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IBM

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MVS/ESA
Data Administration Guide

Version 3 Release 1

IBM

MVS/ESA
Data Administration Guide

SC26-4505-1

Version 3 Release 1

Second Edition (June 1989)

This edition replaces and makes obsolete the previous edition, SC26-4505-0.

This edition applies to Version 3 Release 1 of MVS/DFP^{TM}, Program Number 5665-XA3, and to any subsequent releases until otherwise indicated in new editions or technical newsletters.

The changes for this edition are summarized under "Summary of Changes" following the table of contents. Specific changes are indicated by a vertical bar to the left of the change. A vertical bar to the left of a figure caption indicates that the figure has changed. Editorial changes that have no technical significance are not noted.

Changes are made periodically to this publication; before using this publication in connection with the operation of IBM systems, consult the latest *IBM System/370, 30xx, 4300, and 9370 Processors Bibliography*, GC20-0001, for the editions that are applicable and current.

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MVS/ESA™

MVS/SP™

MVS/XA™

Contents

Summary of Changes

Second Edition, June 1989

New Programming Support for Release 1

DATACLAS and the JCL keyword LIKE can be used for tape data sets. Chapter 10, "Generation Data Groups" discusses how DATACLAS and LIKE can be used in place of a model DSCB for allocating non-SMS-managed generation data sets.

Service Changes

Information on processing a direct data set with BDAM has been moved to Appendix E, "Processing a Direct Data Set" on page 143.

Information on processing an indexed sequential data set has been moved to Appendix F, "Processing an Indexed Sequential Data Set" on page 153.

Minor technical and editorial changes have been made.

First Edition, December 1988

New Programming Support for Release 1

The Storage Management Subsystem (SMS) automates many storage administration tasks. SMS also supports data class, storage class, and management class. These classes can be assigned when allocating a new data set. Much of the information previously provided by the DCB and DD statement can now be provided through data class and storage class. Information on these classes has been added throughout this manual.

The system can determine the block size for your data set. Information on system-determined block size has been added to Chapter 5, "Specifying a Data Control Block and Initializing Data Sets."

Concatenation of like data sets regardless of block size has been expanded to include tape data sets. Tape data sets may be concatenated with each other and with DASD data sets. Information documenting this change has been added to Chapter 8, "Processing a Sequential Data Set."

Changes to support for generation data sets has been documented in Chapter 10, "Generation Data Groups."

The new AVGREC keyword enhances the function of the SPACE keyword by changing an average block request into an average record request and allowing modification of the scale of the primary and secondary quantities. Information on the use of AVGREC has been added to Appendix C, "Allocating Space on Direct Access Volumes."

Passwords are ignored for SMS-managed data sets. Changes to support of passwords have been added to Chapter 11, "I/O Device Control Macros."

Support for IEHATLAS has been removed. Use Device Support Facilities (ICKDSF), discussed in Chapter 6, "Analyzing I/O Errors," instead to diagnose I/O problems and disk drive problems.

Service Changes

MVS/DFP Version 3 publications have new order numbers. Publications listed in the preface reflect these new order numbers.

Minor technical and service changes have been made.

Preface

About This Book

This book is intended to help you use IBM data management access methods other than the virtual storage access method (VSAM) to process data sets. Use this book together with *Data Administration: Macro Instruction Reference*, SC26-4506, to code the macro instructions for non-VSAM data sets. Unless specifically stated otherwise, the information in this book must not be used for programming purposes. However, this book also provides the following types of information, which are explicitly identified where they occur:

General-Use Programming Interface

General-use programming interfaces are provided to allow you to write programs that use the services of MVS/DFP.

End of General-Use Programming Interface

Product-Sensitive Programming Interface

Installation exits and other product-sensitive interfaces are provided to allow your installation to perform tasks such as product tailoring, monitoring, modification, or diagnosis. They are dependent on the detailed design or implementation of the product. Such interfaces should be used only for these specialized purposes. Because of their dependencies on detailed design and implementation, it is to be expected that programs written to such interfaces may need to be changed in order to run with new product releases or versions, or as a result of service.

End of Product-Sensitive Programming Interface

The following products are shown in this publication for the sake of compatibility only. Although they are still supported, their use is not recommended, and where applicable, alternatives are suggested.

- The access methods BDAM and EXCP—we recommend you use VSAM key-sequenced data sets instead of BDAM. Use BSAM, QSAM, or BPAM instead of EXCP. BDAM, also called direct organization, is not recommended because it is a device-dependent access method.
- The access methods BISAM and QISAM—we recommend you use VSAM instead.
- OS CVOLS and VSAM catalogs—Convert all OS CVOLs and VSAM catalogs to integrated catalog facility catalogs.
- Mass Storage System (MSS).

- The macros:
  - DCB (BDAM, BISAM, QISAM)
  - ESETL
  - FREEDBUF
  - GET (QISAM)
  - PUT (QISAM)
  - READ (BDAM, BISAM)
  - RELEX
  - SETL
  - WRITE (BDAM, BISAM)

To learn about VSAM or to write programs that create and process VSAM data sets, see:

- *MVS/ESA Catalog Administration Guide*, SC26-4502, which describes how to create master and user catalogs
- *MVS/ESA Integrated Catalog Adminstration: Access Method Services Reference*, SC26-4500, and *MVS/ESA VSAM Catalog Administration: Access Method Services Reference*, SC26-4501, which describe the access method services commands used to manipulate VSAM data sets
- *MVS/ESA VSAM Administration Guide*, SC26-4518, which describes how to create VSAM data sets
- *MVS/ESA VSAM Administration: Macro Instruction Reference*, SC26-4517, which describes how to code the macro instructions required with VSAM data sets.

To learn about storage administration, see:

- *Storage Management Library*, SBOF-1241
- *MVS/ESA Storage Administration Reference*, SC26-4514.

Required Product Knowledge

To use this book effectively, you should be familiar with:

- Assembler language
- Job control language.

Required Publications

You should be familiar with the information presented in the following publications:

Publication Title	Order Number
Assembler H Version 2 Application Programming: Guide	SC26-4036
Assembler H Version 2 Application Programming: Language Reference	SC26-4037
MVS/ESA Data Administration: Macro Instruction Reference	SC26-4506
MVS/ESA JCL Reference	GC28-1829
MVS/ESA JCL User's Guide	GC28-1830

Related Publications

Some publications from the MVS/SP Version 3 library are referenced in this book. The *MVS/ESA Library Guide for System Product Version 3*, GC28-1563, contains a complete listing of the MVS/SP Version 3 publications and their counterparts for the prior version.

The *MVS/ESA Data Facility Product Version 3: Master Index*, GC26-4512, contains both an index to the MVS/DFP library and a summary of the changes made to the library. You can use it to:

- Find information in other MVS/DFP publications
- Determine how new programming support changes information in the MVS/DFP library
- Determine which MVS/DFP publications have been changed.

In addition, the following publications may be helpful:

Publication Title	Order Number
IBM 3262 Model 5 Printer Product Description	GA24-3936
IBM 4245 Printer Model 1 Component Description and Operator	GA33-1541
IBM 4248 Printer Model 1 Description	GA24-3927
MVS/ESA Message Library: System Codes	GC28-1815
MVS/ESA Message Library: System Messages Volume 1	GC28-1812
MVS/ESA Message Library: System Messages Volume 2	GC28-1813
MVS Storage Management Library: Configuring Storage Subsystems	SC26-4409

Referenced Publications

Within the text, references are made to the publications listed below:

Short Title	Publication Title	Order Number
Access Method Services Reference	*MVS/ESA Integrated Catalog Adminstration: Access Method Services Reference* *MVS/ESA VSAM Catalog Administration: Access Method Services Reference*	SC26-4500 SC26-4501
Application Development Guide	*MVS/ESA Application Development Guide*	GC28-1821
Application Development Macro Reference	*MVS/ESA Application Development Macro Reference*	GC28-1822
Assembler H V2 Application Programming: Guide	*Assembler H Version 2 Application Programming: Guide*	SC26-4036
Assembler H V2 Application Programming: Language Reference	*Assembler H Version 2 Application Programming: Language Reference*	SC26-4037
Catalog Administration Guide	*MVS/ESA Catalog Administration Guide*	SC26-4502
Data Administration: Macro Instruction Reference	*MVS/ESA Data Administration: Macro Instruction Reference*	SC26-4506
DFP: Customization	*MVS/ESA Data Facility Product Version 3: Customization*	SC26-4504
IBM 3800 Printing Subsystem Programmer's Guide	*IBM 3800 Printing Subsystem Programmer's Guide* *IBM 3800 Printing Subsystem Models 3 and 8 Programmer's Guide*	GC26-3846 SH35-0061
ICKDSF User's Guide and Reference	*Device Support Facilities User's Guide and Reference*	GC35-0033
JCL Reference	*MVS/ESA JCL Reference*	GC28-1829
JCL User's Guide	*MVS/ESA JCL User's Guide*	GC28-1830
Magnetic Tape Labels and File Structure	*MVS/ESA Magnetic Tape Labels and File Structure Administration*	SC26-4511
MVS Configuration Program Guide and Reference	*MVS/ESA MVS Configuration Program Guide and Reference*	GC28-1817
Programming Support for the IBM 3505 Card Reader and the IBM 3525 Card Punch	*Programming Support for the IBM 3505 Card Reader and the IBM 3525 Card Punch*	GC21-5097

Short Title	Publication Title	Order Number
RACF General Information	*Resource Access Control Facility (RACF) General Information*	GC28-0722
RACF Security Administrator's Guide	*Resource Access Control Facility (RACF) Security Administrator's Guide*	SC28-1340
SPL: Application Development Guide	*MVS/ESA System Programming Library: Application Development Guide*	GC28-1852
Storage Administration Reference	*MVS/ESA Storage Administration Reference*	SC26-4514
System—Data Administration	*MVS/ESA System—Data Administration*	SC26-4515
TSO/E V2 Command Reference	For MVS/ESA systems: *TSO/E Version 2 Command Reference*	SC28-1881
	For MVS/XA systems: *MVS/Extended Architecture TSO Extensions Command Language Reference*	SC28-1134
TSO/E V2 User's Guide	For MVS/ESA systems: *TSO/E Version 2 User's Guide*	SC28-1880
	For MVS/XA systems: *MVS/Extended Architecture TSO User's Guide*	SC28-1333
Utilities	*MVS/ESA Data Administration: Utilities*	SC26-4516
VSAM Administration Guide	*MVS/ESA VSAM Administration Guide*	SC26-4518

Chapter 1. Introduction to Data Administration

Data administration is the process of systematically and effectively organizing, identifying, storing, cataloging, and retrieving all the information (including programs) that your installation uses.

Data set storage control, along with an extensive catalog system, makes it possible to retrieve data by symbolic name alone, without specifying device types and volume serial numbers. In freeing computer personnel from maintaining complicated volume serial number inventory lists of stored data and programs, the catalog reduces manual intervention and the likelihood of human error.

A *data set* is a collection of logically related data records that are stored on a volume and that may be classified according to installation needs. For example, a sales department could classify its data by geographic area, by individual salesperson, or by any other logical plan. A user can request data from a direct access volume or a tape volume.

The cataloging system makes it possible to classify successive generations or updates of related data. These generations can be given identical names and subsequently be referred to relative to the current generation. The system automatically maintains a list of the most recent generations.

Data administration provides:

- Allocation of space on direct access volumes.
- Automatic retrieval of cataloged data sets by name alone.

Data administration is the management of logical storage. In contrast, *storage administration* is the management of physical storage. Data administration deals with data set names and where they are cataloged. Storage administration deals with where the data set is actually stored, on which volume. On the data set level, storage administration and data administration overlap when you allocate space for a data set. Data administration uses the values you provide when you allocate a data set to determine logical record length, data set name, block size, and other attributes. Storage administration uses the values you provide at allocation time to determine on which volume to place your data set, how many tracks to allocate for it, and other attributes. The Storage Management Subsystem (SMS) automates these storage administration tasks and provides significant functions for the management of data sets. For more information on SMS, see *Storage Administration Reference*.

Your storage administrator can define your storage needs to the system in an SMS configuration. An SMS configuration is a complete set of definitions, defaulting mechanisms, and other system information that SMS uses to manage your data sets. The definitions group data sets according to common characteristics. As you allocate new data sets, a defaulting mechanism, automatic class selection (ACS) routines, assigns these characteristics. With the information contained in the SMS configuration, SMS manages your data sets at an optimum level with a knowledgeable use of the available hardware.

Not all data sets can be managed by SMS. The following data sets do **not** qualify:

- Data sets having duplicate names in the catalog
- Data sets not cataloged in integrated catalog facility catalogs
- Data sets with nonstandard data set names
- Unmovable data sets
- Data sets with absolute track allocations
- ISAM data sets
- SYSIN and SYSOUT data sets
- CVOLs
- Tape data sets
- Mass Storage System data sets.

Another restriction is that data sets managed by SMS cannot be referred to by JOBCAT or STEPCAT.

Overview of Data Set Processing

Input/output routines in the operating system schedule and control all data transfer operations between virtual and auxiliary storage. These routines can:

- Read data
- Write data
- Translate data from ISCII/ASCII (International Standard Code for Information Interchange and American National Standard Code for Information Interchange) to EBCDIC (Extended Binary Coded Decimal Interchange Code) and the reverse
- Block and unblock records
- Overlap reading, writing, and processing operations
- Read and verify volume and data set labels
- Write data set labels
- Position and reposition volumes automatically
- Detect I/O errors and correct them when possible
- Provide exits to user-written error and label routines.

Data management programs also provide a variety of methods for gaining access to a data set. These methods are based on data set organization and data access method. We recommend you use partitioned or sequential organization instead of direct organization, and use VSAM instead of indexed sequential organization.

You can organize your data sets in one of five ways:

- *Partitioned*: Independent groups of sequentially organized records, called members, are in direct access storage. Each member has a simple name stored in a directory that is part of the data set and contains the location of the member's starting point. Partitioned data sets are generally used to store programs. As a result, they are often called *libraries*.
- *Sequential*: Records are organized in physical rather than logical sequence. Given one record, the location of the next record is determined

by its physical position in the data set. You must use the sequential data set organization for all magnetic tape devices, but it is optional on direct access devices. Punched cards and printed output must also be sequentially organized.

- *VSAM*: The records in a VSAM data set can be organized in logical sequence by a key field (key sequence), in the physical sequence in which they are written on the data set (entry sequence), or by relative record number. This access method is for direct or sequential processing of fixed and variable-length records on DASD. See *VSAM Administration Guide* for how to process VSAM data sets.
- *Direct*: Records within the data set, which must be on a direct access volume, may be organized in any manner you choose. All space allocated to the data set is available for data records. No space is required for indexes. You specify addresses by which records are stored and retrieved directly.
- *Indexed Sequential*: Records are arranged in sequence, according to a key that is a part of every record, on the tracks of a direct access volume. An index or set of indexes maintained by the system gives the location of certain principal records. This permits direct and sequential access to any record. Indexed sequential data sets cannot be managed by SMS. The virtual storage access method (VSAM) data sets can be used instead of indexed sequential, and can be managed by SMS.

Requests for input/output operations on data sets through macro instructions use two techniques: the technique for queued access and the technique for basic access. Each technique is identified according to its treatment of buffering and synchronization of input and output with processing. The combination of an access technique and a given data set organization is called an *access method*. In choosing an access method for a data set, therefore, you must consider not only its organization, but also what you need to specify through macros. Also, you may choose a data organization according to the access methods and processing capabilities available.

The code generated by the macros for both techniques is optionally reenterable, depending on the form in which parameters are expressed.

An important feature of data administration is that much of the detailed information needed to store and retrieve data, such as device type, buffer processing technique, and length of output records, need not be supplied until the job is ready to be executed. This device independence permits changes to those specifications to be made without changes in the program. Therefore, you may design and test a program without knowing the exact input/output devices that will be used when it is executed.

Device independence is a feature of both the queued and basic access methods for processing sequential data sets. To some extent, you can determine the degree of device independence. Many useful device-dependent features are available as part of certain macro instructions; achieving device independence requires some selectivity in their use.

Identifying Data Sets

Any information that is a named, organized collection of logically related records can be classified as a data set. The information is not restricted to a specific type, purpose, or storage medium. A data set may be, for example, a source program, a library of macros, or a file of data records used by a processing program.

Whenever you indicate that a new data set is to be created and placed on auxiliary storage, you (or the operating system) must give the data set a name. The data set name identifies a group of records as a data set. All data sets recognized by name (referred to without volume identification) and all data sets residing on a given volume must be distinguished from one another by unique names. To help in this, the system provides a means of qualifying data set names.

A data set name is one simple name or a series of simple names joined so that each represents a level of qualification. For example, the data set name DEPT58.SMITH.DATA3 is composed of three simple names. Proceeding from the left, each simple name is a category within which the next simple name is a subcategory. The first name is called the high-level qualifier, the last is the low-level qualifier.

Each simple name consists of from 1 to 8 alphameric characters, the first of which must be alphabetic. The special character period (.) separates simple names from each other. Including all simple names and periods, the length of the data set name must not exceed 44 characters. Thus, a maximum of 22 simple names can make up a data set name.

To permit different executions of a program to process different data sets without program reassembly, the data set is not referred to by name in the processing program. When the program is executed, the data set name and other pertinent information (such as data set disposition) are specified in a job control statement called the *data definition* (DD) statement. To gain access to the data set during processing, reference is made to a *data control block* (DCB) associated with the name of the DD statement. Space for a data control block that specifies the particular data set to be used is reserved by a DCB macro when your program is assembled.

Overview of New Data Set Allocation

Allocation is the entire process of obtaining a volume and unit of external storage, and setting aside space on that storage for a new data set. Allocation of an existing data set differs from allocation of a new data set in that the storage already exists. If you use JCL, specify `DISP=(NEW,KEEP,DELETE)`) to allocate a NEW data set. If the procedure completes normally, the data set is KEPT, but if the procedure fails, it is DELETED. For existing data sets, the NEW option is replaced with OLD, SHR, or MOD.

To allocate a new DASD data set, you can use:

- JCL DD statements (see *JCL Reference*)
- TSO/E ALLOCATE command (see *TSO/E V2 Command Reference* and *TSO/E V2 User's Guide*)

- DYNALLOC macro (see *Application Development Guide*)

Allocating Non-SMS Data Sets

Here are some JCL examples of allocating different types of non-SMS-managed data sets.

Allocation of a Sequential Data Set:

```
//NEWDS DD UNIT=SYSDA,VOL=SER=SMSPAC,DISP=(NEW,KEEP),
// DSN=SOME.DATA,SPACE=(CYL,(1,1))
```

Allocation of a Partitioned Data Set:

```
//NEWLIB DD UNIT=SYSDA,VOL=SER=SMSPAC,DISP=(NEW,KEEP),
// DSN=SOME.DATA,SPACE=(CYL,(1,1,1))
```

Allocating SMS-Managed Data Sets

Allocating a new data set under SMS, using the automatic class selection routines defined by your storage administrator, is much simpler. With SMS it is unnecessary to specify the UNIT, VOL=SER, or SPACE parameters in the DD statement. This is an example of allocating an SMS-managed data set:

```
//NEWDS  DD DSN=DATASET.NAME,DISP=(NEW,KEEP)
```

When you allocate a data set under SMS, you may specify data set and storage requirements using data class, storage class, and management class. A data class is a named list of data set allocation attributes, such as record length and record format. A storage class is a named list of storage attributes used to specify the logical requirements for accessing your data set, such as an application's DASD input/output response time and availability. A management class is a named list of attributes used for data set management, such as backup, retention, and migration requirements for your data set. The attributes of each class are defined by your storage administrator in an SMS configuration. An SMS configuration is a complete set of definitions, defaulting mechanisms, and other system information that SMS uses to manage storage.

You can specify the name of the data class, storage class, and management class in the JCL DD statement. For this data allocation example, the storage administrator would have to define the classes PDS00001, MANAGE01, and STOR0001.

```
//NEWDS  DD DSN=DATASET.NAME,DISP=(NEW,KEEP),DATACLAS=PDS00001,
// MGMTCLAS=MANAGE01,STORCLAS=STOR0001
```

Using Automatic Class Selection Routines

If you do not specify the class names in the DD statement, the classes and their attributes can be assigned by your storage administrator, using the automatic class selection (ACS) routines. The automatic class selection routines are used to determine:

- If the data set is to be managed by SMS
- If the classes specified in the DD statement are to be used
- If other or defaulted classes are to be assigned.

Storage class and management class apply only to those data sets that are to be managed by SMS. You can use data class with DASD and tape data sets.

Note that tape data sets cannot be SMS-managed. Your storage administrator will define the data classes, storage classes, and management classes to be used by your installation. Your storage administrator should make available a description of each named class, including when that class should be used and how to invoke it.

Using data class, you can easily create data sets without specifying all of the data set attributes normally required.

Your storage administrator can define standard data set attributes and use them to create data classes, which you can then use as a template when you allocate your data set. For example, your storage administrator may define a data class for data sets whose names end in LIST and OUTLIST because they have similar allocation attributes. The ACS routines can then be used to filter the data set names and assign this data class, if the data set names end in LIST or OUTLIST.

You can refer to a data class explicitly, specifying it in the DD statement. You can refer to a data class implicitly, by not specifying a data class in the DD statement and letting the ACS routines assign the data class defined by your storage administrator. Whichever method is used, you will need to know:

- What criteria is used by the installation to choose the data class
- What data classes are defined for your installation
- The allocation attributes associated with each data class
- How to specify data class in the DD statement, if you want to refer to a data class explicitly.

You can override any of the attributes specified in the assigned data class by specifying the values you want in the DD statement.

Another way to allocate a data set without specifying all of the data set attributes normally required is to model the data set after an existing data set. You can do this by referring to the existing data set's name or DD statement in the DD statement for the new data set, using the new JCL keywords LIKE or REFDD. For more information on the new JCL keywords, see *JCL Reference* and *JCL User's Guide*.

For a more detailed description of classes and how to use them, see Chapter 5, "Specifying a Data Control Block and Initializing Data Sets" on page 39.

Executing Macros in 24- or 31-Bit Addressing Mode

Unless otherwise stated, data management macros can be executed only in 24-bit addressing mode. In 24-bit mode, all buffers, parameters, control blocks, save areas, and exit routines must be below 16 megabytes virtual.

Chapter 2. Data Set Storage

The operating system provides a variety of devices for collecting, storing, and distributing data. Despite the variety, the devices have many common characteristics. The generic term *volume* is used to refer to a standard unit of auxiliary storage. A volume may be a reel of magnetic tape, a disk pack, or a drum.

Each data set stored on a volume has its name, location, organization, and other control information stored in the data set label or volume table of contents (for direct access volumes only). Thus, when the name of the data set and the volume where it is stored are made known to the operating system, a complete description of the data set, including its location on the volume, can be retrieved. Then, the data itself can be retrieved, or new data added to the data set.

Various groups of labels are used to identify magnetic tape and direct access volumes, and the data sets they contain. Magnetic tape volumes can have standard or nonstandard labels, or they can be unlabeled. Direct access volumes must use standard labels. Standard labels include a volume label, a data set label for each data set, and optional user labels.

Keeping track of the volume where a particular data set resides can be a burden and a source of error. To alleviate this problem, the system provides for automatic cataloging of data sets. The system can retrieve a cataloged data set if given only the name of the data set. You must ensure that all data sets to be managed by SMS will be cataloged in an integrated catalog facility catalog. This requires that a VSAM volume data set (VVDS) be created on the same volume as the data set. The operating system automatically creates a VVDS if one does not exist on that volume.

By use of the catalog, collections of data sets related by a common external name and the time sequence in which they were cataloged (their generation) can be identified; they are called *generation data groups*. For example, a data set name LAB.PAYROLL(0) refers to the most recent data set of the group; LAB.PAYROLL(-1) refers to the second most recent data set; and so forth. The same data set names can be used repeatedly with no need to keep track of the volume serial numbers used. For more information, see "Relative Generation Number" on page 114.

Direct Access Volumes

Regardless of organization, data sets created using the operating system can be stored on a direct access volume. Each block of data has a distinct location and a unique address, making it possible to find any record without extensive searching. Thus, records can be stored and retrieved either directly or sequentially.

Direct access volumes are used to store executable programs, including the operating system itself. Direct access storage (sometimes called DASD storage) is also used for data and for temporary working storage. One direct access storage volume may be used for many different data sets, and space on it may be reallocated and reused. A volume table of contents (VTOC) is used to account for each data set and available space on the volume.

Each direct access volume is identified by a volume label that is stored at track 0 of cylinder 0. You may specify as many as seven additional labels, located following the standard volume label, for further identification.

The VTOC is a data set consisting of data set control blocks (DSCBs) that describe the contents of the direct access volume. The VTOC can contain seven kinds of DSCBs, each with a different purpose and a different format number. The format 0 DSCB describes an unused (available) record in the VTOC. *System—Data Administration* describes format 1 through format 6 DSCBs and their purposes. *System—Data Administration* also describes the structure of the VTOC.

Each direct access volume is initialized by a utility program before being used on the system. The initialization program generates the volume label and builds the table of contents. For additional information on direct access labels, see Appendix A, "Direct Access Labels" on page 131.

When a data set is to be stored on a direct access volume, you can supply the operating system with the amount of space to be allocated to the data set. You use the SPACE keyword to allocate space expressed in kilobytes, megabytes, blocks, tracks, or cylinders. If you specify your request in terms of average block length, space allocation will be independent of device type. You use the AVGREC keyword to modify the information supplied in the SPACE keyword. AVGREC can be used only when you specify average block length in the SPACE keyword. The average block length will then be treated as average record length and the primary and secondary quantities will be multiplied by the scale specified in AVGREC. Specifying your request using the AVGREC keyword is the easiest way to allocate space. For more information on the use of the SPACE and AVGREC keywords, see Appendix C, "Allocating Space on Direct Access Volumes" on page 139. If the request is made in tracks or cylinders, you must be aware of such device considerations as cylinder capacity and track size.

For SMS-managed data sets, the system selects the volumes. Therefore, you do not need to specify a volume when you define your data set.

Primary and Secondary Space Allocation

An *extent* is a continuous area of space on a DASD storage volume, occupied by or reserved for a specific data set. An extent is also a term used to describe a portion of the control block called the data extent block (DEB). When a data set is allocated as NEW, the extent information is specified in the SPACE parameter (for example, SPACE=(TRK,(2,4))). This initially allocates two tracks (the primary space allocation amount) for the data set. As records are written to the data set and these two tracks are used up, the system automatically obtains four more tracks (the amount specified by the secondary allocation amount). When these four tracks are used another four tracks are obtained. This process is continued until the extent limit for the type of data set is reached.

- A sequential data set can have up to 16 extents
- A partitioned data set can have up to 16 extents

- A direct data set can have up to 16 extents
- A VSAM data set can have up to 123 extents.

Track Characteristics

Although direct access devices differ in physical appearance, capacity, and speed, they are similar in data recording, data checking, data format, and programming. The recording surface of each volume is divided into many concentric tracks. The number of tracks and their capacity vary with the device. Each device has some type of access mechanism, containing read/write heads that transfer data as the recording surface rotates past them.

Track Format

Information is recorded on all direct access volumes in a standard format. Besides device data, each track contains a track descriptor record (capacity record or record 0) and data records.

Figure 1 shows that there are two possible data record formats—count data and count key data—only one of which can be used for a particular data set.

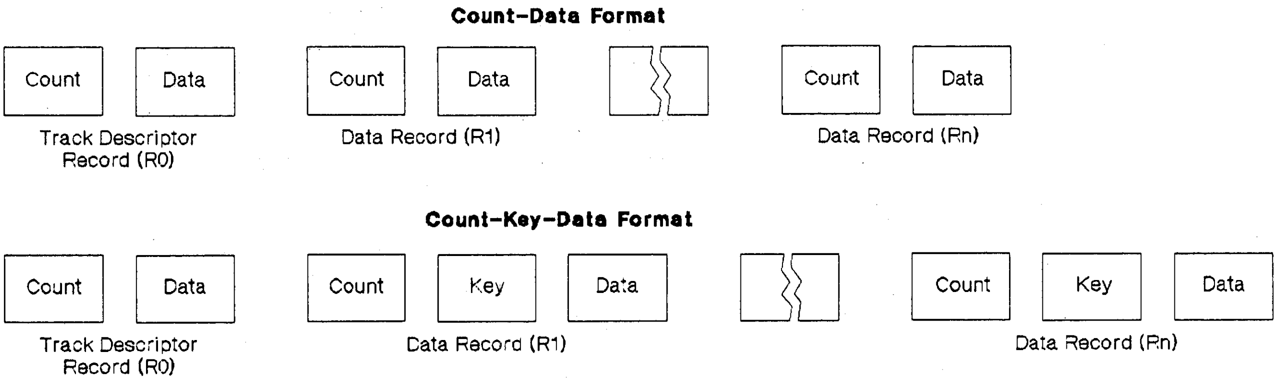


Figure 1. Direct Access Volume Track Formats

Besides device data, the count area contains 8 bytes that identify the location of the record by cylinder, head, and record numbers, its key length (0 if no keys are used), and its data length.

If the records are written with keys, the key area (1 to 255 bytes) contains a record key that specifies the data record by part number, account number, sequence number, or some other identifier. In some cases, records are written with keys so that they can be located quickly.

Track Overflow

If the record overflow feature is available for the direct access device being used, you can reduce the amount of unused space on the volume by specifying the track overflow option in the DCB parameter of the DD statement, or the DCB macro associated with the data set. If the overflow option is used, a block that does not fit on the track is partially written on that track and continued on the next track. (The track where the record is continued must be physically next and must be part of the same extent as the track that holds the first part of the record.)

Each segment (the portion written on one track) of an overflow block has a count area. The data length field in the count area specifies the length of that segment only. If the block is written with a key, there is only one key area for the block. It is written with the first segment. If the track overflow option is not used, blocks are not split between tracks.

Actual and Relative Addressing

Two types of addresses can be used to store and retrieve data on a direct access volume: actual addresses and relative addresses. The only advantage of using actual addresses is the elimination of time required to convert from relative to actual addresses and vice versa. When sequentially processing a multiple volume data set, you can refer only to records of the current volume.

Actual Addresses: When the system returns the actual address of a record on a direct access volume to your program, it is in the form MBBCCHHR, where:

M

is a 1-byte binary number specifying the relative location of an entry in a data extent block (DEB). The DEB is created by the system when the data set is opened. Each extent entry describes a set of consecutive tracks allocated for the data set.

BBCCHH

is three 2-byte binary numbers specifying the cell (bin), cylinder, and head number for the record (its track address). The cylinder and head numbers are recorded in the count area for each record.

R

is a 1-byte binary number specifying the relative block number on the track. The block number is also recorded in the count area.

If you use actual addresses in your program, the data set must be treated as unmovable.

Relative Addresses: Two kinds of relative addresses can be used to refer to records in a direct access data set: relative block addresses and relative track addresses.

The relative block address is a 3-byte binary number that shows the position of the block relative to the first block of the data set. Allocation of noncontiguous sets of blocks does not affect the number. The first block of a data set always has a relative block address of 0.

The relative track address has the form TTR, where:

TT

is an unsigned 2-byte binary number specifying the position of the track relative to the first track allocated for the data set. The TT for the first track is 0. Allocation of noncontiguous sets of tracks does not affect the number.

R

is a 1-byte binary number specifying the number of the block relative to the first block on the track TT. The R value for the first block of data on a track is 1.

Note: With the IBM 3380 Model K, a data set can contain more than 32,767 tracks. Therefore, assembly halfword instructions may result in invalid data being processed.

Magnetic Tape Volumes

You may use a data class to specify your tape data set attributes such as record length and record format. You can either specify the data class in the DD statement or let the ACS routines assign the data class defined by your storage administrator.

Because data sets on magnetic tape devices must be organized sequentially, the operating system does not require space allocation procedures comparable to those for direct access devices. When a new data set is to be placed on a magnetic tape volume, you must specify the data set sequence number if it is not the first data set on the reel. The operating system positions a volume with IBM standard labels, ISO/ANSI/FIPS labels, or no labels so that the data set can be read or written. If the data set has nonstandard labels, you must provide for volume positioning in your nonstandard label processing routines. All data sets stored on a given magnetic tape volume must be recorded in the same density.

When a data set is to be stored on an unlabeled tape volume and you have not specified a volume serial number, the system assigns a serial number to that volume and to any additional volumes required for the data set. Each such volume is assigned a serial number of the form *Lxxxyy*, where *xxx* is the data set sequence number, and *yy* is the volume sequence number for the data set. If you specify volume serial numbers for unlabeled volumes where a data set is to be stored, the system assigns volume serial numbers to any additional volumes required. If data sets residing on unlabeled volumes are to be cataloged or passed, you should specify the volume serial numbers for the volumes required. This ensures that data sets residing on different volumes are not cataloged or passed under identical volume serial numbers. Retrieving such data sets can give unpredictable errors.

Each data set and data set label group must be followed by a tape mark. Tape marks cannot exist within a data set. When the operating system creates a tape with standard labels or no labels, all tape marks are automatically written. Two tape marks follow the last trailer label group on a standard-label volume. On an unlabeled volume, the two tape marks appear after the last data set.

When the operating system creates data sets with nonstandard labels, no tape marks are written. If you want the operating system to retrieve a data set, you must supply the tape marks in your routine that creates the nonstandard-label volume. Otherwise, tape marks are not required after nonstandard labels, because positioning of the tape volumes must be handled by installation routines.

For more information about magnetic tape volume labels, see *Magnetic Tape Labels and File Structure*. For more information about nonstandard labels, see *DFP: Customization*.

The data on magnetic tape volumes can be in either EBCDIC or ISCII/ASCII. ISCII/ASCII is a 7-bit code consisting of 128 characters. It permits data on magnetic tape to be transferred from one computer to another, even though the two computers may be products of different manufacturers.

Data management support of ISCII/ASCII and of the International Organization for Standardization (ISO), American National Standards Institute (ANSI), and

Federal Information Processing Standard (FIPS) tape labels lets data management translate records on input tapes in ISCII/ASCII into EBCDIC for internal processing and translate the EBCDIC into ISCII/ASCII for output. Records on such input tapes may be sorted into ISCII/ASCII collating sequence.

Cataloging Data Sets

Non-VSAM data sets can be cataloged in an integrated catalog facility catalog, VSAM catalog, or an OS CVOL. VSAM data sets can be cataloged in an integrated catalog facility catalog or VSAM catalog. Data sets can be cataloged, uncataloged, or recataloged. The use of OS CVOLs and VSAM catalogs is not recommended; we recommend you use integrated catalog facility catalogs because they give you superior performance, capability, usability, and maintainability. If the data set is to be managed by SMS, it will be cataloged in an integrated catalog facility catalog. OS CVOLs cannot be managed by SMS. For more information on using integrated catalog facility catalogs, see *Catalog Administration Guide*.

Entering a Data Set Name in the Catalog

A non-VSAM data set can be cataloged through (1) job control language (DISP parameter), (2) access method services (ALLOCATE or DEFINE commands), or (3) catalog management macro instructions (CATALOG and CAMLST). An existing data set can be cataloged through the access method services DEFINE RECATALOG command.

Access method services is also used to establish aliases for data set names and to connect user catalogs and OS CVOLs to the master catalog. For information on how to use the access method services commands, see *Access Method Services Reference*. For information on how to use the catalog management macro instructions, see *Catalog Administration Guide* and *System—Data Administration*.

Data set names cannot be cataloged in an OS CVOL if a name is already cataloged whose levels match the highest or higher levels of the specified name. For example, the qualified name A.B.C.D cannot be cataloged if the name A.B or A.B.C is already cataloged, but the name A.B.C.D can be cataloged if AB.C or A.B.C.E is cataloged. This restriction is *not* true for data sets cataloged in an integrated catalog facility or VSAM catalog.

Chapter 3. Record Formats

Introduction

The *record* is the basic unit of information used by a processing program and can be anything from a single character to a mass of information collected by a particular business transaction, or measurements recorded at a given point in an experiment. A collection of logically related records makes up a data set. Most data processing consists of reading, manipulating, and writing individual records.

Blocking is the process of grouping records before they are written on a volume. A block consists of one or more logical records written between consecutive interrecord gaps (IRGs). Blocking conserves storage space on a volume by reducing the number of IRGs in the data set and increases processing efficiency by reducing the number of input/output operations required to process the data set. If you do not specify a block size, the system will determine a block size that is optimum for the device to which your data set is allocated. By letting the system determine the block size, you no longer need to calculate block sizes.

Records are stored in one of four formats: fixed-length (format-F), variable-length for data in EBCDIC (format-V) or for data to be translated to or from ISCII/ASCII (format-D), or undefined-length (format-U).

Before selecting a record format, you should consider:

- The data type (for example, EBCDIC) your program will receive and the type of output it will produce
- The input/output devices that will contain the data set
- The access method you will use to read and write the records.

You identify your record format selection in the data control block using the options in the DCB macro, the DD statement, or the data set label.

ISO/ANSI/FIPS tape records are written in format-F, format-D, format-S or format-U with the restrictions noted under "Fixed-Length Records, ISO/ANSI/FIPS Tapes" on page 15, "ISO/ANSI/FIPS Variable-Length Records" on page 22, and "Undefined-Length Records" on page 26.

Data can only be in format-U for ISO/ANSI Version 1 tapes (ISO 1001-1969 and ANSI X3.27-1969).

When data management reads records from ISO/ANSI/FIPS tapes, it translates the records into EBCDIC. When data management writes records onto ISO/ANSI/FIPS tapes, it translates the records into ISCII/ASCII characters. Because you use input records after they are translated and because output records are translated when you ask data management to write them, you work only with EBCDIC.

Note: Translation routines supplied by the system will convert to ASCII 7-bit code, as explained in *Magnetic Tape Labels and File Structure*. When the character to be translated contains a bit in the high order position, the 7-bit translation does not produce an equivalent character. Instead, it produces a substitute character to note the loss in translation. This means, for example, that random binary data (such as a dump) cannot be recorded in ISO/ANSI/FIPS 7-bit code.

Fixed-Length Records

The size of fixed-length (format-F) records, shown in Figure 2, is constant for all records in the data set. The number of records within a block is constant for every block in the data set, unless the data set contains truncated (short) blocks. If the data set contains unblocked format-F records, one record constitutes one block.

The system automatically performs physical length checking (except for card readers) on blocked or unblocked format-F records. Allowances are made for truncated blocks.

Format-F records are shown in Figure 2. The optional control character (a), used for stacker selection or carriage control, may be included in each record to be printed or punched.

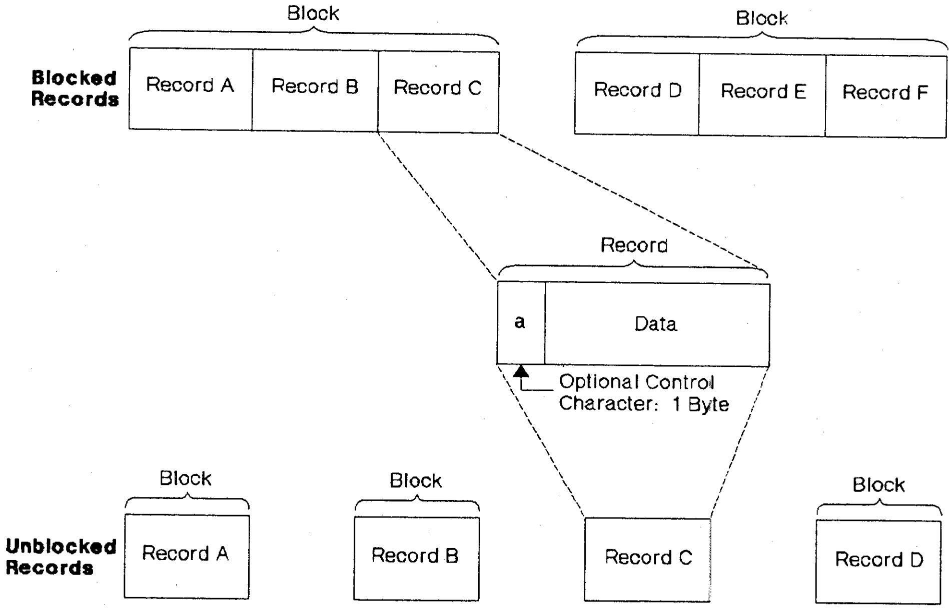


Figure 2. Fixed-Length Records

Fixed-Length Records, Standard Format

During creation of a sequential data set (to be processed by BSAM or QSAM) with fixed-length records, the RECFM subparameter of the DCB macro instruction may specify a standard format (RECFM=FS or FBS). A standard-format data set must conform to the following specifications:

- All records in the data set are format-F records.
- No block except the last block is truncated. (With BSAM, you must ensure that this specification is met.)

- Every track except the last contains the same number of blocks.
- Every track except the last is filled to capacity as determined by the track capacity formula established for the device. (These formulas are presented in Appendix C, "Allocating Space on Direct Access Volumes" on page 139.)
- The data set organization is physical sequential. A member of a partitioned data set cannot be specified.

A sequential data set with fixed-length records having a standard format can be read more efficiently than a data set that doesn't specify a standard format. This efficiency is possible because the system is able to determine the address of each record to be read, because each track contains the same number of blocks.

Restrictions: You should never extend a standard-format data set (by coding DISP=MOD) if the last block is truncated, because the extension will cause the data set to contain a truncated block that isn't the last block. Reading an extended data set with this condition will result in a premature end of data condition when the truncated block is read, giving the appearance that the blocks following this truncated block do not exist. This type of data set on magnetic tape should not be read backward, because the data set would begin with a truncated block. Therefore, you probably won't want to use this type of data set with magnetic tape. If you use one of the basic access method with this type of data set, you should not use the track overflow feature.

Standard format should not be used to read records from a data set that was created using a RECFM other than standard, because other record formats may not create the precise format required by standard.

If at any time the characteristics of your data set are altered from the specifications described above, the data set should no longer be processed with the standard format specification.

Fixed-Length Records, ISO/ANSI/FIPS Tapes

For ISO/ANSI/FIPS tapes, format-F records are the same as described above, with three exceptions:

- Control characters, if present, must be ISO/ANSI/FIPS control characters. For more information about control characters, see Appendix B, "Control Characters" on page 135.
- Record blocks can contain block prefixes.

  The block prefix can vary from 0 to 99 bytes, but the length must be constant for the data set being processed. For blocked records, the block prefix precedes the first logical record. For unblocked records, the block prefix precedes each logical record.

  Using QSAM and BSAM to read records with block prefixes requires that you specify the BUFOFF operand in the DCB. When using QSAM, you do not have access to the block prefix on input. When using BSAM, you must account for the block prefix on both input and output. When using either QSAM or BSAM, you must account for the length of the block prefix in the BLKSIZE and BUFL operands of the DCB.

  When using QSAM to output DB or DBS records and BUFOFF=0 is specified, the value of the BUFL operand, if specified, must be increased by 4. If

BUFL is not specified, then the BLKSIZE operand must be increased by 4. This allows for a 4-byte QSAM internal processing area to be included when the system acquires the buffers. These 4 bytes will not become part of the user's block.

When you use BSAM on output records, the operating system does not recognize a block prefix. Therefore, if you want a block prefix, it must be part of your record. Note that you cannot include block prefixes in QSAM output records.

The block prefix, as for all the data records for ISO/ANSI/FIPS tapes, can only contain EBCDIC characters that correspond to the 128, seven-bit ASCII characters. Thus, you must avoid using data types such as binary, packed decimal, and floating point that cannot always be translated into ISCII/ASCII. (See the note on page 13.)

Figure 3 shows the format of fixed-length records for ISO/ANSI/FIPS tapes and where control characters and block prefixes are positioned if they exist.

- The GET routine tests each record (except the first) for all circumflex characters (X'5E'). If a record completely filled with circumflex characters is detected, the end-of-block (EOB) routine is called to get the next block. A fixed-length record must not consist of only circumflex characters. This restriction is necessary because circumflex characters are used to pad out a block of records when fewer than the maximum number of records are included in a block, and the block is not truncated.

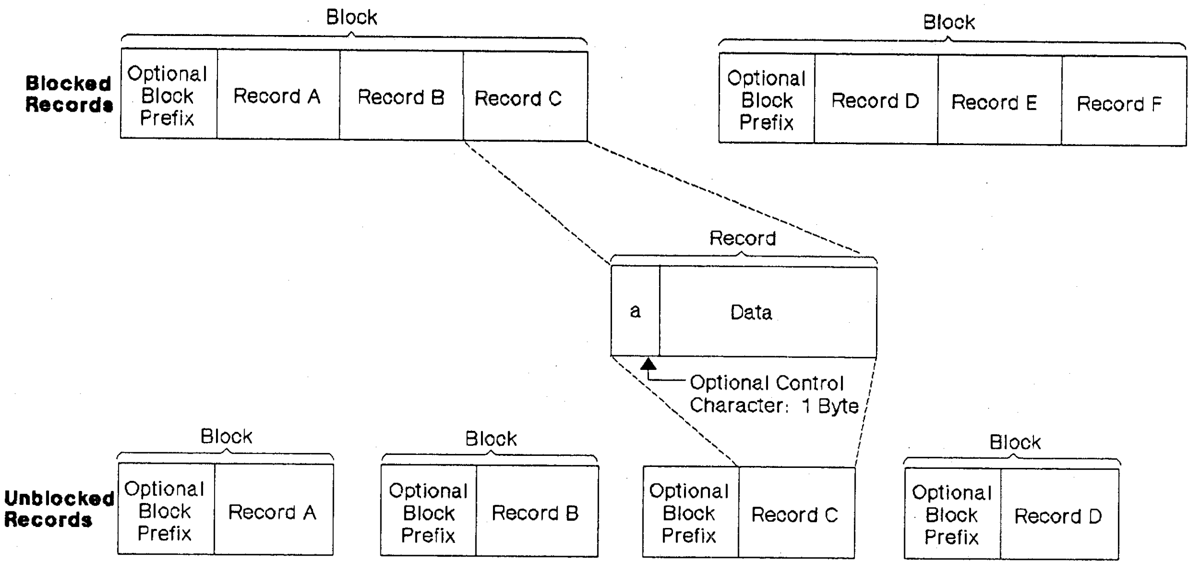


Figure 3. Fixed-Length Records for ISO/ANSI/FIPS Tapes

Variable-Length Records

The variable-length record formats are format-V and format-D. They can also be spanned (format-VS or -DS), blocked (format-VB or -DB), or both (format-VBS and -DBS). Format-D, -DS, and -DBS records are used for ISO/ANSI/FIPS tape data sets. Figure 4 on page 17 shows blocked and unblocked variable-length (format-V) records without spanning.

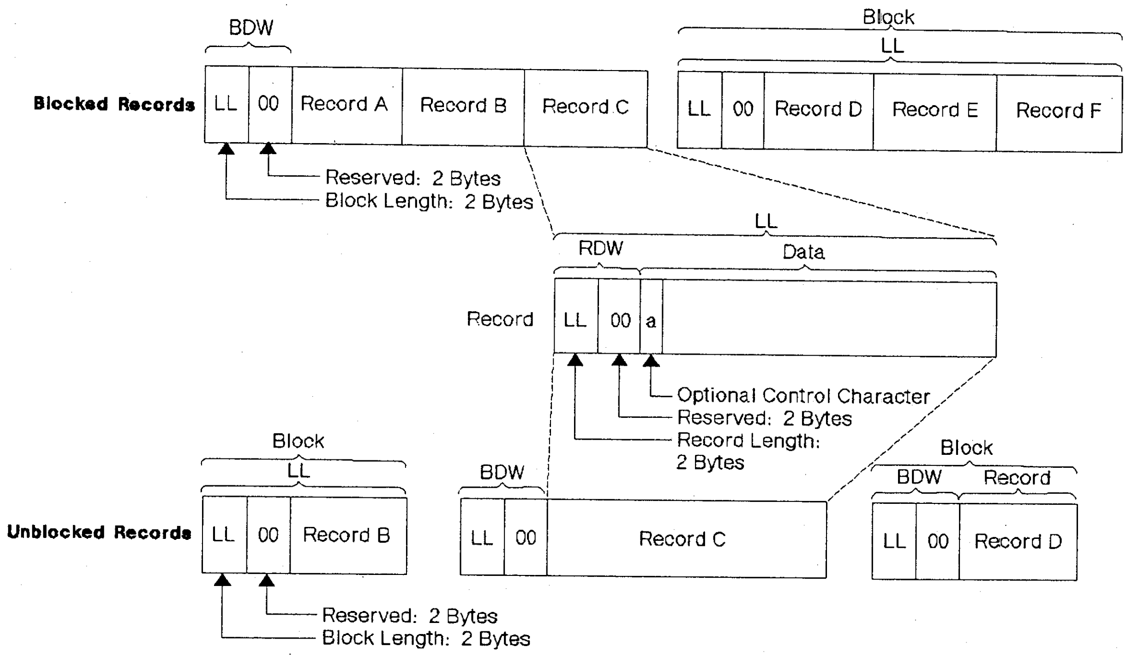


Figure 4. Nonspanned, Format-V Records

Variable-Length Records

Format-V provides for variable-length records and variable-length record segments, each of which describes its own characteristics, and for variable-length blocks of such records or record segments. Except when variable-length track overflow records are specified for volumes on devices with the rotational position sensing feature, the control program performs length checking of the block and uses the record or segment length information in blocking and unblocking. The first 4 bytes of each record, record segment, or block make up a descriptor word containing control information. You must allow for these additional 4 bytes in both your input and output buffers.

Block Descriptor Word: A variable-length block consists of a block descriptor word (BDW) followed by one or more logical records or record segments. The block descriptor word is a 4-byte field that describes the block. The first 2 bytes specify the block length LL—4 bytes for the BDW plus the total length of all records or segments within the block. This length can be from 8 to 32760 bytes or, when you are using WRITE with tape, from 18 to 32760. The third and fourth bytes are reserved for possible future system use and must be 0. If the system does your blocking—that is, when you use the queued access method—the operating system automatically provides the BDW when it writes the data set. If you do your own blocking—that is, when you use the basic access method—you must supply the BDW.

Record Descriptor Word: A variable-length logical record consists of a record descriptor word (RDW) followed by the data. The record descriptor word is a 4-byte field describing the record. The first 2 bytes contain the length LL of the logical record (including the 4-byte RDW). The length can be from 4 to 32756. All bits of the third and fourth bytes must be 0, because other values are used for spanned records. For output, you must provide the RDW except in data mode for spanned records (described under "Buffer Control" on page 89). For output in data mode, you must provide the total data length in the physical record length field (DCBPRECL) of the DCB. For input, the operating system provides the RDW except in data mode. In data mode, the system passes the record length to your program in the logical record length field (DCBLRECL) of the DCB. The optional control character (a) may be specified as the fifth byte of each record and must be followed by at least one byte of data (the length in the RDW, in this case, would be 6). The first byte of data is a table reference character if OPTCD=J has been specified. The RDW, the optional control character, and the optional table reference character are not punched or printed.

Spanned Format-VS Records (Sequential Access Method)

Figure 5 on page 19 shows how the spanning feature of the queued and basic sequential access methods lets you create and process variable-length logical records that are larger than one physical block and/or to pack blocks with variable-length records by splitting the records into segments so that they can be written into more than one block.

When spanning is specified for blocked records, the system tries to fill all blocks. For unblocked records, a record larger than block size is split and written in two or more blocks, each block containing only one record or record segment. Thus the block size may be set to the best block size for a given device or processing situation. It is not restricted by the maximum record length of a data set. A record may, therefore, span several blocks, and may even span volumes. Note that a logical record spanning three or more volumes cannot be processed in update mode (described under "Buffer Control" on page 89) by QSAM. For blocked records, a block can contain a combination of records and record segments, but not multiple segments of the same record. When records are added to or deleted from a data set, or when the data set is processed again with different block size or record size parameters, the record segmenting will change.

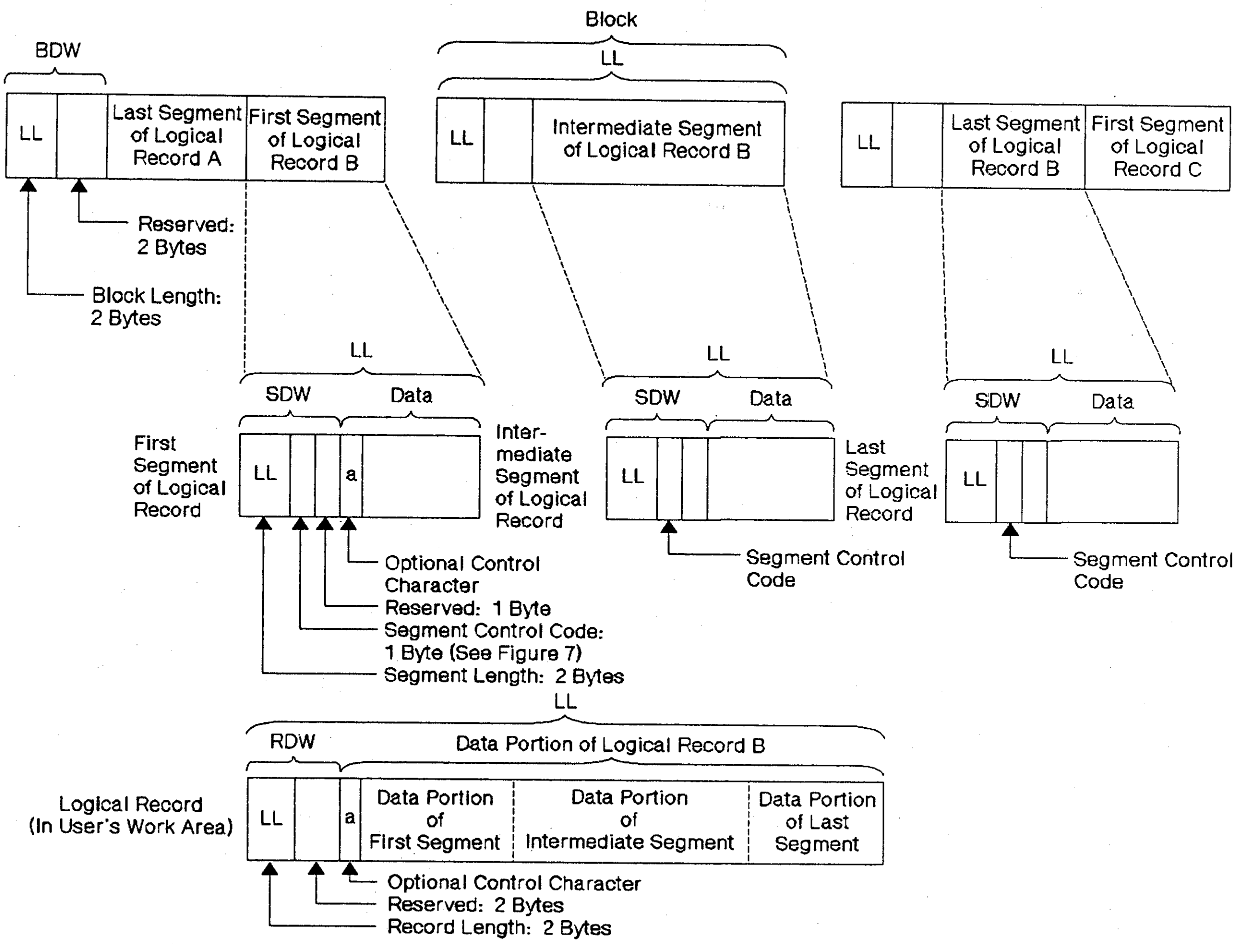

Block
LL
BDW
LL
Last Segment of Logical Record A
First Segment of Logical Record B
Reserved: 2 Bytes
Block Length: 2 Bytes
LL
Intermediate Segment of Logical Record B
LL
Last Segment of Logical Record B
First Segment of Logical Record C
LL
SDW
Data
First Segment of Logical Record
LL
a
Optional Control Character
Reserved: 1 Byte
Segment Control Code: 1 Byte (See Figure 7)
Segment Length: 2 Bytes
Inter-mediate Segment of Logical Record
LL
SDW
Data
LL
Segment Control Code
Last Segment of Logical Record
LL
SDW
Data
LL
Segment Control Code
LL
RDW
Data Portion of Logical Record B
Logical Record (In User's Work Area)
LL
a
Data Portion of First Segment
Data Portion of Intermediate Segment
Data Portion of Last Segment
Optional Control Character
Reserved: 2 Bytes
Record Length: 2 Bytes

Figure 5. Spanned Format-VS Records (Sequential Access Method)

Considerations for Processing Spanned Record Data Sets

When spanned records span volumes, reading errors may occur when using QSAM if a volume that begins with a middle or last segment is mounted first or if an FEOV macro instruction is issued followed by another GET. QSAM cannot begin reading from the middle of the record. The errors include duplicate records, program checks in the user's program, and invalid input from the spanned record data set.

When QSAM opens a spanned record data set in UPDAT mode, it uses logical record interface (LRI) to assemble all segments of the spanned record into a single, logical input record and to disassemble a single logical record into multiple segments for output data blocks. A record area must be provided by using the BUILDRCD macro instruction or by specifying BFTEK=A in the DCB.

Note: When you specify BFTEK=A, the Open routine provides a record area equal to the LRECL specification, which should be the maximum length in bytes. (An LRECL=0 is invalid.)

If you issue the FEOV macro when reading a data set that spans volumes, or if a spanned multivolume data set is opened to other than the first volume, make sure that each volume begins with the first (or only) segment of a logical record. Input routines cannot begin reading in the middle of a logical record.

Segment Descriptor Word: Each record segment consists of a segment descriptor word (SDW) followed by the data. The segment descriptor word, similar to the record descriptor word, is a 4-byte field that describes the segment. The first 2 bytes contain the length LL of the segment, including the 4-byte SDW. The length can be from 5 to 32756 bytes or, when you are using WRITE with tape, from 18 to 32756 bytes. The third byte of the SDW contains the segment control code that specifies the relative position of the segment in the logical record. The segment control code is in the rightmost 2 bits of the byte. The segment control codes are shown in Figure 6. The remaining bits of the third byte and all of the fourth byte are reserved for possible future system use and must be 0.

Binary Code	Relative Position of Segment
00	Complete logical record
01	First segment of a multisegment record
10	Last segment of a multisegment record
11	Segment of a multisegment record other than the first or last segment

Figure 6. Segment Control Codes

The SDW for the first segment replaces the RDW for the record after the record has been segmented. You or the operating system can build the SDW, depending on which access method is used. In the basic sequential access method, you must create and interpret the spanned records yourself. In the queued sequential access method move mode, complete logical records, including the RDW, are processed in your work area. GET consolidates segments into logical records and creates the RDW. PUT forms segments as required and creates the SDW for each segment. Data mode is similar to move mode, but allows reference only to the data portion of the logical record (that is, to one segment) in your work area. The logical record length is passed to you through the DCBLRECL field of the data control block. In locate mode, both GET and PUT process one segment at a time. However, in locate mode, if you provide your own record area using the BUILDRCD macro or if you ask the system to provide a record area by specifying BFTEK=A, then GET, PUT, and PUTX process one logical record at a time. (BFTEK=A or the BUILDRCD macro cannot be specified when logical records exceed 32760 bytes. To process logical records that exceed 32760 bytes, you must use locate mode and specify LRECL=X in your DCB macro.)

A logical record spanning three or more volumes cannot be processed when the data set is opened for update.

When unit record devices are used with spanned records, the system assumes that unblocked records are being processed and the block size must be equivalent to the length of one print line or one card. Records that span blocks are written one segment at a time.

Note: Spanned variable-length records cannot be specified for a SYSIN data set.

Null Segments

A 1 in bit position 0 of the SDW indicates a null segment. A null segment means that there are no more segments in the block. Bits 1 to 7 of the SDW and the remainder of the block must be binary zeros. A null segment is not an end-of-logical-record delimiter. (You do not have to be concerned about null segments unless you have created a data set using null segments.)

Spanned Variable-Length Records (Basic Direct Access Method)

The spanning feature of the basic direct access method (BDAM) lets you create and process variable-length unblocked logical records that span tracks. The feature also lets you pack tracks with variable-length records by splitting the records into segments. Figure 7 shows how these segments can then be written onto more than one track.

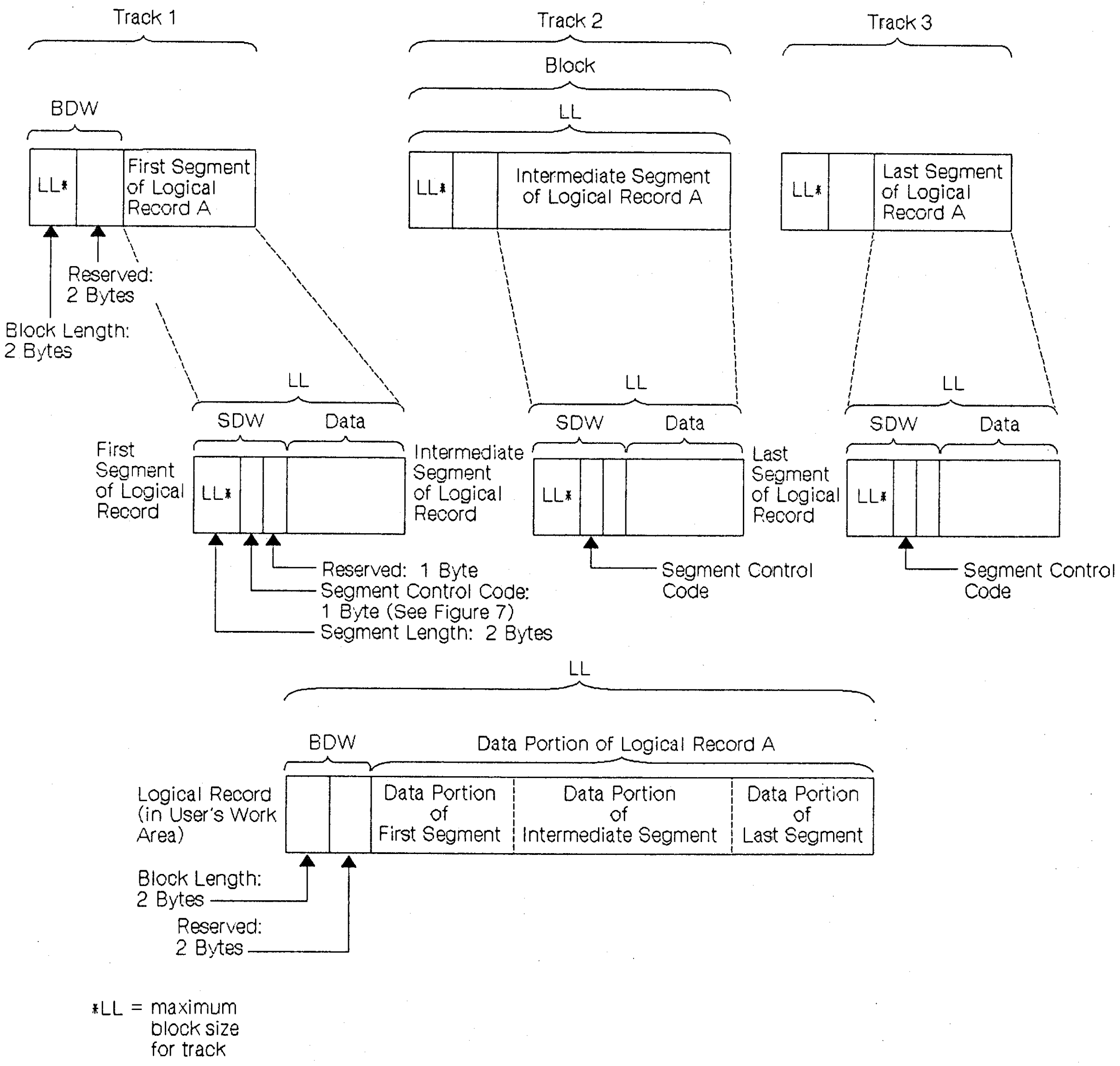

Track 1
Track 2
Track 3
Block
BDW
LL
LL*
First Segment of Logical Record A
LL*
Intermediate Segment of Logical Record A
LL*
Last Segment of Logical Record A
Reserved: 2 Bytes
Block Length: 2 Bytes
LL
LL
LL
SDW
Data
SDW
Data
SDW
Data
First Segment of Logical Record
LL*
Intermediate Segment of Logical Record
LL*
Last Segment of Logical Record
LL*
Reserved: 1 Byte
Segment Control Code: 1 Byte (See Figure 7)
Segment Length: 2 Bytes
Segment Control Code
Segment Control Code
LL
BDW
Data Portion of Logical Record A
Logical Record (in User's Work Area)
Data Portion of First Segment
Data Portion of Intermediate Segment
Data Portion of Last Segment
Block Length: 2 Bytes
Reserved: 2 Bytes
*LL = maximum block size for track

Figure 7. Spanned Format-V Records for Direct Data Sets

When you specify spanned, unblocked record format for the basic direct access method and when a complete logical record cannot fit on the track, the system tries to fill the track with a record segment. Thus the maximum record length of a data set is not restricted by track capacity. Segmenting records allows a record to span several tracks, with each segment of the record on a different track. However, because the system does not allow a record to span volumes, all segments of a logical record in a direct data set are on the same volume.

Note: Use of the basic direct access method (BDAM) is not recommended.

ISO/ANSI/FIPS Variable-Length Records

For ISO/ANSI/FIPS tapes, nonspanned variable-length records are format-D records. ISO/ANSI/FIPS records are the same as format-V records, with the following exceptions:

- *Block prefix*—A record block can contain a block prefix. To specify a block prefix, code the BUFOFF operand in the DCB macro. The block prefix can vary in length from 0 to 99 bytes but its length must remain constant for all records in the data set being processed. For blocked records, the block prefix precedes the RDW for first or only logical record in each block. For unblocked records, the block prefix precedes the RDW for each logical record.

  To specify that the block prefix is to be treated as a BDW by data management for format-D or -DS records on output, code BUFOFF=L as a DCB operand. Your block prefix must be 4 bytes long, and it must contain the length of the block, including the block prefix. The maximum length of a format-D or -DS, BUFOFF=L block is 9999, because the length (stated in binary by the user) is translated to a 4-byte ASCII character decimal field on the ISO/ANSI/FIPS tape when the block is written. It is converted back to a 2-byte length field in binary followed by two bytes of zeros when the block is read. If you use QSAM to write records, data management fills in the block prefix for you. If you use BSAM to write records, you must fill in the block prefix yourself. If you are using chained scheduling to read blocked DB or DBS records, you cannot code BUFOFF=*absolute expression* in the DCB. Instead, BUFOFF=L is required, because the access method needs binary RDWs and valid block lengths to unblock the records.

  When you use QSAM, you cannot read the block prefix into your record area on input. When using BSAM, you must account for the block prefix on both input and output. When using either QSAM or BSAM, you must account for the length of the block prefix in the BLKSIZE and BUFL operands.

  When you use BSAM on output records, the operating system does not recognize the block prefix. Therefore, if you want a block prefix, it must be part of your record.

  The block prefix can only contain EBCDIC characters that correspond to the 128, seven-bit ASCII characters. Thus, you must avoid using data types, such as binary, packed decimal, and floating point, that cannot always be translated into ISCII/ASCII. (See the **Note** in Chapter 3, "Record Formats" on page 13.) For DB and DBS records, the only time the block prefix can contain binary data is when you have coded BUFOFF=L, which tells data management that the prefix is a BDW. Unlike the block prefix, the RDW must always be in binary.

- *Block size*—Version 3 tapes have a maximum block size of 2048. This limit may be overridden by a label validation installation exit.

If you create variable-length blocks that are shorter than 18 bytes, data management pads each one to 18 bytes when the blocks are written onto an ISO/ANSI/FIPS tape. The padding character used is the ISCII/ASCII circumflex character.

- *Control characters*—Control characters, if present, must be ISO/ANSI control characters. For more information about control characters, see Appendix B, "Control Characters" on page 135.

Figure 8 shows the format of nonspanned variable-length records for ISO/ANSI/FIPS tapes, where the record descriptor word (RDW) is located, and where block prefixes and control characters must be placed when they are used.

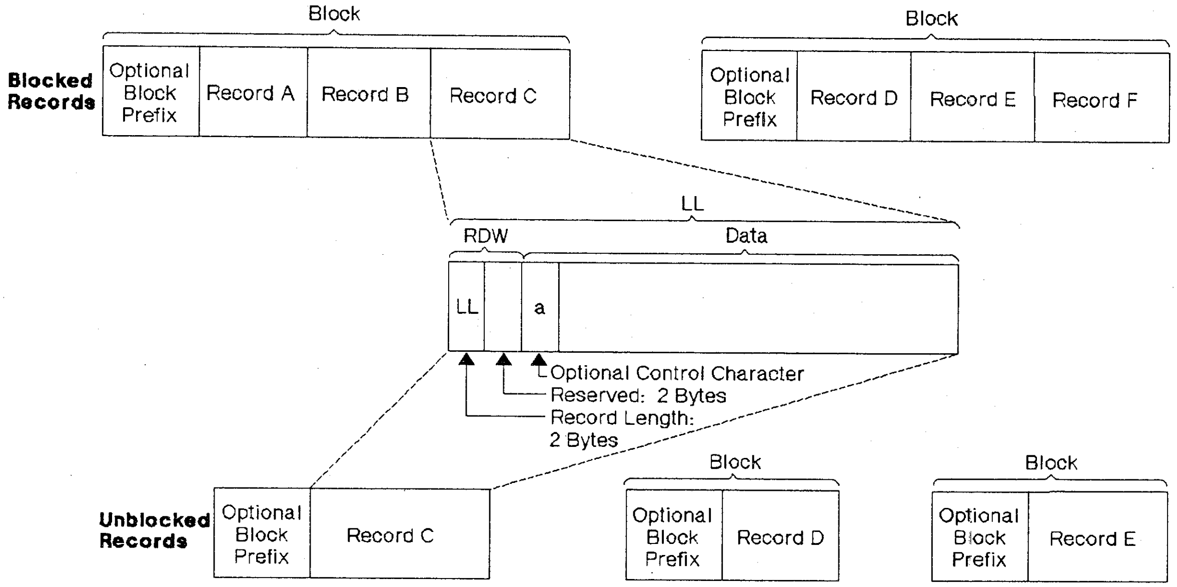


Figure 8. Nonspanned Format-D Records for ISO/ANSI/FIPS Tapes

ISO/ANSI/FIPS Variable-Length Spanned Records

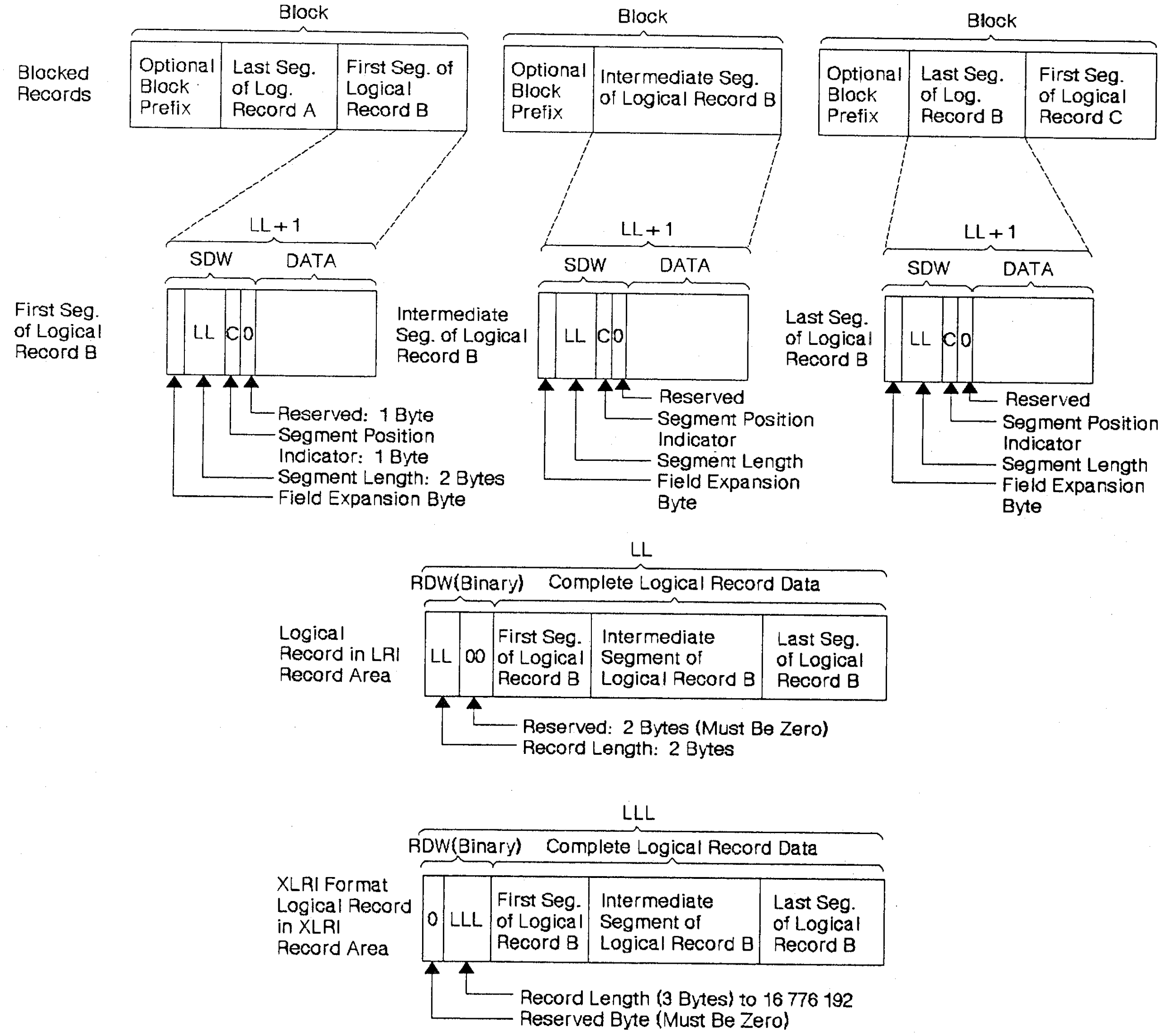
For ISO/ANSI/FIPS tapes, variable-length spanned records must be specified in the DCB RECFM parameter as DCB RECFM=DS or DBS. Format-DS and -DBS records are similar to format-VS or -VBS records with the following exceptions:

- *Segment descriptor word (SDW)*—There is an additional byte preceding each SDW for DS/DBS records. This additional byte is required for conversion of the SDW from IBM to ISO/ANSI/FIPS format, because the ISO/ANSI SDW (called a segment control word) is five bytes long. Otherwise, the SDW for DS/DBS records is the same as the SDW for VS/VBS records. The SDW LL count excludes the additional byte. (See "Processing Considerations for DS and DBS Records" on page 24.)

- *Extended logical record interface (XLRI)*—DS/DBS records may be processed using XLRI. (See "Processing Considerations for DS and DBS Records" on page 24.)

- The exceptions previously noted ("ISO/ANSI/FIPS Variable-Length Records" on page 22) for format-D records still apply.

Figure 9 on page 24 shows what spanned variable-length records for ISO/ANSI/FIPS tapes look like when you are using IBM access methods. The figure shows the segment descriptor word (SDW), where the record descriptor word (RDW) is located, and where block prefixes must be placed when they are used. If you are not using IBM access methods, see Appendix D, "ISO/ANSI/FIPS Record Control Word and Segment Control Word" on page 141, for a description of ISO/ANSI/FIPS record control words and segment control words.



Blocked Records
Block
Optional Block Prefix
Last Seg. of Log. Record A
First Seg. of Logical Record B
Block
Optional Block Prefix
Intermediate Seg. of Logical Record B
Block
Optional Block Prefix
Last Seg. of Log. Record B
First Seg. of Logical Record C
LL+1
SDW
DATA
First Seg. of Logical Record B
LL
C
0
Reserved: 1 Byte
Segment Position Indicator: 1 Byte
Segment Length: 2 Bytes
Field Expansion Byte
Intermediate Seg. of Logical Record B
Reserved
Segment Position Indicator
Segment Length
Field Expansion Byte
Last Seg. of Logical Record B
Reserved
Segment Position Indicator
Segment Length
Field Expansion Byte
LL
RDW(Binary)
Complete Logical Record Data
Logical Record in LRI Record Area
LL
00
First Seg. of Logical Record B
Intermediate Segment of Logical Record B
Last Seg. of Logical Record B
Reserved: 2 Bytes (Must Be Zero)
Record Length: 2 Bytes
LLL
RDW(Binary)
Complete Logical Record Data
XLRI Format Logical Record in XLRI Record Area
0
LLL
First Seg. of Logical Record B
Intermediate Segment of Logical Record B
Last Seg. of Logical Record B
Record Length (3 Bytes) to 16 776 192
Reserved Byte (Must Be Zero)

Figure 9. Spanned Variable-Length (Format-DS) Records for ISO/ANSI/FIPS Tapes

Processing Considerations for DS and DBS Records

When using QSAM, the same application used to process VS/VBS tape files can be used to process DS/DBS tape files. However, you must ensure that ISO/ANSI/FIPS requirements such as block size limitation, tape device, and restriction to EBCDIC characters that correspond to the 128, seven-bit ASCII characters are met. The SCW/SDW conversion and buffer positioning is handled by the GET/PUT routines.

When using BSAM to process a DS/DBS tape file, you must allow for an additional byte at the beginning of each SDW. The SDW LL must exclude the additional byte. On input, you must ignore the unused byte preceding each SDW. On output, you must allocate the additional byte for each SDW.

SDW Conversion: Sequential access method end-of-block (EOB) routines perform conversion between ISO/ANSI/FIPS segment control word (SCW) format and IBM segment descriptor word (SDW) format for both QSAM and BSAM processing. On output, the binary SDW LL value (provided by you when using BSAM and by the access method when using QSAM), is increased by 1 for the extra byte and converted to four ISO/ANSI/FIPS numeric characters. Because the binary SDW LL value will result in four numeric characters, the binary value must not be greater than 9998. The fifth character is used to designate which segment type (complete logical record, first segment, last segment, or intermediate segment) is being processed.

On input, the four numeric characters designating the segment length are converted to two binary SDW LL bytes and decreased by one for the unused byte. The ISO/ANSI/FIPS segment control character maps to the DS/DBS SDW control flags. This conversion leaves an unused byte at the beginning of each SDW. It is set to X'00'. For more detail on this process, see Appendix D, "ISO/ANSI/FIPS Record Control Word and Segment Control Word" on page 141.

XLRI Mode: The extended logical record interface (XLRI) may be used with DS/DBS files to communicate LRECL values over 32760. (XLRI is supported only in QSAM locate mode for ISO/ANSI/FIPS tapes.) XLRI should be used for any case where the logical record will exceed 32760 bytes. Using the LRECL=X for ISO/ANSI/FIPS causes an 013-DC ABEND.

To use XLRI, specify LRECL=0K or LRECL=nK in the DCB macro. Specifying DCBLRECL with the K suffix sets the DCBBFTK bit that indicates that LRECL is coded in K units and that the DCB is to be processed in XLRI mode.

LRECL=0K in the DCB macro specifies that the LRECL value will come from the file label or JCL. When LRECL is from the label, the file must be opened as an input file. The label (HDR2) value for LRECL will be converted to kilobytes and rounded up when XLRI is in effect. When the ISO/ANSI/FIPS label value for LRECL is 00000 to show that the maximum record length may be greater than 99999, the LRECL=nK must be used in the JCL or in the DCB to specify the maximum record length.

The LRECL from JCL can be expressed in absolute form or with the K notation. Absolute values, permissible only from 5 to 32760, will be converted to kilobytes by rounding up to an integral multiple of 1024 when the DCB is for XLRI.

To show the record area size in the DD statement, code LRECL=nK or specify a data class that has the LRECL attribute you need. The value nK may range from 1K to 16383K (expressed in 1024-byte multiples). However, depending on the buffer space available, the value you can specify in most systems will be much smaller than 16383K bytes. This value is used to determine the size of the record area required to contain the largest logical record of the spanned format file.

When using XLRI, the exact LRECL size is communicated in the three low-order bytes of the RDW in the record area. This special RDW format exists only in the record area to communicate the length of the logical record (including the 4-byte RDW) to be written or read. (See the XLRI format of the RDW in Figure 9 on page 24.) DCB LRECL shows the 1024-multiple size of the record area (rounded up to the next nearest kilobyte). The normal DS/DBS SDW format is used at all other times before conversion.

Undefined-Length Records

Format-U permits processing of records that do not conform to the F or V format. Figure 10 shows how each block is treated as a record; therefore, any unblocking that is required must be performed by your program. The optional control character may be used in the first byte of each record. Because the system does not do length checking on format-U records, your program may be designed to read less than a complete block into virtual storage.

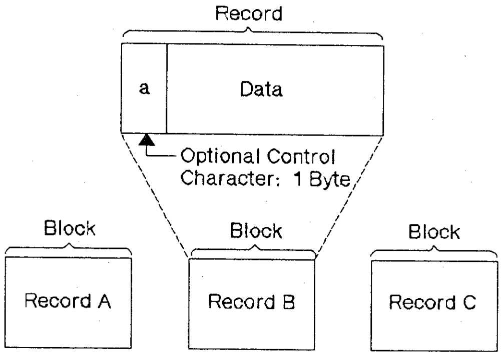


Figure 10. Undefined-Length Records

For format-U records, the user must specify the record length when issuing the WRITE, PUT, or PUTX macro instruction. No length checking is performed by the system, so no error indication will be given if the specified length does not match the buffer size or physical record size.

In update mode, you must issue a GET or READ macro before you issue a PUTX or WRITE macro to a data set on a direct access device. If you change the record length when you issue the PUTX or WRITE macro, the record will be padded with zeros or truncated to match the length of the record received when the GET or READ macro was issued. No error indication will be given.

For Version 3 ISO/ANSI/FIPS tapes, format-U records are not supported. An attempt to process a format-U record from a Version 3 tape will result in entering the label validation installation exit.

ISO/ANSI Version 1 (ISO 1001-1969 and ANSI X3.27-1969) tapes containing format-U records can be used for input only. These records are the same as the format-U records described above, except the control characters must be ISO/ANSI control characters, and block prefixes can be used.

Record Format—Device Type Considerations

Before executing your program, you must supply the operating system with the record format (RECFM) and device-dependent information in data class, a DCB macro instruction, a DD statement, or a data set label. The DCB subparameters for the DD statement differ slightly from those described here. A complete description of the DD statement keywords and a glossary of DCB subparameters are contained in *JCL Reference*.

The record format (RECFM) parameter of the DCB macro specifies the characteristics of the records in the data set as fixed-length (RECFM=F), variable-length (RECFM=V or D), variable-spanned (RECFM=DS or -VS), or undefined-length (RECFM=U). All record formats except U can be blocked. Fixed-length blocked records (RECFM=FB) can be specified as standard (RECFM=FBS), meaning that there are no truncated (short) blocks or unfilled tracks within the data set, with the possible exception of the last block or track. Data sets with a fixed-length, standard format are described under "Fixed-Length Records, Standard Format" on page 14.

As an optional feature, a control character can be contained in each record. This control character will be recognized and processed if the data set is printed or punched. The control characters are transmitted on both tapes and direct access volumes. The presence of a control character is indicated by M or A in the RECFM field of the data control block. M denotes machine code; A denotes American National Standards Institute (ANSI) code. If either M or A is specified, the character must be present in every record; the printer space (PRTSP) or stacker select (STACK) field of the DCB is ignored. The optional control character must be in the first byte of format-F and format-U records and in the fifth byte of format-V records and format-D records where BUFOFF=L. Control character codes are listed in Appendix B, "Control Characters" on page 135. The device-dependent (DEVD) parameter of the DCB macro specifies the type of device where the data set's volume resides:

• TA	magnetic tape
• PR	printer
• PC	card punch
• RD	card reader
• DA	direct access device or Mass Storage System (MSS) virtual volumes

Note: Because the DEVD option is required only for the DCB macro expansion, you are guaranteed the maximum device flexibility by letting it default to DEVD=DA.

Magnetic Tape

Format-F, -V, -D, and -U records are acceptable for magnetic tape. Format-V records are not acceptable on 7-track tape if the data conversion feature is not available. ASCII records are not acceptable on 7-track tape.

When you create a tape data set with variable-length record format-V or -D, the control program pads any data block shorter than 18 bytes. For format-V records, it pads to the right with binary zeros so that the data block length equals 18 bytes. For format-D (ASCII) records, the padding consists of ASCII circumflex characters, which are equivalent to X'5E's.

Note that there is no minimum requirement for block size. However, in nonreturn-to-zero-inverted mode, if a data check occurs on a magnetic tape device, any record shorter than 12 bytes in a read operation will be treated as a noise record and lost. No check for noise will be made unless a data check occurs.

Figure 11 shows how the tape density (DEN) specifies the recording density in bits per inch per track. When DEN is not specified, the highest density capable by the unit will be used.

Recording Density

DEN	7-Track Tape	9-Track Tape	18-Track Tape
1	556 (NRZI)	N/A	N/A
2	800 (NRZI)	800 (NRZI)[1]	N/A
3	N/A	1600 (PE)[2]	N/A
4	N/A	6250 (GCR)[3]	N/A

Notes:

[1] NRZI is for nonreturn-to-zero-inverted mode.

[2] PE is for phase encoded mode.

[3] GCR is for group coded recording mode.

Figure 11. Tape Density (DEN) Values

The track recording technique (TRTCH) for 7-track tape can be specified as:

C

Data conversion is to be used. Data conversion makes it possible to write 8 binary bits of data on 7 tracks. Otherwise, only 6 bits of an 8-bit byte are recorded. The length field of format-V records contains binary data and is not recorded correctly without data conversion.

E

Even parity is to be used; if E is omitted, odd parity is assumed.

T

BCDIC to EBCDIC translation is required.

Paper Tape Reader

The paper tape reader accepts format-F and format-U records. If you use QSAM, you should not specify the records as blocked. Each format-U record is followed by an end-of-record character. Data read from paper tape may optionally be converted into the system's internal representation of one of six standard paper tape codes. Any character found to have a parity error will not be converted when the record is transferred into the input area. Characters deleted in the conversion process are not counted in determining the block size.

The following symbols show the code in which the data was punched. If this information is omitted, I is assumed.

I	IBM BCD perforated tape and transmission code (8 tracks)
F	Friden (8 tracks)
B	Burroughs (7 tracks)
C	National Cash Register (8 tracks)
A	ASCII (8 tracks)
T	Teletype[1] (5 tracks)
N	No conversion

Note that when you are using QSAM, the processing mode must be move mode.

Card Reader and Punch

Format-F and -U records are acceptable to both the reader and the punch; format-V records are acceptable to the punch only. The device control character, if specified in the RECFM parameter, is used to select the stacker; it is not punched. The first 4 bytes (record descriptor word or segment descriptor word) of format-V records or record segments are not punched. For format-V records, at least 1 byte of data must follow the record or segment descriptor word or the carriage control character.

[1] Trademark of the Teletype Corporation

Each punched card corresponds to one physical record. Therefore, you should restrict the maximum record size to 80 (EBCDIC mode) or 160 (column binary mode) data bytes. When mode (C) is used for the card punch, BLKSIZE must be 160 unless you are using PUT. Then you can specify BLKSIZE as 160 or a multiple of 160, and the system handles this as described under "PUT—Write a Record" on page 63. You can specify the read/punch mode of operation (MODE) parameter as either card image (column binary) mode (C) or EBCDIC mode (E). If this information is omitted, E is assumed. The stacker selection parameter (STACK) can be specified as either 1 or 2 to show which bin is to receive the card. If it is not specified, 1 is assumed.

For all QSAM, RECFM=FB, card punch data sets, the block size in the DCB will be adjusted by the system to equal the logical record length. This data set will be treated as RECFM=F. If the system builds the buffers for this data set, the buffer length will be determined by the BUFL parameter. If the BUFL parameter was not specified, the adjusted block size is used for the buffer length.

If the DCB is to be reused with a block size larger than the logical record length, you must reset DCBBLKSI in the DCB and ensure that the buffers are large enough to contain the largest block size expected. You may ensure the buffer size by specifying the BUFL parameter before the first time the data set is opened or by issuing the FREEPOOL macro after each CLOSE macro so the system will build a new buffer pool of the correct size each time the data set is opened.

Punch error correction on the IBM 2540 Card Read Punch is not performed.

The IBM 3525 Card Punch accepts only format-F records for print data sets and for associated data sets. Other record formats are allowed for the read data set, the punch data set, and the interpret punch data set. For more information on programming for the 3525 Card Punch, see *Programming Support for the IBM 3505 Card Reader and the IBM 3525 Card Punch*.

Printer

With the IBM 3800 Printing Subsystem, the data in the record can contain two optional bytes—the optional control character used for carriage control, followed by an optional table reference character used for dynamically selecting a character arrangement table during printing. These characters are discussed below.

Carriage Control Character

You may specify in the DD statement, the DCB macro, or the data set label that an optional control character is part of each record in the data set. The 1-byte character is used to show a carriage control function when the data set is printed or a stacker bin when the data set is punched. Although the character is a part of the record in storage, it is never printed or punched. Note that buffer areas must be large enough to accommodate the character. If the immediate destination of the record is a device, such as a disk, that does not recognize the control character, the system assumes that the control character is the first byte of the data portion of the record. If the destination of the record is a printer or punch and you have not indicated the presence of a control character, the system regards the control character as the first byte of data. A list of the control characters is in Appendix B, "Control Characters" on page 135.

3800 Table Reference Character

The 3800 table reference character is a numeric character (0, 1, 2, or 3) corresponding to the order in which the character arrangement table names have been specified with the CHARS keyword. It is used for selection of a character arrangement table during printing. For more information on the table reference character, see *IBM 3800 Printing Subsystem Programmer's Guide.*

A numeric table reference character (such as 0) selects from within the table that font to which the character corresponds. The characters' number values represent the order in which the font names have been specified with the CHARS parameter. In addition to using table reference characters to correspond to font names specified on the CHARS parameter, you can also code table reference characters that correspond to font names specified in PAGEDEF control structure. Valid table reference characters vary and range between 0 and 126. Table reference characters with values greater than 126 default to a value of 0 (zero). For additional information, see *IBM 3800 Printing Subsystem Programmer's Guide.*

Record Formats

Records of format-F, -V, and -U are acceptable to the printer. The first 4 bytes (record descriptor word or segment descriptor word) of format-V records or record segments are not printed. For format-V records, at least 1 byte of data must follow the record or segment descriptor word or the carriage control character. The carriage control character, if specified in the RECFM parameter, is not printed. The system does not position the printer to channel 1 for the first record unless specified by a carriage control character.

Because each line of print corresponds to one record, the record length should not exceed the length of one line on the printer. For variable-length spanned records, each line corresponds to one record segment, and block size should not exceed the length of one line on the printer.

If carriage control characters are not specified, you can show printer spacing (PRTSP) as 0, 1, 2, or 3. If it is not specified, 1 is assumed.

For all QSAM, RECFM=FB, printer data sets, the block size in the DCB will be adjusted by the system to equal the logical record length. This data set will be treated as RECFM=F. If the system builds the buffers for this data set, the buffer length will be determined by the BUFL parameter. If the BUFL parameter was not specified, the adjusted block size is used for the buffer length.

If the DCB is to be reused with a block size larger than the logical record length, you must reset DCBBLKSI in the DCB and ensure that the buffers are large enough to contain the largest block size expected. You may ensure the buffer size by specifying the BUFL parameter before the first time the data set is opened or by issuing the FREEPOOL macro after each CLOSE macro so the system will build a new buffer pool of the correct size each time the data set is opened.

Direct Access Device

Direct access devices accept records of format-F, -V, or -U. If the records are to be read or written with keys, the key length (KEYLEN) must be specified. In addition, the operating system has a standard track format for all direct access volumes. Each track contains data information and certain control information such as:

- The address of the track
- The address of each record
- The length of each record
- Gaps between areas.

A complete description of track format is contained in "Direct Access Volumes" on page 7.

Chapter 4. Selecting an Access Method

The operating system allows you to concentrate most of your efforts on processing the records read or written by the data management routines. To get the records read and written, your main responsibility is to describe the data set to be processed, the buffering techniques to be used, and the access method. An access method has been defined as the combination of data set organization and the technique (queued or basic) used to gain access to the data.

Overview of Access Methods

Access methods are identified primarily by the data set organization to which they apply. For instance, BDAM is the basic access method for direct organization. However, there are times when an access method identified with one organization can be used to process a data set usually thought of as organized in a different manner. Thus, a data set created by the basic access method for sequential organization (BSAM) may be processed by the basic direct access method (BDAM) and vice versa. If the queued access method is used to process a sequential data set, the access method is called the queued sequential access method (QSAM).

Basic access methods are used for all data organizations, while queued access methods apply only to sequential and indexed sequential data sets as shown in Figure 12.

Note: Use of BDAM is not recommended; we recommend you VSAM key-sequenced data sets instead. Use of BISAM and QISAM is not recommended; we recommend you use VSAM instead.

Data Set	**Access Method**	
Organization	**Basic**	**Queued**
Direct	BDAM	
Indexed Sequential	BISAM	QISAM
Partitioned	BPAM, BSAM	QSAM
Sequential	BSAM	QSAM

Figure 12. Data Management Access Methods

It is possible to control an I/O device directly while processing a data set with any data organization without using a specific access method. The execute channel program (EXCP) macro instruction uses the system programs that provide for scheduling and queuing I/O requests, efficient use of channels and devices, data protection, interruption procedures, error recognition, and retry. Complete details about the EXCP macro are in *System—Data Administration*. Use of the EXCP macro instruction is not recommended.

Using VIO with Temporary Data Sets

Temporary data sets can be handled by a function called virtual I/O (VIO). Data sets for which VIO is specified are located in external page storage. However, to the access methods (BDAM, BPAM, BSAM, QSAM, and EXCP), the data sets appear to reside on a real direct access storage device. VIO provides these advantages:

- Elimination of some of the usual I/O device allocation and data management overhead for temporary DASD data sets
- Generally more efficient use of direct access storage space.

Before anyone can use VIO, the system programmer must specify VIO=YES in the UNITNAME statement when running the MVS configuration program (MVSCP). Your system programmer will specify the appropriate unitname or storage class you need to use to define a VIO data set. You must specify the appropriate unitname in the DD statement for your VIO data set. The UNIT= parameter on the DD statement for your data set must specify a device group or device type that is eligible for VIO. For SMS-managed temporary data sets, you can use VIO by specifying a storage class, which maps to a VIO-eligible storage group, in your DD statement. For information on storage classes, see your storage administrator. For information on specifying a unitname or a storage class in a DD statement, see *JCL User's Guide* and *JCL Reference*. *MVS Configuration Program Guide and Reference* explains how to use the MVS configuration program.

Basic Direct Access Method (BDAM)

Before you use BDAM to process a data set, consider these implications:

- You create a BDAM data set with the basic sequential access method (BSAM). A BDAM data set is also called a *direct data set*. A special operand in the BSAM DCB macro **(MACRF=WL)** shows that you want to create a BDAM data set.
- The problem program must synchronize all I/O operations with a CHECK or a WAIT macro.
- The problem program must block and unblock its own input and output records. (BDAM only reads and writes data blocks.)
- You can find data blocks within a data set with one of the following addressing techniques:
  - Actual device addresses.
  - Relative track address technique. This locates a track on a direct access device relative to the beginning of the data set.
  - Relative block address technique. This locates a fixed-length data block relative to the beginning of the data set.

For more information about coding the DCB macro to process a BDAM data set, see *Data Administration: Macro Instruction Reference*.

Note: Use of BDAM is not recommended.

Basic Indexed Sequential Access Method (BISAM)

Before you use BISAM to process an ISAM data set, consider these implications:

- Indexed sequential data sets cannot be managed by SMS.
- BISAM accesses only ISAM data sets.
- BISAM cannot be used to create an indexed sequential access method (ISAM) data set.
- BISAM directly retrieves logical records by key, updates blocks of records in-place, and inserts new records in their correct key sequence.
- The problem program must synchronize all I/O operations with a CHECK or a WAIT macro.
- Other **DCB** operands are available to reduce input/output operations by defining work areas that contain the highest level master index and the records being processed.

For more information about coding the DCB macro to process a BISAM data set, see *Data Administration: Macro Instruction Reference*.

Note: Use of BISAM is not recommended.

Basic Partitioned Access Method (BPAM)

BPAM processes the directory of a partitioned data set. BSAM processes the data set members.

Before you use BPAM to process a data set, consider these implications:

- One complete partitioned data set must be on one direct-access volume, but you can concatenate multiple input data sets that are on the same or different volumes.
- When you create a partitioned data set, the **SPACE** parameter defines the size of the data set and its directory so that the system can allocate data set space, and for a partitioned data set, preformat the directory.
- You can use either the basic sequential access method (BSAM) or the queued sequential access method (QSAM) to add or retrieve a partitioned data set member without specifying the BLDL, FIND, or the STOW macro by coding the **DSORG=PS** operand in the DCB macro. (Data set positioning and directory maintenance are then handled by the OPEN and CLOSE macros.) But, be advised that you are really processing the member as if it were part of a sequential data set, so you are not using the complete capabilities of BPAM.
- You can use the STOW macro to add, delete, change, or replace an element name or alias in the directory.
- You can process multiple data set members by passing a list of members to BLDL. Then you can use the FIND macro to position to a member before processing it.

For more information about coding the DCB macro to process a BPAM data set (partitioned data set), see *Data Administration: Macro Instruction Reference*.

Basic Sequential Access Method (BSAM)

Before you use BSAM to process a data set, consider these implications:

- The problem program must block and unblock its own input and output records. (BSAM only reads and writes data blocks.)
- The problem program must manage its own input and output buffers. It must give BSAM a buffer address with the READ macro, and it must fill its own output buffer before issuing the WRITE macro.
- The problem program must synchronize its own I/O operations by issuing a CHECK macro for each READ and WRITE macro issued.
- BSAM lets you process nonsequential blocks by repositioning with the NOTE and POINT macros.
- You can read and write direct access device record keys with BSAM.

For more information about coding the DCB macro to process a BSAM data set, see *Data Administration: Macro Instruction Reference.*

Queued Indexed Sequential Access Method (QISAM)

Before you use QISAM to process an ISAM data set, consider these implications:

- Indexed sequential data sets cannot be managed by SMS.
- The characteristics of a QISAM data set are established when the data set is created. You can't change them without reorganizing the data set. The DCB operands that establish these characteristics are: **BLKSIZE, CYLOFL, KEYLEN, LRECL, NTM, OPTCD, RECFM,** and **RKP**.
- A QISAM data set can consist of unblocked fixed-length records (**F**), blocked fixed-length records (**FB**), unblocked variable-length records (**V**), or blocked variable-length records (**VB**).
- QISAM can create an indexed sequential data set (QISAM, load mode), add additional data records at the end of the existing data set (QISAM, resume load mode), update a record in place, or retrieve records sequentially (QISAM, scan mode).
- You can't use track overflow to create or extend an ISAM data set.
- When you create an indexed sequential data set, you can allocate space for the data set's prime area, overflow area, and its cylinder/master index(es) on the same or separate volumes. For more information about space allocation, see *JCL User's Guide.*
- QISAM automatically generates a track index for each cylinder in the data set and one cylinder index for the entire data set. Specify the DCB operands **NTM** and **OPTCD** to show that the data set requires a master index(es). QISAM creates and maintains as many as three levels of master indexes.
- You can purge records by specifying the **OPTCD=L** DCB option when you create an ISAM data set. This option flags the records you want to purge with a X'FF' in the first data byte of a fixed-length record or the fifth byte of a variable-length record. QISAM ignores these flagged records during sequential retrieval.

- You can get reorganization statistics by specifying the **OPTCD=R** DCB option when an ISAM data set is created. The problem program uses these statistics to determine the status of the data set's overflow areas.
- When you create an ISAM data set, you must write the records in ascending key order.

For more information about coding the DCB macro to process a QISAM data set, see *Data Administration: Macro Instruction Reference*.

Note: Use of QISAM is not recommended.

Queued Sequential Access Method (QSAM)

Before you use QSAM to process a data set, consider these implications:

- You can use QSAM to process all record formats except blocks with keys.
- QSAM blocks and unblocks records for you automatically.
- QSAM manages all aspects of I/O buffering for you automatically. The GET macro retrieves the next sequential logical record from the input buffer, and the PUT macro places the next sequential logical record in the output buffer.
- QSAM gives you three transmittal modes: move, locate, and data. These modes give you greater flexibility managing buffers and moving data.

For more information about coding the DCB macro to process a QSAM data set, see *Data Administration: Macro Instruction Reference*.

Chapter 5. Specifying a Data Control Block and Initializing Data Sets

General-Use Programming Interface

This chapter is intended to help you specify a data control block for a data set. It contains general-use programming interfaces, which are provided to allow you to write programs that use the services of MVS/DFP.

Before processing can begin, you must identify the characteristics of a data set, the volume on which it resides, and its processing requirements. During execution, this information is made available to the operating system in the data control block (DCB). A DCB is required for each data set and is created in a processing program by a DCB macro instruction.

Primary sources of information to be placed in the data control block are a DCB macro instruction, a data definition (DD) statement, a data class, and a data set label. A data class can be used to specify all of your data set's attributes except data set name and disposition. In addition, you can provide or change some of the information during execution by storing the pertinent data in the appropriate field of the data control block. The specifications needed for input/output operations are supplied during the initialization procedures of the OPEN macro instruction. Therefore, the pertinent data can be provided when your job is to be executed rather than when you write your program (see Figure 13 on page 40).

When the OPEN macro instruction is executed, the OPEN routine:

- Completes the data control block
- Loads all necessary access method routines not already in virtual storage
- Initializes data sets by reading or writing labels and control information
- Builds the necessary system control blocks.

Information from a DD statement is stored in the job file control block (JFCB) by the operating system. When the job is to be executed, the JFCB is made available to the open routine. The data control block is filled in with information from the DCB macro instruction, the JFCB, or an existing data set label. If more than one source specifies information for a particular field, only one source is used. A DD statement takes precedence over a data set label, and a DCB macro instruction over both. However, you can change most data control block fields either before the data set is opened or when the operating system returns control to your program (at the data control block open exit). Some fields can be changed during processing. Do not try to change a data control block field, such as data set organization, from one that allowed the data set to be allocated to an SMS-managed volume, to one that makes the data set ineligible to be SMS managed. For example, do not specify a data set organization in the DD statement as physical sequential and after the data set has been allocated to an SMS-managed volume, try to open the data set with a data control block that specifies the data set as physical sequential unmovable. The types of data sets that cannot be SMS managed are listed on page 2.

Figure 13 on page 40 illustrates the process and the sequence of filling in the data control block from various sources. The primary source is your program, that is, the DCB macro instruction. Usually, you should use only those DCB parameters that are needed to ensure correct processing. The other parameters can be filled in when your program is to be executed.

When a direct access data set is opened (or a magnetic tape with standard labels is opened for INPUT, RDBACK, or INOUT), any field in the JFCB not completed by a DD statement is filled in from the data set label (if one exists). When opening a magnetic tape for output, the tape label is assumed not to exist or to apply to the current data set unless you specify DISP=MOD and a volume serial number in the volume parameter of the DD statement. Any field not completed in the DCB is filled in from the JFCB. Fields in the DCB can then be completed or changed by your own DCB exit routine. Then all DCB fields are unconditionally merged into corresponding JFCB fields if your data set is opened for output. This is done by specifying OUTPUT, OUTIN, EXTEND, or OUTINX in the OPEN macro instruction. The DSORG field is not merged unless this field contains zeros in the JFCB. If your data set is opened for input (INPUT, INOUT, RDBACK, or UPDAT is specified in the OPEN macro instruction), the DCB fields are not merged unless the corresponding JFCB fields contain zeros.

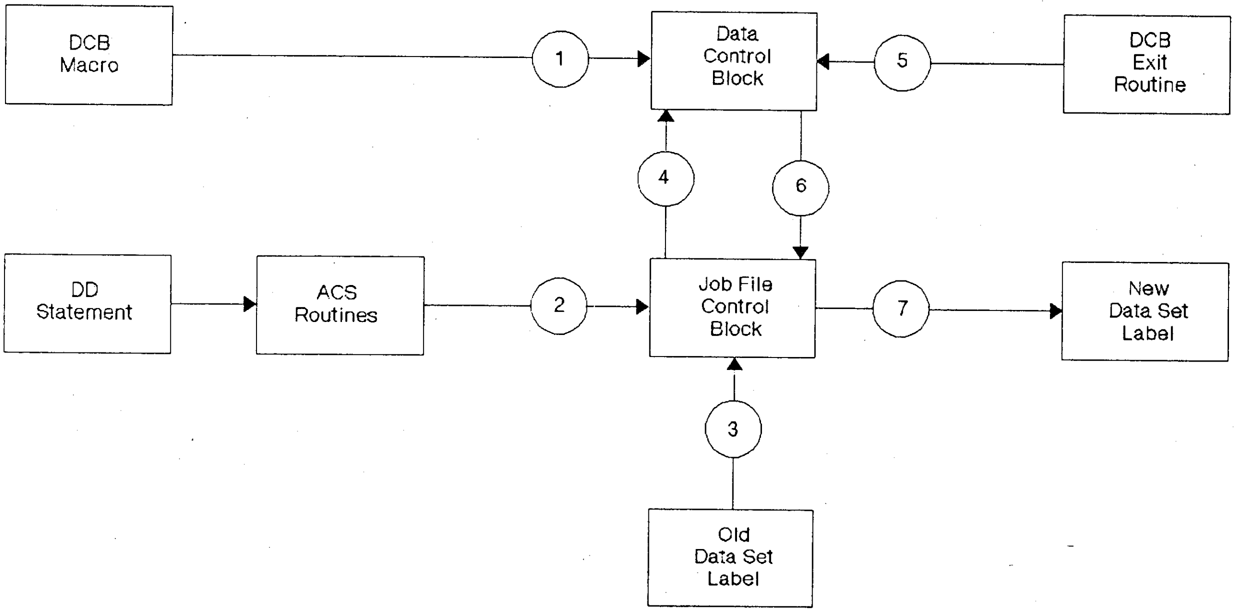


Figure 13. Sources and Sequence of Operations for Completing the Data Control Block

When the data set is closed, the data control block is restored to the condition it had before the data set was opened (the buffer pool is not freed). The open and close routines also use the updated JFCB to write the data set labels for output data sets. If the data set is not closed when your program terminates, the operating system will close it automatically.

The operating system requires several types of processing information to ensure proper control of your input/output operations. The forms of macros in the program, buffering requirements, and the addresses of your special processing routines must be specified during either the assembly or the execution of your program. The DCB parameters specifying buffer requirements are discussed in "Managing SAM Buffer Space" on page 85.

Because macros are expanded during the assembly of your program, you must supply the macro forms that are to be used in processing each data set in the associated DCB macro. You can supply buffering requirements and related information in the DCB macro, the DD statement, or by storing the pertinent data in the appropriate field of the data control block before the end of your DCB exit routine. If the addresses of special processing routines (EODAD, SYNAD, or user exits) are omitted from the DCB macro, you must complete them in the DCB before they are required.

Note: A data set label to JFCB merge is not performed for concatenated data sets at the end-of-volume time. If you want a merge, turn on the unlike attribute bit (DCBOFPPC) in the DCB. This attribute forces the system through OPEN for each data set in the concatenation, where a label to JFCB merge takes place.

Selecting Data Set Options

For each data set you want to process, there must be a corresponding DCB and DD statement. The characteristics of the data set and device-dependent information can be supplied by either source. Also, the DD statement must supply data set identification, device characteristics, space allocation requests, and related information as specified in *JCL User's Guide* and *JCL Reference*. You establish the logical connection between a DCB and a DD statement by specifying the name of the DD statement in the DDNAME field of the DCB macro, or by completing the field yourself before opening the data set.

DCB Parameters

After you have specified the data set characteristics in the DCB macro, you can change them only by changing the DCB during execution. The fields of the DCB discussed below are common to most data organizations and access methods. (For more information about the DCB fields, see *Data Administration: Macro Instruction Reference*.)

Block Size (BLKSIZE): Specifies the maximum length, in bytes, of a data block. If the records are of format F, the block size must be an integral multiple of the record length, except for SYSOUT data sets. (See Chapter 7, "Spooling and Scheduling Data Sets" on page 71.) If the records are of format V, the block size specified must be the maximum block size. If format-V records are unblocked, the block size must be 4 bytes greater than the record length (LRECL). When spanned variable-length records are specified, the block size is independent of the record length. For ISO/ANSI/FIPS Version 3 records, the maximum block size is 2048.

If you do not specify a block size, or specify a zero block size when you allocate the DASD data set, the system will derive an optimum block size for you. You must specify the LRECL, DSORG as PS or PO, and RECFM. The system does not derive a block size for VIO, VSAM, or unmovable data sets, or when the RECFM is U.

When the data set is opened, OPEN will re-derive a block size, subject to the same exceptions, if:

- A zero block size is specified or set by the open exit.

- The system determined the block size at allocation, and the LRECL or RECFM specified via the DCB at open differ from those specified at allocation time.

If you specify a block size other than zero, note that there is no minimum requirement for block size. However, if a data check occurs on a magnetic tape device, any block shorter than 12 bytes in a read operation or 18 bytes in a write operation is treated as a noise record and lost. No check for noise is made unless a data check occurs. The maximum block size for an ISO/ANSI/FIPS Version 3 tape is 2048 bytes. This limit may be overridden by a label validation installation exit. (See *DFP: Customization.*)

Data Set Organization (DSORG): Specifies the organization of the data set as physical sequential (PS), indexed sequential (IS), partitioned (PO), or direct (DA). If the data set is processed using absolute rather than relative addresses, you must mark it as unmovable by adding a U to the DSORG parameter (for example, by coding DSORG=PSU). You must specify the data set organization in the DCB macro. When creating or processing an indexed sequential organization data set or creating a direct data set, you must also specify DSORG in the DD statement. When creating a direct data set, the DSORG in the DCB macro must specify PS or PSU and the DD statement must specify DA or DAU.

Note:

1. Unmovable and indexed sequential data sets cannot be SMS-managed.

Key Length (KEYLEN): Specifies the length (0 to 255) in bytes of an optional key that precedes each block on a direct access device. The value of KEYLEN is not included in BLKSIZE or LRECL but must be included in BUFL if buffer length is specified. Thus, BUFL=KEYLEN+BLKSIZE.

Record Length (LRECL): Specifies the length, in bytes, of each record in the data set. If the records are of variable length, the maximum record length must be specified. For input, the field should be omitted for undefined length (format-U) records. For the extended logical record interface for ISO/ANSI/FIPS variable spanned records, LRECL must be specified as LRECL=0K or LRECL=nK.

Record Format (RECFM): Specifies the characteristics of the records in the data set as fixed-length (F), variable-length (V), ISCII/ASCII variable-length (D), or undefined-length (U). Blocked records are specified as FB, VB, or DB. Spanned records are specified as VS, VBS, DS, or DBS. (ISCII/ASCII records are specified as DS or DBS.) You may also specify the records as fixed-length standard by using FS or FBS. You can request track overflow for records other than standard format by adding a T to the RECFM parameter (for example, by coding FBT).

The type of print control can be specified to be in ANSI format-A or in machine code format-M, as described in Appendix B, "Control Characters" on page 135.

Write Validity Check Option (OPTCD=W): You can specify the write validity check option in either the DCB parameter of the DD statement or the DCB macro. After a record is transferred from main to secondary storage, the system reads the stored record (without data transfer) and, by testing for a data check from the I/O device, verifies that the record was written correctly. Be aware that the write validity check process requires an additional revolution of the device for each record. If the system detects any errors, it starts its standard error recovery procedure.

For buffered tape devices, the write validity check option delays the device end interrupt until the data is physically on tape. When you use the write-validity-check option, you get none of the performance benefits of buffering.

DD Statement Parameters

Each of the data set description fields of the data control block, except as noted for data set organization for direct data sets, can be specified when your job is to be executed. Also, data set identification and disposition, and device characteristics, can be specified at that time. To allocate a data set, you must specify the data set name and disposition in the DD statement. In the DD statement, you may specify a data class, storage class, and management class, and other JCL keywords. You can specify the classes using the JCL keywords DATACLAS, STORCLAS, and MGMTCLAS. If you do not specify a data class, storage class, or management class, the ACS routines assign classes based on the defaults defined by your storage administrator. Storage class and management class can be assigned only to data sets that are to be managed by SMS.

Your storage administrator uses the ACS routines to determine which data sets are to be managed by SMS. The valid classes that can either be specified in your DD statement or assigned by the ACS routines are defined in the SMS configuration by your storage administrator. The ACS routines analyze your JCL, and if you specify a class which you are not authorized to use or a class which does not exist, your allocation fails. For more information on how to specify data class, storage class, and management class in your DD statement, see *JCL User's Guide*.

Data class can be specified for both SMS and non-SMS data sets. Data class can be specified for both DASD and tape data sets. You can use data class together with the JCL keyword LIKE for tape data sets; this will simplify migration to and from SMS-managed storage. When you allocate a data set, the ACS routines assign a data class to the data set, either the data class you specify in your DD statement or the data class defined as the default by your storage administrator. The data set is allocated using the information contained in the assigned data class. See your storage administrator for information on the data classes available to your installation and *Storage Administration Reference* for more information on allocating SMS data sets and using SMS classes.

You can override any of the information contained in a data class by specifying the values you want in your DD statement. A data class can contain any of the following information:

Data Set Characteristics	JCL Keywords Used To Override
data set organization	DSORG
key length	KEYLEN
key offset	KEYOFF
record format	RECFM
record length	LRECL
record organization	RECORG
retention period	RETPD
space allocation	SPACE, AVGREC

For more information on the JCL keywords that override data class information, see *JCL User's Guide* and *JCL Reference*.

The simplest data set allocation is one that uses the data class, storage class, and management class defaults defined by your storage administrator. This example shows how to allocate an SMS-managed data set:

```
//name DD DSNAME=NEW.PLI,DISP=(NEW,KEEP)
```

Changing the DCB

You can complete or change the DCB during execution of your program. You can also determine data set characteristics from information supplied by the data set labels. You can make changes or additions before you open a data set, after you close it, during the DCB open exit routine, or while the data set is open. Naturally, you must supply the information before it is needed.

You should not attempt to change the data set characteristics of an SMS-managed data set to characteristics which make it ineligible to be SMS managed. For example, do not specify a data set organization in the DD statement as PS and after the data set has been allocated to an SMS-managed volume, change the DCB to specify DSORG=PSU. This results in abnormal termination of your program.

Use the data control block DSECT (DCBD) macro to identify the DCB field names symbolically. If you load a base register with the DCB address, you can refer to any field symbolically.

The DCBD macro generates a dummy control section (DSECT) named IHADCB. Each field name symbol consists of DCB followed by the first 5 letters of the keyword operand for the DCB macro. For example, the symbolic name of the block size operand field is DCBBLKSI. (For other DCB field names, see *Data Administration: Macro Instruction Reference*.)

The attributes of each DCB field are defined in the dummy control section. Use the DCB macro's assembly listing to determine the length attribute and the alignment of each DCB field.

You can code the DCBD macro once to describe all DCBs.

Changing an Address in the Data Control Block: Figure 14 on page 45 shows you how to change a field in the data control block.

```
         ....
            OPEN     (TEXTDCB,INOUT),MODE=31
            ...
EOFEXIT     CLOSE    (TEXTDCB,REREAD),MODE=31,TYPE=T
            LA       10,TEXTDCB
            USING    IHADCB,10
            MVC      DCBSYNAD+1(3),=AL3(OUTERROR)
            B        OUTPUT
INERROR     STM      14,12,SYNADSA+12
            ...
OUTERROR    STM      14,12,SYNADSA+12
            ...
TEXTDCB     DCB      DSORG=PS,MACRF=(R,W),DDNAME=TEXTTAPE,     C
                       EODAD=EOFEXIT,SYNAD=INERROR
            DCBD     DSORG=PS
            ...
```

Figure 14. Changing a Field in the Data Control Block

The data set defined by the data control block TEXTDCB is opened for both input and output. When the problem program no longer needs it for input, the EODAD routine closes the data set temporarily to reposition the volume for output. The EODAD routine then uses the dummy control section IHADCB to change the error exit address (SYNAD) from INERROR to OUTERROR.

The EODAD routine loads the address TEXTDCB into register 10, the base register for IHADCB. Then it moves the address OUTERROR into the DCBSYNAD field of the DCB. Even though DCBSYNAD is a fullword field and contains important information in the high-order byte, change only the 3 low-order bytes in the field.

All unused address fields in the DCB, except DCBEXLST, are set to 1 when the DCB macro is expanded. Many system routines interpret a value of 1 in an address field as meaning no address was specified, so use it to dynamically reset any field you don't need.

Opening and Closing a Data Set

Although your program has been assembled, the various data management routines required for I/O operations are not a part of the object code. In other words, your program is not completely assembled until the DCBs are initialized for execution. You initialize by issuing the OPEN macro instruction to open a data set. After all DCBs have been completed, the system ensures that all required access method routines are loaded and ready for use and that all channel programs and buffer areas are ready.

Access method routines are selected and loaded according to data control fields that indicate:

- Data organization
- Buffering technique
- Access method
- I/O unit characteristics
- Record format

This information is used by the system to allocate virtual storage space and load the appropriate routines. These routines, the channel programs and buffer areas created automatically by the system, remain in virtual storage until the close routine signals that they are no longer needed by the DCB that was using them.

When I/O operations for a data set are completed, you should issue a CLOSE macro instruction to return the DCB to its original status, handle volume disposition, create data set labels, complete writing of queued output buffers, and free virtual and auxiliary storage.

Letting the System Determine the Block Size for DASD Data Sets

The system can determine the optimum block size for DASD data sets. If you specify the LRECL and RECFM, but do not specify the block size when the data set is created, the system will derive the optimum block size for the data set and write the block size to the data set label. The system will derive an optimum block size for any physical sequential, or partitioned data set that has fixed or variable length records. When a DASD data set is opened, Open will re-derive the optimum block size if:

- The block size is zero, the data set is physical sequential or partitioned, and the record format and record length are available.
- The block size in the DASD data set label was assigned by the system when the data set was created, and the record length or format have changed from what was specified at the time the data set was created.

The system has similar support for determining block size for spooled data sets. See Chapter 7, "Spooling and Scheduling Data Sets" on page 71.

Open will not re-derive the optimum block size for VSAM or RECFM=U data sets. The system does not determine the block size for *old* data sets or BDAM data sets.

Using a Parameter List with 31-bit Addresses

You can code OPEN and CLOSE with **MODE=31** to specify a long form parameter list that can contain 31-bit addresses. To use this long form parameter list, you must be operating in 31-bit addressing mode. The default, **MODE=24**, specifies a standard form parameter list with 24-bit addresses. If **TYPE=J** is specified, you must use the standard form parameter list.

The standard form parameter list must reside below 16M, but the calling program may be above 16M.

The long form parameter list can reside above or below 16M. Although you may code **MODE=31** on the OPEN or CLOSE call for a DCB, the DCB must reside below 16M. All non-VSAM and non-VTAM ACBs must also reside below

16M. Therefore, the leading byte of the 4-byte ACB or DCB address must contain zeros. If the byte contains something other than zeros, an error message is issued. If an OPEN was attempted, the data set is not opened. If a CLOSE was attempted, the data set is not closed.

It is up to you to keep the mode specified in the **MF=L** and **MF=E** versions of the OPEN and CLOSE macros consistent. If **MODE=31** is specified in the **MF=L** version of the OPEN or CLOSE macro, **MODE=31** must also be coded in the corresponding **MF=E** version of the macro. Unpredictable results occur if the mode specified is not consistent.

Managing Buffer Pools When Closing Data Sets

After closing the data set, you should issue a FREEPOOL macro instruction to release the virtual storage used for the buffer pool. If you plan to process other data sets, use FREEPOOL to regain the buffer pool storage space. If you expect to reopen a data set using the same DCB, use FREEPOOL unless the buffer pool created the first time the data set was opened will meet your needs when you reopen the data set. (FREEPOOL is discussed in more detail in "Buffer Pool Construction" on page 85.)

After the data set has been closed, the DCB can be used for another data set. If you do not close the data set before a task terminates, the operating system closes it automatically. If the DCB is not available to the system at that time, the operating system abnormally ends the task, and data results can be unpredictable. Note, however, that the operating system cannot automatically close any open data sets after the normal end of a program that was brought into virtual storage by the loader. Therefore, loaded programs must include CLOSE macro instructions for all open data sets.

Simultaneous Opening and Closing of Multiple Data Sets

An OPEN or CLOSE macro instruction can be used to begin or end processing of more than one data set. Simultaneous opening or closing is faster than issuing separate macro instructions; however, additional storage space is required for each data set specified. The coding examples in Figure 15 on page 51 and Figure 17 on page 53 show the macro expansions for simultaneous open and close operations.

Opening and Closing Data Sets Shared by More Than One Task

When more than one task is sharing a data set, the following restrictions must be recognized. Failure to adhere to these restrictions endangers the integrity of the shared data set.

- All tasks sharing a DCB must be in the job step that opened the DCB (see "Sharing Data Sets" on page 66).
- Any task that shares a DCB and starts any input or output operations using that DCB must ensure that all those operations are complete before terminating the task. A CLOSE macro instruction issued for the DCB will ensure termination of all input and output operations.
- A DCB can be closed only by the task that opened it.

Opening a VSAM Data Set With a DCB

You can use a DCB to open a VSAM data set if the DCB is for EXCP processing and the data set is being opened for input or update. Open for output is not allowed. The following restrictions apply:

- Your program must be APF authorized or in supervisor state if the data set is being opened for update.
- You must have the password or the RACF authorization needed to access the VSAM data set.
- You can only specify a single volume.
- The data set disposition must either be DISP=(OLD,KEEP,KEEP) or DISP=(SHR,KEEP,KEEP).
- The VSAM data set must not be concatenated to any other data sets.

For more information on using EXCP and a DCB to open a VSAM data set, see *System—Data Administration.*

Considerations for Allocating Direct Access Data Sets

When you allocate space for a new data set on a direct access volume, the tracks contain unknown data. A program that tries to access data on these tracks before known data is written on them may get unpredictable results, such as program checks or I/O errors. The program may even appear to run correctly!

If you must access a newly allocated data set before you put known data into it, use one of the following methods to make it appear empty:

1. At allocation time, specify a primary allocation value of zero; such as SPACE=(TRK,(0,10)) or SPACE=(CYL,(0,50)). This method prevents processing certain labels if user labels are requested (LABEL=(,SUL)).
2. After allocation time, run a program that opens the data set for output and closes it without writing anything. This puts an end-of-file mark at the beginning of the data set.

Considerations for Opening and Closing Data Sets

- Two or more DCBs should never be concurrently open for output to the same data set, except with the basic indexed sequential access method (BISAM).
- If, concurrently, one DCB is open for input or update, and one for output to the same data set on a direct access device, the input or update DCB may be unable to read what the output DCB wrote if the output DCB extended the data set.
- If you want to use the same DD statement for two or more DCBs, you cannot specify parameters for fields in the first DCB and then be assured of obtaining the default parameters for the same fields in any other DCB using the same DD statement. This is true for both input and output and is especially important when you are using more than one access method. Any action on one DCB that alters the JFCB affects the other DCBs and thus can cause unpredictable results. Therefore, unless the parameters of all DCBs using one DD statement are the same, you should use separate DD statements.

- Associated data sets for the IBM 3525 Card Punch can be opened in any order, but all data sets must be opened before any processing can begin. Associated data sets can be closed in any order, but, after a data set has been closed, I/O operations cannot be performed on any of the associated data sets. See *Programming Support for the IBM 3505 Card Reader and the IBM 3525 Card Punch* for more information.

- The OPEN macro gets user control blocks and user storage in the protection key in which the OPEN macro is issued. Therefore, any task that processes the DCB (such as Open, Close, or EOV) must be in the same protection key.

- Volume disposition specified in the OPEN or CLOSE macro instruction can be overridden by the system if necessary. However, you need not be concerned; the system automatically requests the mounting and demounting of volumes, depending on the availability of devices at a particular time. Additional information on volume disposition is provided in *JCL User's Guide*.

Open/Close/EOV Errors

There are two classes of errors that can occur during open, close, and end-of-volume processing: determinate and indeterminate errors. Determinate errors are errors associated with a system completion code. For example, a condition associated with the 213 completion code with a return code of 04 might be detected during open processing, indicating that the data set label could not be found for a data set being opened. Indeterminate errors are errors that cannot be anticipated, such as program checks.

If a determinate error occurs during the processing resulting from a concurrent OPEN or CLOSE macro instruction, an attempt will be made to complete open or close processing of the DCBs that are not associated with the DCB in error. Note that you can also immediately end the task abnormally by coding a DCB ABEND exit routine that shows the "immediate termination" option. For more information on the DCB ABEND exit, see *DFP: Customization*. When all open or close processing is completed, abnormal end processing is begun. Abnormal end involves forcing all DCBs associated with a given OPEN or CLOSE macro to close status, thereby freeing all storage devices and other system resources related to the DCBs.

If an indeterminate error (such as a program check) occurs during open, close, or EOV processing, no attempt is made by the system control program to complete concurrent open or close processing. The DCBs associated with the OPEN or CLOSE macro are forced to close status if possible, and the resources related to each DCB are freed.

To determine the status of any DCB after an error, check the OPEN (CLOSE) return code in register 15. See *Data Administration: Macro Instruction Reference* for the OPEN and CLOSE return codes.

During task termination, the system issues a CLOSE macro for each data set that is still open. If this is an abnormal termination for QSAM, the close routines that would normally finish processing buffers are bypassed. Any outstanding I/O requests are purged. Thus, your last data records may be lost for a QSAM output data set.

It is a good procedure to close an ISAM data set before task termination because, if an I/O error is detected, the ISAM close routines cannot return the problem program registers to the SYNAD routine, causing unpredictable results.

Installation exits

Four installation exit routines are provided for abnormal end with ISO/ANSI/FIPS Version 3 tapes.

- The label validation exit is entered during open/EOV if an invalid label condition is detected and label validation has not been suppressed. Invalid conditions include incorrect alphameric fields, nonstandard values (for example, RECFM=U, block size greater than 2048, or a zero generation number), invalid label sequence, nonsymmetrical labels, invalid expiration date sequence, and duplicate data set names.
- The validation suppression exit is entered during open/EOV if volume security checking has been suppressed, if the volume label accessibility field contains an ISCII/ASCII space character, or if RACF accepts a volume and the accessibility field does not contain an uppercase A through Z.
- The volume access exit is entered during open/EOV if a volume is not RACF protected and the accessibility field in the volume label contains an ISCII/ASCII uppercase A through Z.
- The file access exit is entered after positioning to a requested data set if the accessibility field in the HDR1 label contains an ISCII/ASCII uppercase A through Z.

For additional information about ISO/ANSI/FIPS Version 3 installation exits, see *DFP: Customization.*

DCB Exits

For information on how to use the DCB exit routines, see *DFP: Customization.*

OPEN—Prepare a Data Set for Processing

The OPEN macro instruction is used to complete a data control block for an associated data set. The OPEN macro parameters identify the method of processing and volume positioning if an end-of-volume condition occurs.

Processing Method

You can process a data set as either input or output. This is done by coding INPUT, OUTPUT, or EXTEND as the processing method operand of the OPEN macro. For BSAM, code INOUT, OUTIN, or OUTINX. If the data set resides on a direct access volume, you can code UPDAT in the processing method operand to show that records can be updated. By coding RDBACK in this operand, you can specify that a magnetic tape volume containing format-F or format-U records is to be read backward. RDBACK is supported for magnetic tape only. (Variable-length records cannot be read backward.) If the processing method operand is omitted from the OPEN macro instruction, INPUT is assumed. The operand is ignored by the basic indexed sequential access method (BISAM); it must be specified as OUTPUT or EXTEND when you are using the queued indexed sequential access method (QISAM) to create an indexed sequential data set. You can override the INOUT, OUTIN, UPDAT, or OUTINX at execution time by using the LABEL parameter of the DD statement, as discussed in *JCL Reference.*

Note: Unless label validation has been suppressed, OPEN for MOD (OLD OUTPUT/OUTIN), INOUT, EXTEND, or OUTINX cannot be processed for ISO/ANSI/FIPS Version 3 tapes, because this kind of processing updates only the closing label of the file, causing a label symmetry conflict. An unmatching label should not frame the other end of the file.

Processing SYSIN and SYSOUT Data Sets: SYSIN and SYSOUT data sets must be opened for INPUT and OUTPUT, respectively. INOUT is treated as INPUT; OUTIN, EXTEND, or OUTINX is treated as OUTPUT. UPDAT and RDBACK cannot be used.

In Figure 15, the data sets associated with three DCBs are to be opened simultaneously.

```
         OPEN      (TEXTDCB,,CONVDCB,(OUTPUT),PRINTDCB,                  X
                   (OUTPUT))
```

Figure 15. Opening Three Data Sets Simultaneously

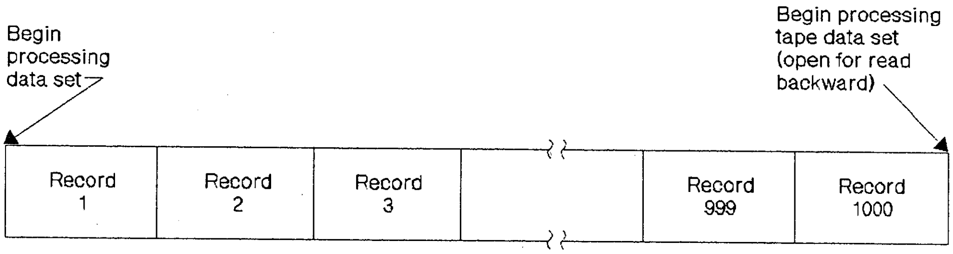
Because no processing method operand is specified for TEXTDCB, the system assumes INPUT. Both CONVDCB and PRINTDCB are opened for output. No volume positioning options are specified; thus, the disposition indicated by the DD statement DISP parameter is used.

CLOSE—Terminate Processing of a Data Set

The CLOSE macro instruction is used to terminate processing of a data set and release it from a DCB. The volume positioning (tapes only) that is to result from closing the data set can also be specified. Volume positioning options are the same as those that can be specified for end-of-volume conditions in the OPEN macro instruction or the DD statement. An additional volume positioning option, REWIND, is available and can be specified by the CLOSE macro instruction for magnetic tape volumes. REWIND positions the tape at the load point regardless of the direction of processing.

You can code CLOSE TYPE=T and perform some close functions for sequential data sets on magnetic tape and direct access volumes processed with BSAM. When you use TYPE=T, the DCB used to process the data set maintains its open status. You don't have to issue another OPEN macro instruction to continue processing the same data set. This option cannot be used in a SYNAD routine.

The TYPE=T operand causes the system control program to process labels, modify some of the fields in the system control blocks for that data set, and reposition the volume (or current volume for multivolume data sets) in much the same way that the normal CLOSE macro does. When you code TYPE=T, you can specify that the volume is either to be positioned at the end of data (the LEAVE option) or to be repositioned at the beginning of data (the REREAD option). Magnetic tape volumes are repositioned either immediately before the first data record or immediately after the last data record; the presence of tape labels has no effect on repositioning. Figure 16 on page 52, which assumes a sample data set containing 1000 records, illustrates the relationship between each positioning option and the point where you resume processing the data set after issuing the temporary close.


Begin processing data set
Begin processing tape data set (open for read backward)
Record 1
Record 2
Record 3
Record 999
Record 1000

If you CLOSE TYPE = T and specify	After temporary close, you will resume processing
LEAVE	Immediately after record 1000
LEAVE (with tape data set open for read backward)	Immediately before record 1
REREAD	Immediately before record 1
REREAD (with tape data set open for read backward)	Immediately after record 1000

Figure 16. Record Processed When LEAVE or REREAD Is Specified for CLOSE TYPE=T

If you code the release (RLSE) operand on the DD statement for an output data set, it is ignored by temporary close (CLOSE TYPE=T). However, if the last operation was a write, then normal close (without TYPE=T) releases any unused space.

Space is released on a track boundary if the extent containing the last record was allocated in units of tracks or in units of average block lengths with ROUND not specified. Space is released on a cylinder boundary if the extent containing the last record was allocated in units of cylinders or in units of average block lengths with ROUND specified. However, a cylinder boundary extent may be released on a track boundary if:

- The DD statement used to access the data set contains a space parameter specifying units of tracks or units of average block lengths with ROUND not specified, or
- No space parameter is supplied in the DD statement and no secondary space value has been saved in the data set label for the data set. In this case, the performance benefit of cylinder boundaries is lost.

For data sets processed with BSAM, you can use CLOSE TYPE=T with the following restrictions:

- The DCB for the data set you are processing on a direct access device must specify either DSORG=PS or DSORG=PSU for input processing, and either DSORG=PS, DSORG=PSU, DSORG=PO, or DSORG=POU for output processing.
- The DCB must not be open for input to a member of a partitioned data set.
- If you open a data set on a direct access device for output and issue CLOSE TYPE=T, the volume will be repositioned only if the data set was created with DSORG=PS, DSORG=PSU, DSORG=PO, or DSORG=POU (you

cannot specify the REREAD option if DSORG=PO or DSORG=POU is specified). (This restriction prohibits the use of temporary close following or during the building of a BDAM data set that is created by specifying BSAM MACRF=WL.)

- If you open the data set for input and issue CLOSE TYPE=T with the LEAVE option, the volume will be repositioned only if the data set specifies DSORG=PS or DSORG=PO.

Note: When a data control block is shared among multiple tasks, only the task that opened the data set can close it unless TYPE=T is specified.

Before issuing the CLOSE macro, a CHECK macro must be issued for all DECBs that have outstanding I/O from WRITE macro instructions. When CLOSE TYPE=T is specified, a CHECK macro must be issued for all DECBs that have outstanding I/O from either WRITE or READ macro instructions.

In Figure 17, the data sets associated with three DCBs are to be closed simultaneously.

```
         CLOSE      (TEXTDCB,,CONVDCB,,PRINTDCB)
```

Figure 17. Closing Three Data Sets Simultaneously

Because no volume positioning operands are specified, the position indicated by the DD statement DISP parameter is used.

Volume Positioning

Releasing Data Sets and Volumes

You are offered the option of being able to release data sets and the volumes the data sets reside on when your task is no longer using them. If you are not sharing data sets, these data sets would otherwise remain unavailable for use by other tasks until the job step that opened them is terminated.

There are two ways to code the CLOSE macro instruction that can result in releasing a data set and the volume on which it resides at the time the data set is closed:

Together with the FREE=CLOSE parameter of the DD statement, you can code:

```
CLOSE   (DCB1,DISP) or
CLOSE   (DCB1,REWIND)
```

If you do not code FREE=CLOSE on the DD statement, you can code:

```
CLOSE   (DCB1,FREE)
```

See *JCL Reference* for information about how to use and code the FREE=CLOSE parameter of the DD statement.

In either case, tape data sets and volumes are freed for use by another job step. Data sets on direct access devices will be freed and the volumes on which they reside will be freed if no other data sets on the volume are open. Additional information on volume disposition is provided in *JCL User's Guide*.

Data sets being temporarily closed (using CLOSE TYPE=T) cannot be released at the time the data set is closed. They will be released at the end of the job step.

For additional information and coding restrictions on the CLOSE macro, see *Data Administration: Macro Instruction Reference*.

End-of-Volume Processing

The access methods pass control to the data management end-of-volume routine when any of the following conditions is detected:

- Tape mark (input tape volume).
- Filemark or end of last extent (input direct access volume).
- End-of-data indicator (input device other than magnetic tape or direct access volume). An example of this would be the last card read on a card reader.
- End of reel (output tape volume).
- End of extent (output direct access volume).

You may issue a force end-of-volume (FEOV) macro instruction before the end-of-volume condition is detected.

If the LABEL parameter of the associated DD statement shows standard labels, the end-of-volume routine checks or creates standard trailer labels. If SUL or AUL is specified, control is passed to the appropriate user label routine if it is specified in your exit list.

If multiple volume data sets are specified in your DD statement, automatic volume switching is accomplished by the end-of-volume routine. When an end-of-volume condition exists on an output data set, additional space is allocated as indicated in your DD statement. If no more volumes are specified or if more than specified are required, the storage is obtained from any available volume on a device of the same type. If no such volume is available, your job is terminated.

If you perform multiple opens and closes without writing any user data in the area of the end-of-tape reflective marker, then header and trailer labels may be written past the marker. Access methods detect the marker. Because the creation of empty data sets does not involve access methods, the end-of-tape marker will not be detected. This may cause the tape to run off the end of the reel.

Volume Positioning for Tapes

When an end-of-volume condition is detected, the system positions the volume according to the disposition specified in the DD statement unless the volume disposition is specified in the OPEN macro instruction. Volume positioning instructions for a sequential data set on magnetic tape can be specified as LEAVE or REREAD.

LEAVE
positions a labeled tape to the point following the tape mark that follows the data set trailer label group, and an unlabeled volume to the point following the tape mark that follows the last block of the data set.

REREAD
positions a labeled tape to the point preceding the data set header label group, and an unlabeled tape to the point preceding the first block of the data set.

If the tape was last read backward:

LEAVE
positions a labeled tape to the point preceding the data set header label group, and an unlabeled tape to the point preceding the first block of the data set.

REREAD
positions a labeled tape to the point following the tape mark that follows the data set trailer label group, and an unlabeled tape to the point following the tape mark that follows the last block of the data set.

If, however, you want to position the current volume according to the option specified in the DISP parameter of the DD statement, you code DISP in the OPEN macro instruction.

DISP
specifies that a tape volume is to be disposed of in the manner implied by the DD statement associated with the data set. Direct access volume positioning and disposition are not affected by this parameter of the OPEN macro instruction. There are several dispositions that can be specified in the DISP parameter of the DD statement; DISP can be PASS, DELETE, KEEP, CATLG, or UNCATLG.

The resultant action at the time an end-of-volume condition arises depends on (1) how many tape units are allocated to the data set and (2) how many volumes are specified for the data set in the DD statement. This is determined by the UNIT and VOLUME parameters of the DD statement associated with the data set. If the number of volumes is greater than the number of units allocated, the current volume will be rewound and unloaded. If the number of volumes is less than or equal to the number of units, the current volume is merely rewound.

For magnetic tape volumes that are not being unloaded, positioning varies according to the direction of the last input operation and the existence of tape labels.

If the tape was last read forward:

LEAVE
positions a labeled tape to the point following the tape mark that follows the data set trailer label group, and an unlabeled volume to the point following the tape mark that follows the last block of the data set.

REREAD
positions a labeled tape to the point preceding the data set header label group, and an unlabeled tape to the point preceding the first block of the data set.

If the tape was last read backward:

LEAVE
positions a labeled tape to the point preceding the data set header label group, and an unlabeled tape to the point preceding the first block of the data set.

REREAD
positions a labeled tape to the point following the tape mark that follows the data set trailer label group, and an unlabeled tape to the point following the tape mark that follows the last block of the data set.

FEOV—Force End of Volume

The FEOV macro instruction directs the operating system to start the end-of-volume processing before the physical end of the current volume is reached. If another volume has been specified for the data set, volume switching takes place automatically. The volume positioning options REWIND and LEAVE are available.

If an FEOV macro is issued for a spanned multivolume data set that is being read using QSAM, errors may occur when the next GET macro is issued. These errors are documented in "Spanned Format-VS Records (Sequential Access Method)" on page 18.

The FEOV macro instruction can only be used when you are using BSAM or QSAM. FEOV is ignored if issued for a SYSIN or SYSOUT data set.

Achieving Device Independence in Sequential Data Sets

Device independence is the characteristic of programs that work on any type of device— direct access device (DASD) or tape, for example. Achieving device independence is important only for a sequential data set because input or output can be on DASD, a magnetic tape drive, a card read/punch, a printer, or a spooled data set. Other data set organizations such as VSAM, partitioned, indexed sequential, and direct are device-dependent because they require the use of a DASD.

Programming Considerations for Sequential Data Sets

Device independence may be useful for:

- Accepting data from several recording devices, such as a disk pack, 7- or 9-track magnetic tape, or unit-record equipment. This situation could arise when several types of data-acquisition devices are feeding a centralized complex.
- Circumventing constraints imposed by the unavailability of input/output devices (for example, when devices on order have not been installed).
- Assembling, testing, and debugging on one system configuration and processing on a different configuration. For example, an IBM 3380 Direct Access Storage drive can be used as a substitute for several magnetic tape units.

Your program will be device independent if you do two things:

- Omit all device-dependent macros and macro instruction parameters from your program.

- Defer specifying any required device-dependent parameters until the program is ready for execution. That is, supply the parameters on your data definition (DD) statement or during the open exit routine.

The following list of macros tells you which macros and macro instruction parameters are device-dependent. Consider only the logical layout of your data record without regard for the type of device used. Even if your data is on a direct access volume, treat it as if it were on a magnetic tape. For example, when updating, you must create a new data set rather than attempt to update the existing data set.

OPEN
: Specify INPUT, OUTPUT, INOUT, OUTIN, OUTINX, or EXTEND. The parameters RDBACK and UPDAT are device-dependent and cause an abnormal termination if directed to a device of the wrong type.

READ
: Specify forward reading (SF) only.

WRITE
: Specify forward writing (SF) only; use only to create new records or modify existing records.

NOTE/POINT
: These macros are valid for both magnetic tape and direct access volumes.

BSP
: This macro is valid for magnetic tape or direct access volumes. However, its use would be an attempt to perform device-dependent action.

CNTRL/PRTOV
: These macros are device-dependent.

DCB Subparameters

MACRF
: Specify R/W or G/P. Processing mode can also be indicated.

DEVD
: Specify DA if any direct access device may be used. Magnetic tape and unit-record equipment DCBs will fit in the area provided during assembly. Specify unit-record devices only if you expect never to change to tape or direct access devices.

KEYLEN
: Can be specified on the DD statement if necessary.

RECFM, LRECL, BLKSIZE
: These can be specified in the DD statement. However, you must consider maximum record size for specific devices, and track overflow cannot be specified unless supported. Also, you must consider whether you expect to process XLRI records.

DSORG
: Specify sequential organization (PS or PSU) to get the full DCB expansion.

OPTCD
: This subparameter is device-dependent; specify it in the DD statement.

SYNAD

Any device-dependent error checking is automatic. Generalize your routine so that no device-dependent information is required.

End of General-Use Programming Interface

Chapter 6. Accessing Records in Data Sets

Accessing Data with READ/WRITE

The basic access method provides the READ and WRITE macro instructions for transmitting data between virtual and auxiliary storage. This technique is used when you want to process records other than sequentially or when you do not want some or all of the automatic functions performed by the queued access method. Although the system does not provide anticipatory buffering or synchronized scheduling, macro instructions are provided to help you program these operations.

The READ and WRITE macro instructions process blocks, not records. Thus, blocking and unblocking of records are your responsibility. Buffers, allocated by either you or the operating system, are filled or emptied individually each time a READ or WRITE macro instruction is issued. Besides, the READ and WRITE macro instructions only start input/output operations. To ensure that the operation is completed successfully, you must issue a CHECK macro instruction to test the data event control block (DECB). (The only exception to this is that, when the SYNAD or EODAD routine is entered, a CHECK macro instruction should not be issued for outstanding READ or WRITE requests.)

Grouping Related Control Blocks in a Paging Environment

Related control blocks (the DCB and DECB) and data areas (buffers and key areas) should be coded so they assemble in the same area of your program. This will reduce the number of paging operations required to read from and write to your data set.

Note: DCB, DECB, and buffers must reside below 16 megabytes.

Using Overlapped I/O with BSAM

When using BSAM with overlapped I/O (multiple I/O requests outstanding at one time), more than one DECB must be used. A different DECB should be specified for each channel program. For example, if you specify NCP=3 in your DCB for the data set and you are reading records from the data set, you should code the following macros in your program:

```
....
.READ DECB1,...
.READ DECB2,...
.READ DECB3,...
.CHECK DECB1
.CHECK DECB2
.CHECK DECB3
....
```

READ—Read a Block

The READ macro retrieves a data block from an input data set and places it in a designated area of virtual storage. To allow overlap of the input operation with processing, the system returns control to your program before the read operation is completed. The DECB created for the read operation must be tested for successful completion before the record is processed or the DECB is reused.

If an indexed sequential data set is being read, the block is brought into virtual storage and the address of the record is returned to you in the DECB.

When you use the READ macro for BSAM to read a direct data set with spanned records and keys and you specify BFTEK=R in your DCB, the data management routines displace record segments after the first in a record by key length. Thus, you can expect the block descriptor word and the segment descriptor word at the same locations in your buffer or buffers, regardless of whether you read the first segment of a record, preceded in the buffer by its key, or a subsequent segment that does not have a key. This procedure is called offset reading.

You can specify variations of the READ macro according to the organization of the data set being processed and the type of processing to be done by the system as follows:

Sequential

SF Read the data set sequentially.

SB Read the data set backward (magnetic tape, format-F and format-U only). When RECFM=FBS, data sets with the last block truncated cannot be read backward.

Indexed Sequential

K Read the data set.

KU Read for update. The system maintains the device address of the record; thus, when a WRITE macro returns the record, no index search is required.

Direct

D Use the direct access method.

I Locate the block using a block identification.

K Locate the block using a key.

F Provide device position feedback.

X Maintain exclusive control of the block.

R Provide next address feedback.

U Next address can be a capacity record or logical record, whichever occurred first.

WRITE—Write a Block

The WRITE macro places a data block in an output data set from a designated area of virtual storage. The WRITE macro can also be used to return an updated record to a data set. To allow overlap of output operations with processing, the system returns control to your program before the write operation is completed. The DECB created for the write operation must be tested for successful completion before the DECB can be reused. For ISCII/ASCII tape data sets, do not issue more than one WRITE on the same record, because the WRITE macro instruction causes the data in the record area to be translated from EBCDIC to ISCII/ASCII.

As with the READ macro, you can specify variations of the WRITE macro according to the organization of the data set and the type of processing to be done by the system as follows:

Sequential

SF Write the data set sequentially.

Indexed Sequential

K Write a block containing an updated record, or replace a record with a fixed, unblocked record having the same key. The record to be replaced need not have been read into virtual storage.

KN Write a new record or change the length of a variable-length record.

Direct

SD Write a dummy fixed-length record. (BDAM load mode)

SZ Write a capacity record (R0). The system supplies the data, writes the capacity record, and advances to the next track. (BDAM load mode)

SFR Write the data set sequentially with next-address feedback. (BDAM load mode variable spanned)

D Use the direct access method.

I Search argument identifies a block.

K Search argument is a key.

A Add a new block.

F Provide record location data (feedback).

X Release exclusive control.

CHECK—Test Completion of Read or Write Operation

When processing a data set, you can test for completion of a READ or WRITE request by issuing a CHECK macro. The system tests for errors and exceptional conditions in the data event control block (DECB). Successive CHECK macros issued for the same data set must be issued in the same order as the associated READ and WRITE macros.

The check routine passes control to the appropriate exit routines specified in the DCB for error analysis (SYNAD) or, for sequential data sets, end-of-data (EODAD). It also automatically starts the end-of-volume procedures (volume switching or extending output data sets).

If you specify OPTCD=Q in the DCB, CHECK causes input data to be translated from ISCII/ASCII to EBCDIC.

WAIT—Wait for Completion of a Read or Write Operation

When processing a data set, you can test for completion of any READ or WRITE request by issuing a WAIT macro. The input/output operation is synchronized with processing, but the DECB is not checked for errors or exceptional conditions, nor are end-of-volume procedures initiated. Your program must perform these operations.

For BDAM and BISAM, a WAIT macro must be issued for each READ or WRITE macro if MACRF=C is not coded in the associated DCB. When MACRF=C is coded, and always for BSAM and BPAM, a CHECK macro must be issued for each READ or WRITE macro. Because the CHECK macro incorporates the function of the WAIT macro, a WAIT is normally redundant for those access methods. The ECBLIST form of the WAIT macro may be useful, though, in selecting which of several outstanding events should be checked first.

The WAIT macro can be used to await completion of multiple read and write operations. Each operation must then be checked or tested separately. **Example:** You have opened an input DCB for BSAM with NCP=2, and an output DCB for BISAM with NCP=1 and without specifying MACRF=C. You have issued two BSAM READ macros and one BISAM WRITE macro. You now issue the WAIT macro with ECBLIST pointing to the BISAM DECB and the first BSAM DECB. (Because BSAM requests are serialized, the first request must execute before the second.) When you regain control, you will inspect the DECBs to see which has completed (second bit on). If it was BISAM, you will issue another WRITE macro. If it was BSAM, you will issue a CHECK macro and then another READ macro.

Data Event Control Block (DECB)

A data event control block is a 16- to 32-byte area reserved by each READ or WRITE macro. It contains the ECB, control information, and pointers to control blocks. The DECB is described in Appendix A of *Data Administration: Macro Instruction Reference*.

The DECB is examined by the check routine when the I/O operation is completed to determine if an uncorrectable error or exceptional condition exists. If it does, control is passed to your SYNAD routine. If you have no SYNAD routine, the task is abnormally terminated.

Accessing Data with GET/PUT

The queued access method provides GET and PUT macros for transmitting data within virtual storage. These macro instructions cause automatic blocking and unblocking of the records stored and retrieved. Anticipatory (look-ahead) buffering and synchronization (overlap) of input and output operations with instruction stream processing are automatic features of the queued access method.

Because the operating system controls buffer processing, you can use as many input/output (I/O) buffers as needed without reissuing GET or PUT macro instructions to fill or empty buffers. Usually, more than one input block is in storage at a time, so I/O operations do not delay record processing.

Because the operating system synchronizes input/output with processing, you need not test for completion, errors, or exceptional conditions. After a GET or PUT macro is issued, control is not returned to your program until an input area is filled or an output area is available. Exits to error analysis (SYNAD) and end-of-volume or end-of-data (EODAD) routines are automatically taken when necessary.

GET—Retrieve a Record

The GET macro is used to obtain a record from an input data set. It operates in a logical sequential and device-independent manner. As required, the GET macro schedules the filling of input buffers, unblocks records, and directs input error recovery procedures. For sequential data sets, it also merges record segments into logical records. After all records have been processed and the GET macro detects an end-of-data indication, the system automatically checks labels on sequential data sets and passes control to your end-of-data (EODAD) routine. If an end-of-volume condition is detected for a sequential data set, the system provides automatic volume switching if the data set extends across several volumes or if concatenated data sets are being processed. If you specify OPTCD=Q in the DCB, GET causes input data to be translated from ISCII/ASCII to EBCDIC.

PUT—Write a Record

The PUT macro is used to write a record into an output data set. Like the GET macro, it operates in a logical sequential and device-independent manner. As required, the PUT macro blocks records, schedules the emptying of output buffers, and handles output error correction procedures. For sequential data sets, it also starts automatic volume switching and label creation, and also segments records for spanning. If you specify OPTCD=Q in the DCB, PUT causes output to be translated from EBCDIC to ISCII/ASCII.

If the PUT macro is directed to a card punch or printer, the system automatically adjusts the number of records or record segments per block of format-F or format-V blocks to 1. Thus, you can specify a record length (LRECL) and block size (BLKSIZE) to provide an optimum block size if the records are temporarily placed on magnetic tape or a direct access volume.

For spanned variable-length records, the block size must be equivalent to the length of one card or one print line. Record size may be greater than block size in this case.

PUTX—Write an Updated Record

The PUTX macro is used to update a data set or to create an output data set using records from an input data set as a base. PUTX updates, replaces, or inserts records from existing data sets but does not create records.

When you use the PUTX macro to update, each record is returned to the data set referred to by a previous locate mode GET macro instruction. The buffer containing the updated record is flagged and written back to the same location on the direct access storage device where it was read. The block is not written until a GET macro instruction is issued for the next buffer, except when a spanned record is to be updated. In that case, the block is written with the next GET macro.

When the PUTX macro is used to create an output data set, you can add new records by using the PUT macro. As required, the PUTX macro blocks records, schedules the writing of output buffers, and handles output error correction procedures.

Parallel Input Processing (QSAM Only)

QSAM parallel input processing may be used to process two or more input data sets concurrently, such as sorting or merging several data sets at the same time. This eliminates the need for issuing a separate GET macro to each DCB processed. The get routine for parallel input processing selects a DCB with a ready record and then transfers control to the normal get routine. If there is no DCB with a ready record, a multiple WAIT macro is issued.

Parallel input processing provides a logical input record from a queue of data sets with equal priority. The function supports QSAM with input processing, simple buffering, locate or move mode, and fixed-, variable-, or undefined-length records. Spanned records, track-overflow records, dummy data sets, and SYSIN data sets are not supported.

Parallel input processing can be interrupted at any time to retrieve records from a specific data set, or to issue control instructions to a specific data set. When the retrieval process has been completed, parallel input processing may be resumed.

Data sets can be added to or deleted from the data set queue at any time. It is important to note, however, that, as each data set reaches an end-of-data condition, the data set must be removed from the queue with the CLOSE macro before a subsequent GET macro is issued for the queue; otherwise, the task may be ended abnormally.

A request for parallel input processing is indicated by including the address of a parallel data access block (PDAB) in the DCB exit list. For additional information on the DCB exit list, see *DFP: Customization*.

With the use of the PDAB macro, you can create and format a work area that identifies the maximum number of DCBs that can be processed at any one time. If you exceed the maximum number of entries indicated in the PDAB macro when adding a DCB to the queue with the OPEN macro, the data set will not be available for parallel input processing; however, it may be available for sequential processing.

When issuing a parallel GET macro, register 1 must always point to a PDAB. You may load the register or let the GET macro do it for you. When control is returned to you, register 1 contains the address of a logical record from one of the data sets in the queue; registers 2 through 13 contain their original contents at the time the GET macro was issued; registers 14, 15, and 0 are changed.

Through the PDAB, you can find the data set from which the record was retrieved. A fullword address in the PDAB (PDADCBEP) points to the address of the DCB. It should be noted that this pointer may be invalid from the time a CLOSE macro is issued to the issuing of the next parallel GET macro.

In Figure 18 on page 65, not more than three data sets (MAXDCB=3 in the PDAB operand) will be open for parallel processing at a time. If data definition statements and data sets are supplied, DATASET1, DATASET2, and DATASET3 will be opened for parallel input processing as specified in the input processing OPEN macro. Other attributes of each data set are QSAM (MACRF=G), simple buffering by default, locate or move mode (MACRF=L or M), fixed-length records (RECFM=F), and exit list entry for a PDAB (X'92'). Note that both locate and move modes may be used in the same data set queue. The mapping macros, DCBD and PDABD, are used to reference the DCBs and the PDAB respectively.

```
           ...
           OPEN  (DATASET1,(INPUT),DATASET2,(INPUT),DATASET3,         X
                 (INPUT),DATASET4,(OUTPUT))
           TM    DATASET1+DCBQSWS-IHADCB,DCBPOPEN  Opened for
                                          parallel processing
           BZ    SEQRTN                   Branch on no to
                                          sequential routine
           TM    DATASET2+DCBQSWS-IHADCB,DCBPOPEN
           BZ    SEQRTN
           TM    DATASET3+DCBQSWS-IHADCB,DCBPOPEN
           BZ    SEQRTN
GETRTN     GET   DCBQUEUE,BUFFERAD,TYPE=P
           LR    10,1                     Save record pointer
           ...
           ...                            Record updated in place
           ...
           PUT   DATASET4,(10)
           B     GETRTN
EODRTN     EQU   *                        Close DCB which just
                                          reached EODAD
           L     2,DCBQUEUE+PDADCBEP-IHAPDAB
           CLOSE   ((2))
           CLC   ZEROS(2),DCBQUEUE+PDANODCB-IHAPDAB  Any DCBs left?
           BL    GETRTN                   Branch if yes
           ...
           ...
DATASET1   DCB   DDNAME=DDNAME1,DSORG=PS,MACRF=GL,RECFM=FB,           X
                 LRECL=80,EODAD=EODRTN,EXLST=SET3XLST
DATASET2   DCB   DDNAME=DDNAME2,DSORG=PS,MACRF=GL,RECFM=FB,           X
                 LRECL=80,EODAD=EODRTN,EXLST=SET3XLST
DATASET3   DCB   DDNAME=DDNAME3,DSORG=PS,MACRF=GMC,RECFM=FB,          X
                 LRECL=80,EODAD=EODRTN,EXLST=SET3XLST
DATASET4   DCB   DDNAME=DDNAME4,DSORG=PS,MACRF=PM,RECFM=FB,           X
                 LRECL=80
DCBQUEUE   PDAB  MAXDCB=3
SET3XLST   DC    0F'0',X'92',AL3(DCBQUEUE)
ZEROS      DC    X'0000'
           DCBD  DSORG=QS
           PDABD
           ...
```

Note: The number of bytes required for PDAB is equal to 24 + 8n, where n is the value of the keyword, MAXDCB.

Figure 18. Parallel Processing of Three Data Sets

Following the OPEN macro, tests are made to determine whether the DCBs were opened for parallel processing. If not, the sequential processing routine is given control.

When one or more data sets are opened for parallel processing, the get routine retrieves a record, saves the pointer in register 10, processes the record, and writes it to DATASET4. This process continues until an end-of-data condition is detected on one of the input data sets; the end-of-data routine locates the completed input data set and removes it from the queue with the CLOSE macro. A test is then made to determine whether any data sets remain on the queue. Processing continues in this manner until the queue is empty.

Sharing Data Sets

There are two conditions under which a data set on a direct access device can be shared by two or more tasks:

- Two or more DCBs are opened and used concurrently by the tasks to refer to the same, shared data set (multiple DCBs).
- Only one DCB is opened and used concurrently by multiple tasks in a single job step (a single, shared DCB).

Job control language (JCL) statements and macros are provided in the operating system that help you ensure the integrity of the data sets you want to share among the tasks that process them. Figure 19 on page 67 and Figure 20 on page 68 show which JCL and macros you should use, depending on the access method your task is using and mode of access (input, output, or update).

Figure 19 describes the macros, JCL, and processing procedures you should use if more than one DCB has been opened to the shared data set. The DCBs can be used by tasks in the same or different job steps.

MULTIPLE DCBs

ACCESS MODE	ACCESS METHOD				
	BSAM,BPAM	QSAM	BDAM	QISAM	BISAM
Input	DISP = SHR	DISP = SHR	DISP = SHR	DISP = SHR	DISP = SHR
Output	No facility	No facility	DISP = SHR	No facility	DISP = SHR and ENQ on Data Set
Update	DISP = SHR user must ENQ on block	DISP = SHR and Guarantee discrete blocks	DISP = SHR BDAM will ENQ on block	DISP = SHR and ENQ on data set and guarantee discrete blocks	DISP = SHR and ENQ on data set and guarantee discrete blocks

DISP=SHR:
Each job step sharing an existing data set must code SHR as the subparameter of the DISP parameter on the DD statement for the shared data set to allow the steps to execute concurrently. For additional information about ensuring data set integrity, see *JCL User's Guide*. If the tasks are in the same job step, DISP=SHR is not required.

No facility:
There are no facilities in the operating system for sharing a data set under these conditions.

ENQ on data set:
Besides coding DISP=SHR on the DD statement for the data set that is to be shared, each task must issue ENQ and DEQ macros naming the data set or block as the resource for which exclusive control is required. The ENQ must be issued before the GET (READ); the DEQ macro should be issued after the PUTX or CHECK macro that ends the operation. For additional information on the use of ENQ and DEQ macros, see *Application Development Macro Reference*.

Guarantee discrete blocks:
When you are using the access methods that provide blocking and unblocking of records (QSAM, QISAM, and BISAM), it is necessary that every task updating the data set ensure that it is not updating a block that contains a record being updated by any other task. There are no facilities in the operating system for ensuring that discrete blocks are being processed by different tasks.

ENQ on block:
If you are updating a shared data set (specified by coding DISP=SHR on the DD statement) using BSAM or BPAM, your task and all other tasks must serialize processing of each block of records by issuing an ENQ macro before the READ macro and a DEQ macro after the CHECK macro that follows the WRITE macro you issued to update the record. If you are using BDAM, it provides for enqueuing on a block using the READ exclusive option that is requested by coding MACRF=X in the DCB and an X in the type operand of the READ and WRITE macros. (For an example of the use of the BDAM macros, see "Exclusive Control for Updating" on page 147.)

Figure 19. JCL, Macro Instructions, and Procedures Required to Share a Data Set Using Multiple DCBs

Figure 20 on page 68 describes the macros you can use to serialize processing of a shared data set when a single DCB is being shared by several tasks in a job step. The DISP=SHR specification on the DD statement is not required.

Data sets can also be shared both ways at the same time. More than one DCB can be opened for a shared data set, while more than one task can be sharing one of the DCBs. Under this condition, the serialization techniques specified for indexed sequential and direct data sets in Figure 19 satisfy the requirement. For sequential and partitioned data sets, the techniques specified in Figure 19 and Figure 20 must be used.

More information on opening and closing data sets by more than one task is in "Opening and Closing a Data Set" on page 45.

Shared Direct Access Storage Devices: At some installations, a direct access storage device is shared by two or more independent computing systems. Tasks executed on these systems can share data sets stored on the device. Careful planning should be exercised in accessing a shared data set or the same storage area on shared devices by multiple independent systems. Without proper intersystem communication, data integrity could be endangered. For details, see *SPL: Application Development Guide*.

A SINGLE SHARED DCB

ACCESS MODE	ACCESS METHOD				
	BSAM, BPAM, BDAM Create	QSAM	BDAM	QISAM	BISAM
Input	ENQ	ENQ	No action required	ENQ	ENQ
Output	ENQ	ENQ	No action required	ENQ and key sequence	ENQ
Update	ENQ	ENQ	No action	ENQ	ENQ

ENQ:
When a data set is being shared by two or more tasks in the same job step (all that use the same DCB), each task processing the data set must issue an ENQ macro instruction on a predefined resource name before issuing the macro or macros that begin the input/output operation. Each task must also release exclusive control by issuing the DEQ macro at the next sequential instruction following the input/output macro. If, however, you are processing an indexed sequential data set sequentially using the SETL and ESETL macros, you must issue the ENQ macro before the SETL macro and the DEQ macro after the ESETL macro. Note also that if two tasks are writing different members of a partitioned data set, each task should issue the ENQ macro before the FIND macro and issue the DEQ macro after the STOW macro that completes processing of the member. Additional reference information on the ENQ and DEQ macros is presented in *Application Development Macro Reference*. For an example of the use of ENQ and DEQ macros with BISAM, see Figure 46 on page 146.

No action required:
See "Sharing Direct Data Sets" on page 151.

ENQ on block:
When updating a shared direct data set, every task must use the BDAM exclusive control option that is requested by coding MACRF=X in the DCB macro and an X in the type operand of the READ and WRITE macro instructions. See "Exclusive Control for Updating" on page 147 for an example of the use of BDAM macros. Note that all tasks sharing a data set must share subpool 0 (see the ATTACH macro description in *Application Development Macro Reference*).

Key sequence:
Tasks sharing a QISAM load mode DCB must ensure that the records to be written are presented in ascending key sequence; otherwise, a sequence check will result in (1) control being passed to the SYNAD routine identified by the DCB, or (2) if there is no SYNAD routine, termination of the task.

Figure 20. Macro Instructions and Procedures Required to Share a Data Set Using a Single DCB

Analyzing I/O Errors

The basic and queued access method both provide special macro instructions for analyzing input/output errors. These macro instructions can be used in SYNAD routines or in error analysis routines.

Device Support Facilities (ICKDSF)—Diagnosing I/O Problems

You can use Device Support Facilities (ICKDSF) Release 9.0 or higher to determine if there are problems with the disk drive or a problem reading or writing data stored on the volume. Device Support Facilities also performs service checking of a volume. The INSPECT command for the Device Support Facilities program can assign alternate tracks. (See *ICKDSF User's Guide and Reference*.)

SYNADAF—Perform SYNAD Analysis Function

The SYNADAF macro analyzes the status, sense, and exceptional condition code data that is available to your error analysis routine. It produces an error message that your routine can write into any appropriate data set. The message is in the form of an unblocked variable-length record, but you can write it as a fixed-length record by omitting the block length and record length fields that precede the message text.

The message comes in two parts. If the data set being analyzed is not a PDSE, only the first message is displayed. If the data set is a PDSE, both messages are displayed. The text of the first message is 120 characters long, and begins with a field of either 36 or 42 blanks; you can use the blank field to add your own remarks to the message. The text of the second message, for PDSEs, is 128 characters long and ends with a field of 79 blanks (reserved for later use). This second message begins in the 5th byte in the message buffer.

Following is a typical message for a tape data set with the blank field omitted:

```
,TESTJOBb,STEP2bbb,283,TA,MASTERbb,READb,DATA CHECKbbbbb,
0000015,BSAM
```

Note: In the above example, 'b' indicates a blank.

This message shows that a data check occurred during reading of the 15th block of a data set. The data set was identified by a DD statement named MASTER, and was on a magnetic tape volume on unit 283. The name of the job was TESTJOB; the name of the job step was STEP2.

Following is a typical message for a PDSE with the blank fields omitted:

```
,PDSEJOBb,STEP2bbb,283,DA,PDSEDDbb,READb,DATA CHECKbbbbb,
00000000100002,BSAMS

,003,0000005,0000000002,00000000,00000000,b ... (79 blanks)
```

This message shows that a data check occurred during reading of the 100002th block of the PDSE. The data set was identified by a DD statement named PDSEDD, and was on a DASD on unit 283. The name of the job was PDSEJOB; the name of the job step was STEP2. The 'S' following BSAM indicates that the data set is a PDSE. The second message identifies the record in which the error occurred. The concatenation number of the data set is 3, its relative record number is 2, and the 5 is a token the system uses to locate the member. The SMS return and reason codes are zero, meaning that no error occurred in SMS.

If the error analysis routine is entered because of an input error, the first 6 bytes of the message (bytes 8 to 13) contain binary information. If no data was transmitted or if the access method is QISAM, the first 6 bytes are blanks or binary zeros. If the error did not prevent data transmission, the first 6 bytes contain the address of the input buffer and the number of bytes read. You can use this information to process records from the block; for example, you might print each record after printing the error message. Before printing the message, however, you should replace this binary information with EBCDIC characters.

The SYNADAF macro provides its own save area and makes this area available to your error analysis routine. When used at the entry point of a SYNAD routine, it fulfills the routine's responsibility for providing a save area. See *Data Administration: Macro Instruction Reference* for more information on the SYNADAF macro.

SYNADRLS—Release SYNADAF Message and Save Areas

The SYNADRLS macro releases the message and save areas provided by the SYNADAF macro. You must issue this macro instruction before returning from the error analysis routine.

Chapter 7. Spooling and Scheduling Data Sets

The job entry subsystem (JES) is a system function that spools and schedules input and output data streams.

Spooling includes two basic functions:

- Input streams are read from the input device and stored on an intermediate storage device in a format convenient for later processing by the system and by the user's program.
- Output streams are similarly stored on an intermediate device until a convenient time for printing or punching.

Scheduling provides the highest degree of system availability through the orderly use of system resources that are the objects of contention.

With spooling, unit record devices are used at full rated speed if enough buffers are available, and they are used only for the time needed to read, print, or punch the data. Without spooling, the device is occupied for the entire time that a job is doing other processing. Also, because data is stored instead of being transmitted directly, output can be queued in any order and scheduled by class and by priority within each class.

You enter data into the system input stream by preceding it with a DD * or a DD DATA JCL statement. This is a SYSIN data set.

Your output data can be printed or punched from a SYSOUT data set that is called the output stream. You code the SYSOUT keyword parameter in your DD statement and designate the appropriate output class. For example, SYSOUT=A requests output class A. The class-device relationship is established for each installation, and a list of devices assigned to each output class will enable you to select the appropriate one. For further information on SYSIN and SYSOUT parameters, see *JCL User's Guide* and *JCL Reference*.

A SYSIN data set cannot be opened by more than one DCB at the same time, as it would result in an S013 abend. SYSIN and SYSOUT cannot be managed by SMS.

SYSIN and SYSOUT must be either BSAM or QSAM data sets and you open and close them in the same manner as any other data set processed on a unit record device. The job entry subsystem (JES) allows multiple opens to the same SYSOUT data set; and the records are interspersed. However, serialization of the data set is the responsibility of the application or user. For more information on serialization, see "Sharing Data Sets" on page 66. The DCB exit routine will be entered in the usual manner if you specify it in an exit list. See *DFP: Customization* for the DCB exits.

When you use QSAM with fixed-length blocked records or BSAM, the DCB block size parameter does not have to be a multiple of logical record length (LRECL) if the block size is specified through the SYSOUT DD statement. Under these conditions, if block size is greater than LRECL but not a multiple of LRECL, block size is reduced to the nearest lower multiple of LRECL when the data set is opened. This feature allows a cataloged procedure to specify blocking for

SYSOUT data sets, even though your LRECL is not known to the system until execution.

Therefore, the SYSOUT DD statement of the go step of a compile-load-go procedure can specify block size without block size being a multiple of LRECL.

Because a SYSOUT data set is written on a direct access device, you should omit the DEVD operand in the DCB macro, or you should code DEVD=DA. Because SYSIN and SYSOUT data sets are spooled on intermediate devices, you should also avoid using device-dependent macros (such as FEOV, CNTRL, PRTOV, or BSP)q in processing these data sets. (See "Achieving Device Independence in Sequential Data Sets" on page 56.) With a 3800, you can use SETPRT when processing spooled data sets. For further information, refer to *IBM 3800 Printing Subsystem Programmer's Guide*.

The job entry subsystem controls all blocking and deblocking of your data to optimize system operation and ignores the number of channel programs (NCP) you specify. The block size (BLKSIZE) and number of buffers (BUFNO) specified in your program have no correlation with what is actually used by the job entry subsystem. Therefore, you can select the blocking factor that best fits your application program with no effect on the spooling efficiency of the system. For QSAM applications, move mode is as efficient as locate mode.

All record formats are allowed, except that spanned records (RECFM=VS or VBS) cannot be specified for SYSIN. A record format of FIXED is supplied if it is not specified for SYSIN.

The minimum record length for SYSIN is 80 bytes. For undefined records, the entire 80-byte image is treated as a record. Therefore, a read of less than 80 bytes results in the transfer of the entire 80-byte image to the record area specified in the READ macro. For fixed and variable length records, an ABEND results if the LRECL is less than 80 bytes.

The logical record length value (JFCLRECL field in the JFCB) is filled in with the logical record length value of the input data set. This value is increased by 4 if the record format is variable (RECFM=V or VB). The logical record length may be a size other than the size of the input device, if the SYSIN input stream is supplied by an internal reader. The job entry subsystem will supply a value in the JFCLRECL field of the JFCB if that field is found to be zero.

The block size value (JFCBLKSI field in the JFCB) is filled in with the block size value of the input data set. This value is increased by 4 greater than the value calculated for the logical record value (that is, input data set logical record length + 4) if the record format is variable (RECFM=V or VB). The job entry subsystem will supply a value in the JFCBLKSI field of the JFCB if that field is found to be 0.

Your program is responsible for printing format, pagination, header control, and stacker select. You can supply control characters for SYSOUT data sets in the normal manner by specifying ANSI or machine characters in the DCB. Standard controls are provided by default if they are not specified. The length of output records must not exceed the allowable maximum length for the ultimate device. Cards can be punched in EBCDIC mode only.

Your SYNAD routine will be entered if an error occurs during data transmission to or from an intermediate storage device. Again, because the specific device is indeterminate, your SYNAD routine code should be device independent.

Chapter 8. Processing a Sequential Data Set

General-Use Programming Interface

This chapter is intended to help you process sequential data sets. It contains general-use programming interfaces, which are provided to allow you to write programs that use the services of MVS/DFP.

Data sets residing on any volume other than direct access volumes must be processed sequentially. In addition, a data set residing on a direct access volume, regardless of organization, can be processed sequentially. This includes data sets created using ISAM or a similar access method. Because the entire data set (prime, index, and overflow areas) will be processed, care should be taken to determine the type of records being processed.

See *Data Administration: Macro Instruction Reference* for the macros used with sequential data sets. For a non-DASD sequential data set, a technique called chained scheduling can be used to accelerate the input/output operations.

Creating a Sequential Data Set

Either the queued or the basic access method may be used to store and retrieve the records of a sequential data set.

As discussed earlier, a processing program should be developed using, as much as possible, factors that are constant, with variable factors specified at execution. For that reason, the following examples are generalized as much as possible. They are neither exhaustive nor intended as complete examples. Rather, they are presented as introductory sequences.

In creating a sequential data set on a magnetic tape or direct access device, you must do the following:

- Code DSORG=PS or PSU in the DCB macro.
- Code a DD statement to describe the data set (see *JCL Reference*). For SMS-managed DASD data sets, either specify a data class in the DD statement or allow the ACS routines to assign a data class.
  or
  Create the data set using the TSO or access method services ALLOCATE command (see *Access Method Services Reference*).
- Process the data set with an OPEN macro (data set is opened for output or OUTIN), a series of PUT or WRITE and CHECK macros, and then a CLOSE macro.

Tape-to-Print, Move Mode—Simple Buffering: The example in Figure 21 on page 76 shows that the GET-move and PUT-move require two movements of the data records. If the record length (LRECL) does not change during processing, only one move is necessary; you can process the record in the input buffer segment. A GET-locate provides a pointer to the current segment.

```
          OPEN      (INDATA,,OUTDATA,(OUTPUT))
NEXTREC   GET       INDATA,WORKAREA                Move mode
          AP        NUMBER,=P'1'
          UNPK      COUNT,NUMBER                   Record count adds 6
          PUT       OUTDATA,COUNT                  bytes to each record
          B         NEXTREC
TAPERROR  SYNADAF   ACSMETH=QSAM                   Control program returns
          LA        0,68(0,1)                      message address in regis-
*                                                  ter 1.
          ST        14,SAVE14                      SYNAD routine prints part
          PUT       OUTDATA,(0)                    of the message (beginning
          SYNADRLS                                 with the unit number) as
          L         14,SAVE14                      a 56-byte fixed-length
          RETURN                                   record. It then returns
ENDJOB    CLOSE     (INDATA,,OUTDATA)              to the control program.
          ...
COUNT     DS        CL6
WORKAREA  DS        CL50
NUMBER    DC        PL4'0'
SAVE14    DS        F
INDATA    DCB       DDNAME=INPUTDD,DSORG=PS,MACRF=(GM),EROPT=ACC,
                SYNAD=TAPERROR,EODAD=ENDJOB
OUTDATA   DCB       DDNAME=OUTPUTDD,DSORG=PS,MACRF=(PM),EROPT=ACC
          ...
```

Figure 21. Creating a Sequential Data Set—Move Mode, Simple Buffering

Retrieving a Sequential Data Set

In retrieving a sequential data set on a magnetic tape or a direct access device, you must do the following:

- Code DSORG=PS or PSU in the DCB macro.
- Tell the system where your data set is located (by coding a DD statement; see *JCL Reference*).
- Process the data set with an OPEN macro (data set is opened for input, INOUT, RDBACK, or UPDAT), a series of GET or READ macros, and then a CLOSE macro.

Tape-to-Print, Locate Mode—Simple Buffering: The example in Figure 22 on page 77 is similar to that in Figure 21. However, because there is no change in the record length, the records can be processed in the input buffer. Only one move of each data record is required.

```
          ....
          OPEN       (INDATA,,OUTDATA,(OUTPUT),ERRORDCB,(OUTPUT))
NEXTREC   GET        INDATA                 Locate mode
          LR         2,1                    Save pointer
          AP         NUMBER,=P'1'
          UNPK       0(6,2),NUMBER          Process in input area
          PUT        OUTDATA                Locate mode
          MVC        0(50,1),0(2)           Move record to output buffer
          B          NEXTREC
TAPERROR  SYNADAF    ACSMETH=QSAM           Message address in register 1
          ST         2,SAVE2                Save register 2 contents
          L          2,8(0,1)               Load pointer to input buffer
          MVC        8(70,1),50(1)          Shift nonblank message fields
          MVI        78(1),C' '             Blank end of message
          MVC        79(49,1),78(1)
          ST         2,128(1)               Save address for debugging
          CH         0,=H'4'                Test SYNADAF return code
          BE         MOVERCD                Branch if data read
          BL         PRINTIT                Branch if data not read
          CLI        128(1),C' '            See if data read anyway
          BE         PRINTIT                Branch if no data
MOVERCD   MVC        78(50,1),0(2)          Add input record to message
PRINTIT   LA         0,4(1)                 Load address of message
          LR         2,14                   Save return address
          PUT        ERRORDCB,(0)           Print message (move mode)
          SYNADRLS                          Release message and save area
          LR         14,2                   Restore return address
          L          2,SAVE2                Restore register 2 contents
          RETURN                            Return to control program
ENDJOB    CLOSE      (INDATA,,OUTDATA,,ERRORDCB)
          ...
NUMBER    DC         PL4'0'
INDATA    DCB        DDNAME=INPUTDD,DSORG=PS,MACRF=(GL),EROPT=ACC,        C
               SYNAD=TAPERROR,EODAD=ENDJOB
OUTDATA   DCB        DDNAME=OUTPUTDD,DSORG=PS,MACRF=(PL)
ERRORDCB  DCB        DDNAME=SYSOUTDD,DSORG=PS,MACRF=(PM),RECFM=V,         C
               BLKSIZE=128,LRECL=124
SAVE2     DS         F
          ...
```

Figure 22. Creating a Sequential Data Set—Locate Mode, Simple Buffering

Modifying a Sequential Data Set

You can modify a sequential data set in two ways:

- Changing the data in existing records (update in place)
- Adding new records to the end of a data set (extending the data set).

Updating a Sequential Data Set in Place

When you update in place, you read records, process them, and write them back to their original positions without destroying the remaining records on the track. The following rules apply:

- You must specify the update option (UPDAT) in the OPEN macro instruction. To perform the update, you can use only the READ, WRITE, CHECK, NOTE, POINT, GET, and PUTX macros.
- You cannot delete any record or change its length; you cannot add new records.
- The data set must be on a direct access device.

A record must be retrieved by a READ or GET macro before it can be updated by a WRITE or PUTX macro. A WRITE or PUTX macro does not need to be issued after each READ or GET macro. The READ and WRITE macros must be execute forms that refer to the same DECB; the DECB must be provided by the list forms of the READ or WRITE macros. (The execute and list forms of the READ and WRITE macros are described in *Data Administration: Macro Instruction Reference.*)

Updating with Overlapped Operations

To overlap input/output and processor activity, you can start several read or write operations before checking the first for completion. You cannot overlap read with write operations, however, as operations of one type must be checked for completion before operations of the other type are started or resumed. Note that each pending read or write operation requires a separate channel program and a separate DECB. If a single DECB were used for successive read operations, only the last record read could be updated.

In Figure 40 on page 109, overlap is achieved by having a read or write request outstanding while each record is being processed. Note the use of the execute and list forms of the READ and WRITE macros, identified by the operands MF=E and MF=L.

Extending a Sequential Data Set

If you want to add records at the end of your data set, you must open the data set for output with DISP=MOD specified in the DD statement or specify the EXTEND option of the OPEN macro. You can then issue PUT or WRITE macros to the data set.

Concatenating Sequential Data Sets

Two or more sequential data sets can be retrieved by the system and processed successively as a single data set. This is called sequential concatenation, and allows the application program to treat a collection of sequential data sets as one data set. You can concatenate up to 255 sequential data sets.

Concatenation can be thought of as the processing of a sequence of "like" and "unlike" data sets. The "like" data sets in the sequence are those that can be processed correctly without notifying the system. A "like" data set either uses the same data control block (DCB), input/output block (IOB), and channel program as the data set preceding it, or meets certain requirements that make the data set eligible to be treated as "like" by the system. All other data sets are treated as "unlike" data sets.

The "unlike" data sets in the sequence cannot be processed correctly unless the DCBOFLGS field in the DCB is turned on, notifying the system that the next data set in the sequence is "unlike." For example, you *must* concatenate as "unlike" data sets with different record formats.

Rules for Concatenating Like Data Sets: To be a "like" data set, a data set must either be able to process correctly using the same channel program as the preceding data set in the sequence, or meet the following eligibility rules:

- The record format is either fixed or variable, and is the same as the record format of the preceding data set.
- LRECL is same as the LRECL of the preceding data set.
- The access method is QSAM or BSAM.
- If the access method is QSAM, then OPEN got the buffer pool.
- Block size was not coded in the DCB macro.
- The device is either a DASD device or a tape device and the device of the preceding data set is either DASD or tape.
- Tape labels are standard or ANSI.
- If mixed tape and DASD, the POINT or CONTROL macros are not used—neither P nor C was coded in the DCB MACRF parameter.

Concatenating Unlike Data Sets: When sequential data sets are concatenated, the system is open to only one of the data sets at a time. If spool data sets or any of the "like" data sets described above are concatenated, the system automatically handles them correctly. You do not need to inform the system that they are being concatenated. However, if "unlike" sequential data sets are concatenated, you must modify the DCBOFLGS field of the DCB to inform the system that you are concatenating data sets. The indication must be made before the end of the current data set is reached. DCBOFPPC is bit 4 of the DCBOFLGS field. You must set bit 4, DCBOFPPC, to 1 by using the instruction OI DCBOFLGS, X'08' as described in Chapter 5, "Specifying a Data Control Block and Initializing Data Sets." If DCBOFPPC is 1, end-of-volume processing for each data set will issue a close for the data set just read and an open for the next concatenated data set. This opening and closing procedure updates the fields in the DCB and, if necessary, builds a new IOB and a new channel program. If the buffer pool was obtained automatically by the open routine, the procedure also frees the buffer pool and obtains a new one for the next concatenated data set. The procedure does not issue a FREEPOOL for the last concatenated data set. Unless you have some way of determining the characteristics of the next data set before it is opened, you should not reset the DCBOFLGS field to indicate "like" attributes during processing. When you concatenate data sets with unlike attributes (that is, turn on the DCBOFPPC bit of the DCBOFLGS field), the EOV exit is not taken. However, the OPEN exit is taken.

When a new data set is reached and DCBOFPPC is on, the GET or READ macro instruction that detected the end of data set must be reissued. Figure 23 illustrates a possible routine for determining when a GET or READ must be reissued. Also, you should not issue multiple input requests (that is, a series of READ macro instructions) in your program. If you do, you will have to arrange some way to determine which requests have been completed and which must be reissued. These restrictions do not apply to "like" data sets, because no OPEN or CLOSE operation is necessary between data sets.

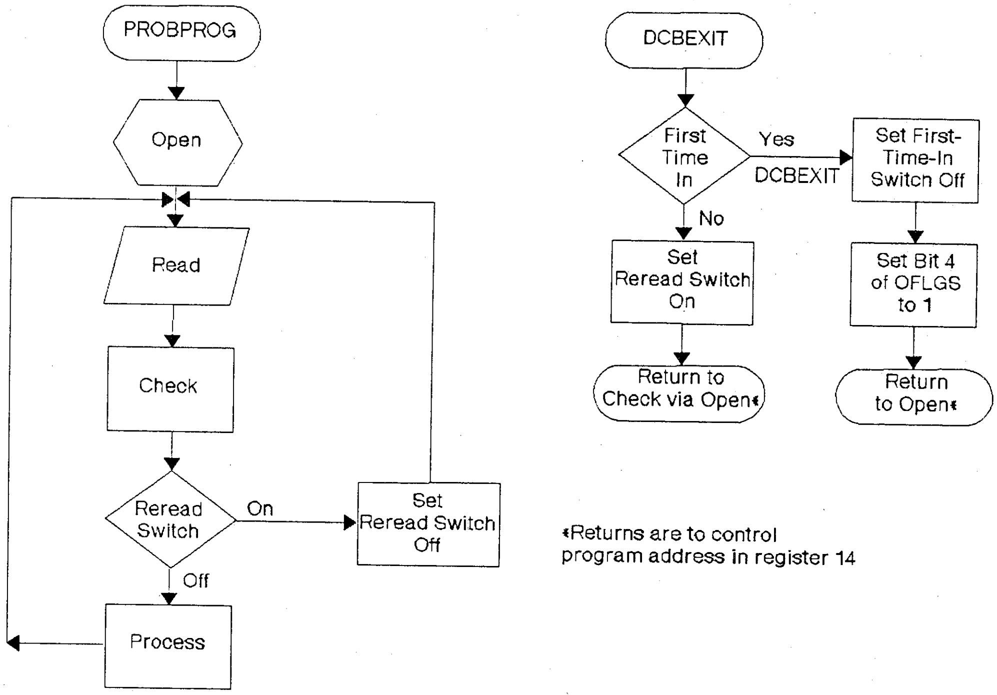


Figure 23. Reissuing a READ or GET for Unlike Concatenated Data Sets

When the change from one data set to another is made, label exits are taken as required; automatic volume switching is also performed for multiple volume data sets. Your end-of-data-set (EODAD) routine is not entered until the last data set has been processed.

To save time when processing two consecutive sequential data sets on a single tape volume, you specify LEAVE in your OPEN macro instruction. Concatenated data sets cannot be read backward.

Processing with Chained Scheduling

To accelerate the input/output operations required for a data set, the operating system provides a technique called chained scheduling. When requested, the system bypasses the normal I/O routines and dynamically chains several input/output operations together. A series of separate read or write operations, functioning with chained scheduling, is issued to the computing system as one continuous operation. In a nonpageable (V=R) address space, the program-controlled interruption (PCI) flag in the CCWs cause the PCI appendage to get control and dynamically chain the next I/O request to the currently executing channel program.

The I/O performance is improved by reduction in both the processor time and the channel start/stop time required to transfer data within virtual storage. Some factors that affect performance improvement are:

- Address space type (real or virtual)
- BUFNO for QSAM
- The number of overlapped requests for BSAM (NCP)
- Other activity on the processor and channel

Chained scheduling can be used only with simple buffering. Each data set for which chained scheduling is specified must be assigned at least two and preferably more buffers with QSAM, or must have a value of at least two and preferably more for NCP with BSAM or BPAM.

The system defaults to chained scheduling for nondirect access devices (other than printers and format-U records), except for those cases in which it is not allowed.

A request for exchange buffering in MVS/DFP is not honored, but compatibly defaults to move mode and therefore has no effect on either a request for chained scheduling or a default to chained scheduling.

A request for chained scheduling is ignored and normal scheduling used if any of the following are encountered when the data set is opened:

- CNTRL macro to be used.
- Bypassing of embedded DOS checkpoint records on tape input.
- Spooled data sets (SYSIN or SYSOUT).
- NCP=1 or BUFNO=1
- A print data set or any associated data set for the 3525 Card Punch. (For more information about programming the 3525, see *Programming Support for the IBM 3505 Card Reader and the IBM 3525 Card Punch.*)

The number of channel program segments that can be chained is limited to the value specified in the NCP operand of BSAM DCBs, and to the value specified in the BUFNO operand of QSAM DCBs.

When the data set is a printer, chained scheduling is not supported (DCB=OPTCD=C) when channel 9 or channel 12 is in the carriage control tape or FCB.

When chained scheduling is being used, the automatic skip feature of the PRTOV macro for the printer will not function. Format control must be achieved by ANSI or machine control characters. (Control characters are discussed in more detail under "Carriage Control Character" on page 30, under "Record Format—Device Type Considerations" on page 27, and under Appendix B, "Control Characters" on page 135.) When you are using QSAM under chained scheduling to read variable-length, blocked, ASCII tape records (format-DB), you must code BUFOFF=L in the DCB for that data set.

Note also that, if you are using BSAM with the chained scheduling option to read format-DB records and have coded a value for the BUFOFF operand other than BUFOFF=L, the input buffers will be converted from ASCII to EBCDIC as usual, but the record length returned to the DCBLRECL field will equal the block size, not the actual length of the record read in; the record descriptor word (RDW), if present, will not have been converted from ASCII to binary.

Chained scheduling is most valuable for programs that require extensive input and output operations. Because a data set using chained scheduling may monopolize available time on a channel in a V=R region, separate channels should be assigned, if possible, when more than one data set is to be processed.

Notes:

1. Chained scheduling is not a DASD option; it is built into the access method for DASD.

Chained Scheduling Functions for DASD

For direct access storage devices (DASD), chained scheduling is not supported. (If the chained scheduling option is specified for DASD, it is ignored.) Instead, the functions of chained scheduling are performed directly by the sequential access method (either BSAM or QSAM).

In QSAM, the value of BUFNO determines how many channel programs or I/O requests will be chained together before I/O is initiated. The default value of BUFNO is 5; when five buffers are full (that is, five I/O requests have been issued), QSAM reads or writes all five records in a single revolution of the disk.

In BSAM, the first READ or WRITE instruction initiates I/O. Subsequent I/O requests (without an associated CHECK or WAIT instruction) will be put in a queue, and the channel program associated with the request will be chained to the previous request in the queue. During channel end processing for the first I/O request, the queue is checked for pending I/O requests and the next request in the queue is started using the channel end appendage. The number of I/O requests that may be chained together is limited to the number of requests that can be handled in one I/O event (and one revolution of the disk) before channel end processing is complete.

Search Direct for Input Operations

To accelerate the input operations required for a data set on DASD, the operating system uses a technique called search direct. Search direct reads in the requested record and the count field of the next record. This allows the operation to get the next record directly, along with the count field of the following record.

You may receive unpredictable results when your application has a dependency that is incompatible with the use of search direct. For example, you may receive unpredictable results when multiple DCBs are open for a file and one of the applications is adding records.

Determining the Length of a Record on Input

When you read a sequential data set, you can determine the length of the record in one of the following five ways, depending on the record format of the data set:

1. For fixed-length, unblocked records, the length of all records is the value in the DCBBLKSI field of the DCB.
2. For variable-length records, the block descriptor word in the record contains the length of the record.
3. For fixed-length blocked or undefined-length records, the following method can be used to calculate the block length. This method can be used with BSAM, BDAM, or BPAM. (This method should not be used when reading track overflow records or when using chained scheduling with format-U records. In these cases, the length of a record cannot be determined.) After checking the DECB for the READ request but before issuing any subsequent data management macros that specify the DCB for the READ request, obtain the IOB address from the DECB. The IOB address can be loaded from the location 16 bytes from the start of the DECB.

   Obtain the residual count from the channel status word (CSW) that has been stored in the input/output block (IOB). The residual count is in the halfword, 14 bytes from the start of the IOB. For SYSIN or SYSOUT data sets, the residual count can also be found in bytes 2 and 3 of the first word of the DECB. Subtract this residual count from the number of data bytes requested to be read by the READ macro instruction. If 'S' was coded as the length parameter of the READ macro, the number of bytes requested is the value of DCBBLKSI at the time the READ was issued. If the length was coded in the READ macro, this value is the number of data bytes and it is contained in the halfword 6 bytes from the beginning of the DECB. The result of the subtraction is the length of the block read. See Figure 24 on page 84.

```
          ....
          OPEN      (DCB,(INPUT))
          LA        DCBR,DCB
          USING     IHADCB,DCBR
          ...
          READ      DECB1,SF,DCB,AREA1,'S'
          READ      DECB2,SF,DCB,AREA2,50
          ...
          CHECK     DECB1
          LH        WORK1,DCBBLKSI                Block size at time of READ
          L         WORK2,DECB1+16                IOB address
          SH        WORK1,14(WORK2)               WORK1 has block length
          ...
          CHECK     DECB2
          LH        WORK1,DECB2+6                 Length requested
          L         WORK2,DECB2+16                IOB address
          SH        WORK1,14(WORK2)               WORK1 has block length
          ...
          MVC       DCBBLKSI,LENGTH3              Length to be read
          READ      DECB3,SF,DCB,AREA3
          ...
          CHECK     DECB3
          LH        WORK1,LENGTH3                 Block size at time of READ
          L         WORK2,DECB+16                 IOB address
          SH        WORK1,14(WORK2)               WORK1 has block length
          ...
DCB       DCB       ...RECFM=U,NCP=2,...
          DCBD
          ...
```

Figure 24. One Method of Determining the Length of the Record When Using BSAM to Read Undefined-Length Records

4. When an undefined-length record is read, the actual length of the record is returned in the DCBLRECL field of the data control block. Because of this use of DCBLRECL, the LRECL operand should be omitted. This method can only be used with QSAM and BSAM.

5. The length to be read or written can be supplied dynamically in a READ/WRITE macro using BSAM. This method cannot be used when using chained scheduling on any nondirect access device.

Writing a Short Block When Using the BSAM WRITE Macro

If you have fixed-blocked record format, you can change the length of a block when you are writing blocks for a sequential data set. The DCB block size field (DCBBLKSI) can be changed to specify a block size that is shorter than what was originally specified for the data set. The DCBBLKSI field must be changed before issuing the WRITE macro instruction and must be a multiple of the LRECL parameter in the DCB. Any subsequent WRITE macros issued will write records with the new block length until the block size is changed again. The DCB block size field should not be changed to specify a block size that is greater than what was originally specified for the data set.

Managing SAM Buffer Space

The operating system provides several methods of buffer acquisition and control. Each buffer (virtual storage area used for intermediate storage of input/output data) usually corresponds in length to the size of a block in the data set being processed. When you use the queued access method, any reference to a buffer actually refers to the next record (buffer segment).

You can assign more than one buffer to a data set by associating the buffer with a buffer pool. A buffer pool must be constructed in a virtual storage area allocated for a given number of buffers of a given length.

The number of buffers you assign to a data set should be a trade-off against the frequency with which you refer to each buffer. A buffer that is not referred to for a fairly long period may be paged out. If this were allowed to happen to any considerable degree, it could decrease throughput.

Buffer segments and buffers within the buffer pool are controlled automatically by the system when the queued access method is used. However, you can tell the system you are finished processing the data in a buffer by issuing a release (RELSE) macro for input or a truncate (TRUNC) macro instruction for output. The simple buffering technique can be used to process a sequential data set or an indexed sequential data set.

If you use the basic access methods, you can use buffers as work areas rather than as intermediate storage areas. You can control them directly, by using the GETBUF and FREEBUF macros, or dynamically for BDAM and BISAM, by requesting dynamic buffering in your DCB macro instruction and your READ or WRITE macro. If you request dynamic buffering, the system will automatically provide a buffer each time a READ macro is issued. That buffer will be freed when you issue a WRITE or FREEDBUF macro instruction.

Buffer Pool Construction

Buffer pool construction can be accomplished in any of three ways:

- Statically, using the BUILD macro
- Explicitly, using the GETPOOL macro
- Automatically, by the system, when the data set is opened

If QSAM simple buffering is used, the buffers are automatically returned to the pool when the data set is closed. If the buffer pool is constructed explicitly or automatically, the virtual storage area must be returned to the system by the FREEPOOL macro.

In many applications, fullword or doubleword alignment of a block within a buffer is important. You can specify in the DCB that buffers are to start on either a doubleword boundary or a fullword boundary that is not also a doubleword boundary (by coding BFALN=D or F). If doubleword alignment is specified for format-V records, the fifth byte of the first record in the block is so aligned. For that reason, fullword alignment must be requested to align the first byte of the variable-length record on a doubleword boundary. The alignment of the records following the first in the block depends on the length of the previous records.

Note that buffer alignment provides alignment only for the buffer. If records from ISCII/ASCII magnetic tape are read and the records use the block prefix, the boundary alignment of logical records within the buffer depends on the length of the block prefix. If the length is 4, logical records are on fullword boundaries. If the length is 8, logical records are on doubleword boundaries.

If the BUILD macro is used to construct the buffer pool, alignment depends on the alignment of the first byte of the reserved storage area.

When you process multiple QISAM data sets, you can use a common buffer pool. To do this, however, you must use the BUILD macro instruction to reformat the buffer pool before opening each data set.

BUILD—Construct a Buffer Pool

When you know, before program assembly, both the number and the size of the buffers required for a given data set, you can reserve an area of appropriate size to be used as a buffer pool. Any type of area can be used—for example, a predefined storage area or an area of coding no longer needed.

A BUILD macro, issued during execution of your program, structures the reserved storage area into a buffer pool. The address of the buffer pool must be the same as that specified for the buffer pool control block (BUFCB) in your DCB. The buffer pool control block is an 8-byte field preceding the buffers in the buffer pool. The number (BUFNO) and length (BUFL) of the buffers must also be specified. The length of BUFL must be at least the block size.

When the data set using the buffer pool is closed, you can reuse the area as required. You can also reissue the BUILD macro to reconstruct the area into a new buffer pool to be used by another data set.

You can assign the buffer pool to two or more data sets that require buffers of the same length. To do this, you must construct an area large enough to accommodate the total number of buffers required at any one time during execution. That is, if each of two data sets requires 5 buffers (BUFNO=5), the BUILD macro should specify 10 buffers. The area must also be large enough to contain the 8-byte buffer pool control block.

BUILDRCD—Build a Buffer Pool and a Record Area

The BUILDRCD macro, like the BUILD macro, causes a buffer pool to be constructed in an area of virtual storage you provide. In addition, BUILDRCD makes it possible for you to access variable-length, spanned records as complete logical records, rather than as segments.

You must be processing with QSAM in the locate mode and you must be processing either VS/VBS or DS/DBS records, if you want to access the variable-length, spanned records as logical records. If you issue the BUILDRCD macro before the data set is opened, or during your DCB exit routine, you automatically get logical records rather than segments of spanned records.

Only one logical record storage area is built, no matter how many buffers are specified; therefore, you can't share the buffer pool with other data sets that may be open at the same time.

GETPOOL—Get a Buffer Pool

If a specified area is not reserved for use as a buffer pool, or if you want to defer specifying the number and length of the buffers until execution of your program, you should use the GETPOOL macro instruction. It allows you to vary the size and number of buffers according to the needs of the data set being processed.

The GETPOOL macro causes the system to allocate a virtual storage area to a buffer pool. The system builds a buffer pool control block and stores its address in the data set's DCB. The GETPOOL macro should be issued either before opening of the data set or during your DCB's OPEN exit routine.

When using GETPOOL with QSAM, specify a buffer length (BUFL) at least as large as the block size.

Automatic Buffer Pool Construction

If you have requested a buffer pool and have not used an appropriate macro by the end of your DCB exit routine, the system automatically allocates virtual storage space for a buffer pool. The buffer pool control block is also assigned and the pool is associated with a specific DCB. For BSAM, a buffer pool is requested by specifying BUFNO. For QSAM, BUFNO can be specified or allowed to default to 5. If you are using the basic access method to process an indexed sequential or direct data set, you must indicate dynamic buffer control. Otherwise, the system does not construct the buffer pool automatically.

Because a buffer pool obtained automatically is not freed automatically when you issue a CLOSE macro, you should also issue a FREEPOOL or FREEMAIN macro (discussed in the next section).

FREEPOOL—Free a Buffer Pool

Any buffer pool assigned to a DCB either automatically by the OPEN macro (except when dynamic buffer control is used) or explicitly by the GETPOOL macro should be released before your program is terminated. The FREEPOOL macro should be issued to release the virtual storage area as soon as the buffers are no longer needed. When you are using the queued access technique, you must close the data set first. If you are not using the queued access method, it is still advisable to close the data set first.

If the OPEN macro was issued while running under a protect key of zero, a buffer pool that was obtained by OPEN should be released by issuing the FREEMAIN macro instead of the FREEPOOL macro. This is necessary because the buffer pool acquired under these conditions will be in storage assigned to subpool 252.

Constructing a Buffer Pool

Figure 25 and Figure 26 on page 89 show several possible methods of constructing a buffer pool. They do not consider the method of processing or controlling the buffers in the pool.

In Figure 25, a static storage area named INPOOL is allocated during program assembly. The BUILD macro, issued during execution, arranges the buffer pool into 10 buffers, each 52 bytes long. Five buffers are assigned to INDCB and 5 to OUTDCB, as specified in the DCB macro for each. The two data sets share the buffer pool because both specify INPOOL as the buffer pool control block. Notice that an additional 8 bytes have been allocated for the buffer pool to contain the buffer pool control block. The 4-byte chain pointer that occupies the first 4 bytes of the buffer is included in the buffer, so no allowance need be made for this field.

```
          ...                            Processing
          BUILD     INPOOL,10,52         Structure a buffer pool
          OPEN      (INDCB,,OUTDCB,(OUTPUT))
          ...                            Processing
ENDJOB    CLOSE     (INDCB,,OUTDCB)
          ...                            Processing
          RETURN                         Return to system control
INDCB     DCB       BUFNO=5,BUFCB=INPOOL,EODAD=ENDJOB,---
OUTDCB    DCB       BUFNO=5,BUFCB=INPOOL,---
CNOP      0,8                            Force boundary alignment
INPOOL    DS        CL528                Buffer pool
          ...
```

Figure 25. Constructing a Buffer Pool from a Static Storage Area

In Figure 26 on page 89, two buffer pools are constructed explicitly by the GETPOOL macros. Ten input buffers are provided, each 52 bytes long, to contain one fixed-length record; 5 output buffers are provided, each 112 bytes long, to contain 2 blocked records plus an 8-byte count field (required by ISAM). Notice that both data sets are closed before the buffer pools are released by the FREEPOOL macros. The same procedure should be used if the buffer pools were constructed automatically by the OPEN macro.

```
          ...
          GETPOOL    INDCB,10,52            Construct a 10-buffer pool
          GETPOOL    OUTDCB,5,112           Construct a 5-buffer pool
          OPEN       (INDCB,,OUTDCB,(OUTPUT))
          ...
ENDJOB    CLOSE      (INDCB,,OUTDCB)
          FREEPOOL   INDCB                  Release buffer pools after all
                                            I/O is complete
          FREEPOOL   OUTDCB
          ...
          RETURN                            Return to system control
INDCB     DCB        DSORG=PS,BFALN=F,LRECL=52,RECFM=F,EODAD=ENDJOB,---
OUTDCB    DCB        DSORG=IS,BFALN=D,LRECL=52,KEYLEN=10,BLKSIZE=104,       C
          ...    RKP=0,RECFM=FB,---
```

Figure 26. Constructing a Buffer Pool Using GETPOOL and FREEPOOL

Buffer Control

Your program can use any of four techniques to control the buffers used by your program. The advantages of each depend to a great extent on the type of job you are doing. Simple buffering is provided for the queued access method. The basic access method provides for either direct or dynamic buffer control.

Although only simple buffering can be used to process an indexed sequential data set, buffer segments and buffers within a buffer pool are controlled automatically by the operating system.

In addition, the queued access method provides three processing modes that determine the extent of data movement in virtual storage. Move, data, and locate mode processing can be specified for either the GET or PUT macro. (Substitute mode is no longer supported; the system defaults to move mode.) The movement of a record is determined as follows:

- *Move mode*—The record is moved from a system input buffer to your work area, or from your work area to an output buffer.
- *Data mode (QSAM format-V spanned records only)*—The same as the move mode, except that only the data portion of the record is moved.
- *Locate mode*—The record is not moved. Instead, the address of the next input or output buffer is placed in register 1. For QSAM format-V spanned records, if you have specified logical records by specifying BFTEK=A or by issuing the BUILDRCD macro, the address returned in register 1 points to a record area where the spanned record is assembled or segmented.

  The PUT-locate routine uses the value in the DCBLRECL field to determine whether another record will fit into your buffer. Therefore, when you write a short record, you can maximize the number of records per block by modifying the DCBLRECL field before you issue a PUT-locate to get a buffer segment for the short record. The processing sequence follows:

  1. Register 1 is returned to you with the address of the next buffer segment.
  2. Move the record into the output buffer segment.

3. Put the length of the next (short) record into DCBLRECL.
4. Issue PUT-locate.
5. Move the short record into the buffer segment.

Two processing modes of the PUTX macro can be used with a GET-locate macro. The update mode returns an updated record to the data set from which it was read; the output mode transfers an updated record to an output data set. There is no actual movement of data in virtual storage. The processing mode is specified by the operand of the PUTX macro, as explained in *Data Administration: Macro Instruction Reference.*

If you use the basic access method, you can control buffers in one of two ways:

- Directly, using the GETBUF macro to retrieve a buffer constructed as described above. A buffer can then be returned to the pool by the FREEBUF macro.
- Dynamically, by requesting a dynamic buffer in your READ or WRITE macro. This technique can be used only when you are using BISAM or BDAM. If you request dynamic buffering, the system automatically provides a buffer each time a READ macro is issued. The buffer is supplied from a buffer pool that is created by the system when the data set is opened. The buffer is released (returned to the pool) upon completion of a WRITE macro instruction when you are updating. If you do not update the record in the buffer and thus release the buffer without writing the record, the FREEDBUF macro may be used. If you are processing an indexed sequential data set, the buffer is automatically released upon the next issuance of the READ macro instruction if there has been no intervening WRITE or FREEDBUF macro.

Simple Buffering

The term simple buffering refers to the relationship of segments within the buffer. All segments in a simple buffer are together in storage and are always associated with the same data set. When the buffer pool is constructed, the system creates a channel command word (CCW) for each buffer in the buffer pool. So, each record must be physically moved from an input buffer segment to an output buffer segment. It can be processed within either segment or in a work area.

If you use simple buffering, records of any format can be processed. New records can be inserted and old records deleted as required to create a new data set. A record can be moved and processed as follows:

- Processed in an input buffer and then moved to an output buffer (GET-locate, PUT-move/PUTX-output)
- Moved from an input buffer to an output buffer where it can be processed (GET-move, PUT-locate)
- Moved from an input buffer to a work area where it can be processed and then moved to an output buffer (GET-move, PUT-move)
- Processed in an input buffer and returned to the same data set (GET-locate, PUTX-update)

The following examples show the control of simple buffers and the processing modes that can be used. The buffer pools may have been constructed in any way previously described.

Simple Buffering—GET-locate, PUT-move/PUTX-output: The GET macro (step A, Figure 27) locates the next input record to be processed. Its address is returned in register 1 by the system. The address is passed to the PUT macro in register 0.

The PUT macro (step B, Figure 27) specifies the address of the record in register 0. The system then moves the record to the next output buffer.

Note: The PUTX-output macro can be used in place of the PUT-move macro. However, processing will be as described under "Exchange Buffering" (see PUT-substitute).

Simple Buffering—GET-move, PUT-locate: The PUT macro locates the address of the next available output buffer. Its address is returned in register 1 and is passed to the GET macro in register 0.

The GET macro specifies the address of the output buffer into which the system moves the next input record.

A filled output buffer is not written until the next PUT macro instruction is issued.

Simple Buffering—GET-move, PUT-move: The GET macro (step A, Figure 28 on page 92) specifies the address of a work area into which the system moves the next record from the input buffer.

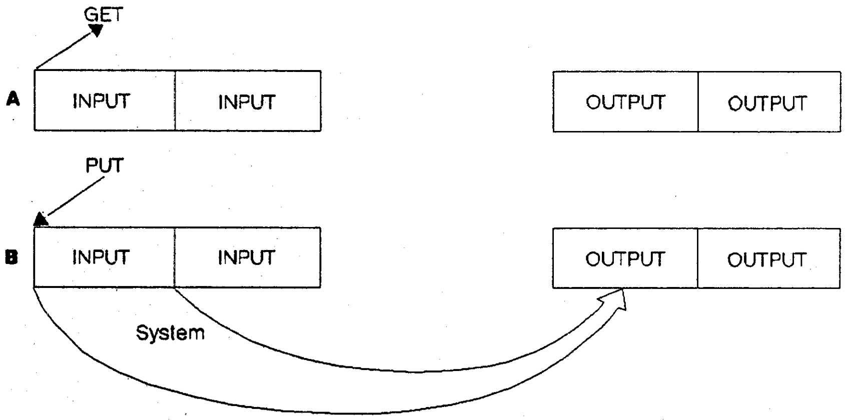


Figure 27. Simple Buffering with MACRF=GL and MACRF=PM

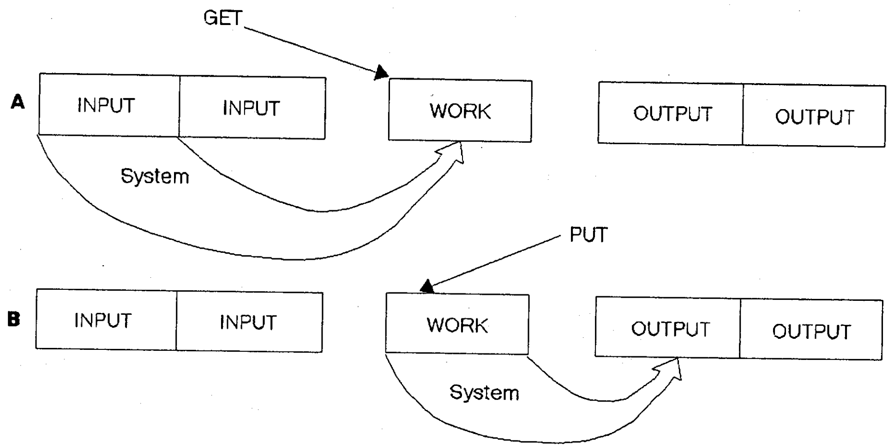


Figure 28. Simple Buffering with MACRF=GM and MACRF=PM

The PUT macro (step B, Figure 28) specifies the address of a work area from which the system moves the record into the next output buffer.

Simple Buffering—GET-locate, PUT-locate: The GET macro (step A, Figure 29) locates the address of the next available input buffer. The address is returned in register 1.

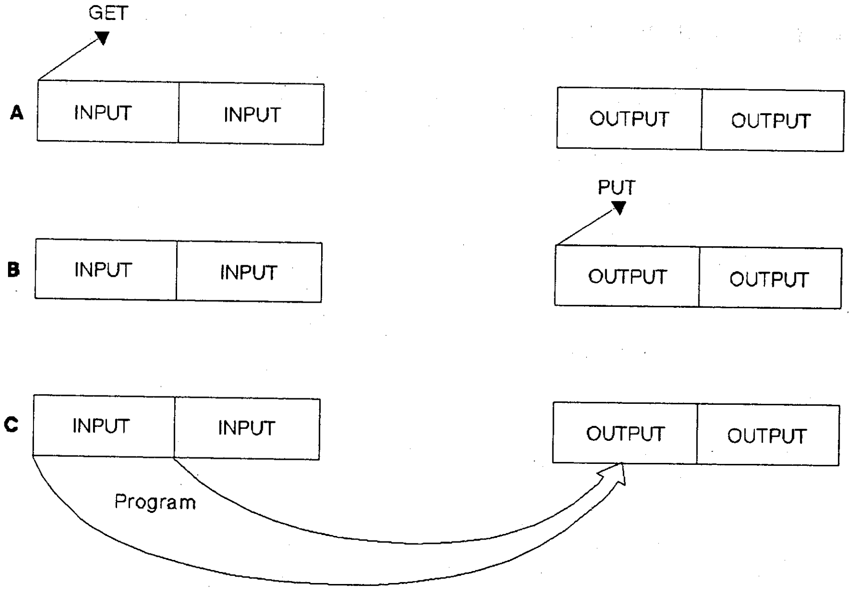
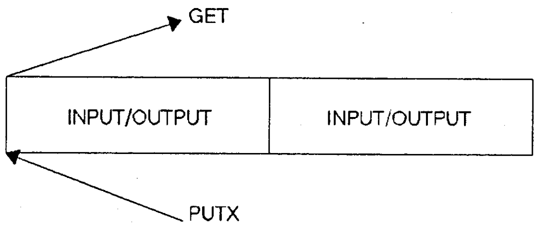


Figure 29. Simple Buffering with MACRF=GL and MACRF=PL

The PUT macro (step B, Figure 29) locates the address of the next available output buffer. Its address is returned in register 1. You must then move the record from the input buffer to the output buffer (step C, Figure 29). Processing can be done either before or after the move operation.

A filled output buffer is not written until the next PUT macro instruction is issued. The CLOSE and FEOV macros write the last record of your data set by issuing TRUNC and PUT macro instructions. Be careful not to issue an extra PUT before issuing CLOSE or FEOV. Otherwise, when the CLOSE or FEOV macro tries to write your last record, the extra PUT will write a meaningless record or produce a sequence error.

Simple Buffering—UPDAT Mode: When a data set is opened with UPDAT specified (Figure 30), only GET-locate and PUTX-update are supported. The GET macro locates the next input record to be processed and its address is returned in register 1 by the system. The user may update the record and issue a PUTX macro that will cause the block to be written back in its original location in the data set after all the logical records in that block have been processed.



(No movement of data takes place)

Figure 30. Simple Buffering with MACRF=GL and MACRF=PM-UPDAT Mode

Exchange Buffering

Exchange buffering is not supported in MVS/DFP. Its request is ignored by the system and move mode is used instead.

Buffering Techniques and GET/PUT Processing Modes

As you can see from the previous examples, the most efficient code is achieved by use of automatic buffer pool construction, and GET-locate and PUTX-output with simple buffering. Figure 31 summarizes the combinations of buffering techniques and processing modes that can be used.

Simple Input Buffering → **Actions** ↓	GET-move, PUT-locate	GET-move, Put-move	GET-locate, PUT-locate	GET-locate, PUT-move	GET-locate (logical record), PUT-locate
Program must move record			X		X
System moves record	X	X		X	
System moves record segment					X
Work area required		X			
PUTX - output can be used				X	

Figure 31. Buffering Technique and GET/PUT Processing Modes

RELSE—Release an Input Buffer

When using the queued access method to process a sequential or an indexed sequential data set, you can direct the system to ignore the remaining records in the input buffer being processed. The next GET macro retrieves a record from another buffer. If format-V spanned records are being used, the next logical record obtained may begin on any segment in any subsequent block.

If you are using move mode, the buffer is made available for refilling as soon as the RELSE macro is issued. When you are using locate mode, the system does not refill the buffer until the next GET macro is issued. If a PUTX macro has been used, the block is written before the buffer is refilled.

TRUNC—Truncate an Output Buffer

When using the queued access method to process a sequential data set, you can direct the system to write a short block. The first record in the next buffer is the next record processed by a PUT-output or PUTX-output mode. If locate mode is being used, the system assumes that a record has been placed in the buffer segment pointed to by the last PUT macro. The last block of a data set is truncated by the close routine. Note that a data set containing format-F records with truncated blocks cannot be read from direct access storage as efficiently as a standard format-F data set.

GETBUF—Get a Buffer from a Pool

The GETBUF macro can be used with the basic access technique to request a buffer from a buffer pool constructed by the BUILD, GETPOOL, or OPEN macro. The address of the buffer is returned by the system in a register you specify when you issue the macro. If no buffer is available, the register contains a 0 instead of an address.

FREEBUF—Return a Buffer to a Pool

The FREEBUF macro is used with the basic access method to return a buffer to the buffer pool from which it was obtained by a GETBUF macro. Although the buffers need not be returned in the order in which they were obtained, they must be returned when they are no longer needed.

FREEDBUF—Return a Dynamic Buffer to a Pool

Any buffer obtained through the dynamic buffer option must be released before it can be used again. When you are processing a direct data set, if you do not update the block in the buffer and thus need to free the buffer instead of writing the block, you must use the FREEDBUF macro. If an uncorrectable input/output error occurs while writing a data set, the control program releases the buffer. If an uncorrectable input/output error occurs while reading a data set and a SYNAD routine is present, issue the FREEDBUF macro to release the buffer before continuing further input/output operations.

When you are processing an indexed sequential data set, if you do not update the block in the buffer or, if there is an uncorrectable input error, the control program releases the buffer when the next READ macro is issued on the same DECB, unless you use the FREEDBUF macro. To effect the release, you must specify the address of the DECB that was used when the block was read using the dynamic buffering option and the address of the DCB associated with the data set being processed.

End of General-Use Programming Interface

Chapter 9. Processing a Partitioned Data Set

A partitioned data set is stored only on a direct access device. It is divided into sequentially organized members, each composed of one or more records (see Figure 32). Each member has a unique name, 1 to 8 characters long, stored in a directory that is part of the data set. The records of a given member are written or retrieved sequentially. See *Data Administration: Macro Instruction Reference* for the macros used with partitioned data sets.

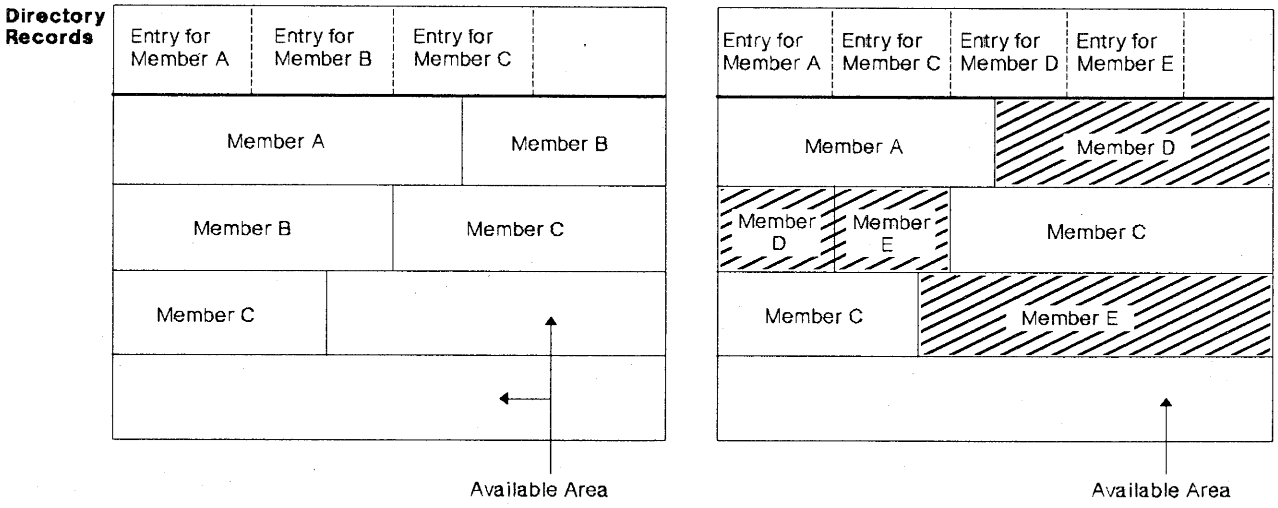


Figure 32. A Partitioned Data Set

The main advantage of using a partitioned data set is that, without searching the entire data set, you can retrieve any individual member after the data set is opened. For example, in a program library that is always a partitioned data set, each member is a separate program or subroutine. The individual members can be added or deleted as required. When a member is deleted, the member name is removed from the directory, but the space used by the member cannot be reused until the data set is reorganized; that is, compressed using the IEBCOPY utility.

The directory, a series of 256-byte records at the beginning of the data set, contains an entry for each member. Each directory entry contains the member name and the starting location of the member within the data set, as shown in Figure 32. Also, you can specify as many as 62 bytes of information in the entry. The directory entries are arranged by name in alphanumeric collating sequence.

The starting location of each member is recorded by the system as a relative track address (from the beginning of the data set) rather than as an absolute track address. Thus, an entire data set that has been compressed, can be moved without changing the relative track addresses in the directory. The data set can be considered as one continuous set of tracks regardless of where the space was actually allocated.

If there is not sufficient space available in the directory for an additional entry, or not enough space available within the data set for an additional member, or no room on the volume for additional extents, no new members can be stored.

A directory cannot be extended and a partitioned data set may not cross a volume boundary.

Partitioned Data Set Directory

The directory of a partitioned data set occupies the beginning of the area allocated to the data set on a direct access volume. It is searched and maintained by the BLDL, FIND, and STOW macros. The directory consists of member entries arranged in ascending order according to the binary value of the member name or alias.

Partitioned data set member entries vary in length and are blocked into 256-byte blocks. Each block contains as many complete entries as will fit in a maximum of 254 bytes; any remaining bytes are left unused and are ignored. Each directory block contains a 2-byte count field that specifies the number of active bytes in a block (including the count field). As shown in Figure 33, each block is preceded by a hardware-defined key field containing the name of the last member entry in the block, that is, the member name with the highest binary value. Figure 33 shows the format of the block returned when using BSAM to read the directory.

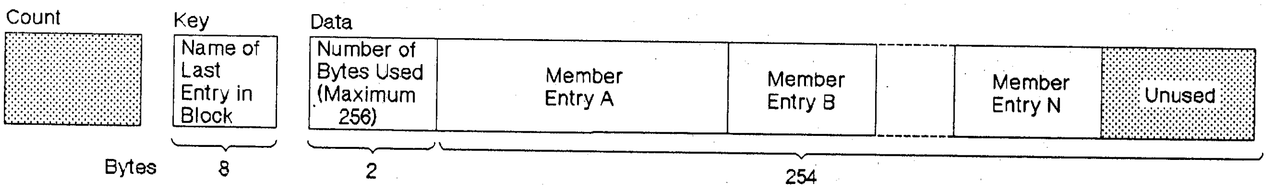


Figure 33. A Partitioned Data Set Directory Block

Each member entry contains a member name or an alias. Each entry also contains the relative track address of the member and a count field, as shown in Figure 34. Also, it may contain a user data field. The last entry in the last directory block has a name field of maximum binary value—all 1′s.

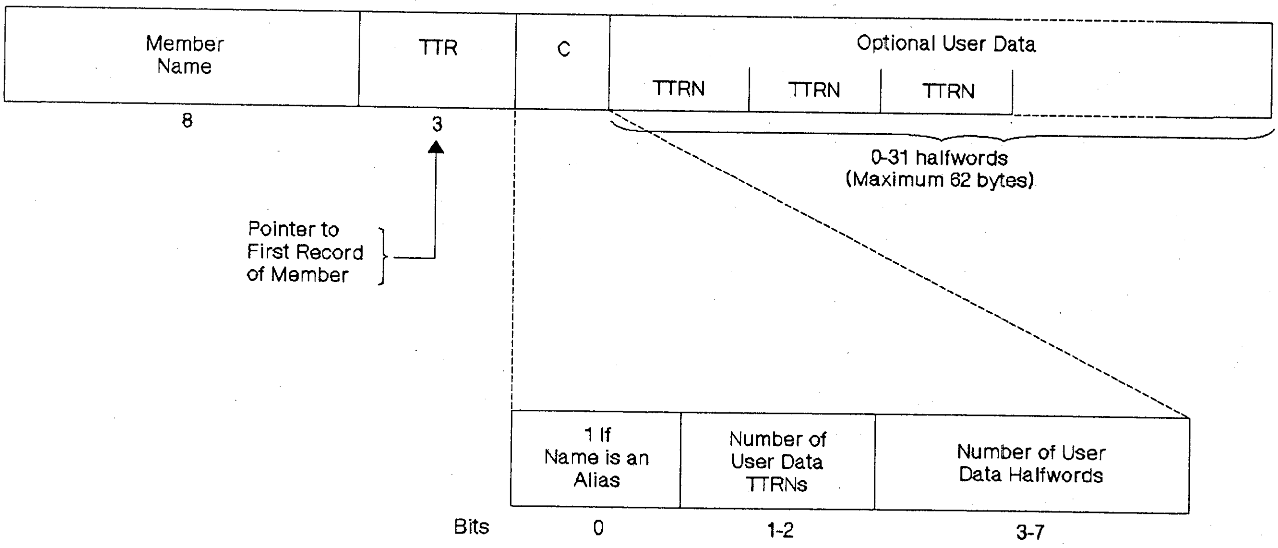

Member Name
TTR
C
Optional User Data
TTRN
TTRN
TTRN
8
3
0-31 halfwords (Maximum 62 bytes)
Pointer to First Record of Member
1 If Name is an Alias
Number of User Data TTRNs
Number of User Data Halfwords
Bits
0
1-2
3-7

Figure 34. A Partitioned Data Set Directory Entry

NAME

specifies the member name or alias. It contains as many as 8 alphameric characters, left-justified, and padded with blanks if necessary.

TTR

is a pointer to the first block of the member. TT is the number of the track, relative to the beginning of the data set, and R is the number of the block, relative to the beginning of that track.

C

specifies the number of halfwords contained in the user data field. It may also contain additional information about the user data field, as shown below:

Bits	0	1-2	3-7

0 when set to 1, indicates that the NAME field contains an alias.

1-2 specifies the number of pointers to locations within the member.

The operating system supports a maximum of three pointers in the user data field. Additional pointers may be contained in a record called a "note list," discussed below. The pointers can be updated automatically if the data set is moved or copied by a utility program such as IEHMOVE. The data set must be marked unmovable under the following conditions:

- More than three pointers are used in the user data field.
- The pointers in the user data field or note list do not conform to the standard format.

  Note: A note list for a partitioned data set containing variable length records does not conform to standard format. Variable-length records contain BDWs and RDWs that are treated as TTRXs by IEHMOVE.

- The pointers are not placed first in the user data field.
- Any direct access address (absolute or relative) is embedded in any data blocks or in another data set that refers to this data set.

3-7 contains a binary value indicating the number of halfwords of user data. This number must include the space used by pointers in the user data field.

You can use the user data field to provide variable data as input to the STOW macro. If pointers to locations within the member are provided, they must be 4 bytes long and placed first in the user data field. The user data field format is as follows:

User Data

TTRN	TTRN	TTRN	Optional

TT is the relative track address of the note list or area to which you are pointing.

R is the relative block number on that track.

N is a binary value that indicates the number of additional pointers contained in a note list pointed to by the TTR. If the pointer is not to a note list, N=0.

A note list consists of additional pointers to blocks within the same member of a partitioned data set. You can divide a member into subgroups and store a pointer to the beginning of each subgroup in the note list. The member may be a load module containing many control sections (CSECTs), each CSECT being a subgroup pointed to by an entry in the note list. You get the pointer to the beginning of the subgroup by using the NOTE macro after you write the first record of the subgroup. Remember that the pointer to the first record of the member is stored in the directory entry by the system.

If the existence of a note list was indicated as shown above, the list can be updated automatically when the data set is moved or copied by a utility program such as IEHMOVE. Each 4-byte entry in the note list has the following format:

```
TTRX
```

TT is the relative track address of the area to which you are pointing.

R is the relative block number on that track.

X is available for any use.

To place the note list in the partitioned data set, you must use the WRITE macro. After checking the write operation, use the NOTE macro to determine the address of the list and place that address in the user data field of the directory entry.

Note: The linkage editor builds a note list for the load modules in overlay format. The addresses in the note list point to the overlay segments that are read into the system separately.

Allocating Space for a Partitioned Data Set

Use the SMS ACS routines to calculate the space requirements for your data set. See *Storage Administration Reference* for how to code the ACS routines. You can have the system determine an optimum block size for you. This eliminates the need for you to perform calculations based on track length. If you do not specify a block size, OPEN will determine an optimum block size for you. When you allocate space for your data set, you can specify the average record length in kilobytes or megabytes by using the SPACE and AVGREC parameters, and have the system use the block size it calculated for your data set.

If your data set will be large, or if you expect to update it extensively, it might be best to allocate a full volume. A partitioned data set cannot extend beyond one volume. If it will be small or seldom change, let the system calculate the space requirements to avoid wasted space or wasted time used for re-creating the data set.

If you wish to estimate the space requirements yourself, you need to answer the following questions to estimate your space requirements accurately and use the space efficiently.

- What is the average size of the members to be stored on your direct access volume?
- How many members will fit on the volume?
- Will you need directory entries for the member names only or will aliases be used? How many?
- Will members be added or replaced frequently?

You can calculate the block size yourself and specify it in the BLKSIZE parameter of the DCB. For example, if the average record length is close to or less than the track length or if the track length exceeds 32760 bytes, the most efficient use of the direct access storage space may be made with a block size of 1/3 or 1/2 the track length. You might then ask for either 75 tracks, or 5 cylinders, thus allowing for 3 480 000 bytes of data.

Each member in a data set and each alias need one directory entry apiece. If you expect to have 10 members (10 directory entries) and an average of 3 aliases for each member (30 directory entries), allocate space for at least 40 directory entries.

Assuming an average length of 70000 bytes for each member, you need space for at least 50 directory entries. If each member also has an average of three aliases, space for an additional 150 directory entries is required.

Space for the directory is expressed in 256-byte blocks. Each block contains from 3 to 21 entries, depending on the length of the user data field. If you expect 200 directory entries, request at least 40 blocks. Any unused space on the last track of the directory is wasted unless there is enough space left to contain a block of the first member.

Either of the following space specifications would cause the same size allocation for a 3380 Model AD4 disk:

```
SPACE=(CYL,(5,,10))

SPACE=(TRK,(75,,10))

SPACE=(23200,(150,,10))
```

The third example above would result in allocation of 75 tracks for data, plus 1 track for directory space. Ten blocks have been allocated for the directory.

You can also allocate space by using both the SPACE and AVGREC JCL keywords together. In the following examples, the average length is 70000 bytes for each member, and each record in the member is 80 bytes long. Using the AVGREC keyword changes the first value specified in SPACE from the average block length to average record length. These examples are device independent because they request space in bytes, rather than tracks or cylinders. They would allocate approximately the same amount of space as the previous examples (about 75 tracks if the device were a 3380 Model AD4 disk).

```
SPACE(80,(44,,10)),AVGREC=K

SPACE(80,(43500,,10)),AVGREC=U
```

For more information on using the SPACE and AVGREC parameters, see Appendix C, "Allocating Space on Direct Access Volumes" on page 139 in this manual, and also see *JCL User's Guide* and *JCL Reference*. See "Appendix C. Device Capacities" in *Data Administration: Macro Instruction Reference* for how to calculate the track capacity for various DASD models.

Although a secondary allocation increment has been omitted in these examples, it could have been supplied to provide for extension of the member area. The directory size, however, cannot be extended. The directory cannot be on secondary space.

Note: The SPACE parameter may be specified in either the data class, or the DD statement, or the LIKE keyword. You may specify the SPACE parameter in the DD statement if you do not want to use the space allocation amount defined in the data class.

Creating a Partitioned Data Set

If you have no need to add entries to the directory, you can create a new data set and write the first member as follows (see Figure 35 on page 101) without needing to use the STOW macro.

- Code DSORG=PS or DSORG=PSU in the DCB macro.
- Indicate in the DD statement that the data is to be stored as a member of a new partitioned data set, that is, DSNAME=name (membername) and DISP=NEW.
- Either specify a data class in the DD statement or, for SMS-managed DASD data sets, allow the ACS routines to assign a data class.
- Request space for the member and the directory in the DD statement, or obtain from data class.
- Process the member with an OPEN macro, a series of PUT or WRITE macros, and then a CLOSE macro instruction. A STOW macro is issued automatically when the data set is closed.

As a result of these steps, the data set and its directory are created, the records of the member are written, and a 12-byte entry is made in the directory.

```
//PDSDD  DD     ---,DSNAME=MASTFILE(MEMBERK),SPACE=(TRK,(100,5,7)),
                DISP=(NEW,CATLG),DCB=(RECFM=FB,LRECL=80,BLKSIZE=80)---

         ...
         OPEN   (OUTDCB,(OUTPUT))
         ...
         PUT    OUTDCB,OUTAREA       Write record to member
         ...
         CLOSE  (OUTDCB)             Automatic STOW
         ...
OUTAREA  DS     CL80                 Area to write from
OUTDCB   DCB    ---,DSORG=PS,DDNAME=PDSDD,MACRF=PM
```

Figure 35. Creating One Member of a Partitioned Data Set

Adding Several Members at a Time

To add additional members to the data set, follow the same procedure. However, a separate DD statement (with the space request omitted) is required for each member. The disposition should be specified as modify, DISP=MOD. The data set must be closed and reopened each time a new member is specified on the DD statement.

To take full advantage of the STOW macro, and thus the BLDL and FIND macros, in future processing, you can provide additional information with each directory entry. You do this by using the basic partitioned access methods, which also allows you to process more than one member without closing and reopening the data set, as follows (see Figure 36 on page 102).

- Request space in the DD statement for the entire data set and the directory.
- Define DSORG=PO or DSORG=POU in the DCB macro.
- Use WRITE and CHECK to write and check the member records.
- Use NOTE to note the location of any note list written within the member, if there is a note list, or to note the location of subgroups if there are any.
- When all the member records have been written, issue a STOW macro instruction to enter the member name, its location pointer, and any additional data in the directory. The STOW macro writes an end-of-file mark after the member.
- Continue to use the WRITE, CHECK, NOTE, and STOW macros until all the members of the data set and the directory entries have been written.

```
//PDSDD  DD    ---,DSN=MASTFILE,DISP=MOD,SPACE=(TRK,(100,5,7))

         ...
         OPEN  (OUTDCB,(OUTPUT))
         LA    STOWREG,STOWLIST   Load address of STOW list
         ...

**   WRITE MEMBER RECORDS AND NOTE LIST

MEMBER   WRITE DECBX,SF,OUTDCB,OUTAREA   WRITE  first record of member
         CHECK DECBX
         LA    NOTEREG,NOTELIST   Load address of NOTE list
*
         WRITE DECBY,SF,OUTDCB,OUTAREA   WRITE and CHECK next record
         CHECK DECBY
*
         NOTE  OUTDCB             To divide the member into subgroups,
         ST    R1,0(NOTEREG)      NOTE the TTRN of the first record in
*                                 the subgroup, storing it in the
*                                 NOTE list.
         LA    NOTEREG,4(NOTEREG)  Increment to next NOTE list entry
         ...
         WRITE DECBZ,SF,OUTDCB,NOTELIST   WRITE NOTE list record at the
*                                         end of the member
         CHECK DECBZ
         NOTE  OUTDCB              NOTE TTRN of NOTE list record
         ST    R1,12(STOWREG)      Store TTRN in STOW list
         STOW  OUTDCB,(STOWREG),A  Enter the information in directory
*                                  for this member after all records
*                                  and NOTE lists are written.
         LA    STOWREG,16(STOWREG) Increment to the next STOW list entry
         ...
*
```

Repeat from label "MEMBER" for each additional member, changing the member name in the "STOWLIST" for each member

```
*
         ...
         CLOSE (OUTDCB)       (NO automatic STOW)
         ...

OUTAREA  DS    CL80           Area to write from
OUTDCB   DCB   ---,DSORG=PO,DDNAME=PDSDD,MACRF=W
R1       EQU   1              Register one, return register from NOTE
NOTEREG  EQU   4              Register to address NOTE list
NOTELIST DS    0F             NOTE list
         DS    F              NOTE list entry  (4 byte TTRN)
         DS    19F            one entry per subgroup
STOWREG  EQU   5              Register to address STOW list
STOWLIST DS    0F             List of member names for STOW
         DC    CL8'MEMBERA'   Name of  member
         DS    CL3            TTR of first record (created by STOW)
         DC    X'23'          C byte, 1 user TTRN, 4 bytes of user data
         DS    CL4            TTRN of NOTE list
         ...                  one list entry per member (16 bytes each)
```

Figure 36. Creating Members of a Partitioned Data Set Using STOW

Processing a Member of a Partitioned Data Set

Because a member of a partitioned data set is sequentially organized, it is processed in the same manner as a sequential data set. Either the basic or queued access method can be used. However, you cannot alter the directory.

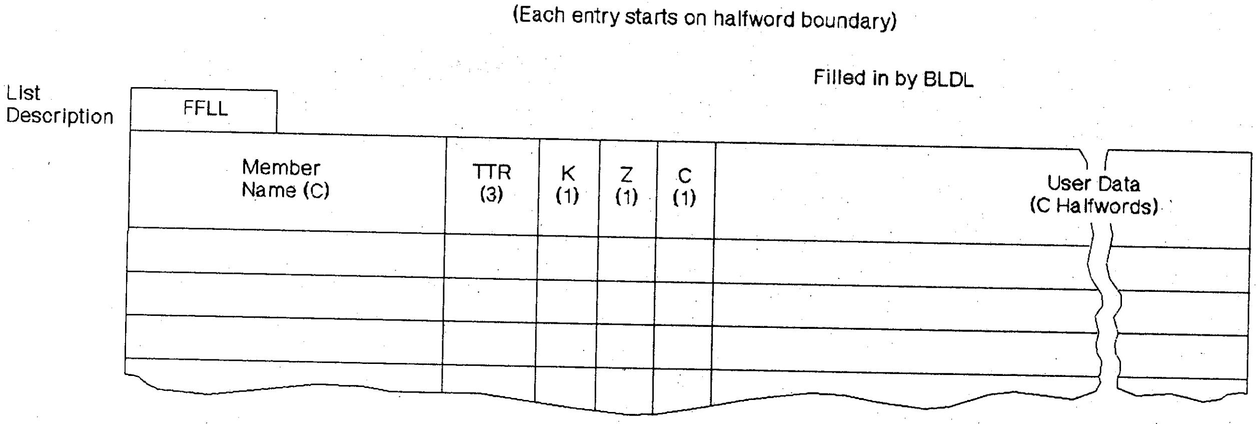
To locate a member or to process the directory, several macros are provided by the operating system. The BLDL macro can be used to read one or more directory entries into virtual storage; the FIND macro locates a member of the data set and positions the DCB for subsequent processing; the STOW macro adds, deletes, replaces, or changes a member name in the directory. To use these macros, you must specify DSORG=PO or POU in the DCB macro. Before issuing FIND, BLDL, or STOW macro, you must check all preceding input/output operations for completion.

BLDL—Construct a Directory Entry List

The BLDL macro reads one or more directory entries into virtual storage. The member names are placed in a BLDL list that is constructed before the BLDL macro is issued. For each member name in the list, the system supplies the address of the member and any additional information contained in the directory entry. Note that, if there is more than one member name in the list, the member names must be in collating sequence, regardless of whether the members are from the same partitioned data set or from different partitioned data sets.

You can improve retrieval time by directing a subsequent FIND macro instruction to the BLDL list rather than to the directory to locate the member to be processed.

The BLDL list, as shown in Figure 37 on page 104, must be preceded by a 4-byte list description that indicates the number of entries in the list and the length of each entry (12 to 76 bytes). The first 8 bytes of each entry contain the member name or alias. The next 6 bytes contain the TTR, K, Z, and C fields. If there is no user data entry, only the TTR and C fields are required. If additional information is to be supplied from the directory, as many as 62 bytes can be reserved.



Programmer Supplies:
FF Number of member entries in list.
LL Even number giving byte length of each entry (minimum of 12).
Member name Eight bytes, left-justified.

BLDL Supplies:
TTR Member starting location.
K If single data set = 0. If concatenation = number.
Not required if no user data.
Z Source of directory entry. Private library = 0.
Link library = 1. Job or step library = 2.
Not required if no user data.
C Same C field from directory. Gives number of user data halfwords.
User data As much as will fit in entry.

Figure 37. BLDL List Format

FIND—Position to a Member

To determine the starting address of a specific member, you must issue a FIND macro. The system places the correct address in the data control block so that a subsequent input or output operation begins processing at that point.

There are two ways you can direct the system to the right member when you use the FIND macro. Specify the address of an area containing the name of the member or specify the address of the TTR field of the entry in a BLDL list you have created by using the BLDL macro. In the first case, the system searches the directory of the data set for the relative track address; in the second case, no search is required, because the relative track address is in the BLDL list entry.

The system will also search a concatenated series of directories when (1) a DCB is supplied that is opened for a concatenated partitioned data set or (2) a DCB is not supplied, in which case either JOBLIB or STEPLIB (themselves perhaps concatenated) followed by LINKLIB is searched.

If you want to process only one member, you can process it as a sequential data set (DSORG=PS) using either BSAM or QSAM. You indicate the name of the member you want to process and the name of the partitioned data set in the DSNAME parameter of the DD statement. When you open the data set, the system places the starting address in the data control block so that a subsequent GET or READ macro begins processing at that point. You cannot use the

FIND, BLDL, or STOW macro when you are processing one member as a sequential data set.

Because the DCBRELAD address in the data control block is updated when the FIND macro is used, you should not issue the FIND macro after WRITE and STOW processing without first closing the data set and reopening it for INPUT processing.

STOW—Update the Directory

When you add more than one member to a partitioned data set, you must issue a STOW macro after writing each member so that an entry for each one will be added to the directory. To use the STOW macro, DSORG=PO or POU must be specified in the DCB macro.

You can also use the STOW macro to delete, replace, or change a member name in the directory and store additional information with the directory entry. Because an alias can also be stored in the directory the same way, you should be consistent in altering all names associated with a given member. For example, if you replace a member, you must delete related alias entries or change them so that they point to the new member. An alias cannot be stored in the directory unless the member is present.

Although you can use any type of DCB with STOW, it is best to use a BPAM DCB. If you use a BPAM DCB, you can issue several writes to create a member followed by a STOW to write the directory entry for the member. Following this STOW, your application may write and STOW another member, or follow the write with a CLOSE (which issues the stow automatically).

If you add only one member to a partitioned data set and indicate the member name in the DSNAME parameter of the DD statement, it is not necessary for you to use BPAM and a STOW macro in your program. If you want to do so, you may use BPAM and STOW, or BSAM or QSAM. If you use a sequential access method, or if you use BPAM and issue a CLOSE macro without issuing a STOW macro, the system will issue a STOW macro instruction using the member name you have specified on the DD statement. Note that no checks are made in STOW to ensure that a stow with a BSAM or QSAM DCB came from CLOSE. When the system issues the STOW, the directory entry that is added is the minimum length (12 bytes). This automatic STOW macro will not be issued if the CLOSE macro is a TYPE=T or if the TCB indicates the task is being abnormally terminated when the DCB is being closed. The DISP parameter on the DD statement determines what directory action parameter will be chosen by the system for the STOW macro.

If DISP=NEW or MOD was specified, a STOW macro with the add option will be issued. If the member name on the DD statement is not present in the data set directory, it will be added. If the member name is already present in the directory, the task will be abnormally terminated.

If DISP=OLD was specified, a STOW macro with the replace option will be issued. The member name will be inserted into the directory, either as an addition, if the name is not already present, or as a replacement, if the name is present.

Thus, with an existing data set, you should use DISP=OLD to force a member into the data set; you should use DISP=MOD to add members with protection against the accidental destruction of an existing member.

Retrieving a Member of a Partitioned Data Set

To retrieve a specific member from a partitioned data set, either the basic or the queued access method can be used as follows (see Figure 38):

- Code DSORG=PS or DSORG=PSU in the DCB macro.
- Indicate in the DD statement that the data is a member of an existing partitioned data set by coding DSNAME=name(membername) and DISP=OLD.
- Process the member with an OPEN macro, a series of GET or READ macros, and then a CLOSE macro instruction.

```
//PDSDD  DD     ---,DSN=MASTFILE(MEMBERK),DISP=OLD
         ...

         OPEN  (INDCB)            Open for input, automatic FIND
         ...
         GET    INDCB,INAREA      Read member record
         ...
         CLOSE (INDCB)
         ...

INAREA   DS     CL80              Area to read into
INDCB    DCB    ---,DSORG=PS,DDNAME=PDSDD,MACRF=GM
```

Figure 38. Retrieving One Member of a Partitioned Data Set

When your program is executed, the directory is searched automatically and the location of the member is placed in the DCB.

To process several members without closing and reopening, or to take advantage of additional data in the directory, this technique should be used (see Figure 39):

- Code DSORG=PO or POU in the DCB macro.
- Indicate in the DD statement the data set name of the partitioned data set by coding DSNAME=name and DISP=OLD.
- Issue the BLDL macro to get the list of member entries you need from the directory.
- Use the FIND or POINT macro to prepare for reading the member records.
- The records may be read from the beginning of the member, or a note list may be read first, to obtain additional locations that point to subcategories within the member.
- Read (and check) the records until all those required have been processed.
- Point to additional categories, if required, and read the records.

- Your end-of-data-set (EODAD) routine receives control at the end of each member. At that time, you can process the next member or close the data set.

- Repeat this procedure for each member to be retrieved.

```
//PDSDD  DD    ---,DSN=MASTFILE,DISP=OLD

         ...
         OPEN  (INDCB)            Open for input, no automatic FIND
         ...
         LA    BLDLREG,BLDLLIST   Load address of BLDL list
         BLDL  INDCB,BLDLLIST     Build a list of selected member
*                                 names in virtual storage
         LA    BLDLREG,4(BLDLREG) Point to the first entry
         ...
```

Read the NOTE list

```
MEMBER   LA    NOTEREG,NOTELIST   Load address of NOTE list
         MVC   TTRN(4),14(BLDLREG)  Move NOTE list TTRN
*                                 to fullword boundary
         POINT INDCB,TTRN         Point to the NOTE list record
         READ  DECBX,SF,INDCB,(NOTEREG)     Read the NOTE list
         CHECK DECBX
         ...
```

Read data from a subgroup

```
SUBGROUP POINT INDCB,(NOTEREG)     Point to subgroup
         READ  DECBY,SF,INDCB,INAREA  Read record in subgroup
         CHECK DECBY
         LA    NOTEREG,4(NOTEREG)  Increment to next subgroup TTRN
         ...
```

Repeat from label "SUBGROUP" for each additional subgroup
Repeat from label "MEMBER" for each additional member

```
         ...
         CLOSE (INDCB)
         ...

INAREA   DS    CL80
INDCB    DCB   ---,DSORG=PO,DDNAME=PDSDD,MACRF=R
TTRN     DS    F              TTRN of the NOTE list to point at
NOTEREG  EQU   4              Register to address NOTE list entries
NOTELIST DS    0F             NOTE list
         DS    F              NOTE list entry  (4 byte TTRN)
         DS    19F            one entry per subgroup
BLDLREG  EQU   5              Register to address BLDL list entries
BLDLLIST DS    0F             List of member names for BLDL
         DC    H'10'          Number of entries (10 for example)
         DC    H'18'          Number of bytes per entry
         DC    CL8'MEMBERA'   Name of  member
         DS    CL3            TTR of first record (created by BLDL)
         DS    X              K byte, concatenation number
         DS    X              Z byte, location code
         DS    X              C byte, flag and user data length
         DS    CL4            TTRN of NOTE list
         ...                  one list entry per member (18 bytes each)
```

Figure 39. Retrieving Several Members and Subgroups of a Partitioned Data Set

Modifying a Partitioned Data Set

Updating a Member of a Partitioned Data Set

A member of a partitioned data set can be updated in place, or it can be deleted and rewritten as a new member.

Updating in Place

When you update in place, you read records, process them, and write them back to their original positions without destroying the remaining records on the track. The following rules apply:

- You must specify the update option (UPDAT) in the OPEN macro instruction. To perform the update, you can use only the READ, WRITE, CHECK, NOTE, POINT, FIND, and BLDL macros.
- You cannot update concatenated partitioned data sets.
- You cannot use chained scheduling.
- You cannot delete any record or change its length; you cannot add new records.

Updating with BSAM: A record must be retrieved by a READ macro before it can be updated by a WRITE macro. Both macros must be execute forms that refer to the same DECB; the DECB must be provided by a list form. (The execute and list forms of the READ and WRITE macros are described in *Data Administration: Macro Instruction Reference*.)

Updating with QSAM: You can update a member of a partitioned data set using the locate mode of QSAM (DCB specifies MACRF=PL) and using the PUTX macro. The DD statement must specify the data set and member name in the DSNAME parameter. This method allows only the updating of the member specified in the DD statement.

Updating with Overlapped Operations: To overlap input/output and processor activity, you can start several read or write operations before checking the first for completion. You cannot overlap read and write operations, however, as operations of one type must be checked for completion before operations of the other type are started or resumed. Note that each outstanding read or write operation requires a separate channel program and a separate DECB. If a single DECB were used for successive read operations, only the last record read could be updated.

In Figure 40 on page 109, overlap is achieved by having a read or write request outstanding while each record is being processed. Note the use of the execute and list forms of the READ and WRITE macros, identified by the operands MF=E and MF=L.

```
//PDSDD   DD      DSNAME=MASTFILE(MEMBERK),DISP=OLD,---
          ...
UPDATDCB  DCB     DSORG=PS,DDNAME=PDSDD,MACRF=(R,W),NCP=2,EODAD=FINISH
          READ    DECBA,SF,UPDATDCB,AREAA,MF=L           Define DECBA
          READ    DECBB,SF,UPDATDCB,AREAB,MF=L           Define DECBB
AREAA     DS      ---                                    Define buffers
AREAB     DS      ---
          ...
          OPEN    (UPDATDCB,UPDAT)                   Open for update
          LA      2,DECBA                            Load DECB addresses
          LA      3,DECBB
READRECD  READ    (2),SF,MF=E                        Read a record
NEXTRECD  READ    (3),SF,MF=E                        Read the next record
          CHECK   (2)                                Check previous read operation
```

(If update is required, branch to R2UPDATE)

```
          LR      4,3                                If no update is required,
          LR      3,2                                switch DECB addresses in
          LR      2,4                                registers 2 and 3
          B       NEXTRECD                           and loop
```

In the following statements, 'R2' and 'R3' refer to the records that were read using the DECBs whose addresses are in registers 2 and 3, respectively. Either register may point to either DECBA or DECBB.

```
R2UPDATE  CALL    UPDATE,((2))                       Call routine to update R2
          CHECK   (3)                                Check read for next record
          WRITE   (2),SF,MF=E                        (R3) Write updated R2
```

(If R3 requires an update, branch to R3UPDATE)

```
          CHECK   (2)                                If R3 requires no update,
          B       READRECD                           check write for R2 and loop
R3UPDATE  CALL    UPDATE,((3))                       Call routine to update R3
          WRITE   (3),SF,MF=E                        Write updated R3
          CHECK   (2)                                Check write for R2
          CHECK   (3)                                Check write for R3
          B       READRECD                           Loop
FINISH    CLOSE   (UPDATDCB)                         End-of-Data exit routine
          ...
```

Figure 40. Updating a Member of a Partitioned Data Set

Rewriting a Partitioned Data Set Member

There is no actual update option that can be used to add or extend records in a partitioned data set. If you want to extend or add a record within a member, you must rewrite the complete member in another area of the data set. Because space is allocated when the data set is created, there is no need to request additional space. Note, however, that a partitioned data set must be contained on one volume. If sufficient space has not been allocated, the data set must be reorganized by the IEBCOPY utility program.

When you rewrite the member, you must provide two DCBs, one for input and one for output. Both DCB macros can refer to the same data set, that is, only one DD statement is required.

If an out-of-space condition occurs when updating a PDS member, the error recovery procedure will STOW the PDS member as 'TEMPNAME'. The original member will remain intact.

Processing a Partitioned Data Set Residing on MSS

If OPTCD=H is specified in the DCB subparameter of a DD statement, it specifies that, if a partitioned data set is being opened for input and resides on an MSS device, then at OPEN time the data set is staged to EOF on the virtual DASD device. If the option is not specified, only the directory is staged at OPEN time and cylinder faults occur during processing. This option might be used with the IEBCOPY utility program opening the PDS to reorganize and compress the data space. This BPAM option, OPTCD=H, may be coded only on the DD statement.

Note: Use of MSS is not recommended.

Concatenating Partitioned Data Sets

Two or more partitioned data sets can be automatically retrieved by the system and processed successively as a single data set. This technique is known as concatenation. There are two types of concatenation: sequential and partitioned.

Sequential Concatenation

Sequential concatenated data sets are processed like a sequential data set (with a DSORG=PS). Data sets which are sequentially concatenated may be sequential data sets, or may be members of partitioned data sets.

Data sets with "like" characteristics are those that may be processed correctly using the same data control block (DCB), input/output block (IOB), and channel program. Any exception makes them "unlike." You need to turn on the DCBOFLGS field in the DCB to process a concatenation of "unlike" data sets. See "Concatenating Unlike Data Sets" on page 79 for more information.

Partitioned Concatenation

Partitioned concatenated data sets are processed with a DSORG=PO. When partitioned data sets are concatenated, the system treats the group as a single data set and only one data extent block (DEB) is constructed. Each partitioned data set may hold up to 16 extents. The maximum number of partitioned data sets that can be concatenated is governed by the limit of 123 extents (input data sets only). For example, 123 single extent data sets can be concatenated but 8 data sets each with 16 extents cannot be concatenated. Because 8 times 16 is 128, these 128 extents cannot be represented in a DEB at one time. The DEB can hold up to 123 extents.

Concatenated partitioned data sets are always treated as having like attributes, except for block size, and use the attributes of the first data set only. BPAM OPEN causes the largest block size among the concatenated data sets to be used.

You process a concatenation of partitioned data sets the same way you process a single partitioned data set with one exception: you must use the FIND macro to begin processing a member; you cannot use the POINT (or NOTE) macro until after the FIND macro has been issued. Figure 39 on page 107 shows how to process a single partitioned data set using FIND. If two members of different data sets in the concatenation have the same name, the FIND macro determines the address of the first one in the concatenation. You would not be able to process the second one in the concatenation. The BLDL macro provides the concatenation number of the data set to which the member belongs in the K field of the BLDL list. (See "BLDL—Construct a Directory Entry List" on page 103.)

Reading a Partitioned Data Set Directory Sequentially

You can read a PDS directory sequentially just by opening the data set to its beginning (without using positioning macros) and reading it.

- The DD statement should identify the DSNAME without a member name. You should specify a disposition option of either OLD or SHR.
- You can use either BSAM or QSAM with MACRF=R or G.
- Specify BLKSIZE=256 and RECFM=F.
- You must test for the last directory entry (X'FFFFFFFF').
- If you also want to read the keys (the name of the last member in that block), use BSAM and specify KEYLEN=8.

Chapter 10. Generation Data Groups

A generation data group is a group of related cataloged data sets. The way these data sets are cataloged is what makes them a generation data group. Within a generation data group, the generations can have like or unlike DCB attributes and data set organizations. If the attributes and organizations of all generations in a group are identical, the generations can be retrieved together as a single data set. Each data set within a generation data group is called a generation data set. Generation data sets are sometimes called generations.

There are advantages to grouping related data sets. Because the catalog management routines can refer to the information in a special index—called a generation index—in the catalog:

- All of the data sets in the group can be referred to by a common name.
- The operating system is able to keep the generations in chronological order.
- Outdated or obsolete generations can be automatically deleted by the operating system.

The management of a generation data group depends upon the fact that generation data sets have sequentially ordered names—absolute and relative names—that represent their age. The absolute generation name is the representation used by the catalog management routines in the catalog. Older data sets have smaller absolute numbers. The relative name is a signed integer used to refer to the latest (0), the next to the latest (-1), and so forth, generation. The relative number can also be used to catalog a new generation (+1).

A generation data group base is created in an integrated catalog facility or VSAM catalog before the generation data sets are cataloged. A generation data group is represented in the integrated catalog facility or VSAM catalog by a generation data group base entry. The access method services DEFINE command is used to create the generation data group base. See *Access Method Services Reference (VSAM)* for information on how to define and/or catalog generation data sets in an integrated catalog facility or VSAM catalog. See *Utilities* for information on how to define and/or catalog generation data sets in an OS CVOL.

Note: OS CVOLs and VSAM catalogs are not recommended.

A generation data group base that is to be managed by SMS must be created in an integrated catalog facility catalog. Generation data sets that are to be managed by SMS must also be cataloged in an integrated catalog facility catalog. Both SMS- and non-SMS-managed generation data sets can be contained in the same generation data group. However, if the catalog of a generation data group is on a volume that is managed by SMS, the pattern DSCB cannot be defined. You can add new non-SMS managed generation data sets to the generation data group by using cataloged data sets as models without needing a model DSCB on the catalog volume.

Absolute Generation and Version Numbers

An absolute generation and version number is used to identify a specific generation of a generation data group. The generation and version numbers are in the form *GxxxxVyy*, where *xxxx* is an unsigned 4-digit decimal generation number (0001 through 9999) and *yy* is an unsigned 2-digit decimal version number (00 through 99).
For example:

- A.B.C.G0001V00 is generation data set 1, version 0, in generation data group A.B.C.

- A.B.C.G0009V01 is generation data set 9, version 1, in generation data group A.B.C.

The number of generations and versions is limited by the number of digits in the absolute generation name, that is, there can be 9999 generations and 100 versions.

The generation number is automatically maintained by the system. The number of generations kept depends on the size of the generation index. For example, if the size of the generation index allows ten entries, the ten latest generations may be maintained in the generation data group.

The version number allows you to perform normal data set operations without disrupting the management of the generation data group. For example, if you want to update the second generation in a 3-generation group, replace generation 2, version 0, with generation 2, version 1. Only one version is kept for each generation.

A generation can be cataloged using either absolute or relative numbers. When a generation is cataloged, a generation and version number is placed as a low level entry in the generation data group. To catalog a version number other than V00, you must use an absolute generation and version number.

A new version of a specific generation can be cataloged automatically by specifying the old generation number along with a new version number. For example, if generation A.B.C.G0005V00 is cataloged and you now create and catalog A.B.C.G0005V01, the new entry is cataloged in the location previously occupied by A.B.C.G0005V00. This process removes the old entry from the catalog but does not scratch the old version. To scratch the old version and make its space available for reallocation, a DD card, describing the data set to be deleted, with DISP=(OLD,DELETE) should be included at the time the data set is to be replaced by the new version.

Relative Generation Number

As an alternative to using absolute generation and version numbers when cataloging or referring to a generation, you can use a relative generation number. To specify a relative number, use the generation data group name followed by a negative integer, a positive integer, or a 0, enclosed in parentheses. For example, A.B.C(-1). A.B.C(+1), or A.B.C(0).

The value of the specified integer tells the operating system what generation number to assign to a new generation, or it tells the system the location of an entry representing a previously cataloged generation.

When you use a relative generation number to catalog a generation, the operating system assigns an absolute generation number and a version number of V00 to represent that generation. The absolute generation number assigned depends on the number last assigned and the value of the relative generation number that you are now specifying. For example if, in a previous job generation, A.B.C.G0005V00 was the last generation cataloged, and you specify A.B.C(+1), the generation now cataloged is assigned the number G0006V00. Though any positive relative generation number can be used, a number greater than 1 may cause absolute generation numbers to be skipped. For example, if you have a single step job, and the generation being cataloged is a +2, one generation number is skipped. However, in a multiple step job, one step may have a +1 and a second step a +2, and no numbers are skipped in this case.

Note: when a volume is not specified in the JCL, and the non-SMS-managed generation data set (GDS) is not opened, that data set is not cataloged. SMS-managed data sets are always cataloged when allocated, with the volume assigned from a storage group.

Programming Considerations for Multiple Step Jobs

One reason for using generation data groups is to allow the system to maintain a given number of related cataloged data sets. If you attempt to delete or uncatalog any but the oldest of the data sets of a generation data group in a multiple step job, catalog management can lose orientation within the data group. This can cause the deletion, uncataloging, or retrieval of the wrong data set when referring to a specified generation. The rule is, if you delete a generation data set in a multiple step job, do not refer to any older generation in subsequent job steps.

Also, it is recommended that, in a multiple step job, you catalog or uncatalog data sets using JCL instead of IEHPROGM or a user program. Because ALLOCATION/UNALLOCATION monitors data sets during job execution and is not aware of the functions performed by these programs, data set orientation may be lost or conflicting functions may be performed in subsequent job steps.

When you use a relative generation number to refer to a generation that was cataloged in a previous job, the relative number has the following meaning:

- A.B.C(0) refers to the latest existing cataloged entry.
- A.B.C(-1) refers to the next-to-the-latest entry, and so forth.

When cataloging is requested via JCL, all actual cataloging occurs at step termination, but the relative generation number remains the same throughout the job. Because this is so:

- A relative number used in the JCL refers to the same generation throughout a job.
- A job step that terminates abnormally may be deferred for a later step restart. If the step cataloged a generation data set successfully in its gen-

eration data group via JCL, you must change all relative generation numbers in the succeeding steps via JCL before resubmitting the job.

For example, if the succeeding steps contained the relative generation numbers:

- A.B.C(+1), that refers to the entry cataloged in the terminated job step, or
- A.B.C(0), that refers to the next to the latest entry, or
- A.B.C(-1), that refers to the latest entry, before A.B.C(0),

you must change them as follows before the step can be restarted: A.B.C(0), A.B.C(-1), A.B.C(-2), and so forth.

Generation Data Group Naming for ISO/ANSI/FIPS Version 3 Labels

In a Version 3 ISO/ANSI/FIPS label (LABEL=(,AL)), the generation number and version number are maintained separately from the file identifier. During label processing, the generation number and version number are removed from the generation data set name. The generation number is placed in the generation number field (file label 1 positions 36 through 39), and the version number is placed in its position on the same label (position 40 and 41). The file identifier portion of a Version 3 HDR1/EOF1/EOV1 label contains the generation data set name without the generation number and version number.

For Version 3 labels, you must observe the following specifications created by the generation data group naming convention.

- Data set names whose last 9 characters are of the form *.GnnnnVnn* (n is 0 through 9) can only be used to specify GDG data sets. When a name ending in *.GnnnnVnn* is encountered, it is automatically processed as a GDG. The generation number *Gnnnn* and the version number *Vnn* are separated from the rest of the data set name and placed in the generation number and version number fields.
- Tape data set names for GDG files are expanded from a maximum of 8 user-specified characters to 17 user-specified characters. (The tape label file identifier field has space for 9 additional user-specified characters because the generation number and version number are no longer contained in this field.)
- A generation number of all zeros is not valid, and will be treated as an error during label validation. The error appears as a "RANG" error in message IEC512I (IECIEUNK) during the label validation installation exit.
- In an MVS system-created GDG name, the version number will always be 0. (MVS will not increase the version number by 1 for subsequent versions.) To obtain a version number other than 0, you must explicitly specify the version number (for example, A.B.C.G0004V03) when the data set is created. You must also explicitly specify the version number to retrieve a GDG with a version number other than 0.
- Because the generation number and version number are not contained on the identifier of HDR1, generations of the same GDG will have the same name. Therefore, an attempt to place more than one generation of a GDG on the same volume will result in an ISO/ANSI/FIPS standards violation in a

system supporting Version 3, and MVS will enter the validation installation exit.

Creating a New Generation

To create a new generation data set, you must first allocate space for the generation, then catalog the generation.

Allocating a Generation

To take full advantage of the facilities of the system, the allocation can be patterned after a previously allocated generation in the same group. This is accomplished by the specification of DCB attributes for the new generation, described as follows.

If you are using absolute generation and version numbers, DCB attributes for a generation can be supplied directly in the DD statement defining the generation to be created and cataloged.

If you are using relative generation numbers to catalog generations, DCB attributes can be supplied either: (1) by referring to a cataloged data set for the use of its attributes or (2) by creating a model DSCB on the volume on which the index resides (the volume containing the catalog). Attributes can be supplied before you catalog a generation, when you catalog it, or at both times. You can supply the DCB attributes through the use of the DATACLAS keyword in the DD statement or through the ACS routines. You may use the DATACLAS and LIKE keywords in place of a model DSCB for non-SMS-managed generation data sets. The generation data sets may be on either tape or DASD. The cataloged data set referred to in LIKE=*dsname* must be on DASD. **The method of creating a model DSCB cannot be used for SMS-managed generation data sets.**

1. You do not need to create a model DSCB if you can refer to a cataloged data set whose attributes are identical to those you desire. You can refer to the cataloged data set's DCB attributes by referring to its DCB or to the DD statement that allocated it. To refer to a cataloged data set for the use of its attributes, you can specify one of the following on the DD statement that creates and catalogs your generation:

   - DCB=(dsname), where dsname is the name of the cataloged data set
   - LIKE=dsname, where dsname is the name of the cataloged data set
   - REFDD=ddname, where ddname is the name of a DD statement that allocated the cataloged data set.

   An example of allocating a generation data set by supplying its DCB attributes through the use of DATACLAS is as follows:

   ```
   //DD1 DD DSN=GDG(+1),DISP=(NEW,CATLG),DATACLAS=ALLOCL01
   ```

   The DCB attributes allocated to the new data set depend on the attributes defined in data class ALLOCL01. Your storage administrator will provide information on the attributes specified by the data classes available to your installation.

   An example of referring to a cataloged data set by referring to its DD statement is as follows:

   ```
   //DD2 DD DSN=GDG(+1),DISP=(NEW,CATLG),REFDD=DD1
   ```

The new generation data set will have the same attributes as the data set defined in the first example.

You can also refer to an existing model DSCB for which you can supply overriding attributes. **This cannot be used for SMS-managed generation data sets.** To refer to an existing model, specify DCB=(modeldscbname, your attributes) on the DD statement that creates and catalogs your generation. Assume that you have a generation data group base name ICFUCAT8.GDGBASE and its model DSCB name is ICFUCAT8.GDGBASE.

You can specify:

```
//DD1  DD DSN=ICFUCAT8.GDGBASE(+1),DISP=(NEW,CATLG),
          UNIT=3380,SPACE=(TRK,(5)),VOL=SER=338001
```

2. You can use the DATACLAS and LIKE keywords in the DD statement for both SMS-managed and non-SMS-managed generation data sets. For non-SMS-managed generation data sets, DATACLAS and LIKE can be used in place of a model DSCB. The data sets may be on either tape or DASD. (See *Magnetic Tape Labels and File Structure* for more information on using data class with tape data sets.)

   The LIKE keyword specifies the allocation attributes of a new data set by copying the attributes of a cataloged model data set. Note that model DSCBs are still used if present on the volume, even if LIKE and DATACLAS are also used for a non-SMS-managed generation data set. This method is recommended, because you would not need to change the JCL (to scratch the model DSCB) when migrating the data to SMS-managed storage or vice versa. If you do not specify DATACLAS and LIKE in the JCL for a non-SMS-managed generation data set, and there is no model DSCB, the allocation will fail.

   An example of allocating a non-SMS-managed generation data set by supplying its DCB attributes through the use of DATACLAS and LIKE is as follows. This example would also work for SMS-managed generation data sets.

   ```
   //DDNAME DSN=HLQ.----.LLQ(+1),DISP=(NEW,CATLG),DATACLAS=dc_name

   //DDNAME DSN=HLQ.----.LLQ(+1),DISP=(NEW,CATLG),LIKE=dsn
   ```

3. (This method is not used for SMS-managed generation data sets.) Create a model DSCB on the volume on which your index resides. You can provide initial DCB attributes when you create your model; however, you need not provide any attributes at this time. Because only the attributes in the data set label are used, the model data set should be allocated with SPACE=(TRK,0) to conserve direct access space. Initial or overriding attributes can be supplied when you create and catalog a generation.[2] To create a model DSCB, include the following DD statement in the job step that builds the index or in any other job step that precedes the step where you create and catalog your generation.

[2] Only one model DSCB is necessary for any number of generations. If you plan to use only one model, do not supply DCB attributes when you create the model. When you subsequently create and catalog a generation, include necessary DCB attributes in the DD statement referring to the generation. In this manner, any number of generation data groups can refer to the same model. Note that the catalog and model data set label are always located on a direct access volume, even for a magnetic tape generation data group.

```
//name DD DSNAME=datagrpname,DISP=(,KEEP),SPACE=(TRK,(0)),
//        UNIT=yyyy,VOLUME=SER=xxxxxx,
//        DCB=(applicable subparameters)
```

The DSNAME is the common name by which each generation is identified; xxxxxx is the serial number of the volume containing the catalog. If no DCB subparameters are wanted initially, you need not code the DCB parameter.

Notes:

a. The model DSCB must reside on the catalog volume. If you move a catalog to a new volume, you also will need to move or create a new model DSCB on this new volume.

b. If you split or merge an integrated catalog facility catalog and the catalog remains on the same volume as the existing model DSCB, you will not have to move or create a new model DSCB.

For more information on the JCL keywords used to allocate a generation data set, see *JCL Reference*.

The new generation data set is cataloged at allocation time, and rolled into the generation data group at end of job step. If your job terminates after allocation but before end of job step, the generation data set is cataloged in a deferred roll-in state. You can re-submit your job to roll the new generation data set into the generation data group. For more information on rolling in generation data sets, see "Rolling In a Generation" on page 120.

Passing a Generation

A new generation may be passed when created. That generation may then be cataloged in a succeeding job step or deleted at the end of the job as in normal disposition processing when DISP=(,PASS) is specified on the DD statement.

However, after a generation has been created with DISP=(NEW,PASS) specified on the DD statement, another new generation for that data group must not be cataloged until the passed version has been deleted or cataloged. To do so would cause the wrong generation to be used when referencing the passed generation data set. If that data set was later cataloged, a bad generation would be cataloged and a good one lost.

For example, if A.B.C(+1) was created with DISP=(NEW,PASS) specified on the DD statement, then A.B.C.(+2) must not be created with DISP=(NEW,CATLG) until A.B.C(+1) has been cataloged or deleted.

By using the proper JCL, the advantages to this support are:

- JCL will not have to be changed to rerun the job.
- The lowest generation version will not be deleted from the index until a valid version is cataloged.

Rolling In a Generation

For SMS-managed generation data groups, a new generation is cataloged at allocation time in a deferred roll-in state when the generation data set is allocated as DISP=(NEW,CATLG). At end of job step, the deferred generation data set will be rolled into the generation data group. It becomes an active generation data set. Generation data sets may be in a deferred roll-in state if the job never reached end of step or if they were allocated as DISP=(NEW,KEEP). Generation data sets in a deferred roll-in state can be referred to by their absolute generation numbers. You can use the access method services command ALTER ROLLIN to roll in these generation data sets.

What happens to the older generations when a new generation is rolled in is determined by the attributes specified for the generation data group. The access method services command DEFINE GENERATIONDATAGROUP creates a generation data group and specifies the limit (the maximum number of active generation data sets) for a generation data group and whether all or only the oldest generation data sets should be rolled off when the limit is reached. When a generation data group is full (contains its maximum number of active generation data sets), and a new generation data set is rolled in at end of job step, the oldest generation data set is rolled off and no longer active. If a generation data group is defined using DEFINE GENERATIONDATAGROUP EMPTY, and is at its limit, then when a new generation data set is rolled in, all the currently active generation data sets are rolled off. What happens to rolled off generation data sets depends on the parameters you specify on the DEFINE GENERATIONDATAGROUP command. For example, if you specify the SCRATCH parameter, the generation data set is scratched when it is rolled off. If you specify the NOSCRATCH parameter, the rolled off generation data set is recataloged as rolled off and is disassociated with its generation data group.

The access method services command ALTER LIMIT can increase or reduce the limit for an existing generation data group. If a limit is reduced, the oldest active generation data sets are automatically rolled off as needed to meet the decreased limit. If a change in the limit causes generations to be rolled off, then the rolled off data sets are listed with their disposition (uncataloged, recataloged, or deleted). If a limit is increased, and there are generation data sets in a deferred roll-in state, these generation data sets are not rolled into the generation data group. The access method services command ALTER ROLLIN can be used to roll the generation data sets into the generation data group in active status.

For more information on how to use the access method services commands DEFINE GENERATIONDATAGROUP and ALTER, see *Access Method Services Reference (VSAM).*

Creating an ISAM Data Set as Part of a Generation Data Group

To create an indexed-sequential data set as part of a generation data group, you must: (1) create the indexed-sequential data set separately from the generation group and (2) use IEHPROGM to put the indexed-sequential data set into the generation group. An ISAM generation data set cannot be SMS managed.

In an integrated catalog facility and VSAM catalogs, use access method services commands to catalog the data set. In an OS CVOL, use the RENAME function to rename the data set. Then use the CATLG function to catalog the data set. For instance, if MASTER is the name of the generation data group, and *GggggVvv* is the absolute generation name, you would code the following:

```
RENAME DSNAME=ISAM,VOL=3380=SCRTCH,NEWNAME=MASTER.GggggVvv
CATLG DSNAME=MASTER.GggggVvv,VOL=3380=SCRTCH
```

Retrieving a Generation

A generation may be retrieved through the use of job control language procedures. Any operation that can be applied to a nongeneration data set can be applied to a generation. For example, a generation can be updated and reentered in the catalog, or it can be copied, printed, punched, or used in the creation of new generation or nongeneration data sets.

You can retrieve a generation by using either relative generation numbers or absolute generation and version numbers.

Note: Refer to generation data sets that are in a deferred roll-in state by their relative number, such as (+1), within the job that creates it. Refer to generation data sets that are in a deferred roll-in state by their absolute generation number (GxxxxVyy) in subsequent jobs.

Because two or more jobs can compete for the same resource, generation data groups should be updated with care, as follows:

- No two jobs running concurrently should refer to the same generation data group. As a partial safeguard against this situation, use absolute generation and version numbers when cataloging or retrieving a generation in a multiprogramming environment. If you use relative numbers, a job running concurrently may update the generation data group index, perhaps cataloging a new generation which you will then retrieve in place of the one you wanted.
- Even when using absolute generation and version numbers, a job running concurrently might catalog a new version of a generation or perhaps delete the generation you wanted to retrieve. For this reason, some degree of control should be maintained over the execution of job steps referring to generation data groups.

Building a Generation Data Group Index

A generation data group contained on an integrated catalog facility catalog or VSAM catalog is managed through access method services. The access method services DEFINE command can be used to create a generation data group and specify how to handle older and obsolete generations.

A generation data group contained on an OS CVOL is managed via the information found in a generation index. (Note that an alias name cannot be assigned to the highest level of a generation index.) The BLDG function of IEHPROGM builds the index. The BLDG function also indicates how older or obsolete generations are to be handled when the index is full. For example, when the index is full, you may want to empty it, scratch existing generations, and begin cataloging a new series of generations. After the index is built, a generation can be cataloged by its generation data group name and either an absolute generation and version number or a relative generation number.

Examples of how to build a generation data group index are found in *Access Method Services Reference (VSAM)* under DEFINE GENERATIONDATAGROUP, and in *Utilities*, under IEHPROGM.

Note: OS CVOLs and VSAM catalogs are not recommended.

Chapter 11. I/O Device Control Macros

The operating system provides you with several macros for controlling input/output devices. Each is, to varying degrees, device dependent. Therefore, you must exercise care if you want to achieve device independence.

When you use the queued access method, only unit record equipment can be controlled directly. When using the basic access method, limited device independence can be achieved between magnetic tape and direct access devices. You must check all read or write operations before issuing a device control macro.

CNTRL—Control an I/O Device

The CNTRL macro performs these device-dependent control functions:

- Card reader stacker selection (SS)
- Printer line spacing (SP)
- Printer carriage control (SK)
- Magnetic tape backspace (BSR) over a specified number of blocks
- Magnetic tape backspace (BSM) past a tape mark and forward space over the tape mark
- Magnetic tape forward space (FSR) over a specified number of blocks
- Magnetic tape forward space (FSM) past a tape mark and a backspace over the tape mark

Backspacing moves the tape toward the load point; forward spacing moves the tape away from the load point.

Note that the CNTRL macro cannot be used with an input data set containing variable-length records on the card reader.

If you specify OPTCD=H in the DCB parameter field of the DD statement, you can use the CNTRL macro to position DOS tapes that contain embedded DOS checkpoint records. The CNTRL macro cannot be used to backspace DOS 7-track tapes that are written in data convert mode and contain embedded checkpoint records.

PRTOV—Test for Printer Overflow

The PRTOV macro tests for channel 9 or 12 of the printer carriage control tape or the forms control buffer (FCB). An overflow condition causes either an automatic skip to channel 1 or, if specified, transfer of control to your routine for overflow processing. If you specify an overflow exit routine, set DCBIFLGS to X'00' before issuing another PRTOV.

If the data set specified in the DCB is not for a printer, no action is taken.

SETPRT—Printer Setup

The SETPRT macro instruction controls how information is printed. It is used with the IBM 3800 Printing Subsystem and with various other universal character set (UCS) printers.

For the IBM 3800 Printing Subsystem, the SETPRT macro instruction is used to initially set or dynamically change the printer control information. For additional information on how to use the SETPRT macro with the 3800 printer, see *IBM 3800 Printing Subsystem Programmer's Guide.*

For printers that have a universal character set (UCS) buffer and optionally, a forms control buffer (FCB), the SETPRT macro instruction is used to specify the UCS and/or FCB images to be used. Note that universal character sets for the various printers are not compatible. The three formats of FCB images (the FCB image for the 3800 Printing Subsystem, the 4248 format FCB and the 3211 format FCB) are incompatible. The 3211 format FCB is used by the 3203, 3211, 4248, 3262 Model 5, and 4245 printers.

IBM-supplied UCS images, UCS image tables, FCB images, and character arrangement table modules are included in the SYS1.IMAGELIB at system generation time. For 1403, 3203, 3211, 3262 Model 5, 4245, and 4248 printers, user-defined character sets can be added to SYS1.IMAGELIB. For a description of how images are added to SYS1.IMAGELIB and how band names/aliases are added to image tables, see *System—Data Administration*. For the 3800, user-defined character arrangement table modules, FCB modules, GRAPHIC modules, copy modification modules, and library character sets can be added to SYS1.IMAGELIB as described in *Utilities*. For information on building a 4248 format FCB (which can also be used for the IBM 3262 Model 5 printer), see *Utilities.*

The FCB contents can be selected from the system library (or an alternate library if you are using a 3800), or defined in your program through the exit list of the DCB macro instruction. For information on the DCB exit list, see *DFP: Customization.*

For a non-3800 printer, the specified UCS or FCB image should be found in one of the following:

- SYS1.IMAGELIB
- Image table (UCS Image only)
- DCB exit list for an FCB

If the image is not found, the operator is asked to specify an alternate image name or cancel the request.

For a printer that has no carriage control tape, you can use the SETPRT macro instruction to select the FCB, to request operator verification of the contents of the buffer, or to allow the operator to align the paper in the printer.

BSP—Backspace a Magnetic Tape or Direct Access Volume

The BSP macro backspaces one block on the magnetic tape or direct access volume being processed. The block can then be reread or rewritten. An attempt to rewrite the block destroys the contents of the remainder of the tape or track.

The direction of movement is toward the load point or beginning of the extent. You may not use the BSP macro if the track overflow option was specified or if the CNTRL, NOTE, or POINT macro instruction is used. The BSP macro should be used only when other device control macros could not be used for backspacing.

Any attempt to backspace across a file mark will result in a return code of X'04' in register 15 and your tape or direct access volume will be positioned after the file mark. This means you cannot issue a successful backspace command after your EODAD routine is entered unless you first reposition the tape or direct access volume into your data set. (CLOSE TYPE=T can position you at the end of your data set.)

You can use the BSP macro to backspace DOS tapes containing embedded DOS checkpoint records. If you use this means of backspacing, you must test for and bypass the embedded checkpoint records. You cannot use the BSP macro for DOS 7-track tapes written in translate mode.

NOTE—Return the Relative Address of a Block

The NOTE macro requests the relative address of the block just read or written. In a multivolume data set, the address is relative to the beginning of the data set on the volume currently being processed.

For magnetic tape, the address is in the form of a 4-byte relative block address. If TYPE=REL is specified or defaults, the address provided by the operating system is returned in register 1. If TYPE=ABS is specified, the physical block identifier of a data block on tape is returned in register 0. The relative block address or the block identifier can later be used as a search argument for the POINT macro.

If a NOTE macro is issued after an automatic volume switch occurs and before a READ or WRITE macro is issued to the next volume, NOTE returns a relative block address of zero.

For a direct access device, the address is in the form of a 4-byte relative track record address (TTR). The address provided by the operating system is returned in register 1, and the amount of unused space available on the track of the direct access device is returned in register 0.

POINT—Position to a Block

The POINT macro repositions a magnetic tape or direct access volume to a specified block. The next read or write operation begins at this block.

In a multivolume data set, you must ensure that the volume referred to is the volume currently being processed. For disk, if a write operation follows the POINT macro, all of the track following the write operation is erased, unless the data set is opened for UPDAT. POINT is not meant to be used before a WRITE macro when a data set is opened for UPDAT. If you specify OPTCD=H in the DCB parameter field of the DD statement, you can use the POINT macro to position DOS tapes that contain embedded checkpoint records. The POINT macro cannot be used to backspace DOS 7-track tapes that are written in data convert mode and contain embedded checkpoint records.

If you specify TYPE=ABS, you can use the physical block identifier as a search argument to locate a data block on tape. The identifier may be provided from the output of a prior execution of the NOTE macro.

When using the POINT macro for a direct access device that is opened for OUTPUT, OUTIN, or INOUT, and the record format is not standard, the number of blocks per track may vary slightly.

SYNCDEV—Control Data Synchronization

The SYNCDEV macro controls data synchronization for devices supporting buffered write mode. Data still in the buffer may not yet reside on the final recording medium. This is called data that is not synchronized. You can do the following:

- Request information regarding synchronization, *or*
- Demand that synchronization occur based on a specified number of data blocks that are allowed to be buffered. If zero is specified, synchronization will always occur.

When SYNCDEV completes successfully (return code 0), a value will be returned that indicates the number of data blocks remaining in the control unit buffer.

Chapter 12. Protecting Data

Control of confidential data in a data set is provided through password protection or RACF protection. You can prevent unauthorized access to payroll data, sales forecast data, and all other data sets that require special security attention. An individual can use a security-protected data set only after supplying a predefined password or receiving RACF authorization.

Password Protection for Non-VSAM Data Sets

Passwords are ignored for all data sets, new and existing, that are managed by SMS. However, passwords can still be defined for SMS data sets and can be used to protect those data sets when SMS is inactive or when you are sharing the data sets with systems that do not have SMS. For information on protecting SMS-managed data sets when SMS is active, see "RACF Protection for Non-VSAM Data Sets" on page 128.

Password protection as described here applies to non-VSAM data sets only. For information on password protection for VSAM data sets, see *Access Method Services Reference (VSAM).*

In addition to the usual label protection that prevents opening of a data set without the correct data set name, the operating system provides data set security options that prevent unauthorized access to confidential data. Two levels of protection options are available. You specify these options in the LABEL field of a DD statement with the parameter PASSWORD or NOPWREAD.

- Password protection (specified by the PASSWORD parameter) makes a data set unavailable for all types of processing until a correct password is entered by the system operator, or for a TSO job by the TSO user.
- No-password-read protection (specified by the NOPWREAD parameter) makes a data set available for input without a password, but requires that the password be entered for output or delete operations.

If an incorrect password is entered twice when a job is being requested by the open or EOV routine, the job is terminated by the system. For a SCRATCH or RENAME request, a return code is given.

You can request password protection when you create the data set, by using the LABEL field of the DD statement in your JCL. The system sets the data set security byte either in the standard header label 1 as shown in *Magnetic Tape Labels and File Structure* or in the identifier data set control block (DSCB). After you have requested security protection for magnetic tapes, you cannot remove it with JCL unless you re-create the data set and scratch the protected data set.

In addition to requesting password protection in your JCL, you must enter at least one record for each protected data set in a data set named PASSWORD, which must be created on the system-residence volume. You should also request password protection for the PASSWORD data set itself to prevent both reading and writing without knowledge of the password.

For a data set on a direct access device, you can place the data set under protection when you enter its password in the PASSWORD data set. You can use the PROTECT macro or the IEHPROGM utility program to add, change, or delete an entry in the PASSWORD data set; with either of these methods, the system updates the DSCB of the data set to reflect its protected status. This provision eliminates the need for you to use JCL whenever you add, change, or remove security protection for a data set on a direct access device. *System—Data Administration* describes how to maintain the PASSWORD data set, including the PROTECT macro instruction; *Utilities* describes the IEHPROGM utility program.

RACF Protection for Non-VSAM Data Sets

Resource Access Control Facility (RACF) protection as described here applies to non-VSAM data sets, tape data sets, and tape volumes. For information on RACF protection for VSAM data sets, see *VSAM Administration Guide*. For detailed information on RACF protection for data sets, see *RACF General Information* and *RACF Security Administrator's Guide*.

RACF is an IBM licensed program that provides access control by identifying and verifying users and authorizing access to DASD and tape data sets and volumes. RACF, or an equivalent product, is the only means of protecting data sets managed by SMS. A generic profile can protect both DASD data sets and tape data sets. You may use RACF to provide access control to tape volumes that have no labels (NL), standard labels (SL), ISO/ANSI/FIPS labels (AL), or to tape volumes that are referenced with bypass label processing (BLP).

You may define a data set to RACF automatically or explicitly. The automatic definition occurs when space is allocated for the DASD data set, if you have the automatic data set protection attribute or if you code PROTECT=YES or SECMODEL=(,) in the DD statement. SECMODEL=(,) allows you to specify the name of the model profile that RACF should use in creating a discrete profile for your data set. The explicit definition of a data set to RACF is by use of the RACF command language.

RACF protection of tape data sets is provided on a volume basis or on a data set basis. A tape volume is defined to RACF explicitly by use of the RACF command language or automatically. A tape data set is defined to RACF whenever a data set is opened for OUTPUT, OUTIN, or OUTINX and RACF tape data set protection is active, whether the data set is the first file in a sequence. All data sets on a tape volume are RACF protected if the volume is RACF protected.

Six levels of access authority are possible in a RACF-defined data set or tape volume.

ALTER
You have total control over the data set. If you define the data set or tape volume to RACF, you have ALTER access authority. With ALTER authority, you can read and write the data set or tape volume, rename the data set, and scratch the data set, and you may authorize other users access to the tape volume or data set.

CONTROL
For non-VSAM data sets, CONTROL authority is equivalent to UPDATE authority.

UPDATE
You are authorized to open the data set or tape volume for OUTPUT and all other open options.

READ
You are authorized to open the data set or tape volume for INPUT only.

EXECUTE
You are authorized to execute from the data set or tape volume (open for BPAM input only).

NONE
You are not authorized to open the data set or tape volume.

If a data set is defined to RACF and is password protected, access to the data set is authorized only through RACF authorization checking. If a tape volume is defined to RACF and the data set(s) on the tape volume is password protected, access to any of the data sets is authorized only through RACF authorization checking of the volume. Data set password protection is bypassed.

To protect multivolume non-VSAM DASD and tape data sets, you must define each volume of the data set to RACF as part of the same volume set. When a RACF-protected data set is opened for output and extended to a new volume, the new volume is automatically defined to RACF as part of the same volume set. When a multivolume physical-sequential data set is opened for output and any of the data set's volumes are defined to RACF, either each subsequent volume must be RACF protected as part of the same volume set, or the data set must not yet exist on the volume. When a RACF protected multivolume tape data set is opened for output, either each subsequent volume must be RACF protected as part of the same volume set, or the tape volume must not yet be defined to RACF. If the first volume opened is not RACF protected, no subsequent volume may be RACF protected. If a multivolume data set is opened for input (or a nonphysical-sequential data set is opened for output), no such consistency check is performed when subsequent volumes are accessed.

ISO/ANSI/FIPS Version 3 installation exits that execute under RACF will receive control during ANSI volume label processing. Control will go to the RACHECK preprocessing and postprocessing installation exits. The same IECIEPRM exit parameter list passed to ANSI installation exits will be passed to the RACF installation exits if the accessibility code is any alphabetic character from A through Z. For more information, see *DFP: Customization*.

Erasing RACF Protected DASD Data Sets

You can create or alter RACF profiles to include an ERASE option for DASD data sets. MVS/DFP tests for this option, and, if you have specified ERASE, it overwrites the DASD space with zeros before making it available for reallocation.

If you have specified ERASE, the entire data set area is overwritten when you use any of the following:

- The DELETE subparameter in the JCL DISP parameter on a DD statement
- The TSO DELETE command (for non-VSAM objects)
- The SCRATCH macro instruction
- The SCRATCH control statement for the IEHPROGM utility program

If the data set is sequential or partitioned and you have specified ERASE, the released area is overwritten when you use any of the following:

- The RLSE subparameter in the JCL SPACE parameter on a DD statement
- The PARTREL macro instruction

See the *RACF General Information* manual and associated publications for more information about specifying and using the ERASE option.

Appendix A. Direct Access Labels

Product-Sensitive Programming Interface

This appendix discusses the standard formats of direct access labels. It contains product-sensitive programming interfaces provided by MVS/DFP. Installation exits and other product-sensitive interfaces are provided to allow your installation to perform tasks such as product tailoring, monitoring, modification, or diagnosis. They are dependent on the detailed design or implementation of the product. Such interfaces should be used only for these specialized purposes. Because of their dependencies on detailed design and implementation, it is to be expected that programs written to such interfaces may need to be changed in order to run with new product releases or versions, or as a result of service.

Only standard label formats are used on direct access volumes. Volume, data set, and optional user labels are used (see Figure 41). In the case of direct access volumes, the data set label is the data set control block (DSCB).

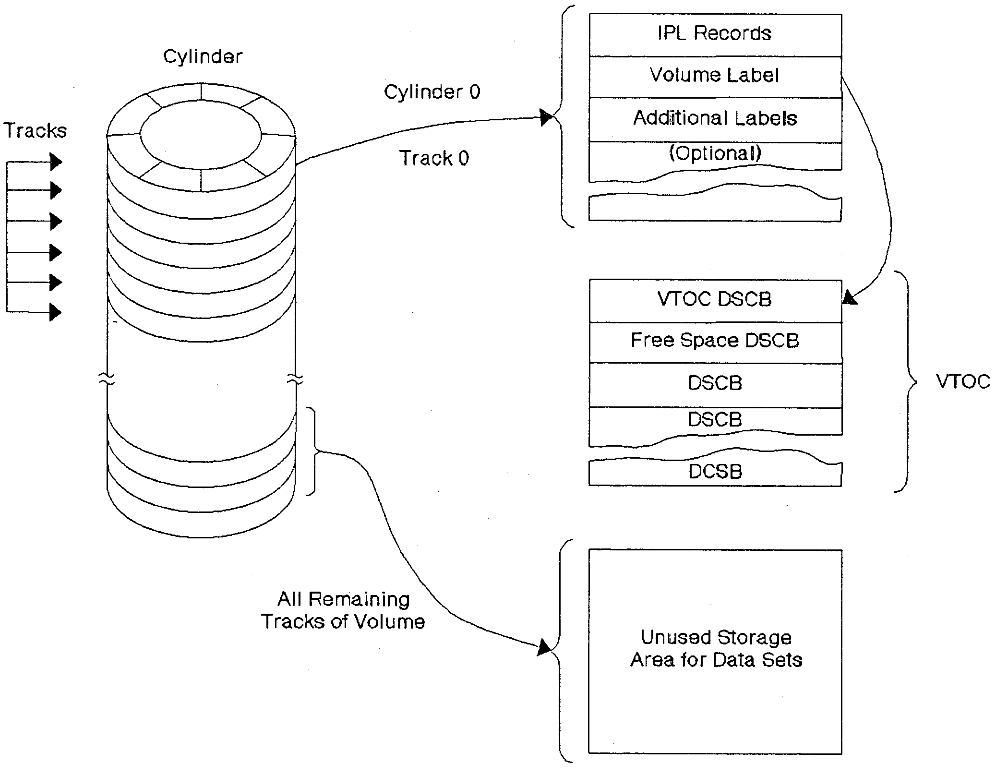


Figure 41. Direct Access Labeling

Volume-Label Group

The volume-label group immediately follows the first two initial program loading (IPL) records on track 0 of cylinder 0 of the volume. It consists of the initial volume label at record 3 plus a maximum of seven additional volume labels. The initial volume label identifies a volume and its owner, and is used to verify that the correct volume is mounted. It can also be used to prevent use of the volume by unauthorized programs. The additional labels can be processed by an installation routine that is incorporated into the system.

The format of the direct access volume label group is shown in Figure 42.

(As many as Seven Additional Volume Labels)
80-Byte Physical Record

Field		
1	(3)	Volume Label Identifier (VOL)
2	(1)	Volume Label Number (1)
3	(6)	Volume Serial Number
4	(1)	Volume Security
5	(5)	VTOC Pointer
6	(21)	Reserved (Blank)
7	(15)	Owner Identification
8	(29)	Blank

Figure 42. Initial Volume Label

Initial Volume Label Format

The 80-byte initial volume label is preceded by a 4-byte key containing VOL1.

Volume Label Identifier (VOL): Field 1 identifies a volume label.

Volume Label Number (1): Field 2 identifies the relative position of the volume label in a volume label group. It must be written as X'F1'.

The operating system identifies an initial volume label when, in reading the initial record, it finds that the first 4 characters of the record are VOL1.

Volume Serial Number: Field 3 contains a unique identification code assigned when the volume enters the system. You can place the code on the external surface of the volume for visual identification. The code is normally numeric (000001 through 999999), but may be any 1 to 6 alphameric or national (#, $, @) characters, or a hyphen (X'60'). If this field is less than 6 characters, it is padded on the right with blanks.

Volume Security: Field 4 is reserved for use by installations that want to provide security for volumes. Make this field a X'C0' unless you have your own security processing routines.

VTOC Pointer: Field 5 of direct access volume label 1 contains the address of the VTOC in the form of CCHHR.

Reserved: Field 6 is reserved for possible future use. Leave it blank.

Owner Name and Address Code: Field 7 contains a unique identification of the owner of the volume.

All the bytes in Field 8 are left blank.

Data Set Control Block (DSCB)

The system automatically constructs a DSCB when space is requested for a data set on a direct access volume. Each data set on a direct access volume has one or more DSCBs to describe its characteristics. The DSCB appears in the VTOC and, in addition to space allocation and other control information, contains operating system data, device-dependent information, and data set characteristics. There are seven kinds of DSCBs, each with a different purpose and a different format number. For an explanation of Format-1 through Format-6 DSCBs, see *System—Data Administration*. Format 0 DSCBs are used to indicate empty space in the VTOC.

User Label Groups

User header and trailer label groups can be included with data sets of physically sequential or direct organization. The labels in each group have the format shown in Figure 43 on page 134.

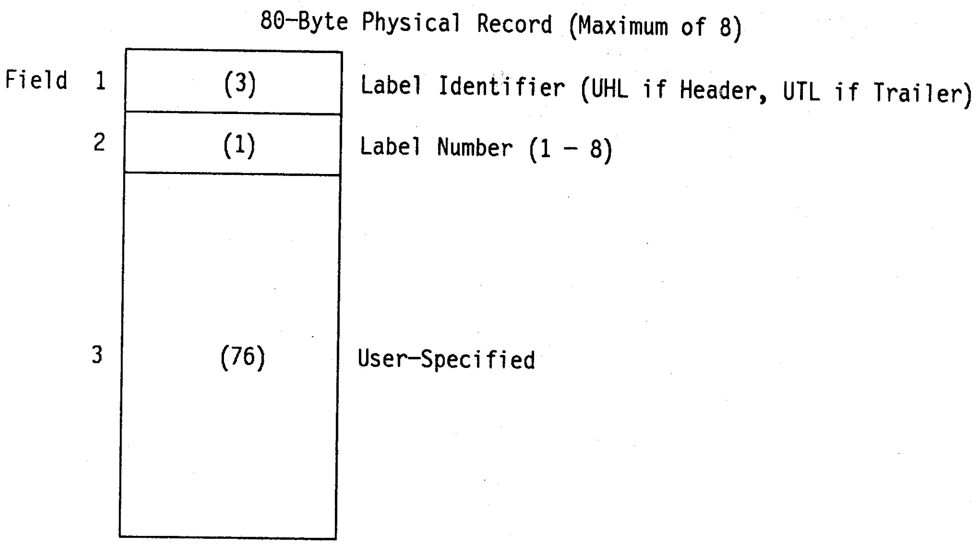

80-Byte Physical Record (Maximum of 8)
Field 1
(3)
Label Identifier (UHL if Header, UTL if Trailer)
2
(1)
Label Number (1 - 8)
3
(76)
User-Specified

Figure 43. User Header and Trailer Labels

Each group can include as many as eight labels, but the space required for both groups must not be more than one track on a direct access device. The current minimum track size allows a maximum of eight labels, including both header and trailer labels. So, a program becomes device dependent (among direct access devices) when it creates more than eight labels.

If user labels are specified in the DD statement (LABEL=SUL), an additional track is normally allocated when the data set is created. No additional track is allocated when specific tracks are requested (SPACE=(ABSTR,...)), or when tracks allocated to another data set are requested (SUBALLOC=...). In either case, labels are written on the first track that is allocated.

User Header Label Group: The operating system writes these labels as directed by the processing program recording the data set. The first 4 characters of the user header label must be UHL1,..., UHL8; you can specify the remaining 76 characters. When the data set is read, the operating system makes the user header labels available to the problem program for processing.

User Trailer Label Group: These labels are recorded (and processed) as explained in the preceding text for user header labels, except that the first 4 characters must be UTL1,...,UTL8.

User Header and Trailer Label Format

Label Identifier: Field 1 indicates the kind of user header label. UHL indicates a user header label; UTL indicates a user trailer label.

Label Number: Field 2 identifies the relative position (1 to 8) of the label within the user label group.

User-Specified: Field 3 (76 bytes).

End of Product-Sensitive Programming Interface

Appendix B. Control Characters

As an optional feature, each logical record, in any record format, may include a control character. This control character is recognized and processed if a data set is being written to a printer or punch.

For format-F and format-U records, this character is the first byte of the logical record.

For format-V records, it must be the fifth byte of the logical record, immediately following the record descriptor word.

Two options are available. If either option is specified in the DCB, the character must appear in every record and other line spacing or stacker selection options also specified in the DCB are ignored.

Machine Code

You can specify in the DCB that the machine code control character has been placed in each logical record. If the record is to be written, the appropriate byte must contain the command code bit configuration specifying both the write and the desired carriage or stacker select operation.

The machine code control characters for a printer are:

Print—Then Act	**Action**	**Act Immediately without Printing**
X'01'	Print only (no space)	
X'09'	Space 1 line	X'0B'
X'11'	Space 2 lines	X'13'
X'19'	Space 3 lines	X'1B'
X'89'	Skip to channel 1	X'8B'
X'91'	Skip to channel 2	X'93'
X'99'	Skip to channel 3	X'9B'
X'A1'	Skip to channel 4	X'A3'
X'A9'	Skip to channel 5	X'AB'
X'B1'	Skip to channel 6	X'B3'
X'B9'	Skip to channel 7	X'BB'
X'C1'	Skip to channel 8	X'C3'
X'C9'	Skip to channel 9	X'CB'
X'D1'	Skip to channel 10	X'D3'
X'D9'	Skip to channel 11	X'DB'
X'E1'	Skip to channel 12	X'E3'

The machine code control characters for a card read punch device are as follows:

Control Code	Action
X'01'	Select stacker 1
X'41'	Select stacker 2
X'5A'[1]	Change from line mode to page mode
X'81'	Select stacker 3

[1] The IBM 3800 Model 3 all-point-addressable mode uses this code to change from compatibility to page mode.

Other command codes for specific devices are contained in publications describing the control units and devices.

Extended American National Standards Institute Code

In place of machine code, you can specify control characters defined by the American National Standards Institute (ANSI). Whenever IBM publications refer to ANSI control characters, they are coded as follows:

Code	Action before Printing a Line
b	Space one line (blank code)
0	Space two lines
-	Space three lines
+	Suppress space
1	Skip to channel 1
2	Skip to channel 2
3	Skip to channel 3
4	Skip to channel 4
5	Skip to channel 5
6	Skip to channel 6
7	Skip to channel 7
8	Skip to channel 8
9	Skip to channel 9
A	Skip to channel 10
B	Skip to channel 11
C	Skip to channel 12

Code	Action after Punching a Card
V	Select punch pocket 1
W	Select punch pocket 2
X'5A'[1]	Change from line to page mode.

[1] The IBM 3800 Model 3 all-point-addressable mode uses this code.

These control characters include those defined by ANSI FORTRAN. If any other character is specified, it is interpreted as 'b' or 'V', depending on whether it is for a printer or a punch; no error indication is returned.

Appendix C. Allocating Space on Direct Access Volumes

When direct access storage space is required for a data set, you can specify the amount of space needed explicitly, using the SPACE parameter. The operating system selects the device and allocates the space accordingly. You can specify the amount of space implicitly by using the space specified in the data class assigned to your data set by the ACS routines. The data class will not be used if SMS is inactive at the time of your allocation.

The amount of space required can be specified in blocks, tracks, or cylinders. If you want to maintain device independence, specify your space requirements in blocks. Device independence is especially important to system-managed storage. If you want to specify your request as record length, you must specify your space requirements in blocks and use the average record (AVGREC) keyword. If your request is in tracks or cylinders, you must be aware of such device considerations as cylinder and track capacity.

Allocation by Blocks: When the amount of space required is expressed in blocks, you must specify the number and average length of the blocks within the data set, as in this example:

```
//  DD SPACE=(300,(5000,100)), ...

     300 = average block length in bytes
    5000 = primary quantity (number of blocks)
     100 = secondary quantity, to be allocated if the primary
           quantity is not enough (in blocks)
```

From this information, the operating system estimates and allocates the number of tracks required. Space is always in complete tracks. You may also request that the space allocated for a specific number of blocks begin and end on cylinder boundaries.

You must be certain that both the quantity and the increment are large enough to contain the largest block to be written. Otherwise, all the space requested is allocated but erased as the system tries to find a space large enough for the record.

Allocation by Average Record Length: When the amount of space required is expressed in average record length, you must specify the number of records within the data set and their average length, and use the AVGREC keyword to modify the scale of your request. When AVGREC is specified, the average block length becomes average record length. The system determines the appropriate block size. The system applies the scale value to the primary and secondary quantities specified in the SPACE keyword. Possible values for the AVGREC keyword are:

- **U**—use a scale of 1
- **K**—use a scale of 1024
- **M**—use a scale of 1,048,576

When the AVGREC keyword is specified, the values specified for primary and secondary quantities in the SPACE keyword are multiplied by the scale and those new values will be used in the space allocation. For example, the following request will result in the primary and secondary quantities being multiplied by 1024:

```
//  DD SPACE=(80,(20,2)),AVGREC=K, ...

                      80  = average record length in bytes
 80 * 20 * 1024 = 1.6 MB  = primary space
 80 *  2 * 1024 = 160 KB  = secondary space, to be allocated if the
           primary space is not enough
```

Allocation by Tracks or Cylinders: The amount of space required can be expressed in tracks or cylinders, as in these examples:

```
//  DD SPACE=(TRK,(100,5)), ...
//  DD SPACE=(CYL,(3,1)), ...
```

Allocation by Absolute Address: If the data set contains location-dependent information in the form of an absolute track address (MBBCCHHR), space should be requested about the number of tracks and the beginning address, as in this example:

```
//  DD SPACE=(ABSTR,(500,15)),UNIT=3380, ...
```

where 500 tracks are required, beginning at relative track 15, which is cylinder 1, track 0.

Note: Data sets to be managed by SMS cannot use absolute address allocation.

Allocation of Mass Storage System (MSS) Virtual Volumes: When the data set is to be stored on an MSS virtual volume, a volume group (MSVGP) parameter may be specified instead of using the SPACE parameter on the DD card. Before the MSVGP parameter can be used, the volume group must be identified to MSS by the utility program IDCAMS.

Allocation of MSS virtual volume space should be in multiples of cylinders, with secondary allocation a multiple of the primary to ensure maximum space usage and minimum fragmentation.

Note: SMS cannot manage MSS data sets. Use of MSS is not recommended.

Additional Space Allocation Options: The DD statement provides you with much flexibility in specifying space requirements. The options are described in detail in *JCL Reference*.

Note: The section on estimating tracks has been moved to Appendix C, "Device Capabilities" in *Data Administration: Macro Instruction Reference*.

Appendix D. ISO/ANSI/FIPS Record Control Word and Segment Control Word

Translation of ISO/ANSI/FIPS Record Control Word

The ISO/ANSI/FIPS record control word (RCW) is expressed in ISCII/ASCII characters and is 4 bytes long. See Figure 44. Note that the RCW is different from the code in the IBM record descriptor word (RDW). The RDW, expressed in binary, is the internal data management equivalent of the ISO/ANSI/FIPS RCW.

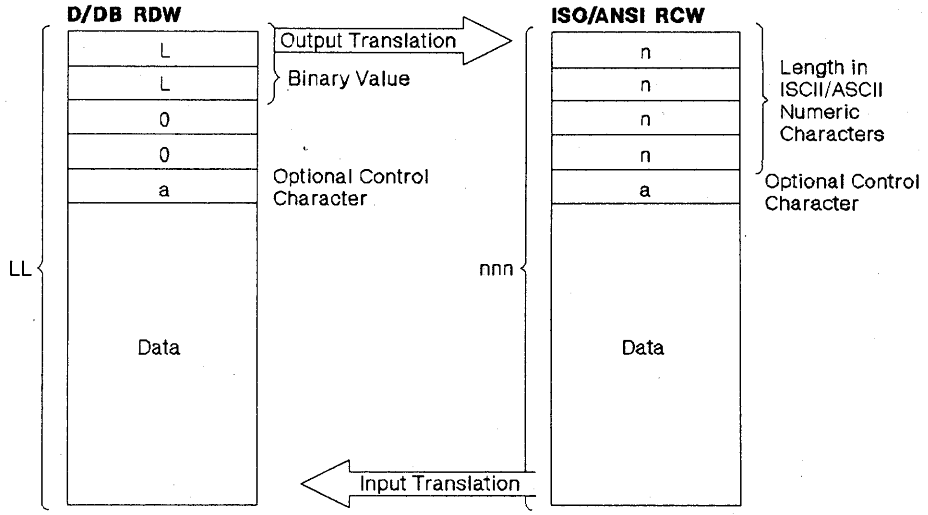
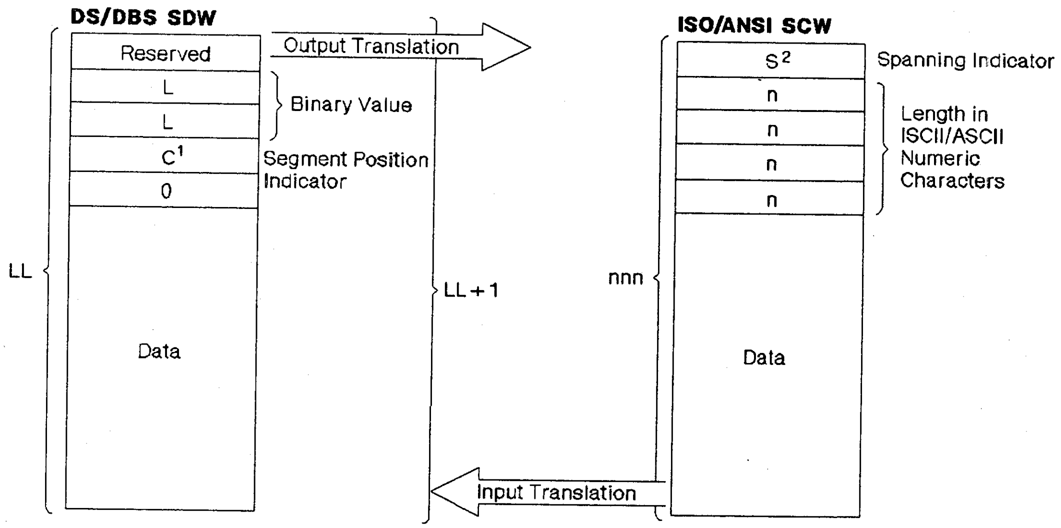

D/DB RDW
L
L
0
0
a
Data
LL
Output Translation
Binary Value
Optional Control Character
Input Translation
ISO/ANSI RCW
n
n
n
n
a
Data
nnn
Length in ISCII/ASCII Numeric Characters
Optional Control Character

Figure 44. Translation of ISO/ANSI/FIPS Record Control Word to D/DB Record Descriptor Word

Translation of ISO/ANSI/FIPS Segment Control Word

The ISO/ANSI/FIPS segment control word (SCW) is expressed in ISCII/ASCII characters and is 5 bytes in length. (See Figure 45.) Note that the SCW is different from the code in the IBM segment descriptor word (SDW). The SDW is the internal data management equivalent of the ISO/ANSI/FIPS SCW. Only 4 bytes are used by data management, but the user buffer area must accommodate an extra byte to allow for translation from the ISO/ANSI/FIPS SCW. The SDW is expressed in binary.



[1] C values for SDW (2 low order bits)

00 = only segment of record
01 = first segment of record
11 = intermediate segment of record
10 = last segment of record

[2] S values for SCW (ASCII characters)

0 = only segment of record
1 = first segment of record
2 = intermediate segment of record
3 = last segment of record

Figure 45. Translation of ISO/ANSI/FIPS Segment Control Word to DS/DBS Segment Descriptor Word

Appendix E. Processing a Direct Data Set

General-Use Programming Interface

This appendix is intended to help you process direct data sets. It contains general-use programming interfaces, which are provided to allow you to write programs that use the services of MVS/DFP.

Use of BDAM is not recommended. We recommend you use VSAM key-sequenced data sets instead.

In a direct data set, there is a relationship between a control number or identification of each record and its location on the direct access volume. This relationship allows you to gain access to a record without an index search. You determine the actual organization of the data set. If the data set has been carefully organized, location of a particular record takes less time than with an indexed sequential data set.

The DSORG parameter of the DCB macro specifies the type of processing to be performed; DSORG in the DD statement specifies the organization of the data set when it is created.

Although you can process a direct data set sequentially using either the queued access method or the basic access method, you cannot read record keys using the queued access method. When you use the basic access method, each unit of data transmitted between virtual storage and an I/O device is regarded by the system as a record. If, in fact, it is a block, you must perform any blocking or deblocking required. For that reason, the LRECL field is not used when processing a direct data set. Only BLKSIZE must be specified when you read, add, or update records on a direct data set.

If dynamic buffering is specified for your direct data set, the system will provide a buffer for your records. If dynamic buffering is not specified, you must provide a buffer for the system to use.

As indicated in the discussion of direct access devices, record keys are optional. If they are specified, they must be used for every record and must be of a fixed length.

Direct Data Set Organization

In developing the organization of your data set, you can use direct addressing. When direct addresses are used, the location of each record in the data set is known.

If format-F records with keys are being written, the key of each record can be used to identify the record. For example, a data set with keys ranging from 0 to 4999 should be allocated space for 5000 records. Each key relates directly to a location that you can refer to as a relative record number. Therefore, each record should be assigned a unique key. If identical keys are used, it is possible, during periods of high processor and channel activity, to skip the desired record and retrieve the next record on the track. The main disadvantage of this type of organization is that records may not exist for many of the keys even though space has been reserved for them.

Space could be allocated based on the number of records in the data set rather than on the range of keys. This type of organization requires the use of a cross-reference table. When a record is written in the data set, you must note the physical location as a relative block number, an actual address, or as a relative track and record number. The addresses must then be stored in a table that is searched when a record is to be retrieved. Disadvantages are that cross-referencing can be used efficiently only with a small data set, storage is required for the table, and processing time is required for searching and updating the table.

A more common, but somewhat complex, technique for organizing the data set involves the use of indirect addressing. In indirect addressing, the address of each record in the data set is determined by a mathematical manipulation of the key. This manipulation is called "randomizing" or "conversion." Because several randomizing procedures could be used, no attempt is made here to describe or explain those that might be most appropriate for your data set.

Creating a Direct Data Set

After the organization of a direct data set has been determined, the process of creating it is almost identical to creating a sequential data set. The BSAM DCB macro should be used with the WRITE macro instruction (the form used to create a direct data set). The following parameters must be specified in the DCB macro instruction:

- DSORG=PS or PSU
- DEVD=DA or omitted
- MACRF=WL

The DD statement must indicate direct access (DSORG=DA or DAU). If keys are used, a key length (KEYLEN) must also be specified. DSORG and KEYLEN may be specified through data class. For more information on data class, see Chapter 5, "Specifying a Data Control Block and Initializing Data Sets" on page 39. Record length (LRECL) need not be specified but may be used to provide compatibility with sequential access method processing of this data set.

It is possible to create a direct data set using QSAM (no keys allowed) or BSAM (with or without keys and the DCB specifies MACRF=W). However, this method is not recommended because, when you access this direct data set, you cannot request a function that requires the information in the capacity record (R0) data field. For example, the following restrictions would apply:

- Variable-length, undefined-length, or variable-length spanned record processing is not allowed.
- The WRITE add function with extended search for fixed-length records (with or without track overflow) is not allowed.

If a VIO data set is opened for processing with the extended search option, the DEBENDCC and DEBENDHH fields of the DEB will reflect the real address of the last record written during the BDAM create step. This prevents BDAM from searching unused tracks. The information needed to determine the data set size is written in the DSCB during the close of the DCB used in the create step. Therefore, if this data set is being created and processed by the same program, and the DCB used for creating the data set has not been closed before opening the DCB to be used for processing, the resultant beginning and ending CCHH will be equal.

If a direct data set is created and updated or read within the same job step, and the OPTCD parameter is used in the creation, updating, or reading of the data set, different DCBs and DD statements should be used.

If you are using direct addressing with keys, you can reserve space for future format-F records by writing a dummy record. To reserve or truncate a track for format-U, format-V, or format-VS records, write a capacity record. The capacity record (R0) contains a 7-byte data field (CCHHRLL), where CCHHR is the ID of the last record on the track, and LL is the number of unused bytes on the track. If a WRITE SZ macro is issued for a track with no records, R is zero and LL is the entire length of the track.

Format-F records are written sequentially as they are presented. When a track is filled, the system automatically writes the capacity record and advances to the next track. Because of the form in which relative track addresses are recorded, direct data sets whose records are to be identified by means other than actual address must be limited in size to no more than 65,536 tracks for the entire data set.

Tape-to-Disk—Direct Data Set: In the example problem in Figure 46 on page 146, a tape containing 204-byte records arranged in key sequence is used to create a direct data set. A 4-byte binary key for each record ranges from 1000 to 8999, so space for 8000 records is requested.

```
//DAOUTPUT DD     DSNAME=SLATE.INDEX.WORDS,DCB=(DSORG=DA,           C
//              BLKSIZE=200,KEYLEN=4,RECFM=F),SPACE=(204,8000),---
//TAPINPUT DD     ---
           ...
DIRECT     START
           ...
           L      9,=F'1000'
           OPEN   (DALOAD,(OUTPUT),TAPEDCB)
           LA     10,COMPARE
NEXTREC    GET    TAPEDCB
           LR     2,1
COMPARE    C      9,0(2)       Compare key of input against
*                                             control number
           BNE    DUMMY
           WRITE  DECB1,SF,DALOAD,(2)         Write data record
           CHECK  DECB1
           AH     9,=H'1'
           B      NEXTREC
DUMMY      C      9,=F'8999'    Have 8000 records been written?
           BH     ENDJOB
           WRITE  DECB2,SD,DALOAD,DUMAREA     Write dummy
           CHECK  DECB2
           AH     9,=H'1'
           BR     10
INPUTEND   LA     10,DUMMY
           BR     10
ENDJOB     CLOSE  (TAPEDCB,,DALOAD)
           ...
DUMAREA    DS     8F
DALOAD     DCB    DSORG=PS,MACRF=(WL),DDNAME=DAOUTPUT,              C
                  DEVD=DA,SYNAD=CHECKER,---
TAPEDCB    DCB    EODAD=INPUTEND,MACRF=(GL), ---
           ...
```

Figure 46. Creating a Direct Data Set

Referring to a Record in a Direct Data Set

After you have determined how your data set is to be organized, you must consider how the individual records will be referred to when the data set is updated or new records are added. The record identification can be represented in any of the following forms:

Relative Block Address: You specify the relative location of the record (block) within the data set as a 3-byte binary number. This type of reference can be used only with format-F records. The system computes the actual track and record number. The relative block address of the first block is 0.

Relative Track Address: You specify the relative track as a 2-byte binary number and the actual record number on that track as a 1-byte binary number. The relative track address of the first track is 0.

Relative Track or Block Address and Actual Key: In addition to the relative track or block address, you specify the address of a virtual storage location containing the record key. The system computes the actual track address and searches for the record with the correct key.

Actual Address: You supply the actual address in the standard 8-byte form—MBBCCHHR. Remember that the use of an actual address may force you to indicate that the data set is unmovable.

Extended Search: You request that the system begin its search with a specified starting location and continue for a certain number of records or tracks. This same option can be used to request a search for unused space where a record can be added.

To use the extended search option, you must indicate in the DCB (DCBLIMCT) the number of tracks (including the starting track) or records (including the starting record) that are to be searched. If you indicate a number of records, the system may actually examine more than this number. In searching a track, the system searches the whole track (starting with the first record); it therefore may examine records that precede the starting record or follow the ending record.

If the DCB specifies a number equal to or greater than the number of tracks allocated to the data set or the number of records within the data set, the entire data set is searched in the attempt to satisfy your request.

Exclusive Control for Updating: When more than one task is referring to the same data set, exclusive control of the block being updated is required to prevent simultaneous reference to the same record. Rather than issuing an ENQ macro each time you update a block, you can request exclusive control through the MACRF field of the DCB and the type operand of the READ macro. The coding example in Figure 48 on page 150 illustrates the use of exclusive control. After the READ macro is executed, your task has exclusive control of the block being updated. No other task in the system requesting access to the block is given access until the operation started by your WRITE macro is complete. If, however, the block is not to be written, you can release exclusive control using the RELEX macro.

Feedback Option: This option specifies that the system is to provide the address of the record requested by a READ or WRITE macro. This address may be in the same form that was presented to the system in the READ or WRITE macro, or as an 8-byte actual address. This option can be specified in the OPTCD parameter of the DCB and in the READ or WRITE macro. If this option is omitted from the DCB but is requested in a READ or WRITE macro, an 8-byte actual address is returned to the user.

The feedback option is automatically provided for a READ macro instruction requesting exclusive control for updating. This feedback will be in the form of an actual address (MBBCCHHR) unless feedback was specified in the OPTCD field of the DCB. In this case, feedback is returned in the format of the addressing scheme used in the problem program (an actual or a relative address). When a WRITE or RELEX macro is issued (which releases the exclusive control that was gotten for the READ request), the system will assume that the addressing scheme used for the WRITE or RELEX macro is in the same format as the addressing scheme used for feedback in the READ macro.

Adding or Updating Records on a Direct Data Set

The techniques for adding records to a direct data set depend on the format of the records and the organization used.

Format-F With Keys: Adding a record amounts to essentially an update by record identification. The reference to the record can be made by either a relative block address or a relative track address.

If you want to add a record passing a relative block address, the system converts the address to an actual track address. That track is searched for a dummy record. If a dummy record is found, the new record is written in place of it. If there is no dummy record on the track, you are informed that the write operation did not take place. If you request the extended search option, the new record will be written in place of the first dummy record found within the search limits you specify. If none is found, you are notified that the write operation could not take place. In the same way, a reference by relative track address causes the record to be written in place of a dummy record on the referenced track or the first within the search limits, if requested. If extended search is used, the search begins with the first record on the track. Without extended search, the search may start at any record on the track. Therefore, records that were added to a track are not necessarily located on the track in the same sequence they were written in.

Format-F Without Keys: Here too, adding a record is really updating a dummy record already in the data set. The main difference is that dummy records cannot be written automatically when the data set is created. You will have to use your own method for flagging dummy records. The update form of the WRITE macro (MACRF=W) must be used rather than the add form (MACRF=WA).

You will have to retrieve the record first (using a READ macro instruction), test for a dummy record, update, and write.

Format-V or Format-U With Keys: The technique used to add records in this case depends on whether records are located by indirect addressing or a cross-reference table. If indirect addressing is used, you must at least initialize each track (write a capacity record) even if no data is actually written. That way the capacity record indicates how much space is available on the track. If a cross-reference table is used, you should exhaust the input and then initialize enough succeeding tracks to contain any additions that might be required.

To add a new record, use a relative track address. The system examines the capacity record to see if there is room on the track. If there is, the new record is written. Under the extended search option, the record is written in the first available area within the search limit.

Format-V or Format-U Without Keys: Because a record of this type does not have a key, you can access the record only by its relative track or actual address (direct addressing only). When you add a record to this data set, you must retain the relative track or actual address data (for example, by updating your cross-reference table). The extended search option is not allowed because it requires keys.

Tape-to-Disk Add—Direct Data Set: The example in Figure 47 on page 149 involves adding records to the data set created in the last example. Notice that the write operation adds the key and the data record to the data set. If the existing record is not a dummy record, an indication is returned in the exception code of the DECB. For that reason, it is better to use the WAIT macro instead of the CHECK macro to test for errors or exceptional conditions.

```
//DIRADD  DD       DSNAME=SLATE.INDEX.WORDS,---
//TAPEDD  DD       ---
          ...
DIRECTAD  START
          ...
          OPEN     (DIRECT,(OUTPUT),TAPEIN)
NEXTREC   GET      TAPEIN,KEY
          L        4,KEY              Set up relative record number
          SH       4,=H'1000'
          ST       4,REF
          WRITE    DECB,DA,DIRECT,DATA,'S',KEY,REF+1
          WAIT     ECB=DECB
          CLC      DECB+1(2),=X'0000'   Check for any errors
          BE       NEXTREC
```

Check error bits and take required action

```
DIRECT    DCB      DDNAME=DIRADD,DSORG=DA,RECFM=F,KEYLEN=4,BLKSIZE=200,   C
               MACRF=(WA)
TAPEIN    DCB      ---
KEY       DS       F
DATA      DS       CL200
REF       DS       F
          ...
```

Figure 47. Adding Records to a Direct Data Set

Tape-to-Disk Update—Direct Data Set: The example in Figure 48 is similar to that in Figure 47, but involves updating rather than adding. There is no check for dummy records. The existing direct data set contains 25000 records whose 5-byte keys range from 00001 to 25000. Each data record is 100 bytes long. The first 30 characters are to be updated. Each input tape record consists of a 5-byte key and a 30-byte data area. Notice that only data is brought into virtual storage for updating.

When you are updating variable-length records, you should use the same length to read and write a record.

```
//DIRECTDD DD      DSNAME=SLATE.INDEX.WORDS,---
//TAPINPUT DD      ---
           ...
DIRUPDAT   START
           ...
           OPEN    (DIRECT,(UPDAT),TAPEDCB)
NEXTREC    GET     TAPEDCB,KEY
           PACK    KEY,KEY
           CVB     3,KEYFIELD
           SH      3,=H'1'
           ST      3,REF
           READ    DECBRD,DIX,DIRECT,'S','S',0,REF+1
           CHECK   DECBRD
           L       3,DECBRD+12
           MVC     0(30,3),DATA
           ST      3,DECBWR+12
           WRITE   DECBWR,DIX,DIRECT,'S','S',0,REF+1
           CHECK   DECBWR
           B       NEXTREC
           ...
KEYFIELD   DS      0D
           DC      XL3'0'
KEY        DS      CL5
DATA       DS      CL30
REF        DS      F
DIRECT     DCB     DSORG=DA,DDNAME=DIRECTDD,MACRF=(RISXC,WIC),           C
               OPTCD=RF,BUFNO=1,BUFL=100
TAPEDCB    DCB     ---
           ...
```

Figure 48. Updating a Direct Data Set

Consideration for User Labels: User labels, if wanted, must be created when the data set is created. They may be updated, but not added or deleted, during processing of a direct data set. When creating a multivolume direct data set using BSAM, you should turn off the header exit entry after OPEN and turn on the trailer label exit entry just before issuing the CLOSE. This eliminates the end-of-volume exits. The first volume, containing the user label track, must be mounted when the data set is closed. If you have requested exclusive control, OPEN and CLOSE will ENQ and DEQ to prevent simultaneous reference to user labels.

Consideration for using the 2305-2 Fixed Head Storage: When a data set on a 2305-2 device is to be used by several tasks simultaneously, or when overlapping I/O (successive writes issued without an intervening CHECK or WAIT) is used, the following combination may produce overlaying of records:

- WRITE-add processing
- Fixed records with or without track overflow

Sharing Direct Data Sets

BDAM permits several tasks to share the same DCB and several jobs to share the same data set. It synchronizes I/O requests at both levels by maintaining a read-exclusive list.

When several tasks share the same DCB and each asks for exclusive control of the same block, BDAM issues a system ENQ for the block (or in some cases the whole track). It reads in the block and passes it to the first caller while putting all subsequent requests for that block on a wait queue. When the first task releases the block, BDAM moves it into the next caller's buffer and posts it complete. The block is passed to subsequent callers in the order the request was received.

BDAM not only synchronizes the I/O requests, but also issues only one ENQ and one I/O request for several read requests for the same block.

Note: Because BDAM processing is not sequential and I/O requests are not related, a caller can continue processing other blocks while waiting for exclusive control of the shared block.

Because BDAM issues a system ENQ for each record held exclusively, it allows a data set to be shared between jobs, so long as all callers use BDAM. BDAM's commonly understood argument is what is enqueued on.

BDAM supports multiple task users of a single DCB when working with existing data sets. When operating in load mode, however, only one task may use the DCB at a time. The following restrictions and comments apply when more than one task shares the same DCB, or when using multiple DCBs for the same data set.

- Subpool 0 must be shared.
- The user should ensure that a WAIT or CHECK macro has been issued for all outstanding BDAM requests before the task issuing the READ or WRITE macro terminates. In case of abnormal termination, this can be done through a STAE/STAI or ESTAE exit.
- FREEDBUF and/or RELEX macros should be issued to free any resources that could still be held by the terminating task. This can be done during or after task termination.

Note: Open, close, and all I/O must be performed in the same key and state (problem state or supervisor state).

End of General-Use Programming Interface

Appendix F. Processing an Indexed Sequential Data Set

General-Use Programming Interface

This appendix is intended to help you process indexed sequential data sets. It contains general-use programming interfaces, which are provided to allow you to write programs that use the services of MVS/DFP.

Use of BISAM or QISAM to process indexed sequential data sets is not recommended; we recommend you use VSAM data sets instead.

The organization of an indexed sequential data set allows you a great deal of flexibility in the operations you can perform. The data set can be read or written sequentially, individual records can be processed in any order, records can be deleted, and new records can be added. The system automatically locates the proper position in the data set for new records and makes any necessary adjustments when records are deleted. However, be aware that indexed sequential data sets cannot be managed by SMS, which means you cannot take advantage of SMS storage management functions to manage ISAM data sets.

The queued access method must be used to create an indexed sequential data set. It can also be used to sequentially process or update the data set and to add records to the end of the data set. The basic access method can be used to insert new records between records already in the data set and to update the data set directly.

Because ISAM data sets cannot take advantage of system-managed storage, you should consider converting ISAM data sets to VSAM data sets. You can use access method services to allocate a VSAM data set and copy the ISAM data set into it. For information on converting to VSAM data sets, see *VSAM Administration Guide*.

Indexed Sequential Data Set Organization

The records in an indexed sequential data set are arranged according to collating sequence by a key field in each record. Each block of records is preceded by a key field that corresponds to the key of the last record in the block.

An indexed sequential data set resides on direct access storage devices and can occupy as many as three different areas:

- *Prime Area*—This area, also called the prime data area, contains data records and related track indexes. It exists for all indexed sequential data sets.
- *Overflow Area*—This area contains records that overflow from the prime area when new data records are added. It is optional.
- *Index Area*—This area contains master and cylinder indexes associated with the data set. It exists for a data set that has a prime area occupying more than one cylinder.

The indexes of an indexed sequential data set are analogous to the card catalog in a library. For example, if you know the name of the book or the author, you can look in the card catalog and obtain a catalog number that will enable you to locate the book in the book files. You then go to the shelves and proceed through rows until you find the shelf containing the book. Usually each row contains a sign to indicate the beginning and ending numbers of all books in that particular row. Thus, as you proceed through the rows, you compare the catalog number obtained from the index with the numbers posted on each row. Upon locating the proper row, you search that row for the shelf that contains the book. Then you look at the individual book numbers on that shelf until you find the particular book.

ISAM uses the indexes in much the same way to locate records in an indexed sequential data set.

As the records are written in the prime area of the data set, the system accounts for the records contained on each track in a track index area. Each entry in the track index identifies the key of the last record on each track. There is a track index for each cylinder in the data set. If more than one cylinder is used, the system develops a higher-level index called a cylinder index. Each entry in the cylinder index identifies the key of the last record in the cylinder. To increase the speed of searching the cylinder index, you can request that a master index be developed for a specified number of cylinders, as shown in Figure 49 on page 155.

Rather than reorganize the whole data set when records are added, you can request that space be allocated for additional records in an overflow area.

Prime Area

Records are written in the prime area when the data set is created or updated. The last track of prime data is reserved for an end-of-file mark. The portion of Figure 49 on page 155 labeled Cylinder 1 illustrates the initial structure of the prime area. Although the prime area can extend across several noncontiguous areas of the volume, all the records are written in key sequence. Each record must contain a key; the system automatically writes the key of the highest record before each block.

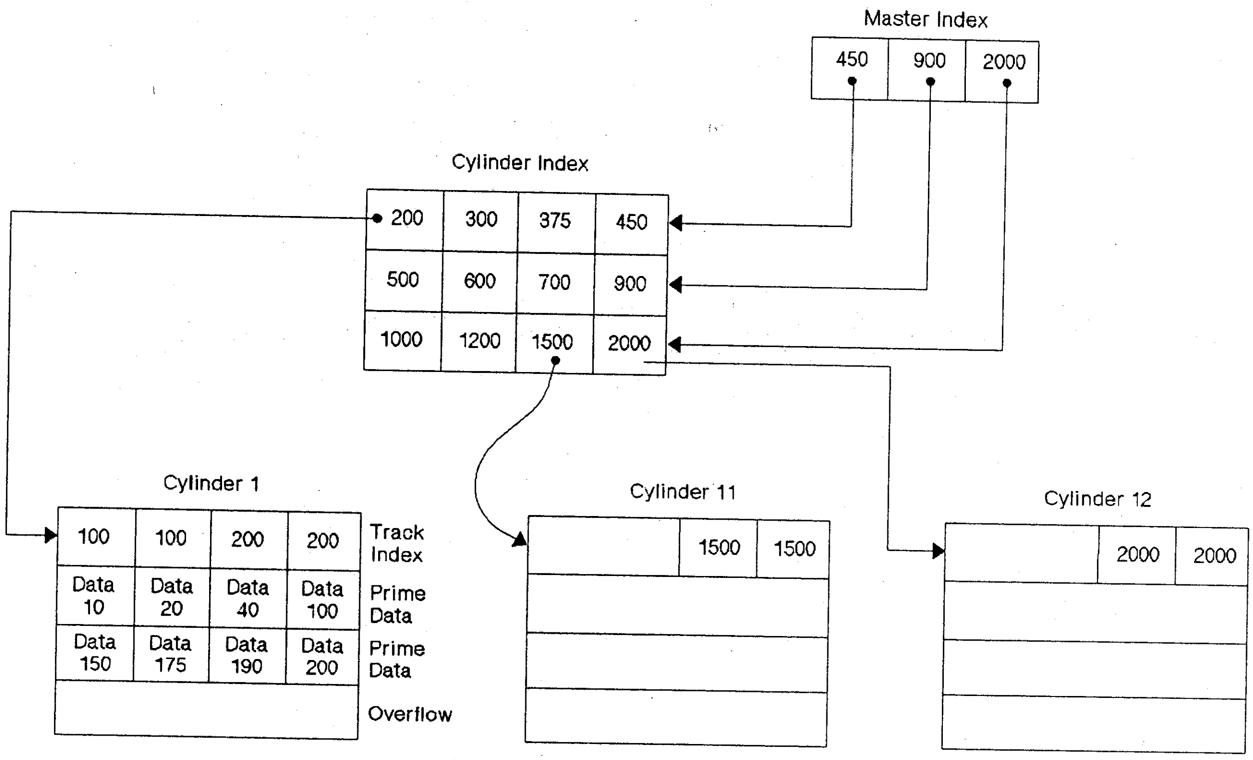


Figure 49. Indexed Sequential Data Set Organization

When the ABSTR option of the SPACE parameter of the DD statement is used to generate a multivolume prime area, the VTOC of the second volume and on all succeeding volumes must be contained within cylinder 0 of the volume.

Index Areas

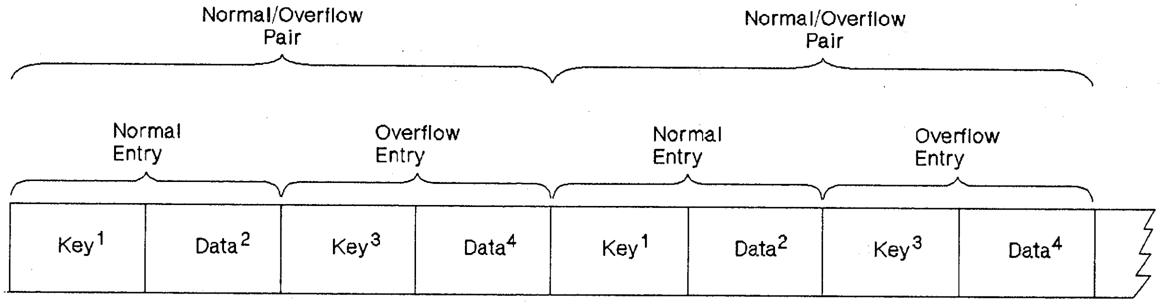
The operating system generates track and cylinder indexes automatically. As many as three levels of master index are created if requested.

Track Index

This is the lowest level of index and is always present. There is one track index for each cylinder in the prime area; it is written on the first track(s) of the cylinder that it indexes.

The index consists of a series of paired entries, that is, of a normal entry and an overflow entry for each prime track. For fixed-length records, each normal entry (and also DCBFIRSH) points to either record 0 or the first prime record on a shared track (a track shared by index and data). For variable-length records, the normal entry contains the key of the highest record on the track and the address of the last record on the track. The overflow entry is originally the same as the normal entry. (This is why 100 appears twice on the track index for cylinder 1 in Figure 49.) The overflow entry is changed when records are added to the data set. Then the overflow entry contains the key of the highest overflow record and the address of the lowest overflow record logically associated with the track. Figure 50 on page 156 shows the format of a track index.

If all the tracks allocated for the prime data area are not used, the index entries for the unused ones are flagged as inactive. The last entry of each track index is a dummy entry indicating the end of the index. When fixed-length record format has been specified, the remainder of the last track of each cylinder used for a track index contains prime data records if there is room for them.



[1] Normal key = key of the highest record on the prime data track

[2] Normal data = address of the prime data track

[3] Overflow key = key of the highest overflow record logically associated with the prime data track

[4] Overflow data = address of the lowest overflow record logically associated with the prime data track

Notes:

- If there are no overflow records, overflow key and data entries are the same as normal key and data entries.
- This figure is a logical representation only; that is, it makes no attempt to show the physical size of track index entries.

Figure 50. Format of Track Index Entries

Each index entry has the same format as the others. It is an unblocked, fixed-length record consisting of a count, a key, and a data area. The length of the key corresponds to the length of the key area in the record to which it points. The data area is always 10 bytes long. It contains the full address of the track or record to which the index points, the level of the index, and the entry type.

Cylinder Index

For every track index created, the system generates a cylinder index entry. There is one cylinder index for a data set that points to a track index. Because there is one track index per cylinder, there is one cylinder index entry for each cylinder in the prime data area, except in the case of a 1-cylinder prime area. As with track indexes, inactive entries are created for any unused cylinders in the prime data area.

Master Index

As an optional feature, the operating system creates, at your request, a master index. The presence of this index makes long, serial searches through a large, cylinder index unnecessary.

You can specify the conditions under which you want a master index created. For example, if you have specified NTM=3 and OPTCD=M in your DCB macro, a master index is created when the cylinder index exceeds 3 tracks. The master index consists of one entry for each track of cylinder index. If your data set is extremely large, a higher-level master index is created when the first-level master index exceeds three tracks. This higher-level master index consists of one entry for each track of the first-level master index. This procedure can be repeated for as many as three levels of master index.

Overflow Areas

As records are added to an indexed sequential data set, space is required to contain those records that will not fit on the prime data track on which they belong. You can request that a number of tracks be set aside as a cylinder overflow area to contain overflows from prime tracks in each cylinder. An advantage of using cylinder overflow areas is a reduction of search time required to locate overflow records. A disadvantage is that there will be unused space if the additions are unevenly distributed throughout the data set.

Instead of, or in addition to, cylinder overflow areas, you can request an independent overflow area. Overflow from anywhere in the prime data area is placed in a specified number of cylinders reserved solely for overflow records. An advantage of having an independent overflow area is a reduction in unused space reserved for overflow. A disadvantage is the increased search time required to locate overflow records in an independent area.

If you request both cylinder overflow and independent overflow, the cylinder overflow area is used first. It is a good practice to request cylinder overflow areas large enough to contain a reasonable number of additional records and an independent overflow area to be used as the cylinder overflow areas are filled.

Creating an Indexed Sequential Data Set

You can create an indexed sequential data set in one step or in several steps. You can create the data set either by writing all records in a single step or by writing one group of records in one step and writing additional groups of records in subsequent steps. Writing records in subsequent steps is called resume loading. When using either one step or several steps, you must present the records for writing in ascending order by key.

To create an indexed sequential data set by the one-step method, you should proceed as follows:

- Code DSORG=IS or DSORG=ISU and MACRF=PM or MACRF=PL in the DCB macro.
- Specify in the DD statement the DCB attributes DSORG=IS or DSORG=ISU, record length (LRECL), block size (BLKSIZE), record format (RECFM), key length (KEYLEN), relative key position (RKP), options required (OPTCD), cylinder overflow (CYLOFL), and the number of tracks for a master index (NTM). Specify space requirements with the SPACE parameter. To reuse previously allocated space, omit the SPACE parameter and code DISP=(OLD, KEEP).
- Open the data set for output.
- Use the PUT macro to place all the records or blocks on the direct access volume.
- Close the data set.

The records that comprise a newly created data set must be presented for writing in ascending order by key. You can merge two or more input data sets. If you want a data set with no records (a null data set), you must write at least one record when you create the data set. You can subsequently delete this record to achieve the null data set.

If an unload is done that deletes all existing records in an ISAM data set, at least one record must be written on the subsequent load. If no record is written, the data set will be unusable.

If the records are blocked, you should not write a record with a hexadecimal value of FF and a key of hexadecimal value FF. This value is used for padding. If it occurs as the last record of a block, the record cannot be retrieved. If the record is moved to the overflow area, it is lost.

When creating an indexed sequential data set, a procedure called loading, you can improve performance by using the full-track-index write option. You do this by specifying OPTCD=U in the DCB. This causes the operating system to accumulate track index entries in virtual storage. Note that the full-track-index write option can be used only for fixed-length records.

If you do not specify full-track-index write, the operating system writes each normal overflow pair of entries for the track index after the associated prime data track has been written. If you do specify full-track-index write, the operating system accumulates track index entries in virtual storage until either (a) there are enough entries to fill a track or (b) end-of-data or end-of-cylinder is reached. Then the operating system writes these entries as a group, writing one group for each track of track index. This option requires allocation of more storage space (the space in which the track index entries are gathered), but the number of I/O operations required to write the index can be significantly decreased.

When you specify the full-track-index write option, the track index entries are written as fixed-length unblocked records. If the area of virtual storage available is not large enough the entries are written as they are created, that is, in normal overflow pairs.

After an indexed sequential data set has been created, its cms characteristics cannot be changed. However, for added flexibility, the system allows you to retrieve records by using either the queued access technique with simple buffering or the basic access method with dynamic buffering.

Tape-to-Disk—Indexed Sequential Data Set: The example in Figure 51 on page 159 shows the creation of an indexed sequential data set from an input tape containing 60-character records. The key by which the data set is organized is in positions 20 through 29. The output records will be an exact image of the input, except that the records will be blocked. One track per cylinder is to be reserved for cylinder overflow. Master indexes are to be built when the cylinder index exceeds 6 tracks. Reorganization information about the status of the cylinder overflow areas is to be maintained by the system. The delete option will be used during any future updating.

```
//INDEXDD DD      DSNAME=SLATE.DICT(PRIME),DCB=(BLKSIZE=240,CYLOFL=1,     C
//                DSORG=IS,OPTCD=MYLR,RECFM=FB,LRECL=60,NTM=6,RKP=19,     C
                  KEYLEN=10),UNIT=3330,SPACE=(CYL,25,,CONTIG),---
//INPUTDD DD      ---
         ...
ISLOAD   START    0
         ...
         DCBD     DSORG=IS
ISLOAD   CSECT
         OPEN     (IPDATA,,ISDATA,(OUTPUT))
NEXTREC  GET      IPDATA                     Locate mode
         LR       0,1                        Address of record in register 1
         PUT      ISDATA,(0)                 Move mode
         B        NEXTREC
         ...
CHECKERR L        3,=A(ISDATA)               Initialize base for errors
         USING    IHADCB,3
         TM       DCBEXCD1,X'04'
         BO       OPERR                      Uncorrectable error
         TM       DCBEXCD1,X'20'
         BO       NOSPACE                    Space not found
         TM       DCBEXCD2,X'80'
         BO       SEQCHK                     Record out of sequence
```

Rest of error checking
Error routine
End of job routine (EODAD FOR IPDATA)

```
IPDATA   DCB      ---
ISDATA   DCB      DDNAME=INDEXDD,DSORG=IS,MACRF=(PM),SYNAD=CHECKERR
         ...
```

Figure 51. Creating an Indexed Sequential Data Set

To create an indexed sequential data set in more than one step, create the first group of records using the one-step method described above. This first section must contain at least one data record. The remaining records can then be added to the end of the data set in subsequent steps, using resume load. Each group to be added must contain records with successively higher keys. This method allows you to create the indexed sequential data set in several short time periods rather than in a single long one.

This method also allows you to provide limited recovery from uncorrectable output errors. When an uncorrectable output error is detected, do not attempt to continue processing or to close the data set. If you have provided a SYNAD routine, it should issue the ABEND macro to terminate processing. If no SYNAD routine is provided, the control program will terminate your processing. If the error shows that space in which to add the record was not found, you must close the data set; issuing subsequent PUT macros can cause unpredictable results. You should begin recovery at the record following the end of the data as of the last successful close. The rerun time is limited to that necessary to add the new records, rather than to that necessary to re-create the whole data set.

When you extend an indexed sequential data set with resume load, the disposition parameter of the DD statement must specify MOD. To ensure that the necessary control information is in the DSCB before attempting to add records, you should at least open and close the data set successfully on a system that includes resume load. This is necessary only if the data set was created on a previous version of the system. Records may be added to the data set by resume load until the space allocated for prime data in the first step has been filled.

During resume load on a data set with a partially filled track and/or a partially filled cylinder, the track index entry and/or the cylinder index entry is overlaid when the track or cylinder is filled. Resume load for variable-length records begins at the next sequential track of the prime data set. If resume load abnormally terminates after these index entries have been overlaid, a subsequent resume load will result in a sequence check when it adds a key that is higher than the highest at the last successful CLOSE but lower than the key in the overlaid index entry. When the SYNAD exit is taken for a sequence check, register 0 contains the address of the high key of the data set. However, if the SYNAD exit is taken during CLOSE, register 0 will contain the IOB address.

Allocating Space for an Indexed Sequential Data Set

An indexed sequential data set has three areas: prime, index, and overflow. Space for these areas can be subdivided and allocated as follows:

- *Prime area*—If you request a prime area only, the system automatically uses a portion of that space for indexes, taking one cylinder at a time as needed. Any unused space in the last cylinder used for index will be allocated as an independent overflow area. More than one volume can be used in most cases, but all volumes must be for devices of the same device type.

- *Index area*—You can request that a separate area be allocated to contain your cylinder and master indexes. The index area must be contained within one volume, but this volume can be on a device of a different type than the one that contains the prime area volume. If a separate index area is requested, you cannot catalog the data set with a DD statement.

  If the total space occupied by the prime area and index area does not exceed one volume, you can request that the separate index area be embedded in the prime area (to reduce access arm movement) by indicating an index size in the SPACE parameter of the DD statement defining the prime area.

  If you request space for prime and index areas only, the system automatically uses any space remaining on the last cylinder used for master and cylinder indexes for overflow, provided the index area is on a device of the same type as the prime area.

- *Overflow area*—Although you can request an independent overflow area, it must be contained within one volume and must be of the same device type as the prime area. If no specific request for index area is made, then it will be allocated from the specified independent overflow area.

To request that a designated number of tracks on each cylinder be used for cylinder overflow records, you must use the CYLOFL parameter of the DCB macro. The number of tracks that you can use on each cylinder equals the total number of tracks on the cylinder minus the number of tracks needed for track index and for prime data, that is:

```
Overflow tracks = total tracks
               - (track index tracks + prime data tracks)
```

Note that, when you create a 1-cylinder data set, ISAM reserves 1 track on the cylinder for the end-of-file filemark. You may not request an independent index for an ISAM data set that has only 1 cylinder of prime data.

When you request space for an indexed sequential data set, the DD statement must follow a number of conventions, as shown below and summarized in Figure 52.

- Space can be requested only in cylinders, SPACE=(CYL,(...)), or absolute tracks, SPACE=(ABSTR,(...)). If the absolute track technique is used, the designated tracks must make up a whole number of cylinders.
- Data set organization (DSORG) must be specified as indexed sequential (IS or ISU) in both the DCB macro and the DCB parameter of the DD statement.
- All required volumes must be mounted when the data set is opened; that is, volume mounting cannot be deferred.
- If your prime area extends beyond one volume, you must indicate the number of units and volumes to be spanned; for example, UNIT=(3380,3),VOLUME=(,,,3).
- You can catalog the data set using the DD statement parameter DISP=(,CATLG) only if the entire data set is defined by one DD statement; that is, if you did not request a separate index or independent overflow area.

As your data set is created, the operating system builds the track indexes in the prime data area. Unless you request a separate index area or an embedded index area, the cylinder and master indexes are built in the independent overflow area. If you did not request an independent overflow area, the cylinder and master indexes are built in the prime area.

If an error is encountered during allocation of a multivolume data set, the IEHPROGM utility program should be used to scratch the DSCBs of the data sets that were successfully allocated. The IEHLIST utility program can be used to determine whether part of the data set has been allocated. The IEHLIST utility program is also useful to determine whether space is available or whether identically named data sets exist before space allocation is attempted for indexed sequential data sets. These utility programs are described in *Utilities*.

Figure 52. Requests for Indexed Sequential Data Sets

Criteria 1. Number of DD Statements	 2. Types of DD Statements	 3. Index Size Coded?	Restrictions on Unit Types and Number of Units Requested	Resulting Arrangement of Areas
3	INDEX PRIME OVFLOW	—	None	Separate index, prime, and overflow areas.
2	INDEX PRIME	—	None	Separate index and prime areas. Any partially used index cylinder is used for independent overflow if the index and prime areas are on the same type of device.
2	PRIME OVFLOW	No	None	Prime area and overflow area with an index at its end.
2	PRIME OVFLOW	Yes	The statement defining the prime area cannot request more than one unit.	Prime area and embedded index, and overflow area.
1	PRIME	No	None	Prime area with index at its end. Any partially used index cylinder is used for independent overflow.
1	PRIME	Yes	Statement cannot request more than one unit.	Prime area with embedded index area; independent overflow in remainder of partially used index cylinder.

Specifying a Prime Data Area

To request that the system allocate space and subdivide it as required, you should code:

```
//ddname DD DSNAME=dsname,DCB=DSORG=IS,
//          SPACE=(CYL,quantity,,CONTIG),UNIT=unitname,
//          DISP=(,KEEP),---
```

You can accomplish the same type of allocation by qualifying your dsname with the element indication (PRIME). This element is assumed if omitted. It is required only if you request an independent index or overflow area. To request an embedded index area when an independent overflow area is specified, you must indicate DSNAME=dsname (PRIME). To indicate the size of the embedded index, you specify SPACE=(CYL,(quantity,,index size)).

Specifying a Separate Index Area

To request a separate index area, other than an embedded area as described above, you must use a separate DD statement. The element name is specified as (INDEX). The space and unit designations are as required. Notice that only the first DD statement can have a data definition name. The data set name (dsname) must be the same.

```
//ddname DD DSNAME=dsname(INDEX),---
//       DD DSNAME=dsname(PRIME),---
```

Specifying an Independent Overflow Area

A request for an independent overflow area is essentially the same as for a separate index area. Only the element name, OVFLOW, is changed. If you do not request a separate index area, only two DD statements are required.

```
//ddname DD DSNAME=dsname(INDEX),---
//       DD DSNAME=dsname(PRIME),---
//       DD DSNAME=dsname(OVFLOW),---
```

Calculating Space Requirements for an Indexed Sequential Data Set

To determine the number of cylinders required for an indexed sequential data set, you must consider the number of blocks that will fit on a cylinder, the number of blocks that will be processed, and the amount of space required for indexes and overflow areas. When you make the computations, consider how much additional space is required for device overhead. The IBM publications for storage devices contain device-specific information on device capacities and overhead formulas. Refer to the publication written for your device. In the formulas that follow, the length of the last (or only) block, shown below as Bn, must include device overhead.

```
Blocks =  Track capacity / Length of blocks
```

The following eight steps summarize calculation of space requirements for an indexed sequential data set.

Note: Use modulo-32 arithmetic when calculating key length and data length terms in your equations. Compute these terms first, then round up to the nearest increment of 32 bytes before completing the equation.

Step 1: After you know how many records will fit on a track and the maximum number of records you expect to create, you can determine how many tracks you will need for your data.

```
Number of tracks required = (Maximum number of blocks / Blocks per track) + 1
```

ISAM load mode reserves the last prime data track for the file mark.

Example: Assume that a 200000 record parts-of-speech dictionary is stored on an IBM 3380 Disk Storage as an indexed sequential data set. Each record in the dictionary has a 12-byte key (the word itself) and an 8-byte data area containing a parts-of-speech code and control information. Each block contains 50 records; LRECL=20 and BLKSIZE=1000. Using the formula as shown below, we find that each track will contain 26 blocks or 1300 records. A total of 155 tracks will be required for the dictionary.

```
Blocks = 47968/(256+((12+267)/32)(32)+((1000+267)/32)(32))
       = 47968/1824 = 26

Records per track = (26 blocks)(50 records per block) = 1300

Prime data
tracks     = (200000 records / 1300 records per track) + 1 = 155
required
```

Step 2: You will want to anticipate the number of tracks required for cylinder overflow areas. The computation is the same as for prime data tracks, but you must remember that overflow records are unblocked and a 10-byte link field is added. Remember also that, if you exceed the space allocated for any cylinder overflow area, an independent overflow area is required. Those records are not placed in another cylinder overflow area.

```
Overflow records = Track capacity / Length of overflow records
per track
```

Example: Approximately 5000 overflow records are expected for the data set described in step 1. Because 55 overflow records will fit on a track, 91 overflow tracks are required. These are 91 overflow tracks for 155 prime data tracks, or approximately 1 overflow track for every 2 prime data tracks. Because the 3380 disk pack for a 3380 Model AD4 has 15 tracks per cylinder, it would probably be best to allocate 5 tracks per cylinder for overflow.

```
Overflow  = 47968/(256+((12+267)/32)(32)+((30+267)/32)(32))
records   = 47968/864
per track = 55

Overflow  = 5000 records / 55 records per track
tracks    = 91
required

Overflow tracks per cylinder = 5
```

Step 3: You will have to set aside space in the prime area for track index entries. There will be two entries (normal and overflow) for each track on a cylinder that contains prime data records. The data field of each index entry is always 10 bytes long. The key length corresponds to the key length for the prime data records. How many index entries will fit on a track?

```
Index entries = Track capacity / Length of index entries
per track
```

Example: Again assuming a 3380 Model AD4 disk pack and records with 12-byte keys, we find that 59 index entries fit on a track.

```
Index     = 47968/(256+((12+267)/32)(32)+((10+267)/32)(32))
entries   = 47968/832
per track = 57
```

Step 4: Unused space on the last track of the track index is a function of the number of tracks required for track index entries, which in turn depends upon the number of tracks per cylinder and the number of track index entries per track. You can use any unused space for any prime data records that will fit.

```
Unused    = (Number of index entries per track)
space       - (2 (Number of tracks per cylinder
            - Number of overflow tracks per cylinder) + 1)
              (Number of bytes per index)
```

Note that, for variable-length records, or when a prime data record will not fit on the last track of the track index, the last track of the track index is not shared with prime data records. In this case, if the remainder of the division is less than or equal to 2, drop the remainder. In all other cases, round the quotient up to the next integer.

Example: The 3380 disk pack from the 3380 Model AD4 has 15 tracks per cylinder. You can fit 57 track index entries into one track. Therefore, you need less than 1 track for each cylinder.

```
Number of
trk index = (2 (15 - 5) + 1) / (57 + 2)
trks per  = 21 / 59
cylinder
```

The space remaining on the track is 47968 - (21 (832)) = 30496 bytes.

This is enough space for 16 blocks of prime data records. Because the normal number of blocks per track is 26, the blocks use 16/26ths of the track, and the effective number of track index tracks per cylinder is therefore 1 - 16/26 or 0.385.

Note that space is required on the last track of the track index for a dummy entry to indicate the end of the track index. The dummy entry consists of an 8-byte count field, a key field the same size as the key field in the preceding entries, and a 10-byte data field.

Step 5: Next you have to calculate the number of tracks available on each cylinder for prime data records. You cannot include tracks set aside for cylinder overflow records.

```
Prime data  = Tracks per cylinder
tracks per    - Overflow tracks per cylinder
cylinder      - Index tracks per cylinder
```

Example: If you set aside 5 cylinder overflow tracks, and you need 0.385ths of a track for the track index, 9.615 tracks are available on each cylinder for prime data records.

```
Prime data tracks  = 15 - 5 - (0.385) = 9.615
per cylinder
```

Step 6: The number of cylinders required to allocate prime space is determined by the number of prime data tracks required divided by the number of prime data tracks available on each cylinder. This area includes space for the prime data records, track indexes, and cylinder overflow records.

```
Number of  = Prime data tracks needed
cylinders    / Prime data tracks per cylinder needed
needed
```

Example: You need 155 tracks for prime data records. You can use 9.615 tracks per cylinder. Therefore, you need 17 cylinders for your prime area and cylinder overflow areas.

```
Number of  = (155) / (9.615) = 16.121  (round up to 17)
cylinders
required
```

Step 7: You will need space for a cylinder index and track indexes. There is a cylinder index entry for each track index (for each cylinder allocated for the data set). The size of each entry is the same as the size of the track index entries; therefore, the number of entries that will fit on a track is the same as the number of track index entries. Unused space on a cylinder index track is not shared.

```
Number of tracks  = (Track indexes + 1)
required for      / (Index entries per track cylinder index)
```

Example: You have 17 track indexes (from Step 6). Because 57 index entries fit on a track (from Step 3), you need 1 track for your cylinder index. The remaining space on the track is unused.

```
Number of tracks required = (17 + 1) / 57 = 18 / 57 = 0.316 < 1
for cylinder index
```

Note that, every time a cylinder index crosses a cylinder boundary, ISAM writes a dummy index entry that lets ISAM chain the index levels together. The addition of dummy entries can increase the number of tracks required for a given index level. To determine how many dummy entries will be required, divide the total number of tracks required by the number of tracks on a cylinder. If the remainder is 0, subtract 1 from the quotient. If the corrected quotient is not 0, calculate the number of tracks these dummy entries require. Also consider any additional cylinder boundaries crossed by the addition of these tracks and by any track indexes starting and stopping within a cylinder.

Step 8: If you have a data set large enough to require master indexes, you will want to calculate the space required according to the number of tracks for master indexes (NTM parameter) you specified in the DCB macro or the DD statement.

If the cylinder index exceeds the NTM specification, an entry is made in the master index for each track of the cylinder index. If the master index itself exceeds the NTM specification, a second-level master index is started. As many as three levels of master indexes are created if required.

The space requirements for the master index are computed in the same way as those for the cylinder index.

Calculate the number of tracks for master indexes as follows:

```
# Tracks for master indexes =
(# Cylinder index tracks + 1) / Index entries per track
```

If the number of cylinder indexes is greater than NTM, calculate the number of tracks for a first level master index as follows:

```
# Tracks for first level master index =
(Cylinder track indexes + 1) / Index entries per track
```

If the number of first level master indexes is greater than NTM, calculate the number of tracks for a second level master index as follows:

```
# Tracks for second level master index =
(First level master index + 1) / Index entries per track
```

If the number of second level master indexes is greater than NTM, calculate the number of tracks for a third level master index as follows:

```
# Tracks for second level master index =
(Second level master index + 1) / Index entries per track
```

Example: Assume that your cylinder index will require 22 tracks. Because large keys are used, only 10 entries will fit on a track. If NTM was specified as 2, 3 tracks will be required for a master index, and two levels of master index will be created.

```
Number of tracks required  = (22 + 1) / 10 = 2.3
for master indexes
```

Note that, every time a master index crosses a cylinder boundary, ISAM writes a dummy index entry that lets ISAM chain the index levels together. The addition of dummy entries can increase the number of tracks required for a given index level. To determine how many dummy entries will be required, divide the total number of tracks required by the number of tracks on a cylinder. If the remainder is 0, subtract 1 from the quotient. If the corrected quotient is not 0, calculate the number of tracks these dummy entries require. Also consider any additional cylinder boundaries crossed by the addition of these tracks and by any track indexes starting and stopping within a cylinder.

Summary: Indexed Sequential Space Requirement Calculations

1. How many blocks will fit on a track?

   ```
   Blocks = Track capacity / Length of blocks
   ```

2. How many overflow records will fit on a track?

   ```
   Overflow records = Track capacity
                    / Length of overflow records per track
   ```

3. How many index entries will fit on a track?

   ```
   Index entries  = Track capacity / Length of index entries
   per track
   ```

4. How much space is left on the last track of the track index?

   ```
   Unused    = (Number of index entries per track)
   space     - (2 (Number of tracks per cylinder
             - Number of overflow tracks per cylinder) + 1)
               (Number of bytes per index)
   ```

5. How many tracks on each cylinder can you use for prime data records?

   ```
   Prime data  = Tracks per cylinder
   tracks per  - Overflow tracks per cylinder
   cylinder    - Index tracks per cylinder
   ```

6. How many cylinders do you need for the prime data area?

   ```
   Number of cylinders  = Prime data tracks needed  / Prime data tracks per cylinder
   needed
   ```

7. How many tracks do you need for the cylinder index?

   ```
   Number of tracks required = (Track indexes + 1) / Index entries per track
   for cylinder index
   ```

8. How many tracks do you need for master indexes?

   ```
   Number of tracks
   required for       = (Number of cylinder index tracks + 1)
   master indexes     / Index entries per track
   ```

Retrieving and Updating an Indexed Sequential Data Set

Sequential Retrieval and Update

To sequentially retrieve and update records in an indexed sequential data set:

- Code DSORG=IS or DSORG=ISU to agree with what you specified when you created the data set, and MACRF=GL, MACRF=SK, or MACRF=PU in the DCB macro.
- Code a DD statement for retrieving the data set. The data set characteristics and options are as defined when the data set was created.
- Open the data set.
- Set the beginning of sequential retrieval (SETL).
- Retrieve records and process as required, marking records for deletion as required.
- Return records to the data set.
- Use ESETL to end sequential retrieval as required and reset the starting point.
- Close the data set to end all retrieval.

Sequential Updates—Indexed Sequential Data Set: Assume that, using the data set created in the previous example, you are to retrieve all records whose keys begin with 915. Those records with a date (positions 13 through 16) before today's date are to be deleted. The date is in the standard form as returned by the system in response to the TIME macro instruction, that is, packed decimal 00yyddds. Overflow records can be logically deleted even though they cannot be physically deleted from the data set.

One way to solve this problem is shown in Figure 53 on page 169.

```
//INDEXDD  DD        DSNAME=SLATE.DICT,---
           ...
ISRETR     START     0
           DCBD      DSORG=IS
ISRETR     CSECT
           ...
           USING     IHADCB,3
           LA        3,ISDATA
           OPEN      (ISDATA)
           SETL      ISDATA,KC,KEYADDR    Set scan limit
           TIME                           Today's date in register 1
           ST        1,TODAY
NEXTREC    GET       ISDATA               Locate mode
           CLC       19(10,1),LIMIT
           BNL       ENDJOB
           CP        12(4,1),TODAY        Compare for old date
           BNL       NEXTREC
           MVI       0(1),X'FF'           Flag old record for
                                           deletion
           PUTX      ISDATA               Return delete record
           B         NEXTREC
TODAY      DS        F
KEYADDR    DC        C'915'               Key prefix
           DC        XL7'0'               Key padding
LIMIT      DC        C'916'
           DC        XL7'0'
           ...
CHECKERR
```

Test DCBEXCD1 and DCBEXDE2 for error indication

Error Routines

```
ENDJOB     CLOSE     (ISDATA)
           ...
ISDATA     DCB       DDNAME=INDEXDD,DSORG=IS,MACRF=(GL,SK,PU),      C
           ...       SYNAD=CHECKRR
```

Figure 53. Sequentially Updating an Indexed Sequential Data Set

Direct Retrieval and Update

By using the basic indexed sequential access method (BISAM) to process an indexed sequential data set, you can directly access the records in the data set for:

- Direct retrieval of a record by its key
- Direct update of a record
- Direct insertion of new records

Because the operations are direct, there can be no anticipatory buffering. However, if 'S' is specified on the READ macro, the system provides dynamic buffering each time a read request is made. (See Figure 54 on page 172.)

To ensure that the requested record is in virtual storage before you start processing, you must issue a WAIT or CHECK macro. If you issue a WAIT macro, you must test the exception code field of the DECB. If you issue a CHECK macro, the system tests the exception code field in the DECB. If an error analysis routine has not been specified and a CHECK is issued, and an error situation exists, the program is abnormally terminated with a system completion code of XX'01' For both WAIT and CHECK, if you want to determine whether the record is an overflow record, you should test the exception code field of the DECB.

After you test the exception code field of the DECB, you need not set it to 0. If you have used a READ KU macro and if you plan to use the same DECB again to rewrite the updated record using a WRITE K macro, you should not set the field to 0. If you do, your record may not be rewritten properly.

To update existing records, you must use the READ KU and WRITE K combination. Because READ KU implies that the record will be rewritten in the data set, the system retains the DECB and the buffer used in the READ KU and uses them when the record is written. If you decide not to write the record, you should use the same DECB in another read or write macro or issue a FREEDBUF macro if dynamic buffering was used. If you issue several READ KU or WRITE K macros before checking the first one, you may destroy some of your updated records unless the records are from different blocks.

When you are using scan mode with QISAM and you want to issue PUTX, issue an ENQ on the data set before processing it and a DEQ after processing is complete. ENQ must be issued before the SETL macro, and DEQ must be issued after the ESETL macro. When you are using BISAM to update the data set, do not modify any DCB fields or issue a DEQ until you have issued CHECK or WAIT.

Sharing a BISAM DCB between Related Tasks: If there is the possibility that your task and another task will be simultaneously accessing the same data set, or the same task has two or more DCBs opened for the same data set, you should use the DCB integrity feature. You specify the DCB integrity feature by coding DISP=SHR in your DD statement. In this way you ensure that the DCB fields are maintained for your program to process the data set correctly. If you do not use DISP=SHR and more than one DCB is open for updating the data set, the results are unpredictable.

If you specify DISP=SHR, you must also issue an ENQ for the data set before each input/output request and a DEQ upon completion of the request. All users of the data set must use the same qname and rname operands for ENQ. For example, the users might use the data set name as the qname operand. For more information about using ENQ and DEQ, see *Application Development Guide* and *Application Development Macro Reference*.

For subtasking, I/O requests should be issued by the task that owns the DCB or a task that will remain active as long as the DCB is open. If the task that issued the I/O request terminates, the storage used by its data areas (such as IOBs) may be freed or queuing switches in the DCB work area may be left set on, causing another task issuing an I/O request to the DCB to program check or to enter the wait state. For example, if a subtask issues and completes a READ KU I/O request, the IOB created by the subtask is attached to the DCB update queue. If that subtask terminates, and subpool zero is not shared with the subtask owning the DCB, the IOB storage area is freed and the integrity of the ISAM update queue is destroyed. A request from another subtask, attempting to use that queue, may cause unpredictable ABENDs. As another example, if a WRITE KEY NEW is in process when the subtask terminates, 'WRITE-KEY-NEW-IN-PROCESS' bit is left set on. If another I/O request is issued to the DCB, the request is queued but cannot proceed.

Direct Update with Exclusive Control—Indexed Sequential Data Set: In the example shown in Figure 54 on page 172, the previously described data set is to be updated directly with transaction records on tape. The input tape records are 30 characters long, the key is in positions 1 through 10, and the update information is in positions 11 through 30. The update information replaces data in positions 31 through 50 of the indexed sequential data record.

```
//INDEXDD   DD      DSNAME=SLATE.DICT,DCB=(DSORG=IS,BUFNO=1,...),---
//TAPEDD    DD      ---

            ...
ISUPDATE    START   0
            ...
NEXTREC     GET     TPDATA,TPRECORD
            ENQ     (RESOURCE,ELEMENT,E,,SYSTEM)
            READ    DECBRW,KU,,'S',MF=E     Read into dynamically
*                                           obtained buffer
            WAIT    ECB=DECBRW
            TM      DECBRW+24,X'FD'         Test for any condition
            BM      RDCHECK                 but overflow
            L       3,DECBRW+16             Pick up pointer to
*                                           record
            MVC     ISUPDATE-ISRECORD       Update record
                    (L'UPDATE,3),UPDATE
            WRITE   DECBRW,K,MF=E
            WAIT    ECB=DECBRW
            TM      DECBRW+24,X'FD'         Any errors?
            BM      WRCHECK
            DEQ     (RESOURCE,ELEMENT,,SYSTEM)
            B       NEXTREC
RDCHECK     TM      DECBRW+24,X'80'         No record found
            BZ      ERROR                   If not, go to error
*                                           routine
            FREEDBUF DECBRW,K,ISDATA        Otherwise, free buffer
            MVC     ISKEY,KEY               Key placed in ISRECORD
            MVC     ISUPDATE,UPDATE         Updated information
*                                           placed in ISRECORD
            WRITE   DECBRW,KN,,WKNAREA,'S',MF=E Add record to data
*                                           set
            WAIT    ECB=DECBRW
            TM      DECBRW+24,X'FD'         Test for errors
            BM      ERROR
            DEQ     (RESOURCE,ELEMENT,,SYSTEM)  Release exclusive
*                                         control
            B       NEXTREC
WKNAREA     DS      4F                      BISAM WRITE KN work
*                                            field
ISRECORD    DS      0CL50                   50-byte record from
*                                            ISDATA
            DS      CL19                    DCB First part of
*                                            ISRECORD
```

Figure 54 (Part 1 of 2). Directly Updating an Indexed Sequential Data Set

```
ISKEY       DS      CL10                    Key field of ISRECORD
            DS      CL1                     Part of ISRECORD
ISUPDATE    DS      CL20                    Update area of ISRECORD
*
            ORG     ISUPDATE                Overlay ISUPDATE with
TPRECORD    DS      0CL30                   TPRECORD 30-byte record
KEY         DS      CL10                    from TPDATA DCB Key
*                                            for locating
UPDATE      DS      CL20                    ISDATA record update
RESOURCE    DC      CL8'SLATE'              information or new data
ELEMENT     DC      C'DICT'
            READ    DECBRW,KU,ISDATA,'S','S',KEY,MF=L
ISDATA      DCB     DDNAME=INDEXDD,DSORG=IS,MACRF=(RUS,WUA),      C
                    MSHI=INDEX,SMSI=2000
TPDATA      DCB     ---
INDEX       DS      2000C
            ...
```

Figure 54 (Part 2 of 2). Directly Updating an Indexed Sequential Data Set

Exclusive control of the data set is requested, because more than one task may be referring to the data set at the same time. Notice that, to avoid tying up the data set until the update is completed, exclusive control is released after each block is written.

Note the use of the FREEDBUF macro instruction in Figure 54. Usually, the FREEDBUF macro has two functions:

- To indicate to the ISAM routines that a record that has been read for update will not be written back
- To free a dynamically obtained buffer

In Figure 54, because the read operation was unsuccessful, the FREEDBUF macro frees only the dynamically obtained buffer.

The first function of FREEDBUF allows you to read a record for update and then decide not to update it without performing a WRITE for update. You can use this function even when your READ macro does not specify dynamic buffering, if you have included S (for dynamic buffering) in the MACRF field of your READ DCB.

You can effect an automatic FREEDBUF merely by reusing the DECB, that is, by issuing another READ or a WRITE KN to the same DECB. You should use this feature whenever possible, because it is more efficient than FREEDBUF. For example, in Figure 54, the FREEDBUF macro could be eliminated, because the WRITE KN addressed the same DECB as the READ KU.

For an indexed sequential data set with variable-length records, you may make three types of updates by using the basic access method. You may read a record and write it back with no change in its length, simply updating some part of the record. You do this with a READ KU followed by a WRITE K, the same way you update fixed-length records.

Two other methods for updating variable-length records use the WRITE KN macro and allow you to change the record length. In one method, a record read for update (by a READ KU) may be updated in a manner that will change the record length and then be written back with its new length by a WRITE KN. In the second method, you may replace a record with another record having the same key and possibly a different length using the WRITE KN macro. To replace a record, it is not necessary to have first read the record.

In either method, when changing the record length, you must place the new length in the DECBLGTH field of the DECB before issuing the WRITE KN macro. If you use a WRITE KN macro to update a variable-length record that has been marked for deletion, the first bit (no record found) of the exceptional condition code field (DECBEXC1) of the DECB is set on. If this condition is found, the record must be written using a WRITE KN with nothing specified in the DECBLGTH field.

Do not try to use the DECBLGTH field to determine the length of a record read, because DECBLGTH is for use with writing records, not reading them. If you are reading fixed-length records, the length of the record read is in DCBLRECL, and if you are reading variable-length records, the length is in the record descriptor word (RDW).

Direct Update—Indexed Sequential Data Set with Variable-Length Records: In Figure 55, an indexed sequential data set with variable-length records is updated directly with transaction records on tape. The transaction records are of variable length and each contains a code identifying the type of transaction. Transaction code 1 indicates that an existing record is to be replaced by one with the same key; 2 indicates that the record is to be updated by appending additional information, thus changing the record length; 3 or greater indicates that the record is to be updated with no change to its length. For this example, the maximum record length of both data sets is 256 bytes. The key is in positions 6 through 15 of the records in both data sets. The transaction code is in position 5 of records on the transaction tape. The work area (REPLAREA) size is equal to the maximum record length plus 16 bytes.

```
//INDEXDD   DD     DSNAME=SLATE.DICT,DCB=(DSORG=IS,BUFNO=1,...),---
//TAPEDD    DD     ---
            ...
ISUPDVLR    START  0
            ...
NEXTREC     GET    TPDATA,TRANAREA
            CLI    TRANCODE,2                Determine if replacement or
*                                            other transaction
            BL     REPLACE                   Branch if replacement
            READ   DECBRW,KU,,'S','S',MF=E   Read record for update
            CHECK  DECBRW,DSORG=IS           Check exceptional conditions
            CLI    TRANCODE,2                Determine if change or append
            BH     CHANGE                    Branch if change
            ...
            ...
* CODE TO MOVE RECORD INTO REPLACEA+16 AND APPEND DATA FROM TRANSACTION
* RECORD
            ...
            MVC    DECBRW+6(2),REPLAREA+16    Move new length from RDW
*                                             into DECBLGTH (DECB+6)
            WRITE  DECBRW,KN,,REPLAREA,MF=E   Rewrite record with
*                                             changed length
            CHECK  DECBRW,DSORG=IS
            B      NEXTREC
CHANGE      ...
            ...
* CODE TO CHANGE FIELDS OR UPDATE FIELDS OF THE RECORD
            ...
            WRITE  DECBRW,K,MF=E               Rewrite record with no
*                                              change of length
            CHECK  DECBRW,DSORG=IS
            B      NEXTREC
REPLACE     MVC    DECBRW+6(2),TRANAREA        Move new length from RDW
*                                              into DECBLGTH (DECB+6)
            WRITE  DECBRW,KN,,TRANAREA-16,MF=E Write transaction record
*                                              as replacement for record
*                                              with the same key
            CHECK  DECBRW,DSORG=IS
            B      NEXTREC
CHECKERR    ...                 SYNAD routine
            ...
REPLAREA    DS     CL272
TRANAREA    DS     CL4
TRANCODE    DS     CL1
KEY         DS     CL10
TRANDATA    DS     CL241
            READ   DECBRW,KU,ISDATA,'S','S',KEY,MF=L
ISDATA      DCB    DDNAME=INDEXDD,DSORG=IS,MACRF=(RUSC,WUAC),SYNAD=CHECKERR
TPDATA      DCB    ---
            ...
```

Figure 55. Directly Updating an Indexed Sequential Data Set with Variable-Length Records

Adding Records to an Indexed Sequential Data Set

Either the queued access method or the basic access method may be used to add records to an indexed sequential data set. A record to be inserted between records already in the data set must be inserted by the basic access method using WRITE KN (key new). Records added to the end of a data set, that is, records with successively higher keys, may be added to the prime data area or the overflow area by the basic access method using WRITE KN, or they may be added to the prime data area by the queued access method using the PUT macro.

Inserting New Records into an Existing Indexed Sequential Data Set

As you add records to an indexed sequential data set, the system inserts each record in its proper sequence according to the record key. The remaining records on the track are then moved up one position each. If the last record does not fit on the track, it is written in the first available location in the overflow area. A 10-byte link field is added to the record put in the overflow area to connect it logically to the correct track. The proper adjustments are made to the track index entries. This procedure is illustrated in Figure 56 on page 177.

Subsequent additions are written either on the prime track or as part of the overflow chain from that track. If the addition belongs after the last prime record on a track but before a previous overflow record from that track, it is written in the first available location in the overflow area. Its link field contains the address of the next record in the chain.

For BISAM, if you add a record that has the same key as a record in the data set, a "duplicate record" condition is indicated in the exception code. However, if you specified the delete option and the record in the data set is marked for deletion, the condition is not reported and the new record replaces the existing record. For more information about exception codes, see *Data Administration: Macro Instruction Reference.*

Adding New Records to the End of an Indexed Sequential Data Set

Records added to the end of a data set, that is, records with successively higher keys, may be added by the basic access method using WRITE KN (key new), or by the queued access method using the PUT macro instruction (resume load). In either case, records may be added to the prime data area.

When you use the WRITE KN macro, the record being added is placed in the prime data area only if there is room for it on the prime data track containing the record with the highest key currently in the data set. If there is not sufficient room on that track, the record is placed in the overflow area and linked to that prime track even though additional prime data tracks originally allocated have not been filled.

When you use the PUT macro (resume load), records are added to the prime data area until the space originally allocated is filled. After this allocated prime area is filled, you can add records to the data set using WRITE KN, in which case they will be placed in the overflow area. Resume load is discussed in more detail under "Creating an Indexed Sequential Data Set" on page 157.

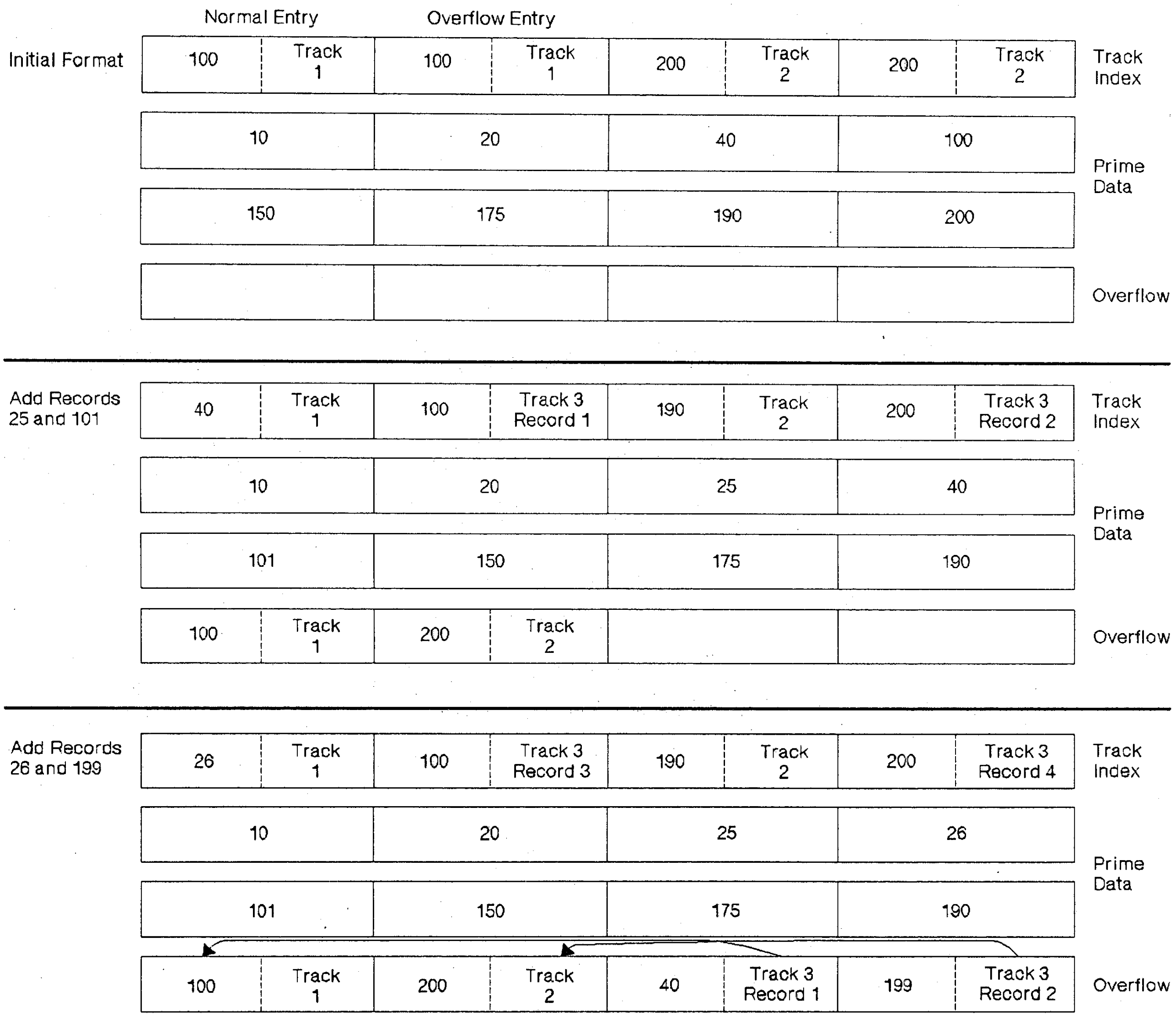


Figure 56. Adding Records to an Indexed Sequential Data Set

In order to add records with successively higher keys using the PUT macro (resume load):

- The key of any record to be added must be higher than the highest key currently in the data set.
- The DD statement must specify DISP=MOD or the EXTEND option is specified in the OPEN macro.
- The data set must have been successfully closed when it was created or when records were previously added using the PUT macro.

You may continue to add fixed-length records in this manner until the original space allocated for prime data is exhausted.

When you add records to an indexed sequential data set using the PUT macro (resume load), new entries are also made in the indexes. During resume load on a data set with a partially filled track and/or a partially filled cylinder, the track index entry and/or the cylinder index entry is overlaid when the track or cylinder is filled. If resume load abnormally terminates after these index entries have been overlaid, a subsequent resume load will get a sequence check when adding a key that is higher than the highest key at the last successful CLOSE but lower than the key in the overlaid index entry. When the SYNAD exit is taken for a sequence check, register 0 contains the address of the highest key of the data set.

Maintaining an Indexed Sequential Data Set

An indexed sequential data set must be reorganized occasionally for two reasons:

- The overflow area will eventually be filled.
- Additions increase the time required to locate records directly.

The frequency of reorganization depends on the activity of the data set and on your timing and storage requirements. There are two ways you can accomplish reorganization:

- You can reorganize the data set in two passes by writing it sequentially into another area of direct access storage or magnetic tape and then re-creating it in the original area.
- You can reorganize the data set in one pass by writing it directly into another area of direct access storage. In this case, the area occupied by the original data set cannot be used by the reorganized data set.

The operating system maintains statistics that are pertinent to reorganization. The statistics, written on the direct access volume and available in the DCB for checking, include the number of cylinder overflow areas, the number of unused tracks in the independent overflow area, and the number of references to overflow records other than the first. They appear in the RORG1, RORG2, and RORG3 fields of the DCB.

If you indicate when creating or updating the data set that you want to be able to flag records for deletion during updating, you can set the delete code (the first byte of a fixed-length record or the fifth byte of a variable-length record) to X'FF'. If a flagged record is forced off its prime track during a subsequent update, it will not be rewritten in the overflow area, as shown in Figure 57 on page 179, unless it has the highest key on that cylinder. Similarly, when you process sequentially, flagged records are not retrieved for processing. During direct processing, flagged records are retrieved the same as any other records, and you should check them for the delete code.

Note that a WRITE KN (key new) to a data set containing variable-length records removes all the deleted records from that prime data track.

Note that, to use the delete option, RKP must be greater than 0 for fixed-length records and greater than 4 for variable-length records.

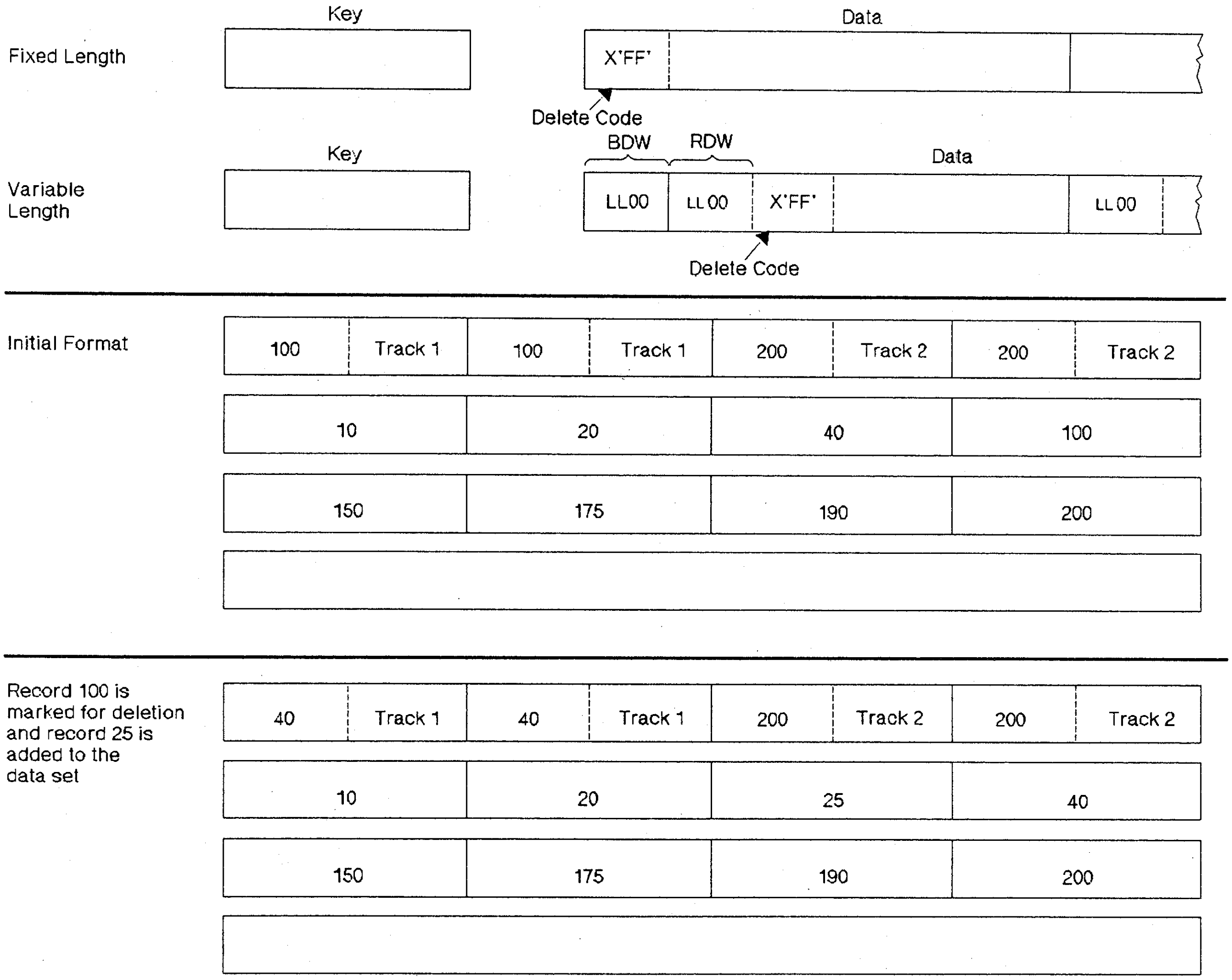
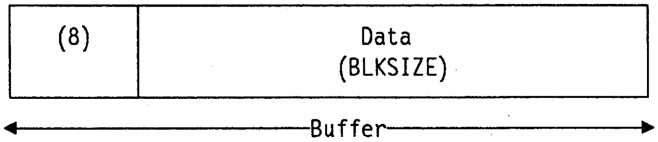


Figure 57. Deleting Records from an Indexed Sequential Data Set

Indexed Sequential Buffer and Work Area Requirements

The only case in which you will ever have to compute the buffer length (BUFL) requirements for your program occurs when you use the BUILD or GETPOOL macro to construct the buffer area. If you are creating an indexed sequential data set (using the PUT macro), each buffer must be 8 bytes longer than the block size to allow for the hardware count field, that is:

```
Buffer length = 8 + Block size
```



One exception to this formula arises when you are dealing with an unblocked format-F record whose key field precedes the data field; its relative key position is 0 (RKP=0). In that case, the key length must also be added, that is:

```
Buffer length = 8 + Key length + Record length
```

(8)	Key (KEYLEN)	Data (LRECL)

←Buffer→

The buffer requirements for using the queued access method to read or update (using the GET or PUTX macro) an indexed sequential data set are discussed below.

For fixed-length unblocked records when both the key and data are to be read and for variable-length unblocked records, padding is added so that the data will be on a doubleword boundary, that is:

```
Buffer length = Key length + Padding + 10 + Block size
```

Key (KEYLEN)	Padding	ISAM Link Field (10)	Data (BLKSIZE)

←Buffer→

For fixed-length unblocked records when only data is to be read:

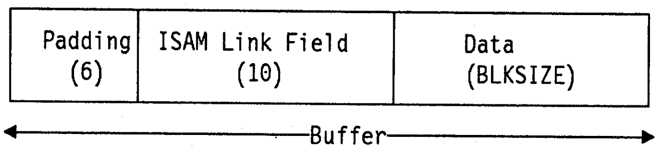
```
Buffer length = 16 + LRECL
```

Padding (6)	ISAM Link Field (10)	Data (LRECL)

←Buffer→

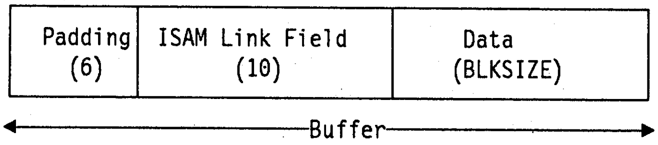
For fixed-length blocked records:

```
Buffer length = 16 + Block size
```



For variable-length blocked records, padding is 2 if the buffer starts on a fullword boundary that is not also a doubleword boundary or 6 if the buffer starts on a doubleword boundary, that is:

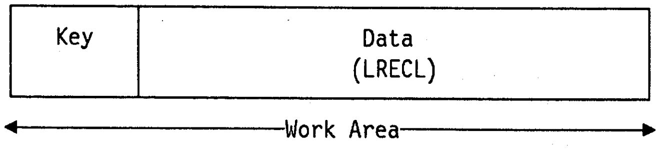
```
Buffer length = 12 or 16 + Block size
```



If you are using the input data set with fixed-length, unblocked records as a basis for creating a new data set, a work area is required.

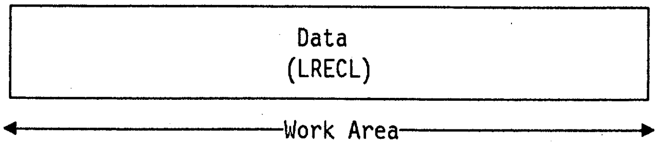
The size of the work area is given by:

```
Work area = Key length + Record length
```



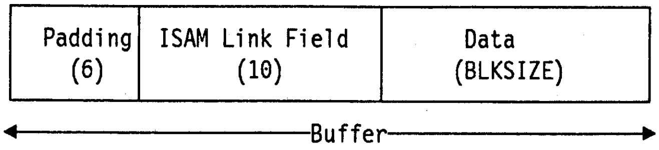
If you are reading only the data portion of fixed-length unblocked records or variable-length records, the work area is the same size as the record, that is:

```
Work area = Record length
```



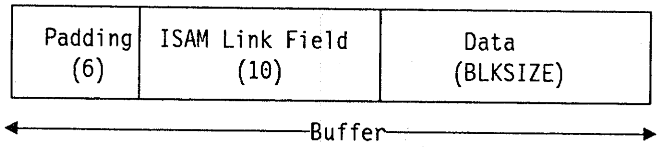
When you use the basic access method to update records in an indexed sequential data set, the key length field need not be considered in determining your buffer requirements. The area for fixed-length records must be:

```
Buffer length = 16 + Block size
```



For variable-length records, padding is 2 if the buffer starts on a fullword boundary that is not also a doubleword boundary or 6 if a buffer starts on a doubleword boundary. Thus, the area must be:

```
Buffer length = 12 or 16 + Blocksize
```



You can save processing time by adding fixed-length or variable-length records to a data set by using the MSWA parameter of the DCB macro to provide a special work area for the operating system. The size of the work area (SMSW parameter in the DCB) must be large enough to contain a full track of data, the count fields of each block, and the work space for inserting the new record.

The size of the work area needed varies according to the record format and the device type. You can calculate it during execution using device-dependent information obtained with the DEVTYPE macro and data set information from the DSCB obtained with the OBTAIN macro. (The DEVTYPE and OBTAIN macros are discussed in *System—Data Administration*.)

Note that you can use the DEVTYPE macro only if the index and prime areas are on devices of the same type or if the index area is on a device with a larger track capacity than the device containing the prime area. If you are not trying to maintain device independence, you may precalculate the size of the work area needed and specify it in the SMSW field of the DCB macro. The maximum value for SMSW is 65535.

For calculating the size of the work area, see the IBM storage device publication specific to your device.

For fixed-length blocked records, SMSW is calculated as follows:

```
SMSW = (DS2HIRPR) (BLKSIZE + 8) + LRECL + KEYLEN
```

The formula for fixed-length unblocked records is

```
SMSW = (DS2HIRPR) (KEYLEN + LRECL + 8) + 2
```

The value for DS2HIRPR is in the index (format-2) DSCB. If you don't use the MSWA and SMSW parameters, the control program supplies a work area using the formula BLKSIZE + LRECL + KEYLEN.

For variable-length records, SMSW may be calculated by one of two methods. The first method may lead to faster processing, although it may require more storage than the second method.

The first method is as follows:

```
SMSW = DS2HIRPR (BLKSIZE + 8) + LRECL + KEYLEN + 10
```

The second method is as follows:

```
SMSW = ( (Trk Cap - Bn + 1) / Block length) (BLKSIZE)
       + 8 (DS2HIRPR) + LRECL + KEYLEN
       + 10 + (REM - N - KEYLEN)
```

In all the above formulas, the terms BLKSIZE, LRECL, KEYLEN, and SMSW are the same as the parameters in the DCB macro (Trk Cap=track capacity). REM is the remainder of the division operation in the formula and N is the first constant in the block length formulas. (REM-N-KEYLEN) is added only if it is positive.

The second method yields a minimum value for SMSW. Therefore, the first method is valid only if its application results in a value higher than the value that would be derived from the second method. If neither MSWA nor SMSW is specified, the control program supplies the work area for variable-length records, using the second method to calculate the size.

Another technique to increase the speed of processing is to provide space in virtual storage for the highest-level index. To specify the address of this area, use the MSHI operand of the DCB. When the address of this area is specified, you must also specify its size, which you can do by using the SMSI operand of the DCB. The maximum value for SMSI is 65535. If you do not use this technique, the index on the volume must be searched. If the high-level index is greater than 65535 bytes in length, your request for the high-level index in storage is ignored.

The size of the storage area (SMSI parameter) varies. To allocate that space during execution, you can find the size of the high-level index in the DCBNCRHI field of the DCB during your DCB exit routine or after the data set is open. Use the DCBD macro to gain access to the DCBNCRHI field (see Chapter 5, "Specifying a Data Control Block and Initializing Data Sets" on page 39). You can also find the size of the high-level index in the DS2NOBYT field of the index (format 2) DSCB, but you must use the utility program IEHLIST to print the information in the DSCB. You can calculate the size of the storage area required for the high-level index by using the formula

```
SMSI = (Number of Tracks in High-Level Index)
       (Number of Entries per Track)
       (Key Length + 10)
```

The formula for calculating the number of tracks in the high-level index is in "Calculating Space Requirements for an Indexed Sequential Data Set" on page 163. When a data set is shared and has the DCB integrity feature (DISP=SHR), the high-level index in storage is not updated when DCB fields are changed.

Controlling an Indexed Sequential Data Set Device

An indexed sequential data set is processed sequentially or directly. Direct processing is accomplished by the basic access method. Because you provide the key for the record you want read or written, all device control is handled automatically by the system. If you are processing the data set sequentially, using the queued access method, the device is automatically positioned at the beginning of the data set.

In some cases, you may want to process only a section or several separate sections of the data set. You do this by using the SETL macro instruction, which directs the system to begin sequential retrieval at the record having a specific key. The processing of succeeding records is the same as for normal sequential processing, except that you must recognize when the last desired record has been processed. At this point, issue the ESETL macro to terminate sequential processing. You can then begin processing at another point in the data set. If you do not specify a SETL macro before retrieving the data, the system assumes default SETL values. (See the GET and SETL macros in *Data Administration: Macro Instruction Reference*.)

SETL—Specify Start of Sequential Retrieval

The SETL macro allows you to retrieve records starting at the beginning of an indexed sequential data set or at any point in the data set. Processing that is to start at a point other than the beginning can be requested in the form of a record key, a key class (key prefix), or an actual address of a prime data record.

The key class concept is useful because you do not have to know the whole key of the first record to be processed. A key class consists of all the keys that begin with identical characters. The key class is defined by specifying the desired characters of the key class at the address specified in the lower-limit operand of the SETL macro and setting the remaining characters to the right of the key class to binary zeros.

To use actual addresses, you must keep a record of where the records were written when the data set was created. The device address of the block containing the record just processed by a PUT-move macro instruction is available in the 8-byte data control block field DCBLPDA. For blocked records, the address is the same for each record in the block.

Normally, when a data set is created with the delete option specified, deleted records cannot be retrieved using the QISAM retrieval mode. When the delete option is not specified in the DCB, the SETL macro options function as follows:

SETL B	Start at the first record in the data set.
SETL K	Start with the record having the specified key.
SETL KH	Start with the record whose key is equal to or higher than the specified key.
SETL KC	Start with the first record having a key that falls into the specified key class.
SETL I	Start with the record found at the specified direct access address in the prime area of the data set.

Because the DCBOPTCD field in the DCB can be changed after the data set is created (by respecifying the OPTCD in the DCB or DD card), it is possible to retrieve deleted records. In this case, SETL functions as noted above.

When the delete option is specified in the DCB, the SETL macro options function as follows:

SETL B — Start retrieval at the first undeleted record in the data set.

SETL K — Start retrieval at the record matching the specified key, if that record is not deleted. If the record is deleted, an NRF (no record found) indication is set in the DCBEXCD field of the DCB, and SYNAD is given control.

SETL KH — Start with the first undeleted record whose key is equal to or higher than the specified key.

SETL KC — Start with the first undeleted record having a key that falls into the specified key class or follows the specified key class.

SETL I — Start with the first undeleted record following the specified direct access address.

With the delete option not specified, QISAM retrieves and handles records marked for deletion as nondeleted records.

Note: Regardless of the SETL or delete option specified, the NRF condition will be posted in the DCBEXCD field of the DCB, and SYNAD is given control if the key or key class:

- Is higher than any key or key class in the data set
- Does not have a matching key or key class in the data set

ESETL—End Sequential Retrieval

The ESETL macro directs the system to stop retrieving records from an indexed sequential data set. A new scan limit can then be set, or processing terminated. An end-of-data-set indication automatically terminates retrieval. An ESETL macro must be executed before another SETL macro (described above) using the same DCB is executed.

Note: If the previous SETL macro completed with an error, an ESETL macro should be executed before another SETL macro.

End of General-Use Programming Interface

Abbreviations

The following abbreviations are defined as they are used in the MVS/DFP library. If you do not find the abbreviation you are looking for, see *Dictionary of Computing*, SC20-1699.

This list includes acronyms and abbreviations developed by the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO). This material is reproduced from the *American National Dictionary for Information Processing*, copyright 1977 by the Computer and Business Equipment Manufacturers American National Standards Institute, 1430 Broadway, New York, New York 10018.

A. ANSI control code (value of RECFM).

ABE. Abnormal end (value of EROPT).

ABEND. Abnormal end.

ABSTR. Absolute track (value of SPACE).

ACC. Accept erroneous block (value of EROPT).

ACS. Automatic class selection.

AFF. Affinity.

AL. American National Standard Labels.

ANSI. American National Standards Institute.

ASCII. American National Standard Code for Information Interchange.

AUL. American National Standard user labels (value of LABEL).

AVGREC. Average record scale (JCL keyword).

B. Blocked records (value of RECFM).

BCDIC. Binary coded decimal interchange code.

BDAM. Basic direct access method.

BDW. Block descriptor word.

BFALN. Buffer alignment (operand of DCB).

BFTEK. Buffer technique (operand of DCB).

BISAM. Basic indexed sequential access method.

BLDL. Build list (macro instruction).

BLKSIZE. Block size (operand of DCB).

BPAM. Basic partitioned access method.

BPI. Bytes per inch.

BSAM. Basic sequential access method.

BSM. Backspace past tape mark and forward space over tape mark. (operand of CNTRL)

BSP. Backspace one block (macro instruction).

BSR. Backspace over a specified number of blocks (records) (operand of CNTRL).

BUFCB. Buffer pool control block (operand of DCB).

BUFL. Buffer length (operand of DCB).

BUFNO. Buffer number (operand of DCB).

BUFOFF. Buffer offset (length of ASCII block prefix by which the buffer is offset; operand of DCB).

CCHHR. Cylinder/head record address.

CCW. Channel command word.

CNTRL. Control (macro instruction).

CONTIG. Contiguous space allocation (value of SPACE).

CSECT. Control section.

CSW. Channel status word.

CYLOFL. Number of tracks for cylinder overflow records (operand of DCB).

D. Format-D (ISCII/ASCII variable-length) records (value of RECFM).

DA. Direct access (value of DEVD or DSORG).

DADSM. Direct access device space management.

DASD. Direct access storage device.

DATACLAS. Data class (JCL keyword).

DAU. Direct access unmovable data set (value of DSORG).

DB. ISCII/ASCII variable-length, blocked records (value of RECFM).

DBS. ISCII/ASCII variable-length, blocked spanned records (value of RECFM).

DCB. Data control block (control block name or macro instruction or parameter on DD statement).

DCBD. Data control block dummy section.

DD. Data definition.

DDNAME. Data definition name.

DEB. Data extent block.

DECB. Data event control block.

DEN. Magnetic tape density (operand of DCB).

DEVD. Device-dependent (operand of DCB).

DFDSS. Data Facility Data Set Services.

DFHSM. Data Facility Hierarchical Storage Manager.

DISP. Device-dependent (operand of DCB).

DS. ISCII/ASCII variable-length, spanned records (value of RECFM).

DSCB. Data set control block.

DSECT. Dummy control section.

DSNAME. Data set name.

DSORG. Data set organization (operand of DCB).

EBCDIC. Extended binary-coded decimal interchange code.

EODAD. End-of-data set exit routine address (operand of DCB).

EOF. End-of-file.

EOV. End-of-volume.

EROPT. Error options (operand of DCB).

ESETL. End sequential retrieval (QISAM macro instruction).

ESTAE. Extended specify task abnormal exit.

EXCP. Execute channel program.

EXLST. Exit list (operand of DCB).

EXPDT. Expiration date for a data set (JCL keyword).

F. Fixed-length records (value of RECFM).

FB. Fixed-length, blocked records (value of RECFM).

FBS. Fixed-length, blocked, standard records (value of RECFM).

FBT. Fixed-length, blocked records with track overflow option (value of RECFM).

FCB. Forms control buffer.

FEOV. Force end-of-volume (macro instruction).

FIPS. Federal Information Processing Standard.

FS. Fixed-length, standard records (value of RECFM).

FSM. Forward space past tape mark and backspace over tape mark (operand of CNTRL).

FSR. Forward space over a specified number of blocks (records) (operand of CNTRL).

GCR. Group coded recording.

GDG. Generation data group.

GDS. Generation data set.

GL. GET macro, locate mode (value of MACRF).

GM. GET macro, move mode (value of MACRF).

H. DOS tapes with embedded checkpoint records (parameter of OPTCD).

HA. Home address.

INOUT. Input then output (operand of OPEN).

I/O. Input/output.

IOB. Input/output block.

IPL. Initial program load.

IRG. Interrecord gap.

IS. Indexed sequential (value of DSORG).

ISAM. Indexed sequential access method.

ISCII. International Standard Code for Information Interchange.

ISO. International Organization for Standardization.

ISU. Indexed sequential unmovable (value of DSORG).

JCL. Job control language.

JFCB. Job file control block.

JFCBE. Job file control block extension.

K. Kilobyte.

KEYLEN. Key length (JCL keyword).

KSDS. Key-sequenced data set.

LPA. Link pack area.

LPALIB. Link pack area library.

LRECL. Logical record length (JCL keyword).

LRI. Logical record interface.

M. Machine control code (value of RECFM).

MACRF. Macro instruction form (operand of DCB).

MBBCCHHR. Module#, bin#, cylinder#, head#, record#.

MGMTCLAS. Management class (JCL keyword).

MOD. Modify data set (value of DISP).

MSHI. Main storage for highest-level index (operand of DCB).

MSS. Mass Storage System.

MSVC. Mass Storage Volume Control.

MSWA. Main storage for work area (operand of DCB).

MVSCP. MVS configuration program.

NCP. Number of channel programs (operand of DCB).

NOPWREAD. No password required to read a data set (value of LABEL).

NRZI. Nonreturn-to-zero-inverted.

NSL. Nonstandard label (value of LABEL).

NTM. Number of tracks in cylinder index for each entry in lowest level of master index (operand of DCB).

OPTCD. Nptional services code (operand of DCB).

OS CVOL. Operating system control volume.

OS/VS. Operating system/virtual storage.

OUTIN. Output then input (operand of OPEN).

PCI. Program-controlled interruption.

PDAB. Parallel data access block.

PDS. Partitioned data set.

PE. Phase encoding (tape recording mode).

PL. PUT macro, locate mode (value of MACRF).

PM. PUT macro, move mode (value of MACRF).

PO. Partitioned organization (value of DSORG).

POU. Partitioned organization unmovable (value of DSORG).

PRTSP. Printer line spacing (operand of DCB).

PS. Physical sequential (value of DSORG).

PSU. Physical sequential unmovable (value of DSORG).

QISAM. Queued indexed sequential access method.

QSAM. Queued sequential access method.

R0. Record zero.

RACF. Resource Access Control Facility.

RCW. Record control word.

RDBACK. Read backward (operand of OPEN).

RDW. Record descriptor word.

RECFM. Record format (JCL keyword).

REFDD. Refer to previous DD statement (JCL keyword).

RETPD. Retention period (JCL keyword).

RKP. Relative key position (operand of DCB).

RLSE. Release unused space (DD statement).

RPS. Rotational position sensing.

S. Standard format records (value of RECFM).

SAM. Sequential access method.

SCW. Segment control word.

SDW. Segment descriptor word.

SER. Volume serial number (value of VOLUME).

SETL. Set lower limit of sequential retrieval. (QISAM macro instruction)

SF. Sequential forward (operand of READ or WRITE).

SK. Skip to a printer channel (operand of CNTRL).

SKP. Skip erroneous block (value of EROPT).

SL. IBM standard labels (value of LABEL).

SMS. Storage Management Subsystem.

SMSI. Size of main-storage area for highest-level index (operand of DCB).

SMSW. Size of main-storage work area (operand of DCB).

SP. Space lines on a printer (operand of CNTRL).

SS. Select stacker on card reader (operand of CNTRL).

STORCLAS. Storage class (JCL keyword).

SUL. IBM standard and user labels (value of LABEL).

SVC. Supervisor call.

SVCLIB. Supervisor call library.

SYNAD. Synchronous error routine address (operand of DCB).

SYSIN. System input stream.

SYSOUT. System output stream.

T. Track overflow option (value of RECFM); user-totaling(value of OPTCD).

TIOT. Task I/O table.

TRC. Table reference character.

TRTCH. Track recording technique (operand of DCB).

TTR. Track record address.

U. Undefined length records (value of RECFM).

UCS. Universal character set.

UHL. User header label.

UTL. User trailer label.

V. Format-V (variable-length) records (value of RECFM).

VB. Variable-length, blocked records (value of RECFM).

VBS. Variable-length, blocked, spanned records (value of RECFM).

VS. Variable-length, spanned records.

VSAM. Virtual storage access method.

VTOC. Volume table of contents.

VVDS. VSAM volume data set.

XLRI. Extended logical record interface.

Glossary

The following terms and abbreviations are defined as they are used in the MVS/DFP library. If you do not find the term or abbreviation you are looking for, see *Dictionary of Computing,* SC20-1699.

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A

abnormal end (ABEND). Termination of a task prior to its completion as a result of an error condition that could not be resolved by error recovery facilities during task execution.

absolute address. An address that, without further modification, identifies a unique DASD storage location.

access method. A technique for organizing and moving data between main storage and input/output devices.

access method services. A multifunction service program that is used to manage both VSAM and non-VSAM data sets and integrated catalog facility or VSAM catalogs. Access method services is used to define data sets and allocate space for them, convert indexed-sequential (ISAM) data sets to key-sequenced data sets, modify data set attributes in the catalog, reorganize data sets, facilitate data portability between operating systems, create backup copies of data sets and indexes, help make inaccessible data sets accessible, list the records of data sets and catalogs, define and build alternate indexes, and convert OS CVOLs and VSAM catalogs to integrated catalog facility catalogs.

ACS routine. A procedural set of ACS language statements. Based on a set of input variables, the ACS language statements generate the name of a predefined SMS class, or a list of names of predefined storage groups, for a data set.

address marker. A byte of data on a disk or diskette, used to identify the data field and ID field in the record.

alias. An alternative name for an entry or for a member of a partitioned data set (PDS).

alias entry. An entry that relates an alias to the real entry name of a user catalog or non-VSAM data set.

allocation. Generically, the entire process of obtaining a volume and unit of external storage, and setting aside space on that storage for a data set.

alternate track. On a direct access storage device, a track designated to contain data in place of a defective primary track.

application. The use to which an access method is put or the end result that it serves; contrasted to the internal operation of the access method.

automatic class selection (ACS). A mechanism for assigning SMS classes and storage groups to data sets.

auxiliary storage. All addressable storage, other than the memory of a processing unit, that can be accessed using an input/output channel; for example, storage on DASD, tape, or mass storage system volumes.

B

backup. The process of copying data and storing it for use in case the original data is somehow damaged or destroyed.

backup data set. A copy that can be used to replace or reconstruct a damaged data set.

base configuration information. The base information for a configuration which includes default device geometry, default unit, system names for the complex, SMS resource status token, default management class, and data set status.

basic direct access method (BDAM). An access method used to directly retrieve or update particular blocks of a data set on a DASD.

basic partitioned access method (BPAM). An access method used to create program libraries on DASD for convenient storage and retrieval of programs.

basic sequential access method (BSAM). An access method for storing or retrieving data blocks in a continuous sequence, using either a sequential access or direct access device.

block prefix. An optional variable length field that may precede unblocked records or blocks of records in ASCII on magnetic tapes.

block size. The number of records, words, or characters in a block; usually specified in bytes.

blocking. The process of combining two or more records into one block.

buffer. A routine or storage used to compensate for a difference in the rate of flow of data, or time of occurrence of events, when transferring data from one device to another.

buffer pool. A continuous area of storage divided into buffers.

C

channel program. One or more channel command words that control a specific sequence of data channel operations. Execution of the specific sequence is initiated by a single start I/O (SIO) instruction.

class. See *SMS class*.

collating sequence. An ordering assigned to a set of items, such that any two sets in that assigned order can be collated. As used in this publication, the order defined by the System/370 8-bit code for alphabetic, numeric, and special characters.

configuration. (1) The arrangement of a computer system as defined by the characteristics of its functional units. (2) See *SMS configuration*.

control character. A character whose occurrence in a particular context initiates, modifies, or stops a control operation. It may be recorded for use in a later action, and may have a graphic representation in some circumstances.

control program. A routine, usually part of an operating system, that aids in controlling the operations and managing the resources of a computer system.

control section (CSECT). The part of a program specified by the programmer to be a relocatable unit, all elements of which are to be loaded into adjoining storage locations for execution.

control unit. A hardware device that controls the reading, writing, or displaying of data at one or more input/output devices. See also *storage control*.

control volume (CVOL). A volume that contains one or more indexes of the catalog.

cylinder. The tracks of a disk storage device that can be accessed without repositioning the access mechanism.

D

data class. A list of the data set allocation parameters and their values, used when allocating a new SMS-managed data set.

data control block (DCB). A control block used by access method routines in storing and retrieving data.

data conversion. The process of changing data from one form of representation to another.

data definition (DD) statement. A job control statement that describes a data set associated with a particular job step.

data extent block (DEB). A control block that describes the physical attributes of the data set.

Data Facility Data Set Services (DFDSS). An IBM licensed program used to copy, move, dump, and restore data sets and volumes.

Data Facility Hierarchical Storage Manager (DFHSM). An IBM licensed program used to back up, recover, and manage volumes.

Data Facility Product (DFP). An IBM licensed program used to manage programs, devices, and data in an MVS operating environment.

data integrity. Preservation of data or programs for their intended purpose. As used in this publication, the safety of data from inadvertent destruction or alteration.

data management. The task of systematically identifying, organizing, storing, and cataloging data in an operating system.

data set. The major unit of data storage and retrieval in the operating system, consisting of data in a prescribed arrangement and described by control information to which the system has access. As used in this publication, a collection of fixed-, variable-, or undefined-length records in auxiliary storage.

data set control block (DSCB). A control block in the VTOC that describes data set characteristics.

data set label. A collection of information that describes the attributes of a data set and is normally stored on the same volume as the data set.

dequeue. To remove items from a queue. Contrast with *enqueue*.

device address. Three or four hexadecimal digits that uniquely define a physical I/O device on a channel path in System/370 mode. The one or two leftmost digits are the address of the channel to which the device is attached. The two rightmost digits represent the unit address.

direct access. The retrieval or storage of data by a reference to its location in a data set rather than relative to the previously retrieved or stored data. See also *addressed-direct access* and *keyed-direct access*.

direct access device space management (DADSM). A DFP component used to control space allocation and deallocation on DASD.

direct access storage device (DASD). A device in which the access time is effectively independent of the location of the data.

direct data set. A data set whose records are in random order on a direct access volume. Each record is stored or retrieved according to its actual address or its address according to the beginning of the data set. Contrast with *sequential data set*.

directory. (1) A table of identifiers and references to the corresponding items of data. (2) An index that is used by a control program to locate one or more blocks of data that are stored in separate areas of data set in direct access storage.

discrete profile. A RACF profile that contains security information about a single data set, user, or resource. Contrast with *generic profile*.

doubleword. A contiguous sequence of bits or characters that comprises two computer words and is capable of being addressed as a unit.

dummy control section (DSECT). A control section that an assembler can use to format an area of storage without producing any object code.

dynamic allocation. The allocation of a data set or volume using the data set name or volume serial number rather than using information contained in a JCL statement.

dynamic buffering. A user-specified option that requests that the system handle acquisition, assignment, and release of buffers.

E

enqueue. To place items on a queue. Contrast with *dequeue*.

entry point. (1) The address or the level of the first instruction executed on entering a computer program, a routine, or a subroutine. A computer program, a routine, or a subroutine may have several different entry points, each perhaps corresponding to a different function or purpose. (2) In a routine, any place to which control can be passed.

ESA/370. A hardware architecture unique to the IBM 3090 Enhanced model processors and the 4381 Model Groups 91E and 92E. It reduces the effort required for managing data sets, removes certain MVS/XA constraints that limit applications, extends addressability for system, subsystem, and application functions, and helps exploit the full capabilities of DFSMS.

exception. An abnormal condition such as an I/O error encountered in processing a data set or file.

exclusive control. Preventing multiple WRITE-add requests from updating the same dummy record or writing over the same available space on a track. When specified by the user, exclusive control requests that the system prevent the data block about to be read from being modified by other requests; it is specified in a READ macro and released in a WRITE or RELEX macro. When a WRITE-add request is about to be processed, the system automatically gets exclusive control of either the data set or the track.

exit list. A control block that contains the addresses of routines that receive control when specified events occur during execution; for example, routines that handle session establishment request processing or I/O errors.

extent. A continuous space on a DASD volume occupied by a data set or portion of a data set. An extent of a data set contains a whole number of control areas.

F

field. In a record or control block, a specified area used for a particular category of data or control information.

flag. (1) Any of various types of indicators used for identification, for example, a wordmark. (2) A character that signals the occurrence of some condition, such as the end of a word.

format-D. ISCII/ASCII or ISO/ANSI/FIPS variable-length records.

format-F. Fixed-length records.

format-U. Undefined-length records.

format-V. Variable-length records.

G

generation data group (GDG). A collection of historically related non-VSAM data sets that are arranged in chronological order; each data set is called a generation data set.

generation data group base entry. An entry that permits a non-VSAM data set to be associated with other non-VSAM data sets as generation data sets.

generation data set (GDS). One of the data sets in a generation data group; it is historically related to the others in the group.

generic profile. A RACF profile that contains security information about multiple data sets, users, or resources that may have similar characteristics and require a similar level of protection. Contrast with *discrete profile*.

gigabyte. 1,073,741,824 bytes.

H

halfword. A contiguous sequence of bits or characters that comprise half a computer word and is capable of being addressed as a unit.

head. A device that reads, writes, or erases data on a storage medium, for example, a small electromagnet used to read, write, or erase data on magnetic drum or magnetic tape, or the set of perforating, reading, or marking devices used for punching, reading, or printing on perforated tape.

header entry. In a parameter list of GENCB, MODCB, SHOWCB, or TESTCB, the entry that identifies the type of request and control block and gives other general information about the request.

header label. (1) An internal label, immediately preceding the first record of a file, that identifies the file and contains data used in file control. (2) The label or data set label that precedes the data records on a unit of recording media.

home address. An address written on a direct access volume, denoting a track's address relative to the beginning of the volume. The home address is written after the index point on each track.

I

indexed sequential access method (ISAM). An access method that retrieves or updates blocks of data using an index to locate the data set.

initial program load (IPL). (1) The initialization procedure that causes an operating system to commence operation. (2) The process by which a configuration image is loaded into storage at the beginning of a work day or after a system malfunction.

integrated catalog facility. The name of the catalog in MVS/DFP that replaces OS CVOLs and VSAM catalogs.

integrated catalog facility catalog. Consists of two types of components: the basic catalog structure (BCS) and at least one VSAM volume data set (VVDS). The integrated catalog facility catalog is a functional replacement for VSAM catalogs and OS CVOLs; integrated catalog facility catalogs feature improvements over VSAM catalogs in reliability, recoverability, performance, usability, and DASD space management. It is also the only catalog that is supported by the Storage Management Subsystem (SMS).

integrity. See *data integrity*.

internal storage. Storage that is accessible by a computer without the use of input/output channels.

I/O device. An addressable input/output unit, such as a direct access storage device, magnetic tape device, or printer.

J

job control language (JCL). A problem-oriented language used to identify the job or describe its requirements to an operating system.

job entry subsystem (JES). A system facility for spooling, job queueing, and managing input and output. The two types of job entry subsystems in MVS are JES2 and JES3.

job step catalog. A catalog made available for a job by means of the STEPCAT DD statement.

K

key. One or more characters within an item of data that are used to identify it or control its use. As used in this publication, one or more consecutive characters taken from a data record, used to identify the record and establish its order with respect to other records.

key-sequenced data set (KSDS). A VSAM data set whose records are loaded in ascending key sequence and controlled by an index. Records are retrieved and stored by keyed access or by addressed access, and new records can be inserted in key sequence because of free space allocated in the data set. Relative byte addresses can change, because of control interval or control area splits.

kilobyte. 1024 bytes.

L

library. A partitioned data set containing a related collection of named members. See *partitioned data set*.

load module. The output of the linkage editor; a program in a format ready to load into virtual storage for execution.

locate mode. A way of providing data by pointing to its location instead of moving it.

logical record. (1) A record from the standpoint of its content, function, and use rather than its physical attributes; that is, defined in terms of the information it contains. (2) A unit of information normally pertaining to a single subject; a logical record is that user record requested of or given to the data management function.

M

management class. A list of the migration, backup, and retention parameters and their values, for an SMS-managed data set.

Mass Storage System. The name for the entire storage system, consisting of the Mass Storage Facility and all devices that are defined to the Mass Storage Control.

mass storage volume. Two data cartridges in the IBM 3850 Mass Storage System that contain information equivalent to what would be stored on a direct-access storage volume.

master catalog. A catalog that contains extensive data set and volume information that VSAM requires to locate data sets, to allocate and deallocate storage space, to verify the authorization of a program or operator to gain access to a data set, and accumulate usage statistics for data sets.

media. The disk surface on which data is stored.

megabyte (Mb). 10^6 bytes.

member. A partition of a partitioned data set.

move mode. A transmittal mode in which the record to be processed is moved into a user work area.

migration. In DFHSM, the process of moving a cataloged data set from a primary volume to a level 1 volume or level 2 volume, from a level 1 volume to a level 2 volume, or from a volume not managed by DFHSM to a level 1 or level 2 volume.

MVS/DFP. An IBM licensed program which is the base for the Storage Management Subsystem.

MVS/ESA. An MVS operating system environment which supports ESA/370.

MVS/SP. An IBM licensed program used to control the MVS operating system and establish a base for an MVS/XA or MVS/ESA environment.

N

non-VSAM data set. A data set created and accessed using one of the following methods: BDAM, BPAM, BSAM, QSAM, QISAM.

O

online. Pertaining to equipment, devices, or data under the direct control of the processor.

operand. Information entered with a command name to define the data on which a command operates and to control the execution of the command.

operating system. Software that controls the execution of programs; an operating system may provide services such as resource allocation, scheduling, input/output control, and data management.

optimum block size. For non-VSAM data sets, optimum block size represents the block size that would result in the greatest space utilization on a device, taking into consideration record length and device characteristics.

OS control volume (OS CVOL). A volume that contains one or more indexes of the catalog.

P

page. (1) A fixed-length block of instructions, data, or both, that can be transferred between real storage and external page storage. (2) To transfer instructions, data, or both between real storage and external page storage.

page space. A system data set that contains pages of virtual storage. The pages are stored into and retrieved from the page space by the auxiliary storage manager.

paging. A technique in which blocks of data, or pages, are moved back and forth between main storage and auxiliary storage. Paging is the implementation of the virtual storage concept.

partitioned data set (PDS). A data set in DASD storage that is divided into partitions, called members, each of which can contain a program, part of a program, or data. See also *library*.

password. A unique string of characters stored in a catalog that a program, a computer operator, or a terminal user must supply to meet security requirements before a program gains access to a data set.

PDS directory. A set of records in a partitioned data set (PDS) used to relate member names to their locations on a DASD volume.

physical record. A record whose characteristics depend on the manner or form in which it is stored, retrieved, or moved. A physical record may contain all or part of one or more logical records.

pointer. An address or other indication of location.

primary space allocation. Initially allocated space on a direct access storage device, occupied by or reserved for a particular data set. See also *secondary space allocation*.

problem program. Any program that is executed when the processing unit is in the problem state; that is, any program that does not contain privileged instructions. This includes IBM-distributed programs, such as language translators and service programs, and programs written by a user.

Q

queued sequential access method (QSAM). An extended version of the basic sequential access method (BSAM). Input data blocks awaiting processing or output data blocks awaiting transfer to auxiliary storage are queued on the system to minimize delays in I/O operations.

R

record. A set of data treated as a unit.

register. An internal computer component capable of storing a specified amount of data and accepting or transferring this data rapidly.

relative address. An address expressed as a difference with respect to a base address.

Resource Access Control Facility (RACF). An IBM licensed program that provides access control by identifying and verifying users to the system. RACF authorizes access to DASD data sets, logs unauthorized access attempts, and logs accesses to protected data sets.

rotational position sensing (RPS). A function that permits a DASD to reconnect to a block multiplexer channel when a specified sector has been reached. This allows the channel to service other devices on the channel during positional delay.

S

save area. An area of main storage in which the contents of registers are saved.

scheduling. The ability to request that a task set should be started at a particular interval or on occurrence of a specified program interrupt.

secondary space allocation. A predefined contiguous space on a DASD volume reserved for additions to a particular data set, and allocated only after the primary allocation space is full. See also *primary space allocation*.

sequence checking. The process of verifying the order of a set of records relative to some field's collating sequence.

sequential access. The retrieval or storage of a data record in: its entry sequence, its key sequence, or its relative record number sequence, relative to the previously retrieved or stored record. See also *addressed-sequential access* and *keyed-sequential access*.

sequential access method (SAM). An access method for storing or retrieving data blocks in a continuous sequence, using either a sequential access or a direct access device.

sequential data set. A data set whose records are organized on the basis of their successive physical positions, such as on magnetic tape. Contrast with *direct data set*.

serialization. In MVS, the prevention of a program from using a resource that is already being used by an interrupted program until the interrupted program is finished using the resource.

SMS class. A list of attributes that SMS applies to data sets having similar allocation (data class), performance (storage class), or backup and retention (management class) needs.

SMS configuration. A configuration base, SMS class and storage group definitions, and ACS routines that SMS uses to manage storage.

SMS-managed data set. A data set that has been assigned a storage class.

spanned record. A logical record whose length exceeds control interval length, and as a result, crosses, or spans, one or more control interval boundaries within a single control area.

spooling. (1) The use of auxiliary storage as a buffer to reduce processing delays when transferring data between peripheral equipment and the processors of a computer. (2) The reading of input data streams and the output of data streams on auxiliary storage devices, concurrently with job execution, in a format convenient for later processing or output operations.

step catalog. See *job step catalog*

storage administrator. A person in the data processing installation who is responsible for defining, implementing, and maintaining storage management policies.

storage class. A list of DASD storage performance, security, and availability service level requirements for an SMS-managed data set.

storage group. A list of traits and characteristics that SMS applies to groups of storage volumes having similar migration, backup, and dump needs. Only the storage administrator can access storage group definitions.

Storage Management Subsystem (SMS). An operating environment that helps automate and centralize the management of storage. To manage storage, SMS provides the storage administrator with control over data class, storage class, management class, storage group, and ACS routine definitions.

substitute mode. A transmittal mode used with exchange buffering on which segments are pointed to, and exchanged with, user work areas.

subtask. (1) A task that is initiated and terminated by a higher order task. (2) A task that is restricted from communication with an operator device.

system-managed storage. An approach to storage management in which the system determines data placement and an automatic data manager handles data backup, movement, space, and security.

system residence volume (SYSRES). The volume on which the nucleus of the operating system and the master catalog are stored.

T

trailer label. A file or data set label that follows the data records on a unit of recording media.

U

universal character set (UCS). A printer feature that permits the use of a variety of character arrays. Character sets used for these printers are called UCS images.

user catalog. An optional catalog used in the same way as the master catalog and pointed to by the master catalog. It also lessens the contention for the master catalog and facilitates volume portability.

V

virtual I/O (VIO). A facility that pages data into and out of external page storage; to the problem program, the data to be read from or written to direct access storage devices.

virtual storage access method (VSAM). An access method for direct or sequential processing of fixed and variable-length records on direct access storage devices. The records in a VSAM data set or file can be organized in logical sequence by a key field (key sequence), in the physical sequence in which they are written on the data set or file (entry sequence), or by relative record number.

volume. A certain portion of data, together with its data carrier, that can be mounted on the system as a unit; for example, a tape reel or a disk pack. For DASD, a volume refers to the amount of space accessible by a single actuator.

volume table of contents (VTOC). A table on a direct access storage device (DASD) that describes each data set on the volume.

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