXPAND_FILESET (EXPFST)	Produces a report which displays the names of all the member files of filesets.
LIST_FILE (LSF)	Lists the label, catalog and usage information for a disk or a tape file.
LIST_FILESET (LSFST)	Lists the characteristics of the files of a fileset.
LIST_FILE_SPACE (LSFSP)	Lists the space allocated to a file.
LOAD_FILE (LDF)	Loads a UFAS-EXTENDED file; copies an IDS/II area.

Table 8-1. File-Level Utilities (2/2)

GCL Commands	Function
LOAD_FILESET (LDFST)	Loads a set UFAS_EXTENDED files; copies an IDS/II fileset.
MAINTAIN_FILE (MNF)	Dumps physical records from a disk or tape file; modifies physical records on a disk file.
MERGE_FILE (MRGF)	Activates the MERGE utility which merges two to eight sorted files into a new file or into an existing file.
MODIFY_FILE (MDF)	Modifies the characteristics of a file.
MODIFY_FILE_SPACE (MDFSP)	Extends the space allocated.
MODIFY_FILE_STATUS (MDFSTAT)	Changes the catalog status of a file.
PRINT_FILE (PRF)	Prints records from a file.
PRINT_FILESET (PRFST)	Prints records from a fileset.
RESTORE_FILE (RSTF)	Restore the contents of a disk file from a tape file or from a UFAS-EXTENDED sequential disk file where it was previously saved by the SAVE_FILE or SAVE_FILESET commands; also restores the contents of a single-volume disk file from a tape previously created by the SAVE_DISK command.
RESTORE_FILESET (RSTFST)	Restores the contents of a set of disk files from a tape file or from a UFAS-EXTENDED sequential disk file or from a set of files where it was previously saved by the SAVE_FILESET command; also restores the contents of a set of single-volume disk files from a tape previously created by the SAVE_DISK command.
SAVE_FILE (SVF)	Saves the contents of disk file into a sequential UFAS-EXTENDED disk file or into a tape file.
SAVE_FILESET (SVFST)	Saves the contents of a set of disk files into a sequential UFAS-EXTENDED disk file, or on to a set of UFAS-EXTENDED disk files, or on to a tape file or on to a set of tape files.
SORT_FILE (SRTF/SORT)	Activates the SORT utility which sorts one or more files into a new file or into an existing file.
SORT_INDEX (SRTIDX)	Sorts and loads the secondary indexes of a UFAS-EXTENDED Indexed sequential file.

For further details on the BUILD_FILE and CREATE_FILE commands, see Section 6. For other commands, see the *IOF Terminal User's Reference Manual.*

8.6 Volume-Level Utilities

Table 8-2 shows the set of volume-level utilities available for UFAS-EXTENDED disk and tape volumes.

Table 8-2. Volume-Level Utilities

GCL Commands	Function
CLEAR_VOLUME (CLRV)	Erases the contents of a volume.
LIST_VOLUME (LSV)	Lists the contents (names and characteristics) of a native disk, or tape volume.
MAINTAIN_VOLUME (MNV)	Dumps physical records from a disk, or tape volume. Changes physical records on a disk volume.
MODIFY_DISK (MDD)	Declares defective tracks on a disk volume.
PREPARE_DISK (PRPD)	Labels and formats a disk volume; you can do the same operation interactively using PREPARE_VOLUME.
PREPARE_TAPE (PRPTP)	Labels a tape volume; you can do the same operation interactively using PREPARE_VOLUME.
PREPARE_VOLUME (PRPV)	Prepares (labels) a disk, or labels a tape volume. Used only in interactive mode. To label and format a disk volume from within a file, use PREPARE_DISK. To label and format a tape volume from within a file, use PREPARE_TAPE.
RESTORE_DISK (RSTD)	Restores a native disk volume from a native tape file created by the SAVE_DISK command.
SAVE_DISK (SVD)	Saves a native disk volume into a native tape file.

For further details, see the *IOF Terminal User's Reference Manual.*

8.7 Visibility of Physical and Logical Space Allocated to UFAS Disk Files

The address space 1 of any UFAS disk file contains how many CIs are allocated, and how many (allocated) CIs are formatted.

This information appears in the USAGE listing of LIST_FILE[SET] or LIST_VOLUME (JCL equivalents FILLIST or VOLIST) when the USAGE option is specified.

When a UFAS disk file has just been created, the physical extents (as listed by the SPACE option) match very closely the logical information (ad listed by the USAGE option).

When a UFAS disk file is extended by using the MODIFY_FILE_SPACE GCL command (or PREALLOC with the EXTEND option), the address space 1 cannot be immediately updated. This means that the USAGE information also remains unchanged (maximum, ratio, number of allocated CIs per address space). The SPACE information, however, gives all the physical extents.

The extra physical space not yet logically described in address space 1 will be described as soon as the current logically described space in address space 1 becomes insufficient in at least 1 other address space when a record is added or modified under UFAS access method control.

The same occurs when an input file is restored or copied onto a larger than necessary output file. The output address space 1 is simply a copy of the input address space 1 and so does not take into account the surplus output space. On the other hand, if the output file is smaller than the input file then either the output file is automatically extended or, if this is not possible, the operation is aborted.

This effect may be propagated if such files are saved/restored or duplicated to any other files, already existing or not.

A. Randomizing Formulas for Relative Files

A.1 Randomizing Techniques

As explained in Section 3, relative files are organized around a Relative Record Number (RRN). It is the RRN which is randomized (or converted) to a disk storage location (or disk address).

Randomizing methods ensure that records are distributed evenly throughout the file. Thus, up to 90% of the file may be used depending on the particular randomizing technique. Optimizing the available space, however, also generates duplicate relative addresses which increase access time.

When you choose a randomizing technique, you must consider the advantages of file space against file-access time.

There are many techniques available, four of which are explained in this Appendix, as follows:

- prime-number division,
- square, enfold, and extract,
- radix conversion,
- frequency analysis.

When you are evaluating which of the above methods to choose, the following criteria will be a guide:

- efficient use of mass storage,
- frequency and distribution of synonyms,
- processing time required for the randomizing calculation,
- even distribution of the RRNs throughout the file.

A.2 Prime-Number Division

The most widely accepted method of transforming a key into a relative record address is to divide the record key field by a prime number. (A prime number is a number divisible only by itself or one). The prime number used should be the largest prime number that is smaller than the total number of possible record locations allocated to the file. The larger the prime number used, the less likely are synonyms to be generated.

Table A-1. Prime Numbers

1. Every third prime number between 2 and 2939

5	197	449	727	1019	1303	1613	1951	2281	2633
13	223	463	733	1033	1321	1627	1987	2297	2659
23	233	487	761	1051	1367	1663	1999	2333	2677
37	251	503	787	1069	1399	1693	2017	2347	2689
47	269	523	811	1093	1427	1709	2039	2371	2707
61	281	557	827	1109	1439	1733	2069	2383	2719
73	307	571	853	1129	1453	1753	2087	2399	2741
89	317	593	863	1163	1481	1783	2111	2423	2767
103	347	607	883	1187	1489	1801	2131	2447	2791
113	359	619	911	1213	1511	1831	2143	2473	2803
137	379	643	937	1229	1543	1867	2179	2531	2837
151	397	659	953	1249	1559	1877	2213	2549	2857
167	419	677	977	1279	1579	1901	2239	2579	2887
181	433	701	997	1291	1601	1931	2267	2609	2909

2. Every fifth prime number between 2953 and 8033

2957	3467	3931	4457	4973	5501	6029	6551	7043	7603
3001	3517	4001	4507	5009	5527	6067	6577	7109	7649
3041	3541	4021	4547	5051	5573	6101	6637	7159	7691
3083	3581	4073	4591	5099	5641	6143	6679	7211	7727
3137	3617	4111	4639	5147	5659	6199	6709	7243	7789
3187	3659	4153	4663	5189	5701	6229	6763	7307	7841
3221	3697	4211	4721	5233	5743	6271	6803	7349	7879
3259	3733	4241	4759	5281	5801	6311	6841	7417	7927
3313	3779	4271	4799	5333	5839	6343	6883	7477	7963
3343	3823	4327	4861	5393	5861	6373	6947	7507	7991
3373	3863	4363	4909	5419	5897	6427	6971	7541	8009
3433	3911	4421	4943	5449	5953	6481	7001	7573	8027

When you divide the record key by the prime number selected, discard the quotient and use the remainder as an address.

EXAMPLE:

Assume you have a 800-record file whose record keys range from 0 (zero) to 999 999 999. Space is to be allocated to this file for 1 000 record "slots". The divisor is 997 - the highest prime number below 1 000. This leaves only three record locations unused out of the 1 000 allocated.

❑

If, for example, the record key to be processed is 777 775 925; then

`777 775 925 / 997 =` *`780 116 with a remainder of 273`*`.`

Thus, this record will be stored in relative record address 273.

NOTE:

If the record key to be divided is alphabetic or alphanumeric, it can be treated as a binary field. In this case, the prime number would also be in binary form. The final calculations are also performed binarily so that the relative address is produced in a usable form.

A.3 Square, Enfold, and Extract

In this randomizing technique, the record key field is squared, the result is split in half, and then the two halves are added together. You extract the number of digits needed for the address from the middle of the result. Normally, the two low-order (rightmost) characters are ignored and you extract starting from the third low-order character and continue to the fourth-order character and so on.

EXAMPLE 1:

A file of 8 000 records with record keys ranging from (0) zero to 999 999 999. You wish to allocate a file for 10 000 record locations.

❑

If the record key to be processed is 493 725 816, then:

Squared: 243,765,181,384,865,856

$$\begin{tikzcd}[column sep=small]
\text{Enfolded:} & \underline{243{,}765{,}181} \arrow[dr] & + & \underline{384{,}865{,}856} \arrow[dl] \\
& & \underline{628{,}631{,}037} \arrow[d] & \\
\text{Extracted result:} & & \underline{86{,}310}\ \text{relative record address} &
\end{tikzcd}$$

This result is obviously not suitable as it stands for a file of only 10 000 record locations. It would be usable only in the unlikely event of a 99 999-record file. For example 1, only four digits should have been extracted, yielding a maximum address value of 9 999. This is still of no use where, for example, only 7 000 record locations are to be allocated to the file.

EXAMPLE 2:

A file of 4 000 records with record keys in the same range as for the first example, (from (0) zero to 999 999 999) is to have file space allocated to it sufficient for 6 000 record locations.

If the key to be processed is the same as that used in Example 1, the initial extracted result (for four digits) would give a relative record address of 6 310.

Apart from this relative record address not being suitable for a file with only 6 000 record locations, the maximum address value that could be produced is still about 9 999.

In this case, reduce the initial expected result in order to adapt the the highest value to the available file space. Here, multiplying the preliminary extracted result by 0.6 will have the desired effect:

6 310 * 0.6 = 3 786 relative record address.

❑

A.4 Radix Conversion

For this technique, it is assumed that the record key is a number of a radix other than 10. The key is then converted "back" to radix 10, digit by digit. The sum of this process has the number of digits needed for the relative record address extracted from it, starting with the low-order characters. You can then adapt this initial extracted result to the available file space as that used in "Square, Enfold, and Extract".

EXAMPLE:

A file containing 6 000 records with record keys ranging from 0 (zero) to 99 999 is to have space allocated to it sufficient for 7 500 record locations.

For example, if the record key to be processed is 14 623, and it is assumed to be a radix 11 number, then:

1 4 6 2 3 becomes:

(1*11**4) + (4*11**3) + (6*11**2) + (2*11**1) + (3*11**0) =

(1 * 14641) + (4 * 1331) + (6 * 121) + (2 * 11) + (3 * 1) =

(14641) + (5324) + (726) + (22) + (3) = 20716

Preliminary extracted result = 0716

Relative record address = (0716 * 0.75) = (0)537

❑

A.5 Frequency Analysis

This method has two uses:

- to determine the pattern of distribution for a given file, indicating which positions are best for truncating or extracting relative record addresses from the record keys; in other words you can use it to evaluate the most suitable randomizing technique for a file,
- to develop relative addresses from the record keys, in extended form; in other words, it is a randomizing method in its own right.

Using Frequency Analysis to Evaluate a Randomizing Technique

Frequency analysis consists of analyzing the keys of all the records in the file, to determine how frequently a digit appears in each given record key position. For each digit position in the key, examine the records to determine the number of times each digit (0 to 9) appears.

For example, in a file consisting of 16 045 records,

- 0 (zero) might occur in the fifth key position in 5 168 records,
- 1 might occur in the fifth key position for 5 638 different records,
- 2 might occur in that position for 4 958 records,
- 3 might occur for 281 records,
- the numbers 4 to 9 might not appear in this key position for any record.

This frequency-analysis count gives the actual distribution of digits appearing in every key position. If the distribution were perfectly even, each of the digits would occur the same number of times. Because there are 10 digits, this means that, with a total of 16 045 records, each digit would occur approximately 1 605 times in any one key position.

To determine the deviation from such an ideal distribution, measure the difference between it and the real digit occurrence for each key position.

Thus, if 0 occurs in the fifth key position of 5 168 records, the deviation would be:

```
(5 168 - 1 605) = 3 563.
```

- Do this for each digit in that key position before adding all the results to find the total deviation for the key position.
- Then express the total deviation as a percentage of the total number of items.

The lower the figure, the more even the distribution. In this example, 0% could arise only if there were exactly 1 605 occurrences of each of the digits 0 to 9 in a given key position throughout the file.

Table A-2. Pattern of distribution

	Key Position Number							
Digits	1	2	3	4	5	6	7	Total
0	16045	0	0	1852	5168	1807	1738	26610
1	0	0	4408	3147	5638	2120	1748	17061
2	0	2198	3792	1174	4958	1745	1743	15610
3	0	576	2231	2724	281	1684	1610	9106
4	0	1195	2459	1194	0	1378	1617	7843
5	0	12076	3155	1267	0	1647	1688	19833
6	0	0	0	1243	0	1560	1660	4409
7	0	0	0	1228	0	1329	1450	4007
8	0	0	0	1227	0	1415	1411	4053
9	0	0	0	989	0	1360	1434	3783
Total Deviation	28885	22133	16045	5821	21903	1961	1035	
Total File	16045	16045	16045	16045	16045	16045	16045	
% File	180	138	100	36	137	12	6	

The pattern of distribution indicates which positions are best for truncating or extracting relative record addresses from the record keys. Note that the total variance for key position 3 in the Example of 16 045 (100% of the total file) is coincidental.

A.5.1 Using Frequency Analysis to Develop Randomized Relative Record Addresses

- Express each individual key digit count as a percentage of the total number of records in the file, 16 045 in the example above,
- Calculate the cumulative total (in the last column of Table A-2) for all key-position occurrences for each digit.

Table A-3. Developing a relative address

		Key Position Number							
Digits		1	2	3	4	5	6	7	Total
0	%	100			12	32	11	11	
	Constant	39915	26610	26610	28207	30868	28074	28074	26610
1	%			27	20	35	13	11	
	Constant	17061	17061	19364	18767	20047	18170	17999	17061
2	%		14	24	7	31	11	11	
	Constant	15610	16703	17483	16156	18030	16469	16469	15610
3	%		4	14	17	2	10	10	
	Constant	9106	9288	9743	9880	9197	9561	9561	9106
4	%		7	15	7		9	10	
	Constant	7843	8118	8431	8118	7843	8196	8235	7843
5	%		75	20	8		10	11	
	Constant	19833	27270	21816	20626	19833	20825	20924	19833
6	%				8		10	10	
	Constant	4409	4409	4409	4585	4409	4629	4629	4409
7	%				8		8	9	
	Constant	4007	4007	4007	4167	4007	4167	4187	4007
8	%				8		9	9	
	Constant	4053	4053	4053	4215	4053	4235	4235	4053
9	%				6		8	9	
	Constant	3783	3783	3783	3896	3783	3934	3953	3783

- From the percentages of individual key-digit count and all key-digit totals thus produced, calculate an adjusted constant for each digit in every record key position, by using the following formula:

```
Constant = (( KN% / 2) * dT) + dT ... where:
Kn% = individual key percentage for digit y
dT = all-key total for digit y
```

Thus the constant for converting a 1 appearing in the fifth key position is as follows:

```
(17 061 +  ( (35% / 2) * 17 061 )
= 17 061 + 2 985.7
= 20 046.7
= 20 047 rounded up.
```

Whether rounding is done at this stage depends on the total range of values produced from the total number of record positions to be allocated to the file. To obtain the value range, calculate the minimum and maximum values:

	Max. Value*		Min. Value*	
	Digit	Constant	Digit	Constant
Key 1	0	39915	0	39915
Key 2	5	27270	4	8118
Key 3	5	21816	4	8431
Key 4	0	28207	9	3896
Key 5	0	30868	3	9197
Key 6	0	28074	9	3934
Key 7	0	28074	9	3953
		204224		77444

* Rounding to the nearest decimal integer is assumed.

The range of values that would be produced by the file measured in our example is:

```
      204 224 - 77 444 = 126 780
```

For a relative file consisting of 16 045 records, it would be reasonable to allocate about 20 000 record locations. Clearly, the assumption made to round the constant value is justified.

Before you can use the aggregate constant values as relative record addresses for storing records, do the following two operations:

- Adjust the range of values from 126 780 to 20 000,
- Deduct a constant from whatever value is produced (the lowest value produced should be 1),

Multiply the value produced from Table A-3 by 0.157 to reduce the range of possibilities to 19 904, thereby "wasting" only 96 record locations out of the 20 000 allocated.

You can find the constant to be deducted by applying the ratio 0.157 to the minimum aggregate constant value produced for the example file.

```
       77 444 * 0.157 = 12 159   rounded up
       204 224 * 0.157 = 32 064  rounded up
```

Thus, by applying a standard constant of 12 159, you will distribute "wasted" record locations evenly: 48 at either end of the file. These are a token allowance for any new records that might be added in the future with keys producing aggregate constant values outside the range allowed for by the frequency analysis of the original file.

EXAMPLE:

Record key = 0451185
Constants = 39 915 + 8 118 + 2 1816 + 18 767 + 20 047 + 4 235 + 20 924 =
133 822
Constants Aggregate = 133 822
Adjusted Aggregate = (133 822 * 0.157) = 21 011 rounded up
Relative Record Address = (21 011 - 12 159) = 8 852

The advantage of treating the constants as in Table A-3 is that records are located according to the mean frequency of their key values, although this effect would nevertheless be diffused.
For instance, the most probable key-value combination, 0511110, would be stored in relative record address 14 675; and the least probable key-value combination in the file, 0339399, would be stored in relative record address 6.
To compensate, there might be many duplicate relative addresses (which your program must handle also), although this would obviously depend on the actual key-value combinations in the file.
Alternatively, consider only the five low-order digits in the constants aggregate, which for record key 0451185 would mean ignoring the leading 1, leaving 33 822.
In this randomizing solution, you need multiply only the maximum total number, 99 999, by 0.2 to produce a relative record address that can be used for a 20 000-record file.

❑

A.6 Non-Numeric Keys

Where key fields include alphabetic, special characters or alphanumeric characters, one method of randomizing would be to treat the field as a binary number and perform binary arithmetic on it. This has the advantage of avoiding unnecessary duplicate relative addresses.

Another method of randomizing is to convert each character into two numeric digits. You then manipulate the resultant key by decimal arithmetic according to the particular randomizing method employed. This method is useful where binary arithmetic is impracticable, but it does result in doubling the length of the keys.

B. Label and Volume Formats of Magnetic Tapes

B.1 Magnetic-Tape Conventions

A wide range of magnetic-tape handlers featuring various recording densities and transfer rates is available. Within this range are handlers capable of processing 7 - or 9-track tape, using either the non-return-to-zero invert (NRZI) or the phase encoded (PE) technique of recording.

Such a wide range of tape handlers allows the user to choose peripheral devices not only on system performance-to-cost ratios, but also on the desire to interchange tapes with other equipment manufacturers.

GCOS7 software creates and reads tapes:

- in EBCDIC code with odd parity (called GCOS7/EBCDIC),
- in ASCII code, on 9-track tape, with odd parity (called GCOS7/ASCII).

GCOS7/ASCII tapes must be labeled and may not contain U-type data blocks (undefined), that is, data blocks with an undefined record format.

This Appendix gives detailed information on the standard formats. A standard tape format:

- contains labels in a range of formats defined later in Figure B-1 or contains no labels, ($NONE) (in JCL, LABEL = NONE) in which case the first tape mark indicates the end of recorded data,
- contains data blocks corresponding to one of the five accepted data-block standards:

  F FB V VB U

Magnetic-tape files may be cataloged or uncataloged. For a cataloged file, use the CREATE_MT_FILE (CRMTF) command to declare the file to the system and the catalog. For a description of the CREATE_MT_FILE, see Section 7. For uncataloged files, the necessary information is supplied via the file-define parameter DEFi (described in Section 7).

B.1.1 Reel/File Relationship

A file can be placed on a single reel of tape, or on several reels of tape. When one file occupies one reel of tape, the file is considered to be a single section, that is, a single-volume file. In this instance, a file section equates to a volume (each reel of tape is a magnetic tape volume). When one file extends over two or more reels of tape, the file is considered a multisection, that is, a multivolume file; here again, a file section equates to a volume (section 1 is on volume 1, section 2 is on volume 2, etc.)

NOTE:

Non-standard format tapes and unlabeled tapes are single volume files only.

In COBOL, you can force the end of volume (CLOSE reel option) and make the end-of-reel visible for a multivolume file. See the *COBOL 85 Reference Manual* for details.

B.1.2 File Organization

Sequential file organization is used for magnetic-tape files. The records in the file, sorted or unsorted, are always read by the program sequentially. No random accesses are possible. When a record is to be inserted or deleted, the entire volume (reel) must be copied. A record may not be read in update mode and then written back in the same location. Old-master/new-master is the normal type of processing for magnetic tape.

B.1.3 Data Organization

DATA BLOCKS

Data blocks can consist of one or more records, depending upon the record size, and are of fixed or variable length.

Minimum and maximum block lengths depend on the software, the hardware, and the use of the tape for information interchange with other systems.

SOFTWARE AND HARDWARE LIMITATIONS

The hardware allows a minimum block length of 18 characters. The minimum buffer must be at least this size.

The hardware and software allow an unlimited maximum block length. Language restrictions and the amount of memory space available for buffers determine this limit.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS FOR INTERCHANGE

ANSI standards allow a minimum block length of 18 characters and a maximum block length of 2048 characters for interchange tapes. All GCOS7 systems can create and read blocks within these limits.

DATA RECORDS

Records within magnetic tape blocks may be fixed length, variable length, or undefined (GCOS7/EBCDIC only). If interchange is desired, limit the maximum record size to the maximum block size allowed by the American National Standards Institute standard, 2048 characters.

COMPACTED DATA

Data can be compacted on magnetic tapes by suppressing repetitive blanks.

To do this, apply the COMPACT parameter in the CREATE_MT_FILE command, and this attribute becomes a characteristic of the file, stored in the file label, and valid during the entire existence of the file.

The following restrictions apply to a compacted file:

- only variable record format is allowed,
- the BLKSIZE given by the user must be at least equal to RECSIZE + 4 bytes with an additional byte as a control character for each 128 characters of data,

For details of the COMPACT parameter, see the *IOF Terminal User’s Reference Manual.*

B.2 Native Magnetic Tape Label and Volume Formats

B.2.1 General Information

GCOS7 magnetic-tape software creates and processes tapes that conform to the EBCDIC and ASCII code and collating sequences.

LABELS

Magnetic-tape labels are special 80-character blocks that identify reels (volumes), files, and sections of files stored on magnetic tape.

All labels are identified by their first four characters:

- the first three characters indicate the type of label,
- the fourth character indicates the number of the label within that type (HDR2 = second file header label).

Table B-1 lists the label identifiers, their meaning, and the number that may be used per reel or file according to the GCOS 7/EBCDIC and GCOS 7/ASCII standards.

Table B-1. Label Types

		Maximum Number	
Identifier	Meaning	GCOS 7/EBCDIC	GCOS 7/ASCI
VOL	Volume header label	8 per reel	1 per reel
UVL	User volume header label		9 per reel
HDR	File header label	8 per section	9 per section
UHL	User header label	8 per section	26 per section
EOV	End-of-volume trailer label	8 per reel	9 per reel
EOF	End-of-life trailer label	8 per file	9 per file
UTL	User trailer label	8 per section	26 per section

For an explanation of section, refer to the paragraph "Reel/File Relationship" earlier in this Appendix.

The software reads all the labels in Table B-1 (see Figure B-1 at the end of this Appendix) but processes only the VOL1, HDR1, HDR2, EOF1, EOF2, EOV1 and EOV2 labels. All other labels are bypassed. The software creates tapes with the formats shown in Figure B-2.

TAPE MARKS

The hexadecimal character 13 (the ASCII DC3 character and the EBCDIC TM character both have this hexadecimal equivalent) is used as a tape mark. The software writes one tape mark to separate labels from data, one to indicate the end of a reel, and two tape marks to indicate the end of a file. Since tape marks are not placed in the input buffer when they are read, the programmer need never be concerned with them when processing standard tapes.

REFLECTIVE MARKERS

Two reflective tabs are pasted on the nonrecording side of the tape. One tab, the beginning-of-tape (BOT) marker, is about 10 feet from the start of the reel. The other tab, the end-of-tape (EOT) marker, is about 18 feet from the end of the tape. These markers are detected by a photoelectric system.

GCOS7/EBCDIC STANDARD FORMAT

The GCOS7/EBCDIC format is the label format used by the magnetic tape software to process tapes written in EBCDIC or BCD code.

HEADER LABELS

Header label blocks are the identifying blocks that precede data on standard-format tapes.

Table B-2. Volume Header Label 1 (GCOS7/EBCDIC)

Field Name	Position	Length	Description
Label Identifier	1	4	Contains VOL1 to identify this as a volume header label.
Volume Serial Number	5	6	Contains information supplied by the programmer that uniquely identifies this reel. It may be 1-6 alphanumeric characters long, left justified, with trailing blanks.
Volume Security	11	1	Not currently used. Set to zero.
Reserved	12	30	Contains blanks.
Owner's Name	42	10	Contains data supplied by the programmer to identify the owner of the volume. Any alphanumeric characters may be used.
Reserved	52	29	Contains blanks.

VOL - Volume Header Label

Each reel of magnetic tape is considered a volume and must contain a volume header label (VOL1) to identify it. The VOL1 label, placed as the first data on tape by the magnetic-tape software, contains the information indicated in Table B-2.

HDR - File Header Labels

The file header labels (HDR1 and HDR2) are automatically created by the software when a new file or file section is opened, and are automatically read each time a file or file section is opened. HDR1 contains operating system data and device dependent information. Table B-3 describes the format of HDR1.

Table B-3. File Header Label 1 (GCOS7/EBCDIC) (1/2)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains HDR1 to identify this as a file header label.
File Identifier	5	17	Contains the 17 rightmost characters of the external file name. If the name is longer than 17, then the remaining characters are placed in the HDR2 label.
Volume Serial Number	22	6	Contains the first volume identifier. It may be 1-6 alphanumeric characters, left justified, with trailing blanks.
Volume Sequence Number	28	4	Contains the sequence number of this volume, decimal 0001 for a single-volume file and for the first volume of a multivolume file.
File Sequence Number	32	4	Contains the sequence number of this file within a multifile set; it is decimal 0001 for a single-volume file and for the first volume of a multivolume file.
Generation Number	36	4	Contains the file generation number (1 to 9999). If not used,it contains 0001.
Version Number	40	2	Contains the file version number (decimal 0 to 99). If not used, it contains 0.

Table B-3. File Header Label 1 (GCOS7/EBCDIC) (2/2)

Field Name	Relative Position	Length	Description
Creation Date	42	6	Contains the date when the file was created. The date is in the following format - a blank followed by two numeric characters that represent the year, followed by three numeric characters that represent the sequence day within the year (88001 = Jan 1, 1988).
Expiration Date	48	6	Contains the date the file expires. The format is the same as the format of the creation date.
File Security Indicator	54	1	Contains decimal 1 if the file is cataloged. Contains zero otherwise.
Block Count	55	6	Not used. Set to zero.
System Code	61	13	Contains a unique code that identifies the operating system that created this file. This format is GCOS-4 64 nnn; nnn is the version number of the system (e.g., 001, 002).
Reserved	74	7	Contains blanks.

The HDR2 file label contains information on the file organization. Note that when an input tape does not have a HDR2 label, the BLKSIZE, RECSIZE, and RECFORM must be user-supplied either in the application program or in the DEFi (JCL equivalent DEFINE) parameter. Table B-4 gives the format of HDR2.

Table B-4. File Header Label 2 (GCOS7/EBCDIC) (1/2)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains HDR2 to identify this as a file header label.
Record Format Indicator	5	1	Contains a single character record format code, F, V, or U.
Block Length	6	5	Contains the maximum block length, excluding BSNs. Minimum value is 00018.
Record Length	11	5	Contains the maximum record length present in the file including the record header.
Recording Density	16	1	A one-byte code specifying the recording density. 2 = D800 3 = D1600 4 = D6250
Initial Volume Indicator	17	1	A one-byte code : 0 = first volume of a multi-volume 1 = not first volume.
Job Program Identifier	18	17	Not currently used. Contains blanks.
Recording Technique	35	2	Contains blanks. Declares file to be EBCDIC/odd parity.

Table B-4. File Header Label 2 (GCOS7/EBCDIC) (2/2)

Field Name	Relative Position	Length	Description
Control Character Identifier	37	1	Contains C if the data is compact, otherwise contains blank.
BSN Indicator	38	1	Contents : 1 = BSN present 0 = No BSN The value 1 is the GCOS 7 default value.

Block Format Code	39	1	Indicates whether file is blocked or unblocked.
			Blank = unblocked
			B = blocked

Reserved	40	13	Contains blanks.
Remainder of the file name	53	27	Contains leftmost 27 characters of the external file name. If external file name length is less than or equal to 17 bytes, then this field contain blanks.
Reserved	80	1	Contains blank.

TRAILER LABELS

Trailer label blocks are the identifying blocks that follow data on GCOS7/EBCDIC standard format tapes.

EOF - End-of-File Trailer Labels

The software places the end-of-file trailer labels on the tape each time an output file is closed. When the EOF labels are encountered on an input file, they indicate that all data in the file has been processed (end-of-file). In this case, up to eight end-of-file labels can be read, but only the first two are processed.

The software then compares the data blocks count contained in this label with the number of data blocks input during processing. For a multivolume file, the count in this label reflects the number of data blocks in the last volume only. Since the block count is for data blocks only, it does not include tape marks or label blocks (software or user). The EOF1 label has the same format as the corresponding HDR1 label, with a few exceptions. Table B-5 shows the EOF1 format.

Table B-5. End-of-File Trailer Label 1 (GCOS7/EBCDIC)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains EOF1.
	5	50	(Same as HDR1 label).
Block Count	55	6	Contains a decimal number that indicates the number of blocks in the file (single-volume files) or in this section of the file (multivolume files.)
	61	20	(Same as HDR1 label).

For an explanation of section, refer to the paragraph "Reel/File Relationship" earlier in this Appendix.

The EOF2 label is the same as the HDR2 label except for the label identifier (EOF2).

EOV - End-of-Volume Trailer Labels

The software places end-of-volume trailer labels at the end of a tape when the file on the tape extends to another reel. When an EOV label is encountered on an input file, this label indicates that all the data in a file section has been processed (end-of-section). In this case, up to eight end-of-volume labels can be read, but only the first is processed.

The software compares the data block count contained in the label with the number of data blocks input while processing this section of the file. The count is for data blocks only and does not include tape marks or label blocks (software or user). An EOV1 label has the same format as the corresponding HDR1 label, with a few exceptions. Table B-6 shows the EOV1 format.

Table B-6. End-of-Volume Trailer Label 1 (GCOS7/EBCDIC)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains EOV1.
	5	50	(Same as HDR1 label).
Block Count	55	6	Contains a decimal number that indicates the number of blocks in the volume of the file.
	61	20	(Same as HDR1 label).

The EOV2 label is the same as the HDR2 label except for the label identifier (EOV2).

VOLUME FORMATS

Figure B-1 shows magnetic tape volume formats that can be read by GCOS7/EBCDIC. GCOS7 software reads all labels but processes only the VOL1, HDR1, HDR2, EOF1, EOF2, EOV1, and EOV2 labels. All others are bypassed.

By comparison, when a tape volume is accepted (on input) by AVR (Automatic Volume Recognition) as having no labels ($NONE), the access method software assumes the tape contains a series of data blocks bounded by a single tape mark. This tape mark is taken as the end-of-file.

Single-Volume File

VOL 1-8	HDR 1-8	UHL 1-8	T M	DATA BLOCKS OF FILE	T M	EOF 1-8	UTL 1-8	T M	T M

Single-Volume File ($NONE)

DATA BLOCKS OF FILE	T M

Multivolume File

VOL 1-8	HDR 1-8	UHL 1-8	T M	DATA BLOCKS OF FIRST REEL	T M	EOV 1-8	UTL 1-8	T M

VOL 1-8	HDR 1-8	UHL 1-8	T M	DATA BLOCKS OF LAST REEL	T M	EOF 1-8	UTL 1-8	T M	T M

Multifile Single Volume

VOL 1-8	HDR 1-8	UHL 1-8	T M	FILE A	T M	EOF 1-8	UTL 1-8	T M	HDR 1-8	UHL 1-8	T M	FILE B	T M	EOF 1-8	UTL 1-8	T M	T M

Figure B-1. Magnetic Tape Label Formats Read by GCOS7/EBCDIC (1/2)

Multifile Multivolume

VOL 1-8	HDR 1-8	UHL 1-8	T M	FILE A	T M	EOF 1-8	UTL 1-8	T M	HDR 1-8	UHL 1-8	T M	FIRST SECTION OF FILE B

T M	EOV 1-8	UTL 1-8	T M	VOL 1-8	HDR 1-8	UHL 1-8	T M	LAST SECTION OF FILE B	T M

EOV 1-8	UTL 1-8	T M	HDR 1-8	UHL 1-8	T M	FILE C	T M	EOF 1-8	UTL 1-8	T M	T M

Figure B-1. Magnetic Tape Label Formats Read by GCOS7/EBCDIC (2/2)

NOTE:

For a labeling scheme to be accepted as GCOS7/EBCDIC (described in the CREATE_MT_FILE (JCL equivalent PREALLOC) command as ANSI=0 and in the file-define parameter group DEFi (JCL equivalent DEFINE) as DATACODE= EBCDIC), the minimum requirements are VOL1, HDR1, EOF1, EOV1 labels. If HDR2, EOF2, or EOV2 labels are present, they will also be processed, but they are not mandatory.

Table B-7. Magnetic-Tape Formats Written by GCOS7/EBCDIC

Empty labeled Volume : after PREPARE_TAPE (PRPTP)

VOL1	HDR1	T M

Volume containing a single-volume file or the last section of multivolume file

VOL1	HDR1	HDR2	T M	DATA BLOCKS	T M	EOF1	EOF2	T M	T M

Volume containing an intermediate file section of a multivolume file

VOL1	HDR1	HDR2	T M	DATA BLOCKS	T M	EOV1	EOV2	T M

Single volume unlabeled file ($none) : GCOS 7/EBCDIC only

DATA BLOCKS OF FILE	T M

A volume of Multivolume Multifile

VOL1	HDR1	HDR2	T M	DATA BLOCKS OF FILE A	T M	EOF1	EOF2	T M	HDR1	HDR2	T M

DATA BLOCKS OF 1st SECTION OF FILE B	T M	EOV1	EOV2	T M

Multifile Single Volume

VOL1	HDR1	HDR2	T M	DATA BLOCKS OF FILE A	T M	EOF1	EOF2	T M	HDR1	HDR2	T M

DATA BLOCKS OF FILE B	T M	EOF1	EOF2	T M	T M

B.2.2 GCOS7/ASCII Standard Format

The GCOS7/ASCII format is the label format used by the magnetic tape software to process tapes written in the ASCII code.

HEADER LABELS

Header label blocks are the identifying blocks that precede data on standard-format tapes.

Table B-8. 8. Volume Header Label 1 (GCOS7/ASCII)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains VOL1
Volume Serial Number	5	6	Contains a unique identification code supplied by the user. The code may be 1 to 6 alpha-numeric characters long, left justified with trailing blanks.
Volume Access	11	1	An alphanumeric character indicating restrictions on access to the volume. A space indicates no restrictions
Reserved	12	26	Contains spaces.
Owner’s Name	38	14	Alphanumeric characters identifying the owner. Default is all spaces.
Reserved	52	28	Contains spaces.
Label Standard Version	80	1	3 = 1974 version of International standard (ISO/1001), the current version generated by GCOS 7. 1,2 = previous versions of the International standard.

VOL - Volume Header Label

Each reel of magnetic tape is a volume and must contain a volume header label (VOL1) to identify it. The VOL1 label, placed as the first data on the tape by the magnetic-tape software, contains the information shown in Table B-7.

HDR - File Header Labels

The file header labels (HDR1 and HDR2) are automatically created by the software when a new file or file section is opened. HDR1 contains operating system data and device dependent information. Table B-8 shows the format of HDR1.

Table B-9. File Header Label 1 (GCOS7/ASCII) (1/2)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains HDR1 to identify this as a file label.
File Identifier	5	17	Contains the external file name for ASCII magnetic-tape files, this cannot exceed 17 characters.
Volume Serial Number	22	6	Contains the first volume identifier.
Volume Sequence Number	28	4	Contains the sequence number of this file within a multifile set; it is decimal 1 for a single volume file and for the first file of a multivolume set.
File Sequence Number	32	4	Contains the sequence number of the file within a multifile set; 0001 for a single-file volume and for the first file of a multivolume set.
Generation Number	36	4	Contains the file generation number (1 to 9999). Default (no generations) is 0001.
Version Number	40	2	Contains the file version number (00 to 99). If not used, contains 0.
Creation Date	12	6	Contains the date on which the file was created. The date is in the following format - a blank followed by two numeric characters which represent the year, followed by three numeric characters which represent the day within the year.

Table B-9. File Header Label 1 (GCOS7/ASCII) (2/2)

Field Name	Relative Position	Length	Description
Expiration Date	48	6	Contains the date on which the file expires. The format is the same as that of the creation date.
File Security Indicator	54	1	Contains decimal 1 if the file is cataloged, and spaces if it is not.
Block Count	55	6	Not used, contains zero.
System Code	61	13	Contains a unique code that identifies the operating system. The format is GCOS-4 LL nnn, where LL is the level number (61, 62, 64 or 66) and nnn is the version number of the system (001, etc).
Reserved	74	7	Contains blanks.

The HDR2 file label contains information on the file organization. Table B-9 shows the format of the HDR2 label.

Table B-10. File Header Label 2 (GCOS7/ASCII)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains HDR2 to identify this as a file header label.
Record-Format Indicator	5	1	Contains a single character record format code.F for fixed length and V for variable length.
Block Length	6	5	Contains the maximum block length including the block header. The minimum value is 00018.
Record Length	11	5	Contains the maximum record length including the record header.
Reserved	16	35	Contains blanks.
BSN Indicator	51	2	Indicates whether BSNs are used. 0 = no BSN 6 = Level 64/66 BSN 6 = Level 61 BSN
Reserved	53	28	Contains blanks.

TRAILER LABELS

Trailer label blocks are the identifying blocks that follow data on GCOS7/ASCII standard-format tapes.

EOF - End-of-File Trailer Labels

The software places the end-of-file trailer labels on the tape each time an output file is closed. When EOF labels are encountered on an input file, they indicate that all data in the file has been processed (end-of-file). For files in GCOS7/ASCII format, up to nine end-of-file labels can be read, but only the first two are processed.

The software then compares the data-blocks count in this label with the number of data blocks input during processing. For a multivolume file, the count in this label reflects the number of data blocks in the last volume only. Since the block count is for data blocks only, it does not include tape marks or label blocks (software or user). The EOF1 label has the same format as the corresponding HDR1 label, with a few label exceptions. Table B-10 shows the EOF1 format.

Table B-11. End-of-File Label 1 (GCOS7/ASCII)

Field Name	Relative Position	Length	Description
Label Identifier	1	4	Contains EOF1.
	5	50	(Same as HDR1 label).
Block Count	55	6	Contains a decimal number that indicates the number of blocks in the file (single-volume files) or in this section of the file (multivolume files).
	61	20	(Same as HDR1 label).

The EOF2 label is the same as the HDR2 label except for the label identifier (EOF2).

EOV - End-of-Volume Trailer Labels

The software places the end-of-volume at the end of a reel of tape when the file (or last file for a multivolume, multifile set) extends onto another reel. When an EOV label is encountered on an input file, this label indicates that all the data in a file section has been processed (end-of-section). In the case of GCOS7/ASCII tapes, there may be up to nine EOV labels, but only the first is processed.

The software compares the data-block count contained in the label with the number of data blocks input while processing this section of the file. The count is for data blocks only, and does not include tape marks or label blocks (software or user). An EOV1 label has the same format as the EOF1 label except for the label identifier (EOV1).

VOLUME FORMATS

Figure B-3 shows the magnetic-tape formats that can be read by GCOS7/ASCII. GCOS7 software reads all labels but processes only the VOL1, HDR1, HDR2, EOF1, EOF2 and EOV1 labels. All other labels are bypassed.

Single-Volume File

VOL 1	UVL 1-9	HDR 1-9	UHL 1-26	T M	DATA BLOCKS OF FILE	T M	EOF 1-9	UTL 1-26	T M	T M

Multivolume File

VOL 1	UVL 1-9	HDR 1-9	UHL 1-26	T M	DATA BLOCKS OF FIRST REEL	T M	EOF 1-9	UTL 1-26	T M

VOL 1	UVL 1-9	HDR 1-9	UHL 1-26	T M	DATA BLOCKS OF LAST REEL	T M	EOF 1-9	UTL 1-26	T M	T M

Multifile Single Volume

VOL 1	UVL 1-9	HDR 1-9	UHL 1-26	T M	FILE A	T M	EOF 1-9	UTL 1-26	T M	HDR 1-9	UHL 1-26	T M

FILE B	T M	EOF 1-9	UTL 1-26	T M	T M

Multifile Multivolume

VOL 1	UVL 1-9	HDR 1-9	UHL 1-26	T M	FILE A	T M	EOF 1-9	UTL 1-26	T M	HDR 1-9	UHL 1-26	T M

First section of file B	T M	EOF 1-9	UTL 1-26	T M	VOL 1	UVL 1-9	HDR 1-9	UHL 1-26	T M	Last section of file B	T M

EOF 1-9	UTL 1-26	T M	HDR 1-9	UHL 1-26	T M	FILE C	T M	EOF 1-9	UTL 1-26	T M	T M

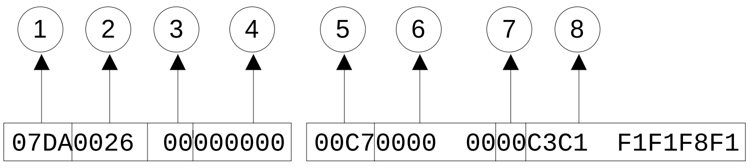
Figure B-2. Magnetic Tape Label Formats Accepted by GCOS7/ASCII

C. Hexadecimal Layout of Address Spaces in an Indexed Sequential File

This Appendix helps you analyze CI layouts and debug CIs for indexed sequential files. The layouts are intended only as a guide.

The following example represents a UFAS-EXTENDED file allocated on a non-FSA disk. In the case of a FBO file, an extra byte precedes the CI header and an extra byte follows the end of the CI.

INDEX CI (Address spaces 3, 4, 6 and 7)



```
07DA0026  00000000  00C70000  0000C3C1  F1F1F8F1  00000100  C3C1F1F8  F8F70000
0200C3C1  F2F0F0F2  00000300  C3C1F2F2  F1F70000  0400C3C1  F2F2F9F2  00000500
C3C1F2F4  F4F20000  0600C3C1  F2F6F5F8  00000700  C3C1F2F7  F9F20000  0800C3C3
F0F0F6F8  00000900  C3C3F2F1  F3F60000  0A00C3C6  F0F7F4F7  00000B00  C3C6F2F1
F4F20000  0C00C3F6  F1F6F3F8  00000D00  C3F6F6F3  F5F10000  0E00C3F6  F8F9F0F4
00000F00  C3F7F2F6  F6F60000  100003F7  F3F2F9F8  00001100  C3F7F3F7  F8F40000
1200C3F7  F3F9F7F2  00001300  C3F7F4F1  F6F10000  1400C3F7  F4F2F8F2  00001500
C3F7F4F5  F1F30000  1600C3F7  F4F7F4F2  00001700  C3F7F4F9  F9F90000  1800C3F7
F5F2F3F0  00001900  C3F7F5F5  F1F80000
```

KEY TO INDEX CI LAYOUT

i) CI Header

Amount of space used within the CI is 2018 (2016 in the case of an FSA disk file).

Amount of free space available within the CI. (The CISIZE is 2048).

Key type. 00 = primary key (index), 01 = secondary key (index). Here the primary key size is 6 characters and the keyloc is 35.

CI number within the address space. Here the first CI is shown (000000)

Last active line number of the CI (index entry). Here it is 00C7.

ii) Index entry

CI number of the lower level CI in which the highest referenced key is to be found. For example, a CI index in address spaces 3 and 6 points to a CI index in address space 4 and 7 respectively, whereas a CI index in address spaces 4 and 7 points to a data CI.

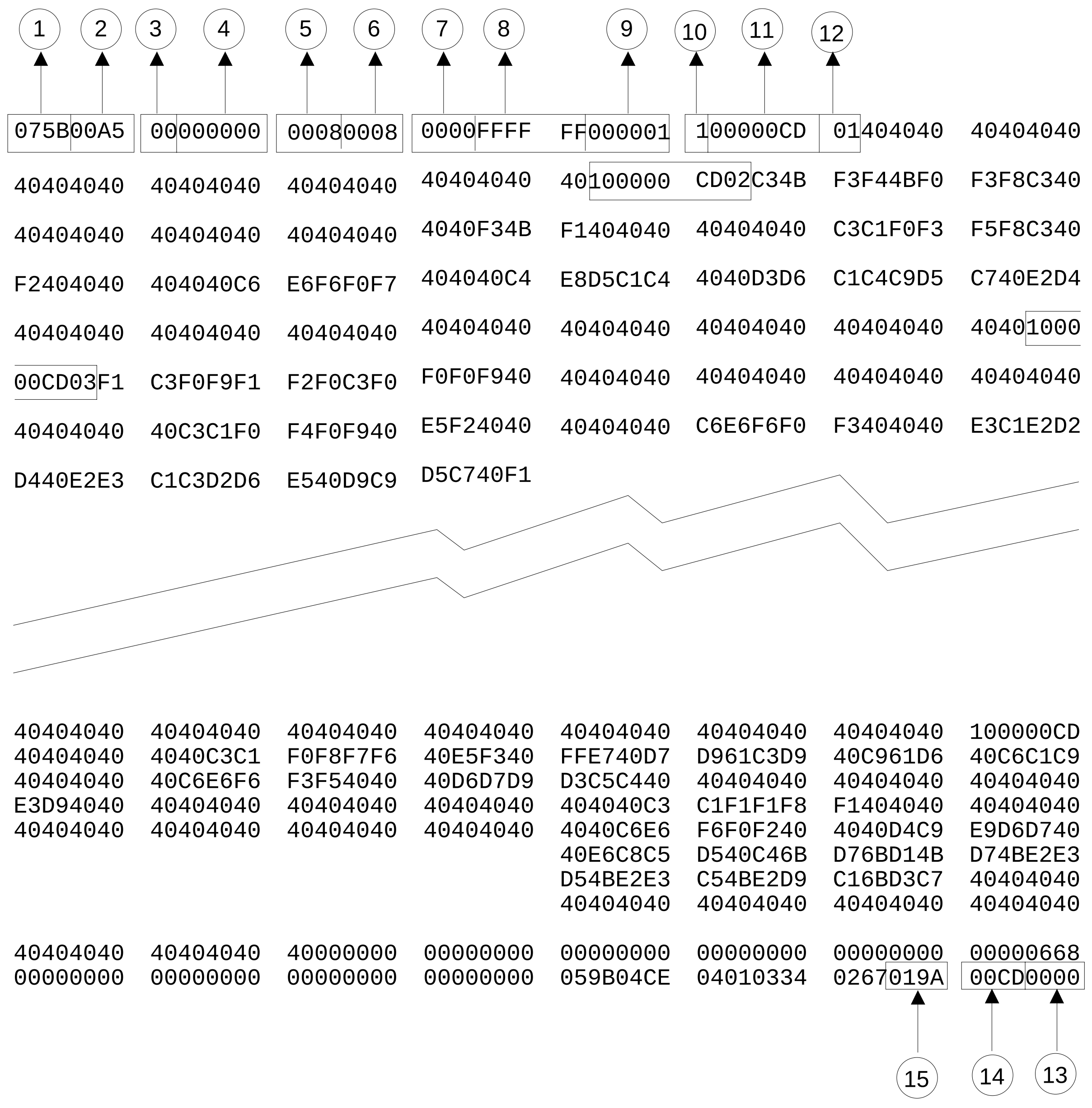
Referenced CI status.

00 = one or more valid records in the CI
80 = all records in the CI have been deleted

The highest key value in the index CI of the next lowest level. Here it is C3C1F1F1F8F1.

There is only one CI header, but there are many index entries.

DATA CI (address space 2)



```
075B00A5  00000000  00080008  0000FFFF  FF000001  100000CD  01404040  40404040
40404040  40404040  40404040  40404040  40100000  CD02C34B  F3F44BF0  F3F8C340
40404040  40404040  40404040  4040F34B  F1404040  40404040  C3C1F0F3  F5F8C340
F2404040  404040C6  E6F6F0F7  404040C4  E8D5C1C4  4040D3D6  C1C4C9D5  C740E2D4
40404040  40404040  40404040  40404040  40404040  40404040  40404040  40401000
00CD03F1  C3F0F9F1  F2F0C3F0  F0F0F940  40404040  40404040  40404040  40404040
40404040  40C3C1F0  F4F0F940  E5F24040  40404040  C6E6F6F0  F3404040  E3C1E2D2
D440E2E3  C1C3D2D6  E540D9C9  D5C740F1

40404040  40404040  40404040  40404040  40404040  40404040  40404040  100000CD
40404040  4040C3C1  F0F8F7F6  40E5F340  FFE740D7  D961C3D9  40C961D6  40C6C1C9
40404040  40C6E6F6  F3F54040  40D6D7D9  D3C5C440  40404040  40404040  40404040
E3D94040  40404040  40404040  40404040  404040C3  C1F1F1F8  F1404040  40404040
40404040  40404040  40404040  40404040  4040C6E6  F6F0F240  4040D4C9  E9D6D740
                                        40E6C8C5  D540C46B  D76BD14B  D74BE2E3
                                        D54BE2E3  C54BE2D9  C16BD3C7  40404040
                                        40404040  40404040  40404040  40404040

40404040  40404040  40000000  00000000  00000000  00000000  00000000  00000668
00000000  00000000  00000000  00000000  059B04CE  04010334  0267019A  00CD0000
```

KEY TO DATA CI LAYOUT

Since the records are large, only part of the data CI is shown.

CI Header: length 20 bytes

Amount of space used within the CI.

Amount of free space available within the CI.

Key type (always 00).

CI number within the address space. Here it is the first CI (000000).

Last logical line number of the CI. Here it is 0008.

Last physical line number of the CI. Here it is 0008. In the case of an empty CI it would be FFFFFF.

First line number of the CI. Here the first record is shown (0000).

Reserved.

The number of the next CI, in this case 1. If this were the last CI, it would be set to FFFFFF.

Record header: length 5 bytes

Record status

	1 = active record
	0 = deleted record

Record length, including header, here 205 bytes.

Number of the next line in the chain of records found in the CI. If a record has the highest key of the CI, this zone is FF.

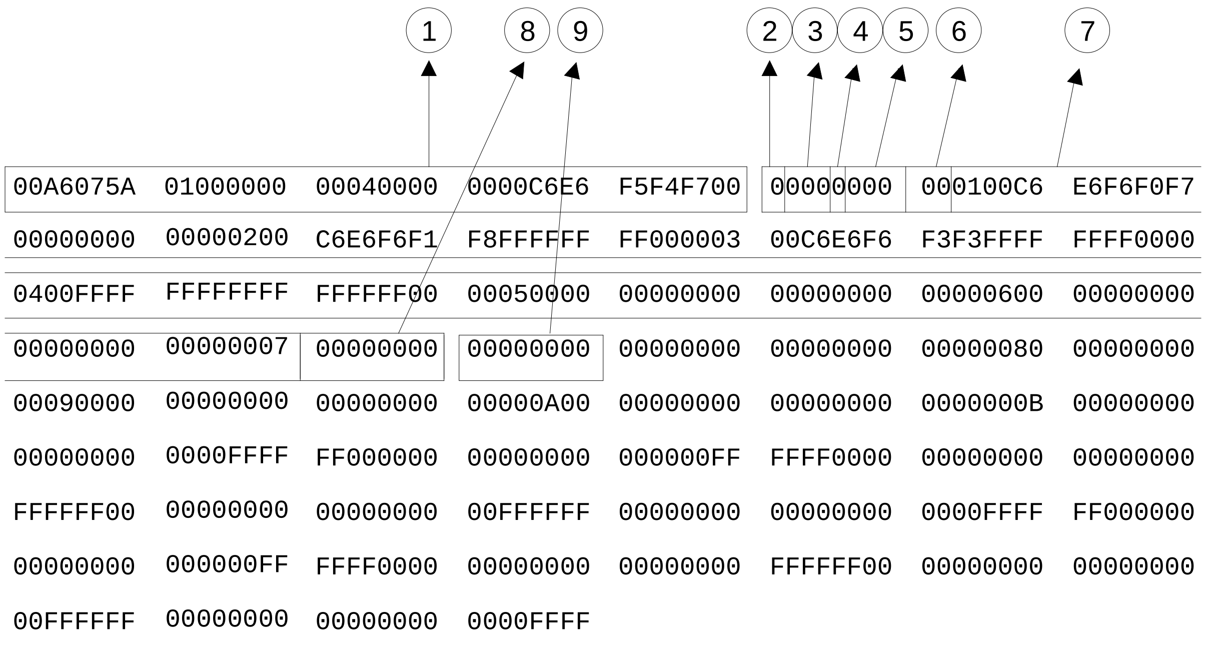
Record descriptor: length 2 bytes

CI offset related to the end of the header of line 00.

As for 13, line 01.

As for 13.

Dense Index CI (address space 5)



```
00A6075A  01000000  00040000  0000C6E6  F5F4F700  00000000  000100C6  E6F6F0F7
00000000  00000200  C6E6F6F1  F8FFFFFF  FF000003  00C6E6F6  F3F3FFFF  FFFF0000
0400FFFF  FFFFFFFF  FFFFFF00  00050000  00000000  00000000  00000600  00000000
00000000  00000007  00000000  00000000  00000000  00000000  00000080  00000000
00090000  00000000  00000000  00000A00  00000000  00000000  0000000B  00000000
00000000  0000FFFF  FF000000  00000000  000000FF  FFFF0000  00000000  00000000
FFFFFF00  00000000  00000000  00FFFFFF  00000000  00000000  0000FFFF  FF000000
00000000  000000FF  FFFF0000  00000000  00000000  FFFFFF00  00000000  00000000
00FFFFFF  00000000  00000000  0000FFFF
```

KEY TO DENSE INDEX CI LAYOUT

CI Header: 20 bytes

Amount of space used within the CI.

Record header

Record status	0001 (1) = active record 0000 (0) = deleted record
Reserved (12 bits)	
Spanning flag (2bits)	00 (0) = No record exists with identical key 01 (4) = This is the first record in a group of records having identical keys 11 (c) = This is an intermediate record in a group of records having identical keys 10 (8) = This is the last record in a group of records having identical keys.

Record length including header;

Number of the next line in the chain of records found in the CI. If a record has the highest key in the CI, this zone is set to FF.

Record key.

Duplicate number. Indicates a duplicate key group if the spanning flag is other than 00.

SFRA space (Simple File Relative Address) of variable length. This contains the addresses of data records having the secondary key referenced in 7.

SFRA = data CI number (3 bytes) + line number (1 byte)

D. JCL - GCL / GCL - JCL Correspondence Tables

This list is not comprehensive because there are some JCL statements that have no equivalent in GCL.

Table D-1. JCL-GCL Correspondence (1/2)

JCL	GCL	Abbreviation
COMPARE	COMPARE_FILE COMPARE_FILESET	CMPF CMPFST
CREATE	LOAD_FILE LOAD_FILESET	LDF LDFST
DEALLOC	DELETE_FILE DELETE_FILESET	DLF DLFST
FILALLOC	CREATE_FILE CREATE_FILESET	CRF CRFST
FILDUPLI	COPY_FILE COPY_FILESET	CPF CPFST
FILLIST	LIST_FILE LIST_FILESET LIST_FILE_SPACE	LSF LSFST LSFSP
FILMAINT	MAINTAIN_FILE	MNF
FILMODIF	CLEAR_FILE MODIFY_FILE_STATUS MODIFY_FILE	CLRF MDFSTAT MDF

Table D-1 JCL-GCL Correspondence (2/2)

JCL	GCL	Abbreviation
FILREST	RESTORE_CATALOG RESTORE_FILE RESTORE_FILESET	RSTCAT RSTF RSTFST
FILSAVE	SAVE_CATALOG SAVE_FILE SAVE_FILESET	SVCAT SVF SVFST
LIBALLOC	BUILD_LIBRARY	BLIB
LIBDELET	CLEAR_LIBRARY DELETE_LIBRARY	CLRLIB DLLIB
MERGE	MERGE_FILE	MRGF
PREALLOC	BUILD_FILE CREATE_MT_FILE MODIFY_FILE_SPACE	BF CRMTF MDFSP
PRINT	PRINT_FILE PRINT_FILESET	PRF PRFST
SETLIST	EXPAND_FILESET	EXPFST
SORT	SORT_FILE	SRTF
SORTIDX	SORT_INDEX	SRTIDX
VOLLIST	LIST_VOLUME	LSV
VOLMAINT	MAINTAIN_VOLUME	MNV
VOLMODIF	MODIFY_DISK	MDD
VOLPREP	CLEAR_VOLUME PREPARE_DISK PREPARE_TAPE	CLRV PRPD PRPTP
VOLREST	RESTORE_DISK	RSTD
VOLSAVE	SAVE_DISK	SVD

Table D-2. GCL-JCL Correspondence (1/2)

GCL	Abbreviation	JCL
BUILD_FILE	BF	PREALLOC
BUILD_LIBRARY	BLIB	LIBALLOC
CLEAR_FILE	CLRF	FILMODIF
CLEAR_LIBRARY	CLRLIB	LIBDELET
CLEAR_VOLUME	CLRV	VOLPREP
COMPARE_FILE	CMPF	COMPARE
COMPARE_FILESET	CMPFST	COMPARE
COPY_FILE	CPF	FILDUPLI
COPY_FILESET	CPFST	FILDUPLI
CREATE_FILE	CRF	FILALLOC
CREATE_FILESET	CRFST	FILALLOC
CREATE_CT_FILE	CRCTF	FILALLOC
CREATE_MT_FILE	CRMTF	PREALLOC
DELETE_FILE	DLF	PREALLOC
DELETE_FILESET	DLFST	DEALLOC
DELETE_LIBRARY	DLLIB	DEALLOC
EXPAND_FILESET	EXPFST	LIBDELET
LIST_FILE	LSF	SETLIST
LIST_FILEST	LSFST	FILLIST
LIST_FILE_SPACE	LSFSP	FILLIST
LIST_VOLUME	LSV	VOLLIST
LOAD_FILE	LDF	CREATE
LOAD_FILESET	LDFST	CREATE

Table D-2 GCL-JCL Correspondence (2/2)

GCL	Abbreviation	JCL
MAINTAIN_FILE	MNF	FILMAINT
MAINTAIN_VOLUME	MNV	VOLMAINT
MERGE_FILE	MRGF	MERGE
MODIFY_DISK	MDD	VOLMODIF
MODIFY_FILE	MDF	FILMODIF
MODIFY_FILE_SPACE	MDFSP	PREALLOC
MODIFY_FILE_STATUS	MDSTAT	FILMODIF
PREPARE_DISK	PRPD	VOLPREP
PREPARE_TAPE	PRPTP	VOLPREP
PREPARE_VOLUME	PRPV	VOLPREP
PRINT_FILE	PRF	PRINT
PRINT_FILSET	PRFST	PRINT
RESTORE_CATALOG	RSTCAT	FILREST
RESTORE_DISK	RSTD	VOLREST
RESTORE_FILE	RSTF	FILREST
RESTORE_FILESET	RSTFST	FILREST
SAVE_CATALOG	SVCAT	FILSAVE
SAVE_DISK	SVD	VOLSAVE
SAVE_FILE	SVF	FILSAVE
SAVE_FILESET	SVFST	FILSAVE
SORT_FILE	SRTF	SORT
SORT_INDEX	SRTIDX	SORTIDX

E. More About Buffers

As explained in Section 5, you can control the use of buffers by specifying the three parameters: POOLSIZE, NBBUF and BUFPOOL. This Appendix contains further information about buffers and memory resources.

Buffer Algorithm

Buffers can be in one of the following states:

- busy
- remember
- empty

A busy buffer is one that contains a CI that is being accessed.

A remember buffer is one that contains a CI that is kept in memory in order to be reused subsequently. Whenever a buffer can be "remembered", this avoids an I/O operation.

An empty buffer is a buffer whose contents are meaningless, for example, after the abort of a commitment unit.

When a program needs to process a record, UFAS-EXTENDED first checks if the record is in one of the remember buffers. If it is, that remember buffer is activated and the search ends. This means that no physical read needs to be made. A record is kept of the number of times a remember buffer is reused. This count is printed out in the JOR at the end of the job (HITCOUNT).

If the required record is not in a remember buffer, a data CI must be read.

UFAS-EXTENDED finds space in allocated memory to accommodate these CIs (data or index). Figure E-1 describes how buffers are handled.

UFAS-EXTENDED checks whether all buffers have been allocated, that is, whether the maximum number of buffers for this file has been reached. If all buffers have been allocated, one remember buffer will be deleted and a CI will be read into it.

If the maximum number of buffers is not reached, a new buffer will be created provided the maximum size of the memory allocated to buffers is not reached.

If the maximum size of the buffer pool is reached, one or more buffers will be deleted to make space for the requested CI.

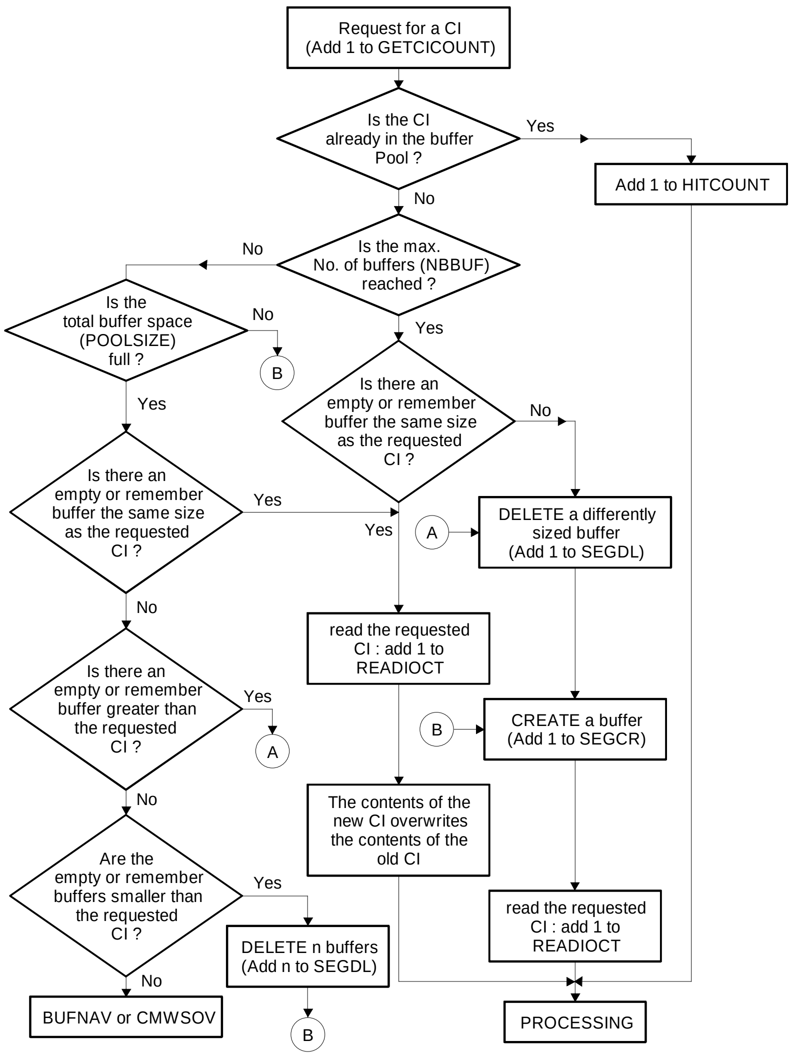

Request for a CI
(Add 1 to GETCICOUNT)
Is the CI already in the buffer Pool ?
Yes
Add 1 to HITCOUNT
No
Is the max. No. of buffers (NBBUF) reached ?
No
Yes
Is the total buffer space (POOLSIZE) full ?
No
B
Yes
Is there an empty or remember buffer the same size as the requested CI ?
No
Is there an empty or remember buffer the same size as the requested CI ?
Yes
Yes
A
DELETE a differently sized buffer
(Add 1 to SEGDL)
No
read the requested CI : add 1 to READIOCT
Is there an empty or remember buffer greater than the requested CI ?
Yes
A
B
CREATE a buffer
(Add 1 to SEGCR)
No
The contents of the new CI overwrites the contents of the old CI
Are the empty or remember buffers smaller than the requested CI ?
Yes
read the requested CI : add 1 to READIOCT
DELETE n buffers
(Add n to SEGDL)
No
BUFNAV or CMWSOV
B
PROCESSING

Figure E-1. Buffer Handling

F. UFAS Files under UFAS-EXTENDED

This Appendix applies only if you are allocating UFAS files under UFAS-EXTENDED through the VERSION = PREVIOUS parameter.

Compatibility between UFAS-EXTENDED and UFAS

For reasons of compatibility UFAS-EXTENDED continues to fully support the old UFAS files. However, you are recommended to convert such files to the new fixed-block file format.

For coupled systems, both systems must run with the same version of UFAS because there is no dynamic sharing facility and no backup (TCRF) facility between a UFAS-EXTENDED and a UFAS system or vice versa.

If a file is unstable in a release, the file must be recovered in that release.

Since Release V6, the VERSION = PREVIOUS parameter can be specified only in the JCL statement PREALLOC, and not in the BUILD_FILE command.

Features of UFAS

The size of an index CI can be different from the size of a data CI, because it is computed by UFAS on the basis of the CASIZE parameter.

UFAS supports 18,500 buffers in a TDS application where VERSION = PREVIOUS.

800 files can be shared at system level and 500 files can be simultaneously opened for a TDS application.

CONTROL AREA (CA)

One or more CIs make up an allocated area of the file known as a Control Area (CA). A CA is the unit of expansion for such an indexed sequential file. For a given file all CAs contain the same number of CIs. Only address space 2 (containing data) and address space 5 (containing all secondary keys) have their CIs grouped into CAs. This is important when you are allocating space for such an indexed sequential file. See the BUILD FILE command in Section 6. Once you have specified the size of a CA, UFAS-EXTENDED builds CAs dynamically as the file grows.

Choosing the CASIZE

CASIZE is the number of data CIs per CA. CASIZE is also the number of index entries in an index CI. Maximize the CASIZE within the following limits if possible:

```
     20 <= CASIZE <= 100
```

This means that the most efficient range of values for CASIZE is from 20 to 100 CIs. However, you may use a value greater than 100 if this eliminates a level of indexes, with a consequent saving of I/Os during processing.

For example, if you have a CISIZE of 4096 and a CASIZE of 100, Table 6-1 shows that there are 144 CIs per cylinder for an MS/D500 disk drive. In other words, one CA is approximately equal to one cylinder on an MS/D500 disk drive.

If you omit CASIZE, then UFAS-EXTENDED automatically calculates the CASIZE. CASIZE is initially chosen so that the number of data CIs that will fit it occupy one cylinder minus two tracks, and CAFSP = 0.

To leave free space at initial file loading time in each CA which is an integral number of empty CIs, specify the amount of free space to be left by using the CAFSP parameter in the BUILD FILE command.

Mass Insertion

Mass Insertion mode is not available for UFAS files with VERSION set to PREVIOUS.

Example Showing how to Allocate a File with the UFAS File Format

This example shows you how to allocate a file in the UFAS file format (VERSION=PREVIOUS).

```
PREALLOC R.HANS:V1:MS/D500
```

Allocates the file named R.HANS on the MS/D500 volume named V1

```
    UFAS = INDEXED
    SIZE = 5000 UNIT =
RECORD
    INCRSIZE = 1000
    CISIZE = 2048
    CIFSP = 25

    RECSIZE = 120
    KEYLOC = 1
    KEYSIZE = 4
    VERSION = PREVIOUS
    CASIZE = 30
    CAFSP = 10;
```

The file size is 5000 records; the increment size is 1000 records. The CI size is 2048 bytes and the CI free space is 25% (allows the subsequent insertion of 4 records). The record size is 120 bytes; the key field starts in byte 1. The key is 4 bytes long. The file is allocated in UFAS format. Each CA contains 30 CIs. The CA free space is 10% (allows the insertion of 3 CIs)

❑

G. Batch Performance Improvement

G.1 Overview

The Batch Booster option provides greatly improved I/O (input/output) performance. This feature enables multiple block I/O operations during disk access, instead of block by block operations. This optimizes ELAPSE and CPU time during file accesses.

The Batch Booster is also known as the BPB (blocks per buffer) option, since it is requested via the BPB parameter. The terms "Batch Booster" and "BPB Processing" are used interchangeably to refer to the features described in this Appendix.

The Batch Booster is a billed option (MI) of GCOS 7 HPS AP and EXMS Version V7. The Batch Booster is described in more detail in the manual *Batch Booster*.

G.1.1 How to Activate the Batch Booster Option

The statements or keywords used to activate the Batch Booster are as described below.

G.1.1.1 Activation External to the Program

The Batch Booster can be activated in the step enclosure or by a utility as shown in the following table:

Statement	Keyword	Parameter
JCL Step Enclosure		
DEFINE	BPB	

JCL Utilities

INDEF	BPB
OUTDEF	
PRTDEF	

G.1.1.2 Activation Within a Program

The Batch Booster cannot be initiated by a COBOL or C Language program.

In GPL, use H_FD, or H_DEFINE/H_DCFILE with the BPB parameter.

G.1.2 How BPB Processing Works

UFAS-EXTENDED transfers several CIs from or to the buffers in a single Input/Output. The number of CIs depends on the value you set with the BPB parameter. This value must be in the range 2 to 255.

The value of BPB is automatically decreased by the access method to comply with the rule:

BPB * CISIZE must be less than 64K bytes.

G.2 Conditions for BPB Processing

BPB processing is possible under the following conditions:

- **file access** must be at record level
- the **value** of the BPB parameter must be greater than 1
- the **application** must be BATCH monoprocess
- the **file organization** must be SEQUENTIAL or RELATIVE
- **file assignment** must be:

  ONEWRITE/SPREAD
  ONEWRITE/SPWRITE
  NORMAL/SPREAD
  NORMAL/SPWRITE
  NORMAL/READ
  NORMAL/WRITE
  or MONITOR/READ with READLOCK=STAT

- **open mode** must be INPUT, OUTPUT, or APPEND
- **access mode** must be SEQUENTIAL
- **version** must be CURRENT
- there must be **no journalization**
- there must be **no GAC (General Access Control)**

When these conditions are not met, BPB processing is ineffective. The value of BPB is ignored and the processing is executed as if the value were set to 1. The process is not usually aborted, and there is no error message or return code. This is not the case, however, with the use of the multi SCB mechanism (for instance, access to UFAS files under IQS). If this mechanism is used with a BPB parameter greater than 1, you will receive the return code CONFLICT.

G.3 Support of Data Management Utilities

BPB processing is effective with the following data management utilities which work at record level:

COMPARE	on both input files, and on the output file, provided that the files are not relative files in direct access.
CREATE	on the input or the output file, provided that the file is not a relative file in direct access.
PRINT	on the input file.
FILSAVE	on the output file provided that it is a UFAS disk file.

G.3.1 File Transfer

The file transfer utility supports BPB processing **on the local file only**. Therefore:

- at the sending site, BPB is effective for the input file
- at the receiving site, BPB is effective for the output file.

G.3.2 SORT/MERGE Utilities

G.3.2.1 Sort

The conditions under which Sort calls the UFAS Access Method are given below.

Mono-Process Sort

For files of UFAS Indexed Organization, Sort always calls UFAS access method (but the UFAS BPB does not apply in this case).

For **Input** UFAS Sequential or UFAS Relative files, Sort calls the UFAS access method in the following cases:

- SHARE = FREE, DIR, ONEWRITE, or (SHARE=MONITOR and READLOCK=STAT)
- or "all volumes are not mounted for the file",
- or TRUNCSSF,
- or concatenation,
- or REPEAT and CKPTLIM,
- or the DSL contains: KEYADDR or ADDATA or ADDROUT.

For **Output** UFAS Sequential or UFAS Relative files, Sort calls the UFAS access method in the following cases:

- SHARE not = NORMAL,
- or "all volumes are not mounted for the file",
- or REPEAT and CKPTLIM.

NOTE:

For SHARE = MONITOR, (READLOCK = STAT) or (ACCESS = SPREAD or SPWRITE) are mandatory for INFILE. For OUTFILE, ACCESS = SPWRITE is mandatory when SHARE = MONITOR.

Multi-Process Sort

For files UFAS Indexed Organization, Sort always calls the UFAS access method (but the UFAS BPB does not apply in this case).

For **Input** UFAS Sequential or UFAS Relative files, Sort calls the UFAS access method in the following cases:

SHARE = FREE, DIR, ONEWRITE, or (SHARE=MONITOR and READLOCK=STAT)

- or "all volumes are not mounted for the file",
- or TRUNCSSF,
- or concatenation,
- or the DSL contains
  (KEYADDR or ADDATA or ADDROUT)
  and
  (START
  or HALT
  or (((INVREC^=CONTINUE) or (ERROPT^=IGNORE)) and (RECFORM=V))

For Output UFAS Sequential or UFAS Relative files, Sort calls the UFAS access method in the following cases:

- SHARE not = NORMAL,
- or "all volumes are not mounted for the file".

NOTE:
For SHARE = MONITOR, (READLOCK = STAT) or (ACCESS = SPREAD or SPWRITE) are mandatory for INFILE. For OUTFILE, ACCESS = SPWRITE is mandatory when SHARE = MONITOR.

G.3.2.2 Merge

Merge calls the UFAS access method under the same conditions as Sort (except that the DSL conditions do not apply).

G.4 Usage In GCL

This appendix describes the usage of BPB in batch and consequently via JCL. However, GCL can also benefit from BPB.

In GCL, BPB is available via the GCL command EXEC_PG and the GCL commands which call the GCOS 7 utilities.

For more details, see the manual *Batch Booster*.

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