4

SC33-6094-0
File No. S370/4300-34

VSE/Advanced Functions System Management Guide

Program Number 5746-XE9

Release 2

IBM

SC33-6094-0
File No. S370/4300-34

Program Product

VSE/Advanced Functions System Management Guide

Program Number 5746-XE9

Release 2

IBM

Summary of Amendments

This publication, although a -0 edition, actually is a major revision of the DOS/VSE SCP publication *DOS/VSE System Management Guide*, GC33-5371-7. For a complete overview of new functions that have become available since Release 34 of the DOS/VS SCP, refer to the publication *Introduction to the VSE System.*

The amendments cover:

- Sharing of data on DASD across computing systems
- Chaining of libraries
- Sharing of libraries across partitions and across computing systems
- Extended multiprogramming and subtasking support (up to twelve partitions and up to 208 subtasks)
- Improved label processing
- New initial program load functions and simplified supervisor assembly
- Linkage editor work files in VSE/VSAM managed data space, as supported by the VSE/VSAM Space Management for SAM feature.
- More ease of use with VSE/VSAM space management (simplified job control language)
- Inclusion of Device Support Facilities (DSF)

Significant changes are indicated by a vertical bar to the left of the changes.

First Edition (October, 1979)

This edition applies to Release 2 of VSE/Advanced Functions and to all subsequent releases until otherwise indicated in new editions or Technical Newsletters. Changes are continually made to the information herein; before using this publication in connection with the operation of IBM systems, consult the latest *IBM System/370 Bibliography*, GC20-0001, for the editions that are applicable and current.

It is possible that this material may contain reference to, or information about, IBM products (machines and programs), programming, or services that are not announced in your country. Such references or information must not be construed to mean that IBM intends to announce such IBM products, programming, or services in your country.

Publications are not stocked at the address given below; requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be addressed to IBM Laboratory, Programming Publications Department, Schoenaicher Strasse 220, D-7030 Boeblingen, Germany. IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation whatever. You may, of course, continue to use the information you supply.

THIS MANUAL ...

... is a guide to using the functions available with the licensed VSE/Advanced Functions and its complementary system control programming (SCP) code.

'VSE' refers to the IBM Disk Operating System/Virtual Storage Extended (DOS/VSE). VSE comprises your *entire* operating system, that is, not only VSE/Advanced Functions which is the minimum required support, but also any optional installed system support. The latter may consist of IBM-supplied support programs (such as VSE/POWER, VSE/ICCF) or of system support programs that you supplied yourself.

System management, which is discussed on a conceptual and functional level, refers not only to the way VSE/Advanced Functions is organized, but also to the way you, the user, can efficiently manage your system.

Before you begin reading this manual, you should be familiar with the information contained in the *Introduction to the VSE System*.

This book is not a guide to data management; instead, a separate manual is provided for this purpose, called the *VSE System Data Management Concepts*.

After reading this manual and the above mentioned manuals, you should be able to turn directly to the VSE library of reference manuals in order to work with your operating system. A reference manual is organized so that you can easily retrieve specific information on the formats of the control statements, macro instructions, labels, and messages, which you deal with daily.

This manual is divided into four chapters:

Chapter 1: VSE/Advanced Functions Overview provides conceptual information on multiprogramming, virtual storage, and multitasking.

Chapter 2: Planning the System gives planning information for system generation.

Chapter 3: Using the System provides information on how to use the system, in particular on the use of the IPL, job control, linkage editor, and librarian programs.

Chapter 4: Using the Facilities and Options of VSE/Advanced Functions provides guidance information on how to use facilities and options of VSE/Advanced Functions; for example, writing IPL and job control user exit routines, checkpointing and restarting a program, or designing programs for virtual mode execution.

For reference purposes the organization of the system residence disk file (SYSRES) is shown in Appendix A.

The following IBM manuals are referred to in the text of this manual:

IBM System /370 Principles of Operation	GA22-7000
IBM 4300 Processors, Principles of Operation	GA22-7070
Using the VSE/VSAM Space Management for SAM Feature	SC24-5192
VSE System Data Management Concepts	GC24-5209
VSE/Advanced Functions Macro User's Guide	SC24-5210
VSE/Advanced Functions Macro Reference	SC24-5211
VSE/Advanced Functions Tape Labels	SC24-5212
VSE/Advanced Functions DASD Labels	SC24-5213
DOS/VSE IBM 3800 Printing Subsystem Programmer's Guide	GC26-3900
OS/VS, DOS/VSE, VM/370 Environmental Recording Editing and Printing (EREP) Program	GC28-0772
Guide to the DOS/VSE Assembler	GC33-4024
DOS/VSE OLTEP	GC33-5383
Data Security Under the VSE System	GC33-6077
VSE/Fast Copy Data Set Installation Reference	SC33-6082
VSE/Advanced Functions Sysem Control Statements	SC33-6095
VSE/Advanced Functions System Generation	SC33-6096
VSE/Advanced Functions Operating Procedures	SC33-6097
VSE/Advanced Functions Messages	SC33-6098
VSE/Advanced Functions Serviceability Aids and Debugging Procedures	SC33-6099
VSE/Advanced Functions System Utilities	SC33-6100
VSE/Advanced Functions Maintain System History Program User's Guide	SC33-6101
Introduction to the VSE System	GC33-6108

Table of Contents

List of Figures

Chapter 1: VSE/Advanced Functions Overview

Chapter 2: Planning the System

Chapter 3: Using the System

Chapter 4: Using the Facilities and Options of VSE/Advanced Functions

Appendix A: System Layout on Disk

Chapter 1: VSE/Advanced Functions Overview

VSE/Advanced Functions is a combination of programs that interact with user-written programs running on an IBM System/370 or an IBM 3031 or a 4300 Processor. A reference to System/370 implies, in this manual, a reference to the IBM 3031. When installed on a 4300 Processor, VSE/Advanced Functions may run in either 370 mode or ECPS:VSE mode. VSE/Advanced Functions installed on a System/370 or an IBM 3031 runs in 370 mode only.

This chapter expands on the conceptual information contained in *Introduction to the VSE System* about the following topics:

- Multiprogramming
- Virtual storage
- Multitasking

Multiprogramming

Multiprogramming is a technique that allows the concurrent execution of more than one program in a single computer system. Multiprogramming balances the difference between the speed of the central processor (also called central processing unit or, abbreviated, CPU) and the relatively slower speed of the I/O devices, and improves the overall throughput of the system.

When a single executing program requests an I/O operation, it may not be able to continue processing until the I/O request has been satisfied. During this time, the CPU is idle. With multiprogramming, when one program stops processing, the CPU is put at the disposal of another program.

A program is said to be *in control of the system* when its instructions are being executed by the CPU. A program can voluntarily yield control of the CPU, or control can be withdrawn from it. Programs that share the use of the CPU in multiprogramming do not have an equal claim on the CPU. Instead, one program is given a greater priority than another.

When a program must wait for an event to occur before it can continue processing, it yields control of the CPU. The operating system then passes control to a program of lower priority. Conversely, the operating system withdraws control from a program whenever a program with higher priority is ready to resume processing. This generally happens when the I/O operation for which the program has been waiting is completed.

Multiprogramming, therefore, allows the I/O operations of one program to be overlapped by the processing of other programs. When a program has to wait for the completion of an I/O operation, the system sets the program in the wait state and selects another program for execution on the basis of its priority and readiness to run. This process, called task selection, is performed by the supervisor program of VSE/Advanced

Functions. The supervisor is always resident in storage and controls many functions of VSE/Advanced Functions. The supervisor is discussed in detail in the section *Tailoring the Supervisor* in *Chapter 2: Planning the System.*

Partitions

Efficient use of the system relates not only to the degree of CPU activity but also to storage management. Storage is allocated to partitions to accommodate the programs that will be executed in them. At times, only a portion of the partition is used by the program being executed. Some programs require a large partition. The operating system automatically balances the storage demands made by programs by making processor storage not being used by one program available to a program in another partition as required.

The number of partitions supported equals the number of problem programs that can be executed concurrently within the system. There is always support for one background (BG) partition and one foreground (F1) partition. Optionally, support for up to ten additional foreground partitions can be requested; see Figure 1-1. The actual number of partitions in a particular configuration is a supervisor generation option, and as such is described in the section *Tailoring the Supervisor* in *Chapter 2: Planning the System.*

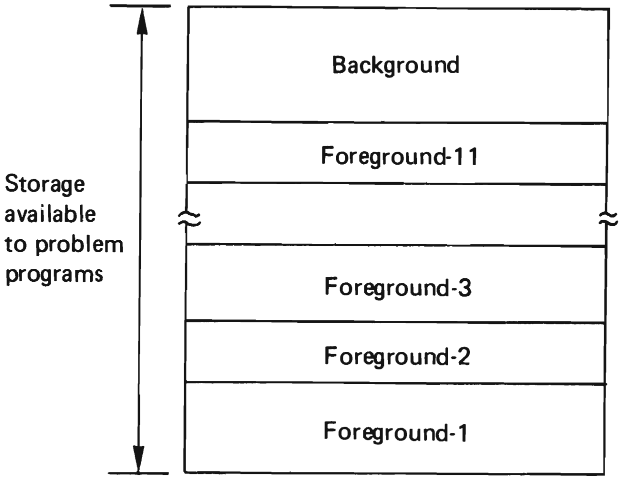


Figure 1-1. The Partitions of a VSE System

The background partition is automatically activated by IPL. A foreground partition must be activated via the BATCH or START operator command. (The BATCH and START operator commands are discussed in detail in *VSE/Advanced Functions Operating Procedures.*)

Partition Priorities

During supervisor generation, default priorities are established for each partition defined in the system. The default priorities are (from low to high): BG, FB, FA, F9, ... F2, F1.

During processing the operator can display the partition priorities and change them dynamically by issuing the PRTY command. This can be used to accelerate the execution of a given program. However, the priorities should be reset to the installation standards as soon as possible to handle the normal flow of jobs through the system.

Besides assigning a fixed priority to a certain partition, you can also specify two or more partitions for balancing. Balanced partitions are treated as a single entity within which the supervisor assigns priorities; that is, dynamically distributes CPU time to the individual partitions.

Changing priorities while jobs are being executed should be done with special care if the licensed program VSE/POWER or teleprocessing, which normally run in a high-priority partition, are active in the system.

Storage Protection

Storage protection, which is standard on all System/370 and 4300 processor models, ensures that the instructions and data of one program in a given partition do not interfere with those of another program in another partition.

Device Considerations Under Multiprogramming

Generally, the same physical I/O device (or extent of a direct access or diskette device) may not be used concurrently by programs being executed in different partitions. Exceptions to this are:

- The device or extents assigned to the system logical units:

SYSRES	for system residence
SYSREC	for the recording of system information such as console messages and hardware statistics
SYSLOG	for system-operator communication
SYSDMP	for alternate dump files
SYSCAT	for use with VSE/VSAM, a licensed VSE access method.

  These devices (extents) are considered to belong to the system as a whole, rather than to individual partitions. (A description of these system logical units is contained in the section *Symbolic I/O Assignment* in *Chapter 3: Using the System*).

- The page data set.

- The lock communication file, used for DASD sharing across computing systems.

- A private library can be defined and used in any partition, except when being condensed in another partition (for more information refer to *Using the Libraries* in *Chapter 3: Using the System*).
- A file on a direct access device can be accessed across partitions, providing it is not being created simultaneously by programs in more than one partition (see *Track Hold Option* in *Chapter 2, Planning the System* for information on protection when updating a file concurrently by separate tasks).

If, for example, you wish to link edit programs in different partitions concurrently, different physical devices or extents (except for SYSRES and SYSLOG) must be assigned for each partition to all logical units used by the linkage editor program. Figure 1-2 shows an example of the device assignments in order to link edit in two partitions concurrently.

Logical Unit	F1 Partition	BG Partition
SYSIN	X'181'	X'00C'
SYSLST	X'182'	X'00E'
SYSLOG	X'01F'	X'01F'
SYSLNK	X'131'	X'132'
SYS001	X'131'	X'132'
SYSRES	X'130'	X'130'

Figure 1-2. Assigning Different Physical Devices to the Same Logical Units

In this case, the output on SYSLST in F1 is written on a tape. A listing of this output can be obtained by printing the tape after the job is completed. If VSE/POWER is used, the listing could be automatically obtained whenever a printer becomes available.

Virtual Storage

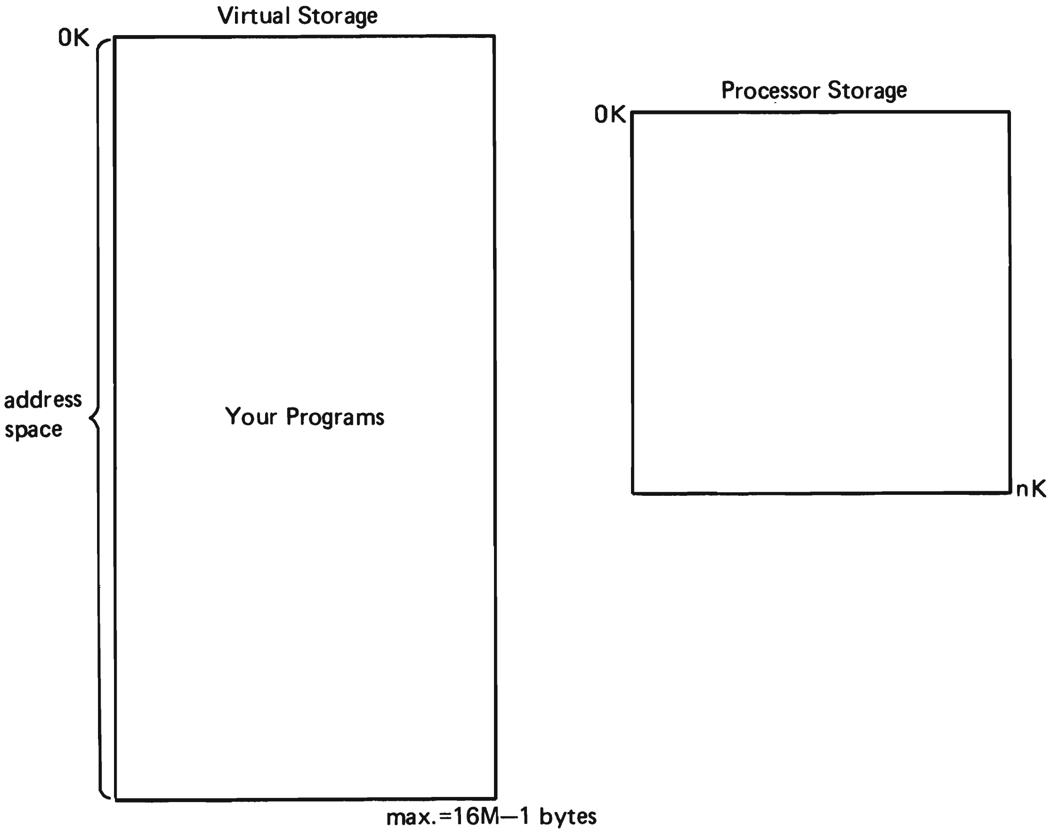
The objective of the virtual storage concept is to achieve greater throughput. Multiprogramming, for example, increases throughput by sharing CPU time between two or more partitions. Virtual storage enables you to improve real (processor) storage utilization.

In the previous multiprogramming discussion the statement is made that "Multiprogramming . . . allows the concurrent execution of more than one program . . . ". Note that concurrent does not mean simultaneous. Even in the multiprogramming environment, when two or more programs are executing in storage, the CPU can execute only one instruction at a time. Hence, the space in storage used by all other instructions, data areas etc. is temporarily not needed. All that must be in storage at any one point in time is the instruction (and its associated data areas) that is being executed. The Virtual Storage concept exploits this fact.

Virtual Storage in VSE

Through a combination of hardware design and programming support, VSE has an address space, called *virtual storage*, that can extend to the maximum allowed by the system's addressing scheme, which is 16,777,216 bytes (16M bytes).

How much of the maximum address space (16 M bytes) will be used in a particular system depends on a number of factors: the size of the computer's processor storage, the amount of disk storage available, the number of partitions, their sizes, and the characteristics of the installation's programs and operating environment.



It is in the address space that programs conceptually run.

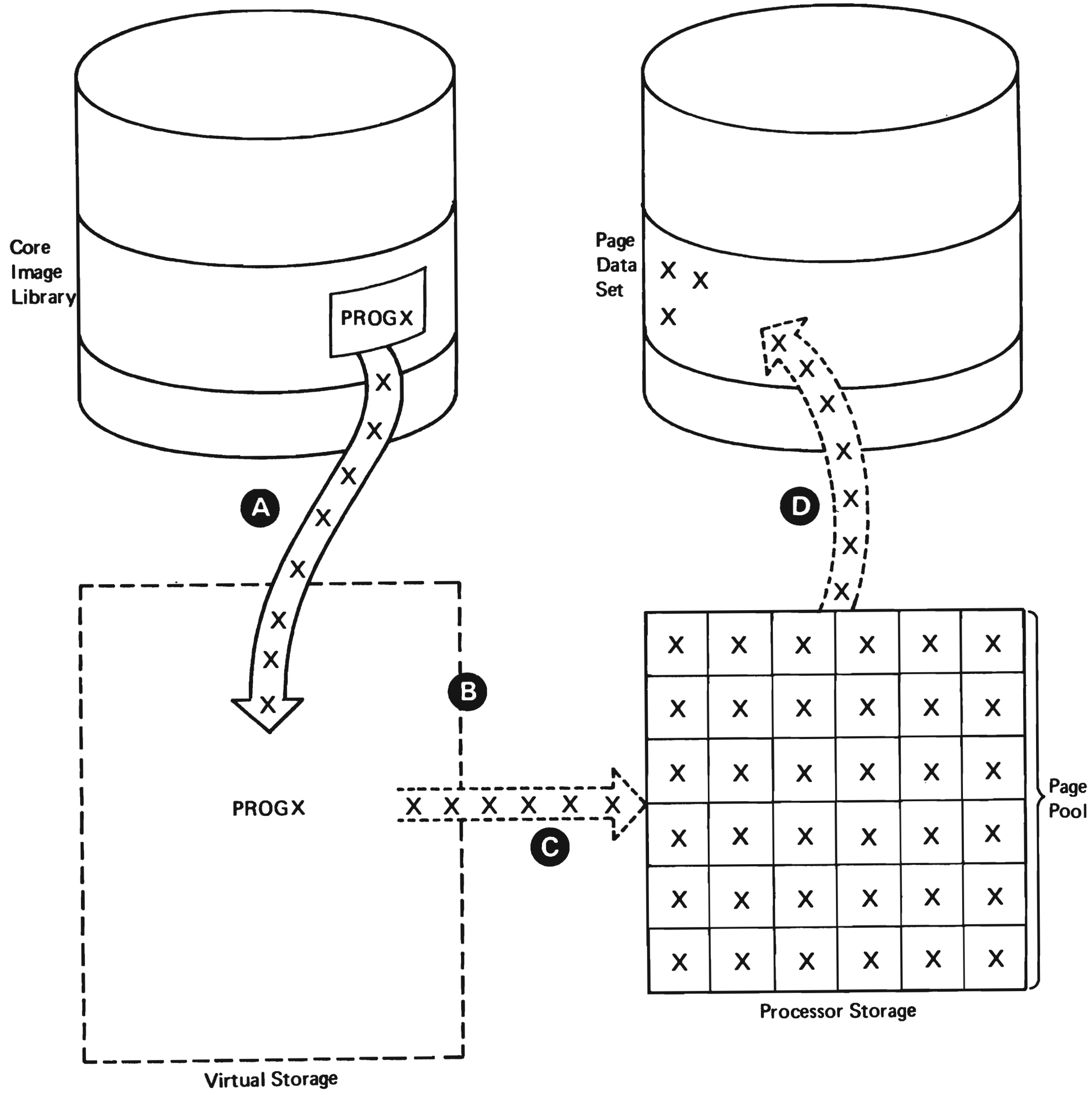
Figure 1-3. Virtual Storage and Processor Storage

Your programs are conceptually loaded and run in *address space*. See Figure 1-3. Of course, each instruction of a program must be in processor storage when the instruction is executed, and so must the data this instruction manipulates. The other instructions and data of that program in virtual storage need not be in processor storage at that same moment; they can reside on auxiliary storage until needed. The file used for this purpose is called the *page data set*.

It would be inefficient, however, to bring every instruction and its associated data into processor storage individually. Virtual storage is manipulated in sections called *pages*; the size of a page in VSE is 2K bytes. Processor storage is also divided into 2K byte sections; these are called *page frames.* Page frames accommodate pages of a program during execution.

The resident routines of the VSE/Advanced Functions supervisor occupy the low address page frames, while the remaining page frames are available for the execution of processing programs and the pageable routines of the supervisor. These remaining page frames are collectively called the *page pool.*

When a program is loaded from the core image library into virtual storage, all its pages are brought into page frames of the page pool. If there are not enough page frames available to contain all the pages of a program, the system writes the contents of some page frames to the *page data set.* See Figure 1-4.



A program named PROGX (A) is "conceptually" loaded into virtual storage (B). The supervisor finds *page frames* in the *page pool* of processor storage (C). When there are not enough page frames to accommodate all of PROGX, the supervisor stores the contents of some page frames on the page data set (D). The remaining pages of the program can then be loaded.

Figure 1-4. Storage Management Concept – VSE/Advanced Functions

Storage Management

The following discussion amplifies the concept of storage management shown in Figure 1-4.

When programs are loaded for execution they may be loaded in non-contiguous page frames of processor storage. The supervisor knows what processor storage locations pages of a given program occupy. If the program should cancel, due to an error, the listing produced by the system reflects the virtual addresses where the program was conceptually running. In Figure 1-5, a 16K-byte program named INVEN, is conceptually loaded at the virtual storage location 1024K. As shown, the system selected eight *page frames* of processor storage which are not contiguous. If the program were to end abnormally, and a listing representing storage was produced (on SYSLST), the INVEN program would be shown as occupying addresses 1024K through 1040K minus 1.

All of the information pertaining to the virtual storage and page frames is maintained within the system in a series of tables. It is through these tables that the virtual storage exists. Entries in these tables reflect the current status of a given page of virtual storage.

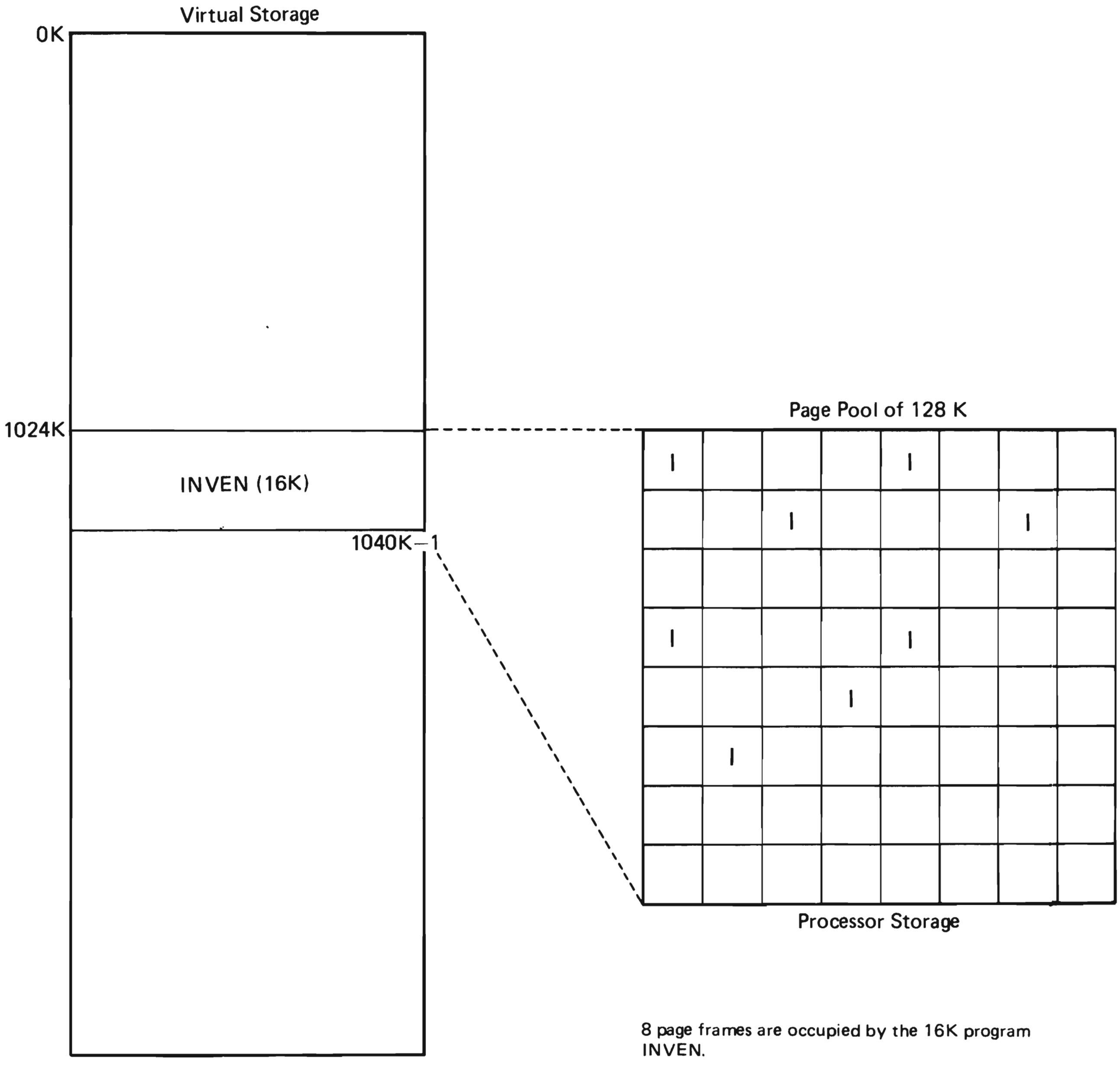


Figure 1-5. Running a Program in Virtual Storage

Relating Virtual Storage to Locations in Processor Storage

Since the system does not anticipate where in processor storage a page will be loaded, the virtual addresses must be translated into real addresses when required for execution. The address translation is performed by a combination of the system hardware and the VSE/Advanced Functions supervisor.

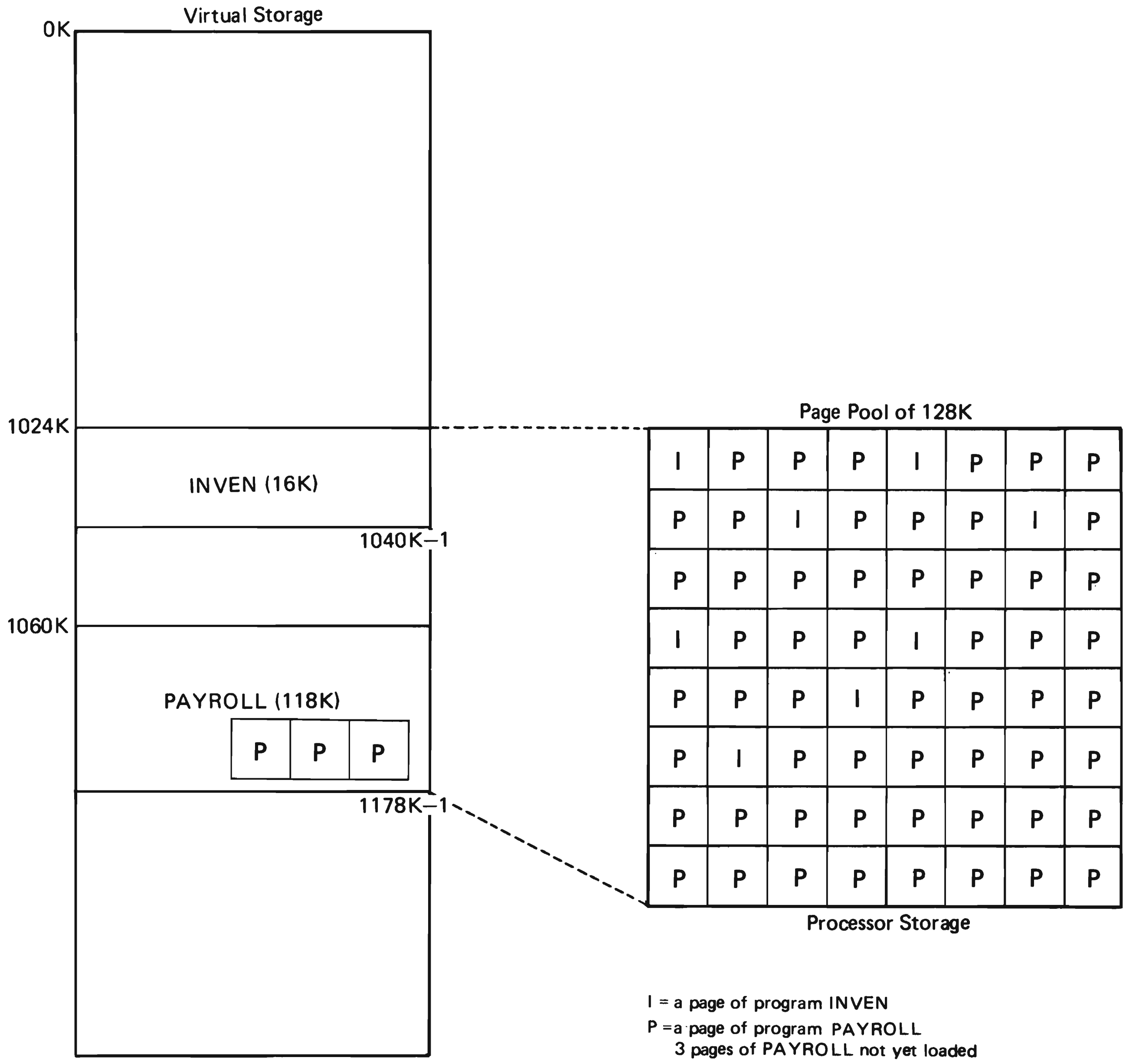
If an entire program fits in processor storage, none of the program's pages will be placed on the page data set.

In the example shown in Figure 1-5, no page of INVEN will be *paged out* as long as the demand on processor storage does not exceed the number of available page frames.

If a second program were to be executed (multiprogramming) and this program together with INVEN were larger in size than the number of frames available in the page pool, the system would store as many pages as necessary on the page data set to keep both programs running.

In Figure 1-6 a program called PAYROLL is being executed as well as INVEN. PAYROLL is a 118K program. As the *page pool* in this example is only 128K, the total demand (INVEN + PAYROLL) of 134K exceeds the processor storage resource by 6K or three page frames.

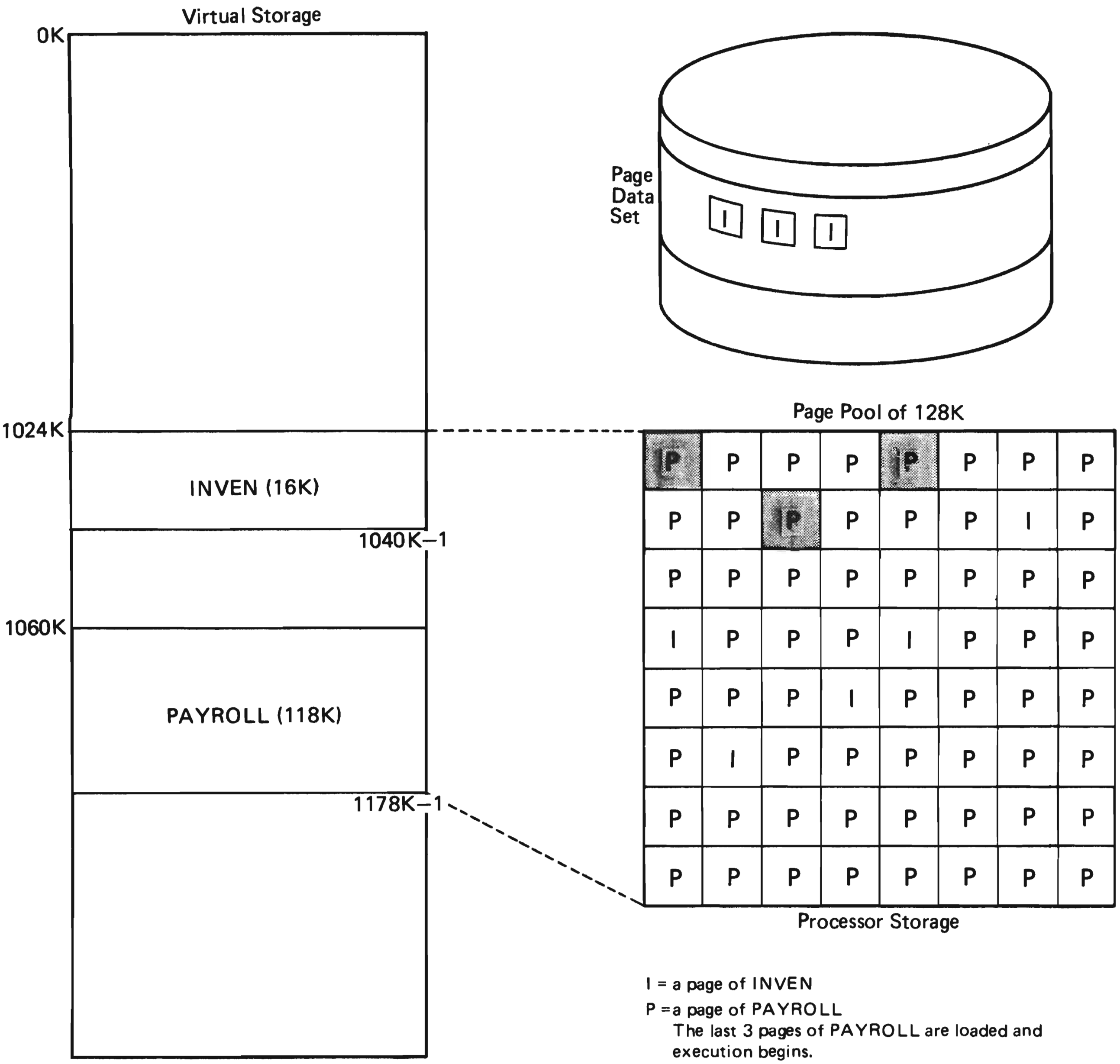
The program PAYROLL will not start executing until all of its pages have been loaded into processor storage. After having loaded 112K of program PAYROLL, the supervisor must make three page frames available for that program. It does this by selecting the three least recently used pages and storing them on the page data set. See Figure 1-7. Once the pages have been saved on the page data set the page frames are available for the last three pages of the program PAYROLL. See Figure 1-8.



I	P	P	P	I	P	P	P
P	P	I	P	P	P	I	P
P	P	P	P	P	P	P	P
I	P	P	P	I	P	P	P
P	P	P	I	P	P	P	P
P	I	P	P	P	P	P	P
P	P	P	P	P	P	P	P
P	P	P	P	P	P	P	P

I = a page of program INVEN
P = a page of program PAYROLL
3 pages of PAYROLL not yet loaded

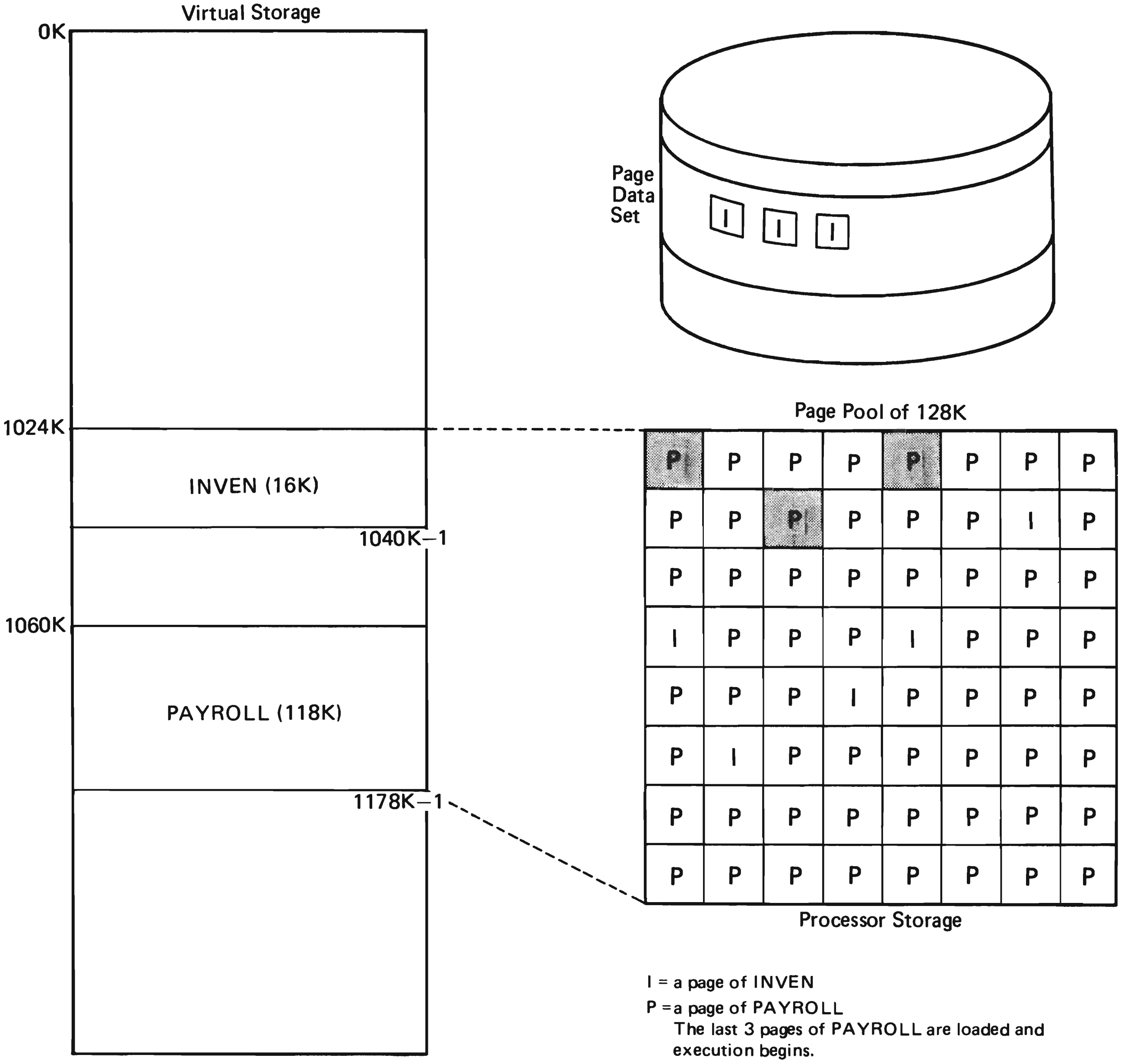
Figure 1-6. Loading Program Pages into Page Frames



I = a page of INVEN

P =a page of PAYROLL
The last 3 pages of PAYROLL are loaded and execution begins.

Figure 1-7. Storing Pages on the Page Data Set (Pageouts)



P	P	P	P	P	P	P	P
P	P	P	P	P	P	I	P
P	P	P	P	P	P	P	P
I	P	P	P	I	P	P	P
P	P	P	I	P	P	P	P
P	I	P	P	P	P	P	P
P	P	P	P	P	P	P	P
P	P	P	P	P	P	P	P

During execution, whenever a required instruction or some data is not present in processor storage, execution is interrupted by a so-called *page fault.* The required page must then be read into processor storage.

Figure 1-8. Managing the Page Pool

Virtual Storage Implementation under VSE/Advanced Functions

Under VSE/Advanced Functions you may generate a system that will execute on 4300 or /370 hardware. Using the 4300 hardware, your VSE system may be generated to run in either ECPS:VSE mode or 370 mode. VSE on the System/370 hardware may run only in 370 mode.

The generated supervisor in 370 mode is functionally the same, whether the hardware is System/370 or a 4300 processor.

The concepts of virtual storage are the same in both modes of execution; however, the implementation differs slightly.

This section discusses: virtual storage, processor storage, and program execution (with and without paging). The implementation of most of these items is the same in both modes. The differences between the two execution modes (ECPS:VSE or /370) are discussed and illustrated later in this section.

Division of Address Space

As stated earlier, all programs, including the supervisor, run in an address space called virtual storage. This address space is divided into areas: for the supervisor, the partitions, a shared virtual area (SVA).

Supervisor Area. The address space reserved for the supervisor is the low addresses of your virtual storage. The supervisor area begins at location 0K and extends up to the size of your generated supervisor (see Figure 1-9).

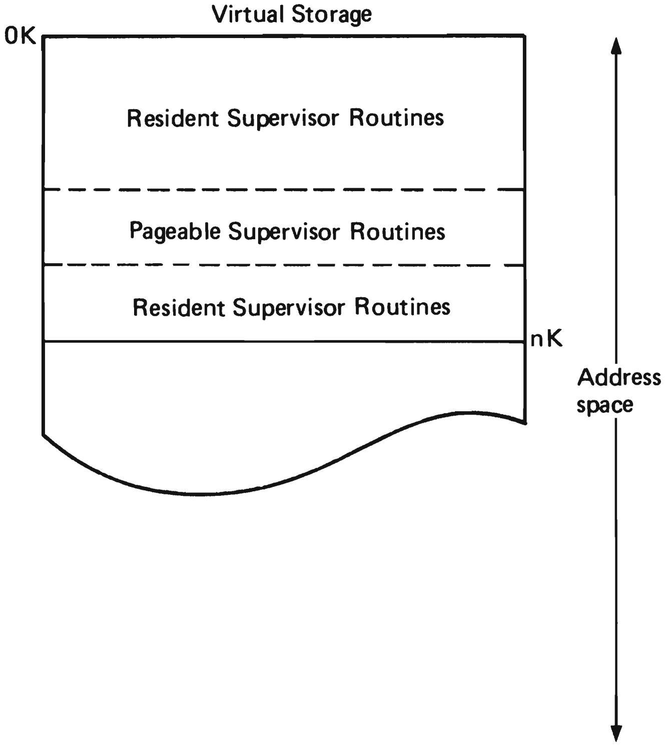

Virtual Storage
0K
Resident Supervisor Routines
Pageable Supervisor Routines
Resident Supervisor Routines
nK
Address space

Figure 1-9. Supervisor Area in Virtual Storage Address Space

Partitions. The virtual storage contains the areas which are used by the partitions. Programs will execute from these areas. The number of partitions is determined at system generation. See *Chapter 2, Planning the*

System. The distribution of the partitions in the address space follows the default partition priority scheme, that is, the lower priority partitions have the lower addresses. The sequence is always BG, F4, F3, F2, F1 for a five partition system.

Figure 1-10 shows the layout of virtual storage for a 4-partition VSE system. In this figure each partition is 200K in size.

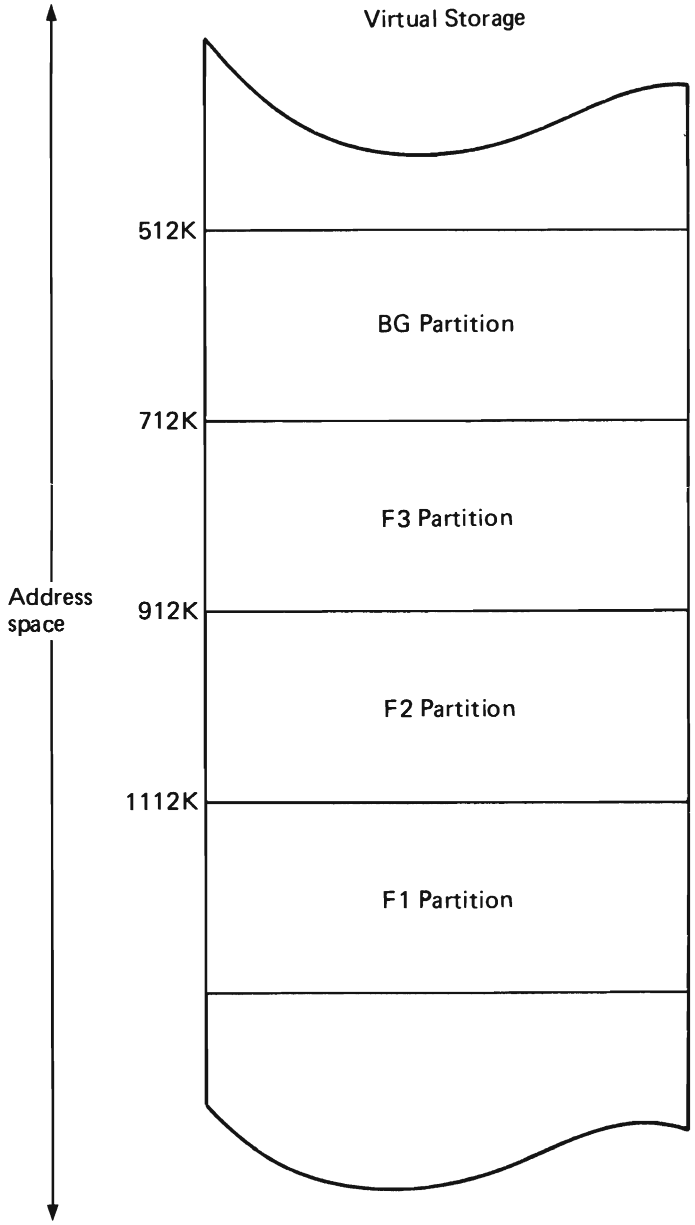


Figure 1-10. Partition Distribution in a Four Partition System

The Shared Virtual Area (SVA). The SVA occupies the address space immediately following the partitions, see Figure 1-11. Certain frequently used programs are loaded into the SVA. Such programs (or parts of programs), which are relocatable and reenterable, are available for concurrent use by programs executing in any partition. Additional information on the use of the SVA is contained in this guide where appropriate.

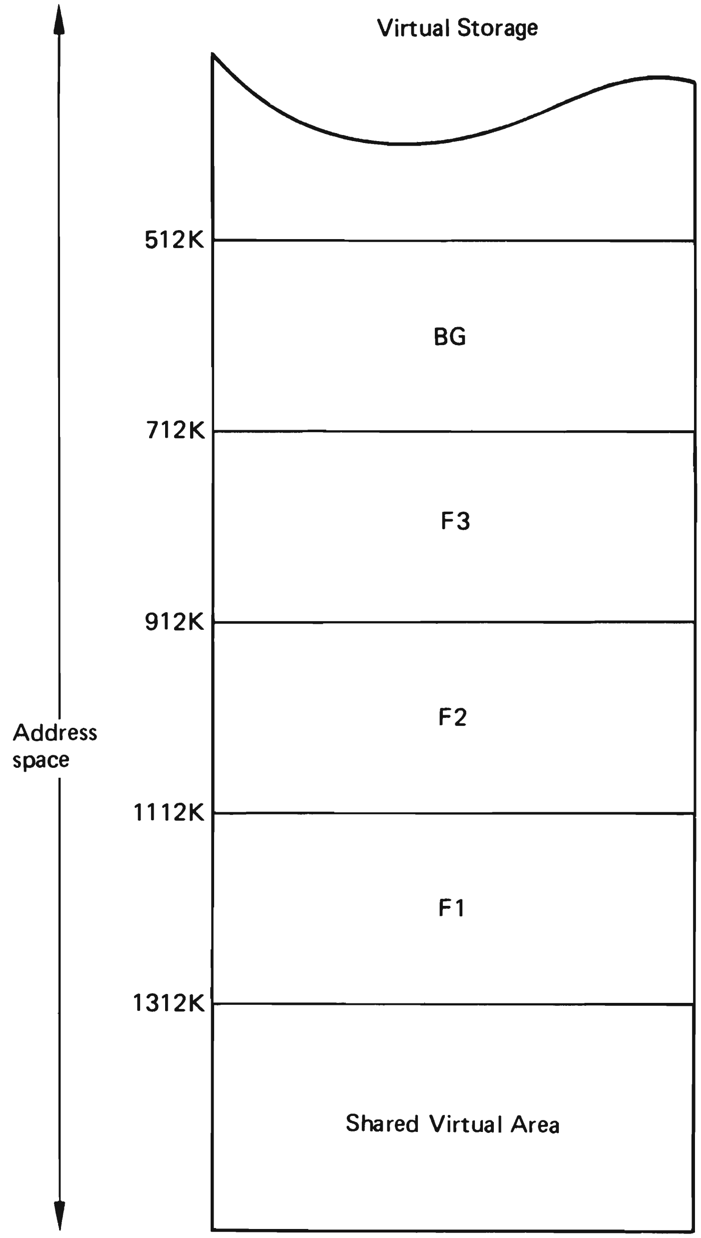


Figure 1-11. Shared Virtual Area in a Four Partition System

Processor Storage Utilization

Under VSE/Advanced Functions, processor storage is used as follows:

- For the accommodation of the resident supervisor routines.
- For the loading and execution of the pageable supervisor routines.
- For the loading and execution of programs.

As shown in Figure 1-12, all page frames of processor storage not needed for the resident supervisor routines are available to the *page pool.* It is from this page pool that the system selects page frames for pages of executing programs (including the pageable routines of the supervisor).

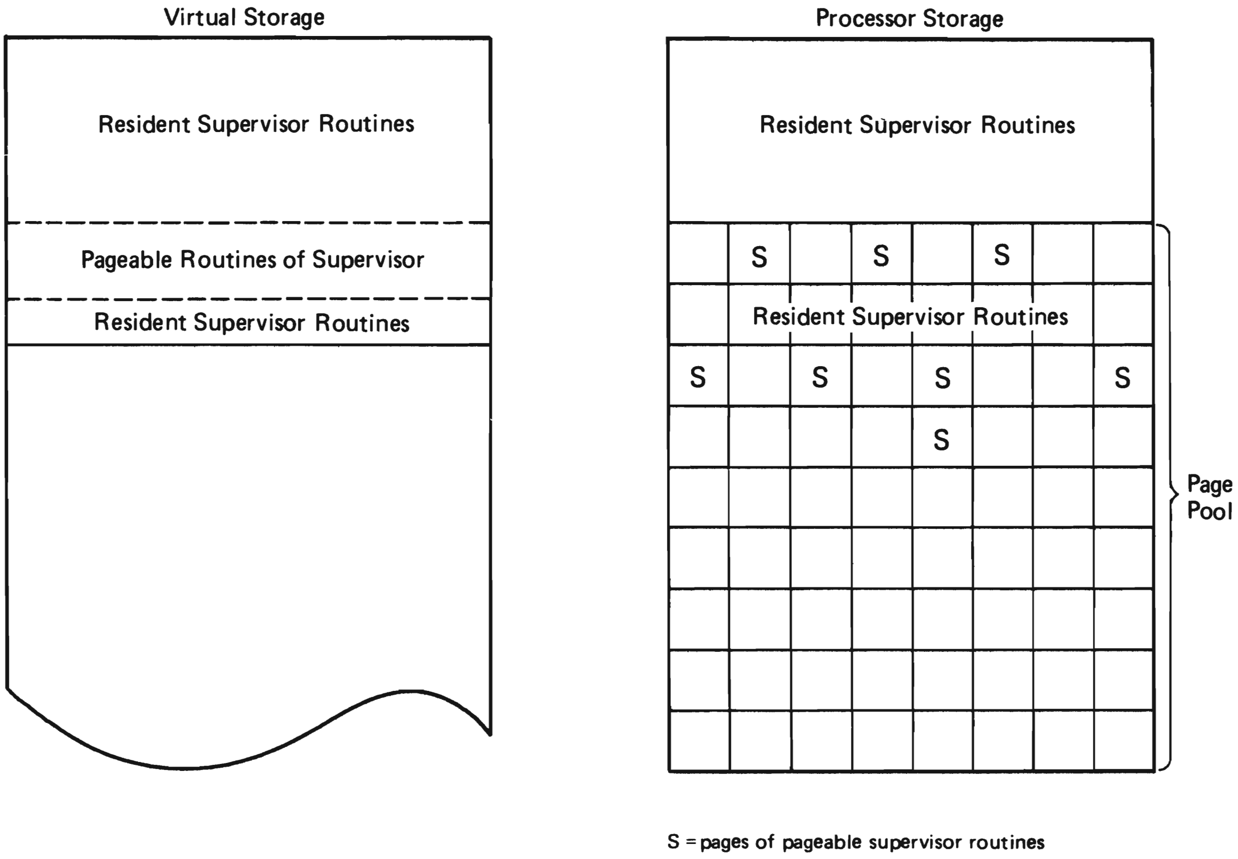

Virtual Storage
Resident Supervisor Routines
Pageable Routines of Supervisor
Resident Supervisor Routines
Processor Storage
Resident Supervisor Routines
S
S
S
Resident Supervisor Routines
S
S
S
S
S
Page Pool
S = pages of pageable supervisor routines

Figure 1-12. Supervisor Routines – Fixed and Pageable

Executing Programs in Virtual and Real Mode

All programs when executing are conceptually running in the address space associated with a partition. The operating system selects page frames from the page pool for pages of the executing programs. The execution can be in one of two modes:

Execution in Virtual Mode: The page frames occupied by pages of programs running in virtual mode continue to be part of the page pool. The operating system will manage the processor storage placing some pages on the page data set, when necessary, and retrieving those pages as required. Programs in virtual mode are *pageable*.

Execution in Real Mode: The page frames occupied by pages of programs running in real mode are taken out of the page pool for the duration of that program's execution; the page frames will not be selected for another program of higher priority; the program is fixed in processor storage and is *non-pageable*.

To have a program executed in real mode, an amount of processor storage must be allocated to the partition in which that program is to run. The allocated processor storage remains part of the page pool until real mode execution begins. Certain programs – such as those with critical time dependencies – may have to run in real mode. A partition may execute in only one mode at a given point in time; for example, the BG partition can not initiate both real and virtual execution at the same time.

Storage Allocation

From a storage management point of view, only minor differences exist in virtual and processor storage utilization techniques between ECPS:VSE and 370 mode. These differences are indicated as the following topics are being discussed:

- Address space layout
- Partition allocation
- Processor storage allocation for real mode execution
- Dynamic storage areas.

Address Space Layout. In *ECPS:VSE mode*, the virtual storage is one area whose size is determined at Initial Microprogram Load (IML).

In *370 mode*, the virtual storage is logically divided into two areas: real address space and virtual address space, see Figure 1-13. The size of the real address space is determined at the time of Initial Program Load (IPL); it is equal to the amount of processor storage installed. A default size of your virtual storage is determined by the system according to the chosen supervisor options. You may override this default by specifying a size of your own choosing at the time of IPL. The supervisor resides in the low addresses of your virtual storage. In 370 mode, this is in the real address area. See Figure 1-14.

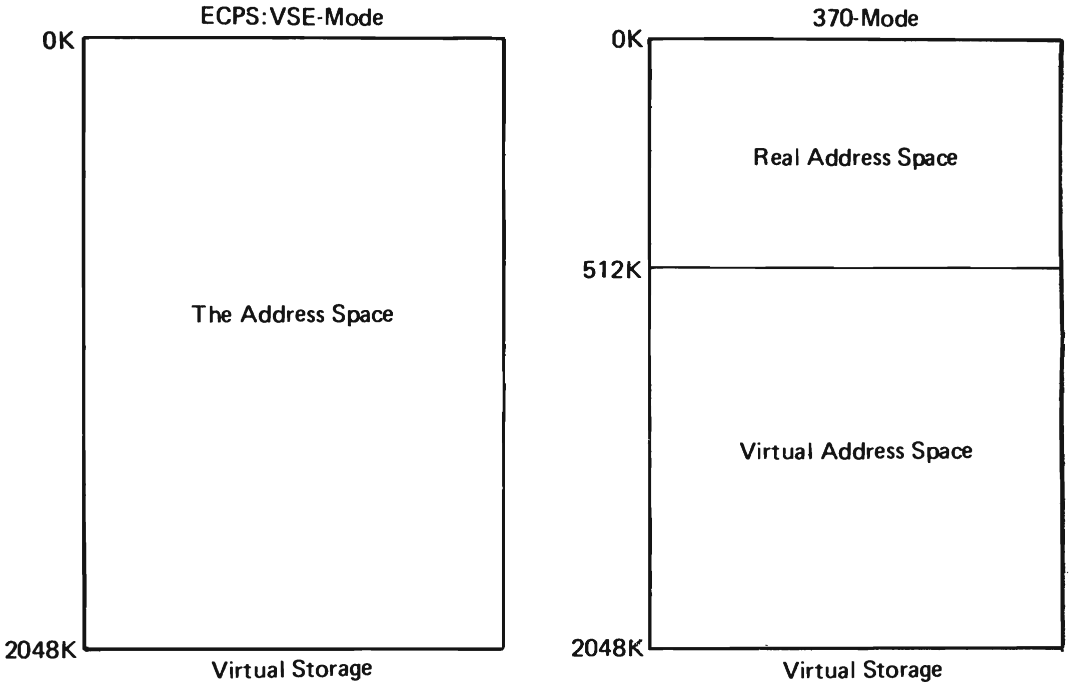
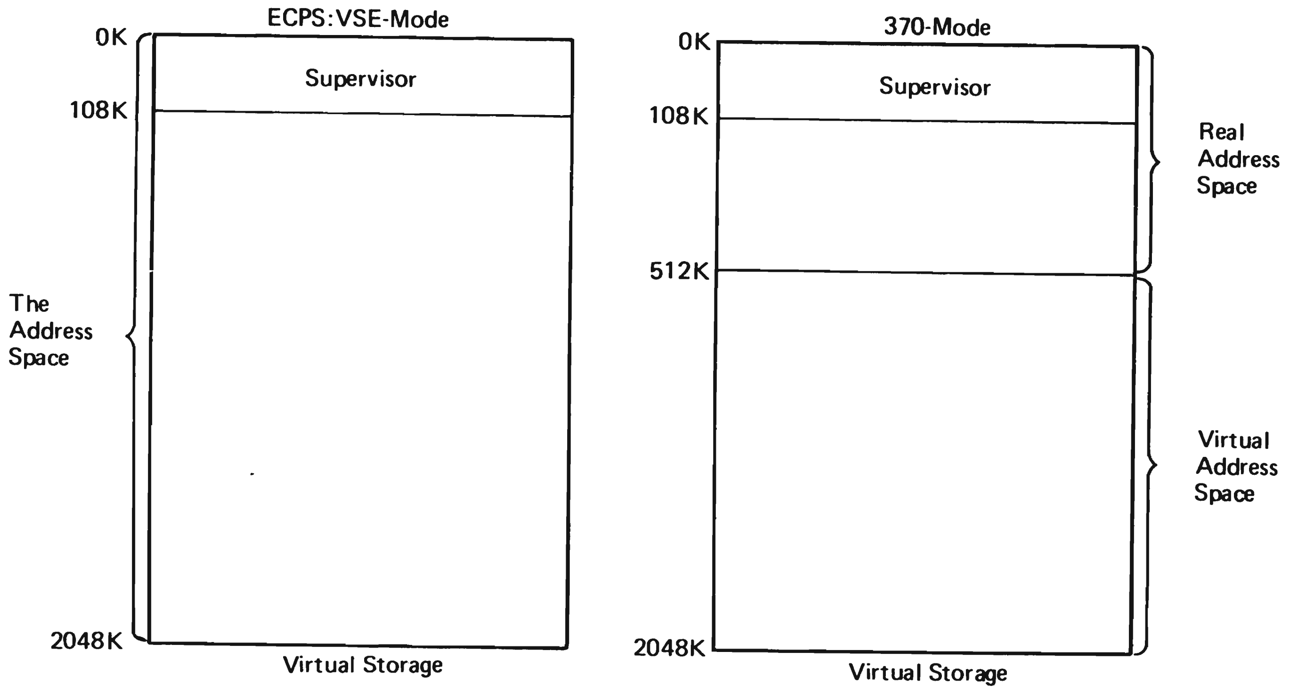


Figure 1-13. Address Space for 2048K Bytes of Virtual Storage and 512K Bytes of Processor Storage



108K as supervisor size is an arbitrary number, somewhere above the minimum supervisor size.

Figure 1-14. Supervisor Location in Both ECPS:VSE and 370 Mode

Partition Allocation. Only the number of partitions but not their sizes are defined when the supervisor is assembled. IPL allocates all of the address space available for the partitions to the Background (BG). After IPL, you allocate the foreground (FG) partition sizes. See *Chapter 3, Using the System*.

Figure 1-15 shows the layout of a 4-partition system after IPL and allocation, respectively, has taken place.

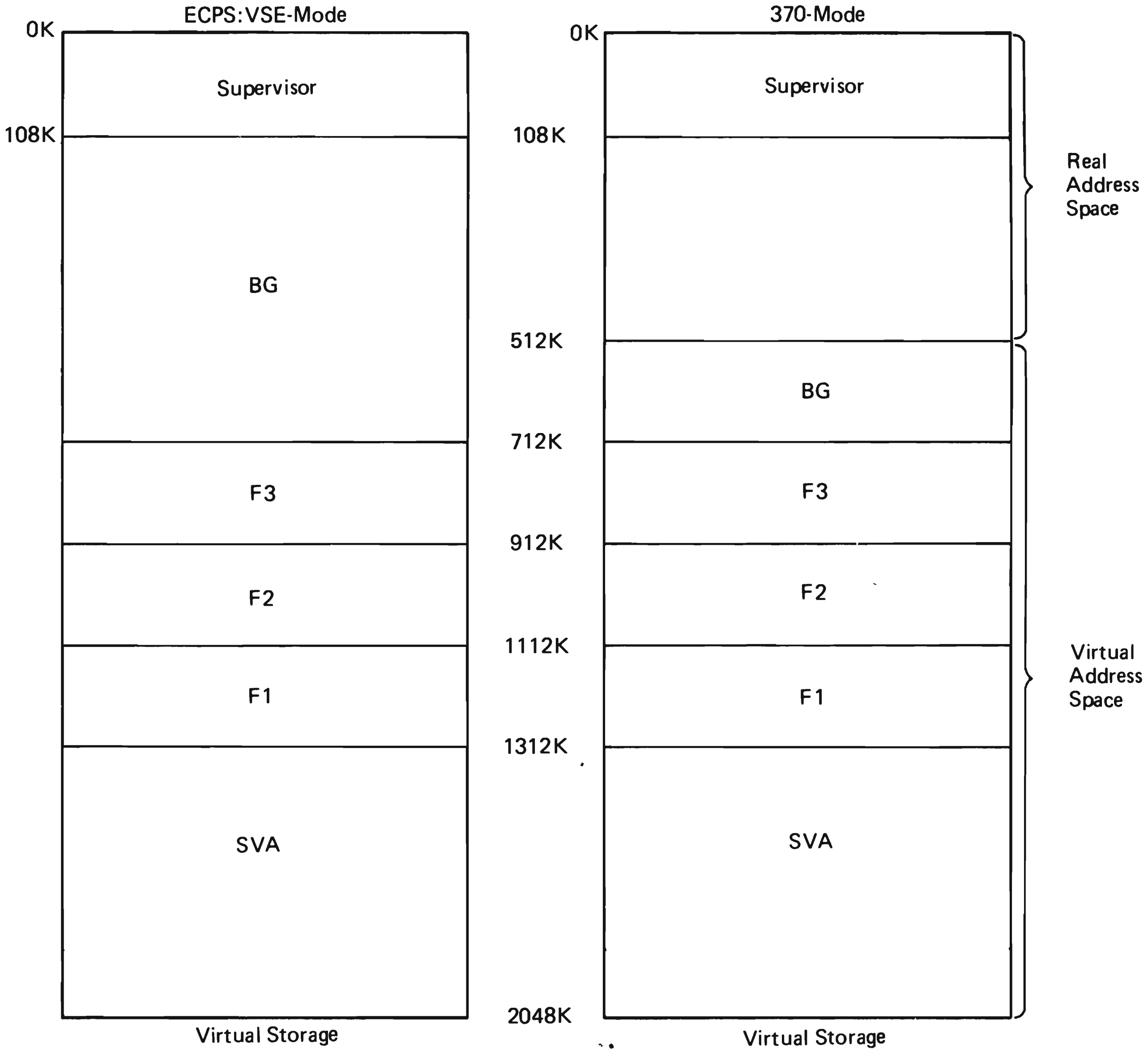


Figure 1-15 assumes a virtual storage size of 2048K and a processor storage size of 512K. The supervisor will occupy the low address 108K of this system.

In ***ECPS:VSE mode*****, the address space from the end of the supervisor to the beginning of the Foreground 3 partition belongs to the BG partition (616K).**

In ***370 mode*** **the BG partition's address space starts at the beginning of the virtual address space (512K). The real address space is the address space from which programs running in** ***real mode*** **are executed.**

Figure 1-15. A 4-Partition System in ECPS:VSE and 370 Mode

Processor Storage Allocation for Real Mode Execution. A specific number of page frames of processor storage may be allocated to any of the partitions for real mode execution. The allocation may be done at any time with the ALLOCR command.

Submitting

```
ALLOCR BG=20K, F1=24K
```

for example, causes the following:

- **In ECPS:VSE mode:** The operating system notes that 10 page frames and 12 page frames of processor storage are available to partitions background and foreground 1, respectively, for real mode execution.

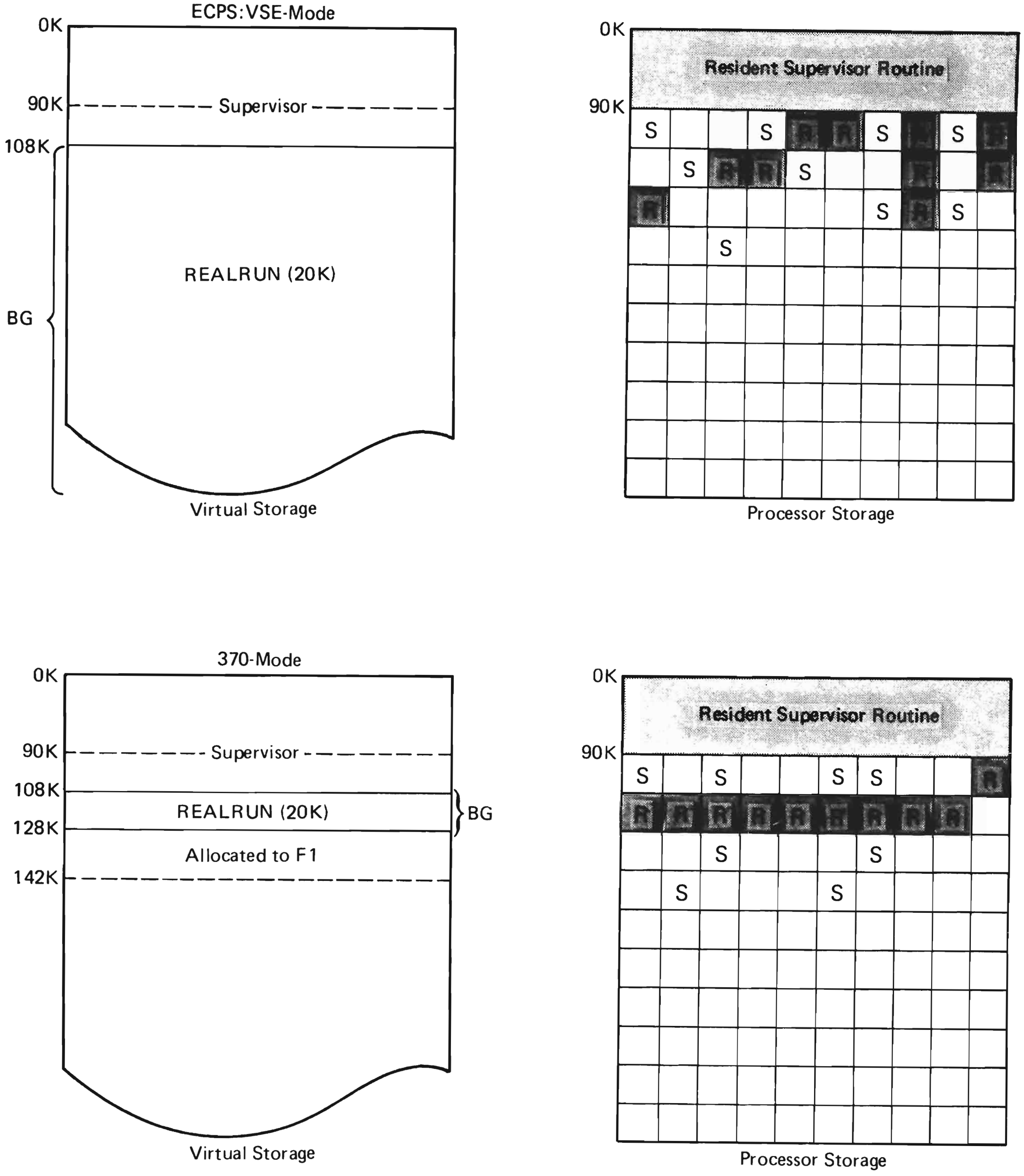
- **In 370 mode:** 20K and 24K of real address space are allocated to partitions background and foreground 1, respectively. In addition, when real mode execution takes place, the processor storage addresses used by the operating system are the same as the addresses within the allocated real address space.

With the above ALLOCR command the largest program that can be executed real in the two partitions are 20K in BG and 24K in F1.

When not occupied by a program running in real mode, the page frames allocated to a partition are part of the page pool.

When a program running in real mode does not require all the allocated page frames, the unused page frames may be made available to the page pool by specifying the amount of storage required by the program in the SIZE operand of the EXEC job control statement for the program. In order to execute a program in real mode an EXEC statement with the REAL parameter must be used. For more details on the EXEC statement see *Chapter 3, Using the System.*

Figure 1-16 shows the results of the above discussed ALLOCR command with a 20K-program REALRUN executing in the BG partition in real mode.



R = pages of REALRUN in processor storage

S = pages of supervisor pageable routines in storage

The shaded portions of processor storage are not part of the page pool at this time. The illustration assumes a supervisor with 90K resident routines and 18K pageable routines. The program REALRUN is 20K in size and is executing in real mode in the BG partition. Note that in *ECPS:VSE mode* the page frames are selected randomly from the page pool, while in *370 mode* the page frames occupied by REALRUN have the same processor storage addresses as the pages that are occupied by REALRUN within virtual storage. The allocation for F1 has not affected the page pool.

Figure 1-16. Executing in Real Mode

Fixing Pages in Processor Storage. The allocated page frames are used not only for programs running in real mode, but may also be used for programs running in virtual mode.

Some programs that run in virtual mode contain instructions or data that must be in processor storage when needed and therefore cannot tolerate paging. The pages containing such code or data can be fixed via the PFIX macro instruction, and freed immediately after use via the PFREE macro instruction. The licensed program VSE/POWER is an example of an IBM program that uses PFIX/PFREE macros.

When pages of a program running in a given partition are fixed in response to the PFIX macro, they are fixed in the page frames allocated to the partition. If a PFIX macro is issued and enough storage is not allocated, the pages are not fixed, and a completion code indicating this is returned to the program.

Fixing pages in processor storage means that, in a multiprogramming environment, fewer page frames are available to other programs running in virtual mode, potentially degrading total system performance. When channel programs with large I/O areas are involved, the initial size of the page pool may be too small. Consider this effect carefully before allowing the use of the PFIX macro at your installation.

Dynamic Storage Areas. Under VSE/Advanced Functions there is a requirement for certain system functions to acquire virtual storage dynamically during program execution. An area called GETVIS area is used for this purpose. Each partition has its own *partition GETVIS* area, the SVA includes the system GETVIS area. The GETVIS areas occupy the high address space associated with each partition and the SVA. Figure 1-17 shows the virtual storage layout in ECPS:VSE and 370 mode with the GETVIS areas included. For further information on the size and use of GETVIS areas see *Chapter 3, Using the System.*

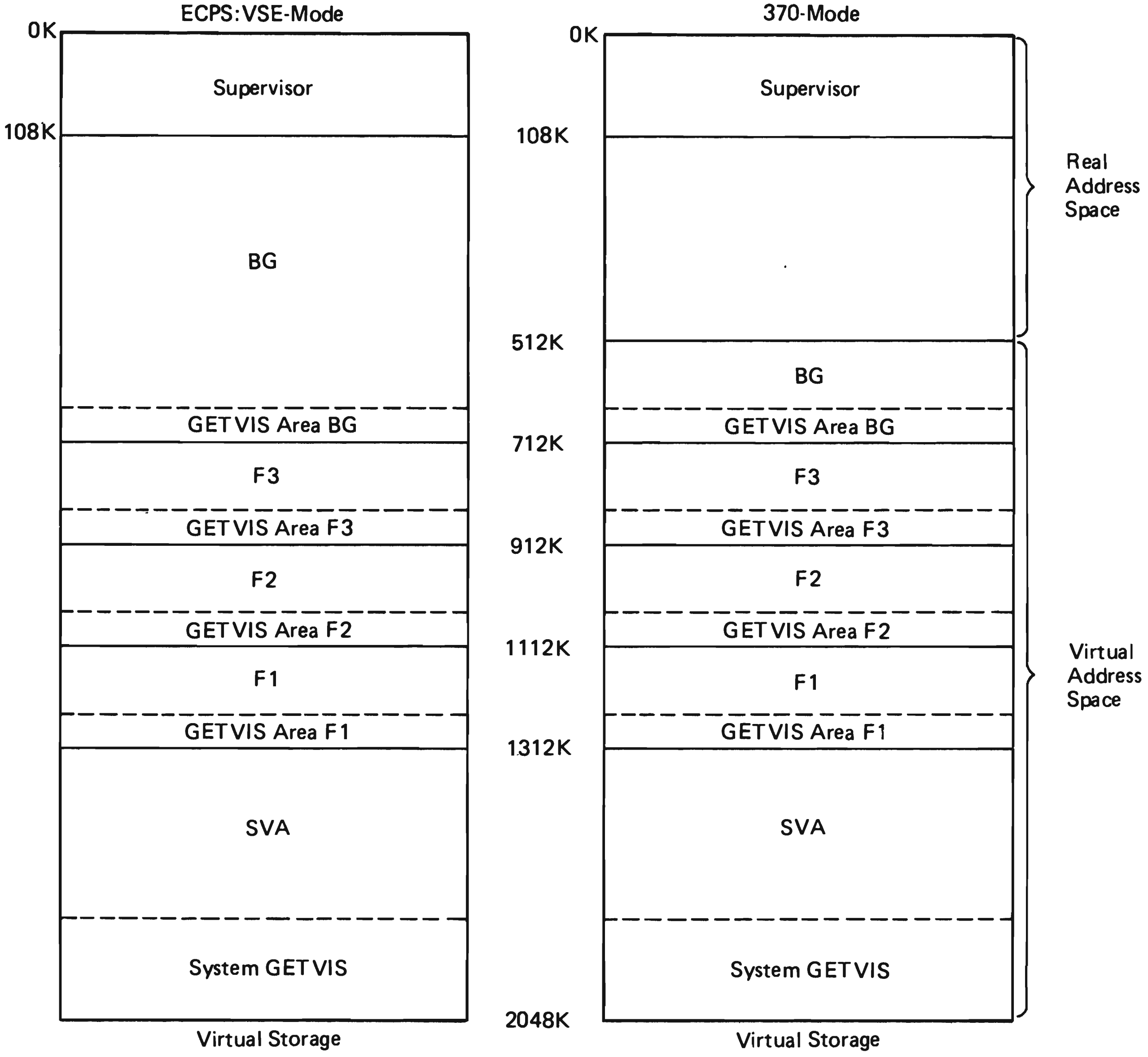


Figure 1-17. A 4-Partition System in ECPS:VSE and 370 Mode with the GETVIS Areas

Multitasking

At the beginning of this chapter, we defined multiprogramming as the ability to execute more than one program concurrently in separate partitions within a single computer system. Multitasking can be regarded as an extension of multiprogramming in that it provides the ability to execute more than one program concurrently in a single partition. In simple terms, therefore, multitasking can be regarded as multiprogramming within one partition.

Some installations using former versions of DOS/VS, employed multitasking to run more than five programs in a 5-partition system. The additional partitions that VSE/Advanced Functions provides serve the same purpose. However, running programs concurrently in separate partitions usually requires less preparation than running programs concurrently in the same partition.

Two Types of Multitasking

Programs (or parts of a program) that are executed concurrently in a given partition are called tasks. A distinction is drawn between the main task in a partition and one or more subtasks in the same partition. The main task is that program (or program part) which is initiated by job control. The subtasks are programs (or program parts) that are initiated through the use of the ATTACH macro in an assembler language routine.

A subtask executed in a given partition may be (1) logically independent, or (2) logically dependent.

In the first case, one (usually the main) task monitors the execution of the subtasks, treating them as independent programs. Such subtasks may be coded in any programming language. This type of multitasking is sometimes called multiprogramming within a partition. It is a suitable technique to use, for example, for concurrent execution of more programs than partitions are available.

In the second case, both the main task and the subtasks are program routines that are logically part of the same program. Thus, the tasks can communicate with one another. In this case the subtasks are likely to be coded in assembler language to allow the use of the task intercommunication macros. They can share code (in particular, an access method or subroutines), provided that it is of a read-only nature (that is, that the code or subroutines are not modified during execution). This technique is complex and can best be understood after studying the first type of multitasking.

The maximum number of subtasks that can be active at any one time within the entire system is a supervisor generation option.

Cross-Partition Event Control

Highly complex applications may have a need for communication between programs executing in separate partitions. For example, two such programs may need to perform operations on a common file, and the operations may require actual communication between the two programs.

Through cross-partition event control macros, one partition can delay the execution of part of a program until another partition signals the completion of a critical event. This allows synchronized multiprogramming in separate partitions – thus protecting programs against inadvertent destruction of each other – while at the same time providing for any necessary communication between them. IBM licensed programs require this support in certain complex applications. One example is the licensed program VSE/POWER generated with SPOOL=YES. For details about cross-partition event control, see the manual *VSE/Advanced Functions Macro Reference.*

Reliability/Availability/Serviceability

VSE/Advanced Functions includes routines that analyze and record CPU, channel, and device errors and attempt to recover from them. The data is stored on the system recorder file (SYSREC). The information obtained from this file serves not only as an aid in diagnosing machine errors, but also helps IBM customer engineers to increase reliability, availability and serviceability (RAS) of your system.

If on-line recovery is impossible, the system may be placed in a hard wait state. A message is then issued to the system operator to run the EREP program to obtain the diagnostic data.

On the IBM System/370 Models 115 and 125, errors in the CPU and natively attached input/output devices (for example, card reader/punch, disk and printer) are recorded on the system diskette. IBM System/370 Model 158, the IBM 3031 and the 4300 processors have a similar hardware error recording feature in addition to a software error recording facility. This hardware error recording is independent of the software routines.

Recovery Management Support

The Recovery Management Support routines, referred to as RMS, provide the following RAS facilities:

- Machine Check Analysis and Recovery
- Channel Check Handler

These facilities provide hardware error analysis and attempt recovery. Another RAS facility, the Recovery Management Support Recorder (RMSR) provides for recording of error and operational statistics on SYSREC as follows:

- Machine Check (CPU)
- Channel Check
- Unit check
- Tape/disk error statistics by volume
- MDR (Miscellaneous Data Recorder)
- IPL information
- End-of-Day statistics held in main storage

Chapter 2: Planning the System

After a brief description of the system generation procedure in general, this chapter discusses in greater detail three major considerations during system generation, namely:

- Planning the libraries (planning the contents, the location and size of the libraries).
- Planning the system files and work files.
- Tailoring the supervisor (adding functions to those of the basic supervisor).

Because of the nature of this information, this chapter primarily addresses programmers who are responsible for planning the system.

System Generation Procedure

Proper and detailed planning is essential for efficient system generation and minimizes the need to modify the system after it is generated. You may want to contact your IBM marketing representative to set up a system generation planning meeting. IBM field engineering could be invited to attend the meeting to discuss the procedure to install the VSE/Advanced Functions which includes SCP (system control programs). Generating a system includes:

- *Planning the contents, organization, and size of the system and (optionally) private libraries.* This entails distributing the storage space available (on the disk packs) between the libraries desired for day-to-day use. You must consider the size of the system core image library and other system and private libraries.
- *Planning the location and size of system and work files.* This entails determining, what system files are required, how large they must be and where they shall be placed. Additionally, work file space needed to assemble the supervisor and to link edit and catalog the components selected to the system core image library must be reserved.
- *Planning the options and estimating the approximate size of the supervisor.* This entails selecting, from the programming services provided by IBM, those options which you wish to include in the supervisor, and estimating the cost of these services in terms of bytes of storage.

Handling the Distribution System

To install the VSE/Advanced Functions system, you work with the IBM-supplied distribution medium (normally a magnetic tape), which is composed of four system libraries

core image
relocatable
source statement
procedure

and a system history file.

If you cannot do an online system generation (see the discussion further below), your system generation approach should be as follows:

1. Restore the VSE/Advanced Functions system and also the supplied history file to disk. (This step does not apply if you receive the IBM supplied code on disk.)
2. Do an initial program load (IPL) of the restored supervisor.
3. Generate the supervisor by coding a set of supervisor generation macros, which define the system configuration and the services you wish the supervisor to contain. These are described in detail in the section *Tailoring the Supervisor.*
4. Delete from the libraries any components you do not require and then condense to free library space.
5. Assemble or compile and/or link edit programs – both your own and IBM's – and catalog them into the appropriate libraries.

After you deleted any of the supplied components, you must update your history file by running the service program MSHP (Maintain System History Program). The usage of MSHP is described in *VSE/Advanced Functions Maintain System History Program User's Guide.*

Having determined what elements are to be contained in the system libraries, you may wish to retain additional elements in private libraries and therefore want to create private core image, relocatable, source statement, or procedure libraries. These choices are discussed in the section *Planning the Libraries.*

The system libraries, together with certain system work areas, constitute the system residence file (SYSRES), which is one extent of a direct access storage volume. The SYSRES file is described in *Appendix A: System Layout on Disk.*

After establishing your SYSRES file and the history file, you should copy those onto tape or disk for backup purposes. The utility program Backup System and the licensed program Fast Copy Data Set are provided for this purpose. They are described in *VSE/Advanced Functions System Utilities* and *Fast Copy Data Set Installation Reference*, respectively.

Online System Generation. If you already have a running VSE system or a DOS/VSE with Release 1 of VSE/Advanced Functions it may be advantageous to generate the new system under control of the currently running system. The various steps such as assembling a new supervisor, deleting unwanted components, updating the history file can be performed in one partition while your normal operation continues undisturbed in other partitions.

As a first step, you execute the MSHP program in order to restore the new system to disk (unless you received the new system on disk). After you generated a new supervisor and (possibly) established a set of private libraries, you may want to merge your own programs from the old libraries into those new libraries or into the new SYSRES file; you do this by executing the CORGZ librarian program. You then IPL from the new system and perform any other required steps.

For complete details on how to perform a system generation refer to *VSE/Advanced Functions System Generation*.

Planning the Libraries

The components of VSE/Advanced Functions are shipped in four system libraries: the core image library, the relocatable library, the source statement library, and the procedure library. Most programs and procedures developed and used by your installation will also be stored in these libraries. In addition to the system libraries, VSE/Advanced Functions supports private libraries which you may use to either substitute for or supplement the corresponding system libraries.

Planning the size, contents, and location of these libraries according to the needs of your installation is an essential part of the system generation procedure. Such detailed planning will ensure that:

- No disk space is wasted by components not required in your installation.
- The libraries are large enough to allow for future additions.
- The libraries are accessed by the system with maximum efficiency.

Following a brief description of the purpose and contents of the individual libraries, this section discusses the major considerations involved in tailoring the libraries to the needs of your installation:

- Which libraries are required.
- How many disk drives are available and where on these devices should the individual libraries be placed.
- How large should each of the libraries be and what should they contain.

Note that this section is intended to give only general guidance for planning the libraries. More details about DASD space requirements for the libraries are contained in *VSE/Advanced Functions System Generation*. How to change the size of a library, how to insert elements into or delete elements from a library, and how to create private libraries is described in *Chapter 3, Using the System.*

Purpose and Contents of the Libraries

The following is a brief summary of the purpose and contents of the system and private libraries.

Core Image Library

In order to be executed, all programs must be link edited into phases and placed in the core image library (CIL). IBM supplies the VSE/Advanced Functions components pre-linked and cataloged in the CIL. A complete list of the supplied components is shipped with the program directory documentation which accompanies your VSE/Advanced Functions system. Prior to receiving the system, consult *VSE/Advanced Functions System Generation* for a listing of the VSE/Advanced Functions components.

IBM also supplies cataloged distribution supervisors. Assembler source statements used to generate these supervisors are shown as part of the *Program Directory* and are contained in the source statement library.

You have to decide which of the IBM supplied phases to retain in the CIL. To delete unwanted components, use the delete procedures contained in the procedure library. See *VSE/Advanced Functions System Generation* for a list of these procedures.

Besides IBM components you may add to the CIL your own application programs such as your payroll or accounts receivable programs, program packages obtained from IBM, or program packages from other sources. If you wish to include such programs in the CIL, you must link edit them yourself. For information on how to do so, refer to the description of the linkage editor in *Chapter 3, Using the System.*

Relocatable Library

The relocatable library as shipped by IBM uses a considerable amount of DASD space. The library contains:

- VSE/Advanced Functions component object modules.
- Compiler required logical input/output control system (LIOCS) modules.

Object Modules. These modules make up unlinked code of the executable component phases in the CIL. The modules have been link edited and cataloged into the CIL you receive. These modules are provided in the relocatable library for maintenance purposes only.

LIOCS Modules. The LIOCS modules needed by the various compilers are cataloged in the relocatable library. There are different modules for each device type and access method. Some modules can be used by more than one compiler. For a complete list of the LIOCS module names and device applicability, see *VSE/Advanced Functions System Generation.*

Source Statement Library

The elements in the source statement library are called books. A book is either a sequence of source statements or a macro definition.

You can catalog into the source statement library sets of source statements that are used by more than one program, and then include these statements in your source program by specifying a COPY (assembler, DOS/VS RPG II, and COBOL) or %INCLUDE (PL/I) statement.

The macro definitions in the source statement library include those macros supplied by IBM as well as any others which you may have written and cataloged yourself. When you issue a macro instruction in your program, the corresponding macro definition is retrieved from the source statement library and included in your program according to the parameters you specified.

Each book in the source statement library is classified as belonging to a specific sublibrary; for example, an assembler, a PL/I, or a COBOL sublibrary. Sublibraries are identified by a 1-letter prefix added to the book name. Letters A through I and the letters P, R and Z are reserved for sublibraries containing system components. You can use all other letters, the digits 0 through 9, and the special characters $, &, and #, to define your own sublibraries.

Procedure Library

Frequently-used sets of control statements can be cataloged into the procedure library. The elements of the procedure library, called cataloged procedures, can consist of IPL (Initial Program Load), job control statements and/or SYSIPT data. Included VSE/POWER JECL statements will be treated as VSE/Advanced Functions comment statements.

You can also catalog procedures containing data that is to be read from SYSIPT under control of the device-independent sequential IOCS, by your program or by IBM-supplied service programs and language translators. SYSIPT in-line data can be, for example, the control statements processed by the librarian or the sort/merge program.

Cataloged procedures are retrieved from the procedure library by a special form of the EXEC job control statement.

The procedures shipped in the procedure library are provided as system installation aids. They include:

- library-member-delete and module-link procedures
- MSHP history file update procedures
- standard label definition procedures

Delete and Link Procedures. The delete procedures are provided to assist you in tailoring your libraries. A complete list of the delete procedures is provided in the manual *VSE/Advanced Functions System Generation*. Once your system is installed, these procedures themselves can be deleted.

The link procedures are provided to link edit IBM-supplied modules contained in the relocatable library to the core image library. These procedures are provided for system-service purposes (the modules have been link edited prior to your receiving the system).

MSHP History File Update Procedures. If you have installed a component without the use of MSHP (Maintain System History Program) there is no entry in the *history file* for that component. This can occur if, for example, you have a DOS/VS Release 34.0 or earlier with a licensed program, such as DOS/VS COBOL, running under it. The MSHP history file update procedures may be used to create a history file entry for the component, in this example DOS/VS COBOL. Now, you may use MSHP for subsequent modification (updates, maintenance etc.) of that component. For more details on the use of the program MSHP see *VSE/Advanced Functions Maintain System History Program User's Guide*.

Standard Label Procedures. These procedures are discussed in section *Label Information Area* in this chapter. A complete listing showing the contents of the procedures is included in the Program Directory Document shipped to all recipients of VSE/Advanced Functions.

Private Libraries

In addition to system libraries, you may establish private libraries. Private libraries form a single extent on one volume. They are created by using the program CORGZ and have the same format as system libraries.

You may establish private relocatable, source statement, or procedure libraries either to supplement or to replace the corresponding system library (note, however, that you must have a *system* procedure library if you intend to use ASI, the Automated System Initialization). The system core image library cannot be replaced by a private core image library; it can only be supplemented by private core image libraries.

By replacing the system relocatable, source statement, or procedure library with a private library (on a device different from the one that holds the SYSRES file), you extend the space available to the system core image library. Conversely, you may reduce the size of the system core image library by placing selected programs in a private core image library.

You may define as many core image, relocatable and procedure libraries as desired, and you may place them on any disk device supported by VSE/Advanced Functions.

Here are a few examples for the use of private libraries:

- Having a private core image library for each partition, each on a separate disk drive, will reduce disk arm movement on the SYSRES volume, which means faster access to libraries.

- Private libraries are useful in a testing environment where you want to keep working copies of your programs intact on one library while *you* test modifications to the same program from another library.

- A number of small libraries instead of a few large libraries greatly eases the task of maintaining the libraries.

- You can concatenate libraries, in any partition, in order to establish certain search orders for the various system programs that retrieve phases, modules, books, or procedures from the libraries. By placing libraries containing frequently used members at the head of the concatenation chain, you can considerably speed up the retrieval of library members (for details on how libraries are searched, see section *Using the Libraries* in chapter *Using the System*).

Private libraries thus add a great deal of flexibility to your system and aid in tuning your system.

Choosing the Libraries for an Installation

In an operational VSE System, certain VSE/Advanced Functions components must reside in the system core image library. Therefore, a system core image library must be present in every VSE installation. Which of the other libraries you need depends largely on the type and amount of work to be done and the resources available at your installation.

Relocatable and Source Statement Libraries

Although these libraries are optional, few installations can operate efficiently without them. If, for example, you work with a PL/I compiler and you need to have the PL/I resident library routines on-line at all times, these routines must be in a relocatable library. Similarly, when you assemble programs that use IBM-supplied macros, the corresponding macro definitions *must* be present in a source statement library. The same holds for your own modules and macros.

Procedure Library

In most data processing installations there are a number of programs that are frequently executed. An inventory control program, for instance, may have to be run daily or weekly. Or a payroll program may have to be executed weekly or monthly. These programs are probably used for a long period of time without being changed.

For each of these programs, there would be one or more sets of job control statements which the programmer prepared and tested when the program was first run. These sets of job control statements can be cataloged as cataloged procedures in a procedure library; then, to retrieve a set, only one statement is required. This minimizes repetitive operator handling (which often includes the replacement of defective cards or reinsertion of diskettes) and reduces machine time and errors.

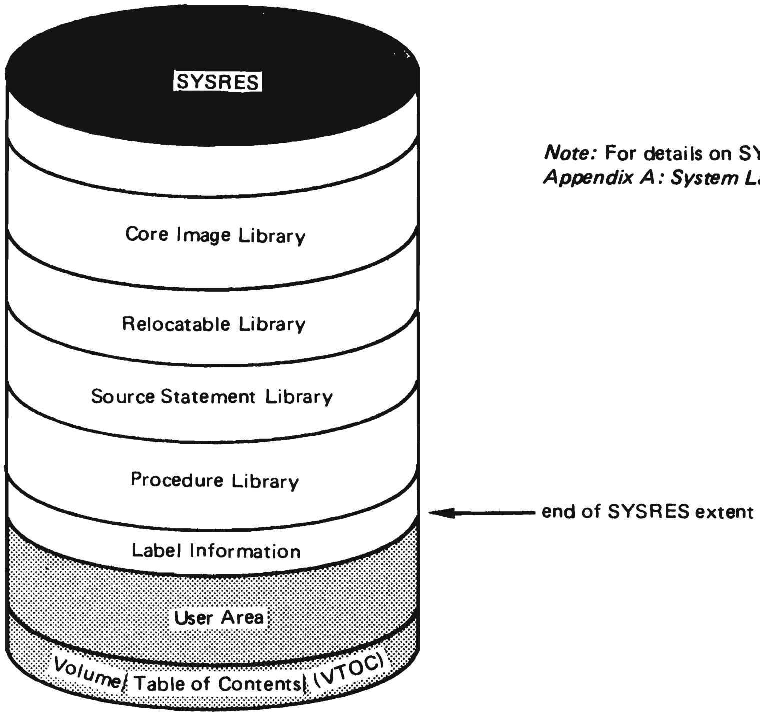
A cataloged procedure is exactly the same as what is described above as a fixed set of job control statements. But the individual procedure is no longer collected by the operator and selected manually for use; instead, it is cataloged and retrieved through a special form of the EXEC job control statement. Cataloged procedures can be modified as they are retrieved from the library.

The use of cataloged procedures is discussed in *Chapter 3, Using the System*.

Automated System Initialization (ASI) allows you to automate initial program load (IPL) and partition start-up. If you plan to use ASI, you must catalog your IPL procedure(s) and your job control procedures (to start up particular partitions) into the system procedure library. For more information about ASI, refer to *Starting the System* in *Chapter 3*.

Determining the Location of the Libraries

Having decided which libraries you want in your system, you must determine where on the available devices these libraries are to be placed. All system libraries must reside in the SYSRES extent of the system disk pack in a predefined sequence (see Figure 2-1). Although it is theoretically possible to have private libraries on the system pack, outside the SYSRES extent, this is not recommended because it involves increased movement of the disk arm.



Note: For details on SYSRES refer to *Appendix A: System Layout on Disk.*

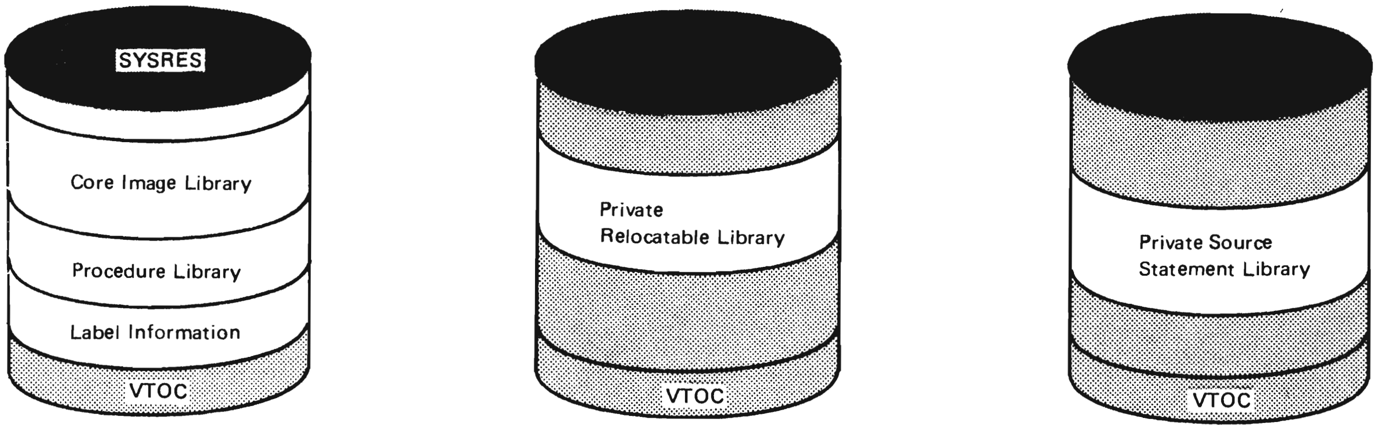
Figure 2-1. The Relative Location of the Four System Libraries

You can define private core image, relocatable, source statement and/or procedure libraries on extra volumes. The system relocatable and *system* source statement libraries can be removed from SYSRES and established as private libraries; the same holds for the system procedure library unless you intend to use ASI, the Automated System Initialization. The system core image library, however, must always be present on SYSRES. It can be supplemented but not replaced by a private core image library. Also, you *must* have a system procedure library if you use ASI.

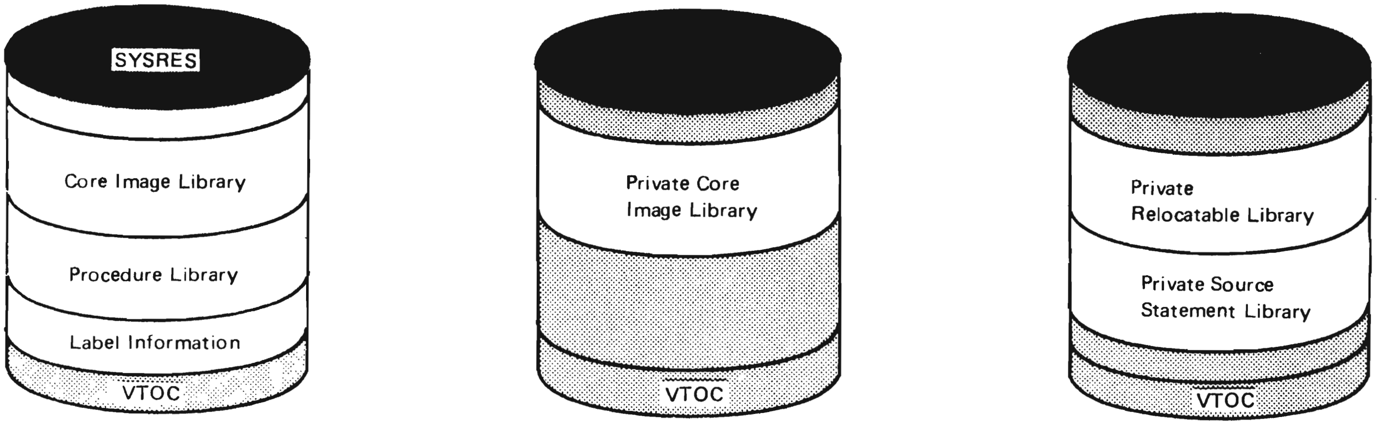
When deciding on the location of your libraries you should also consider the I/O activity on these libraries and place, for example, libraries with high I/O activity on separate volumes.

Figure 2-2 shows two examples of how you can organize the libraries in a system with three disk drives. Any other combination of libraries on the available devices is possible.

The examples in Figure 2-2 are to demonstrate that you can distribute your private libraries among the available devices as you may see fit. A more practical example of how you can organize your libraries is given in Figure 2-3. The example assumes a system with four disk drives, but it is also applicable for a system with less than four drives. One partition, as shown in the upper part of the figure, serves primarily for compiling, assembling and link editing. Two private core image libraries are defined in this partition: one that holds the language translators, a second one contains your own executable programs. The second private core image library is also defined in another partition which is shown in the lower part of Figure 2-3. This partition is reserved for production work; instead of compiler/assembler libraries, a data file is assigned.

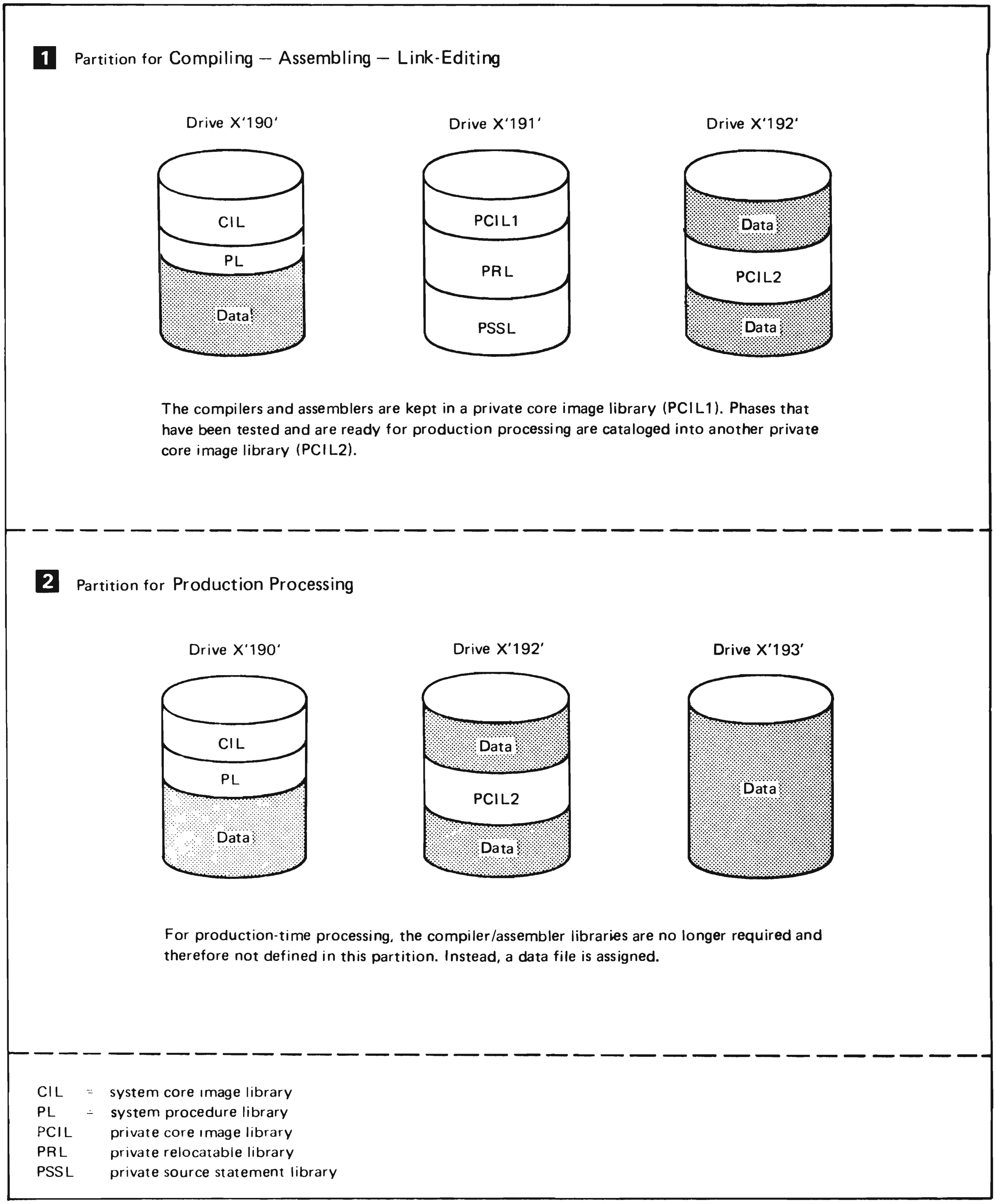


If a private relocatable library and a private source statement library are to *replace* the corresponding system library, the core image library directly precedes the procedure library. These private libraries can also be used to supplement the system relocatable and source statement libraries, in which case the SYSRES file would appear exactly as shown in Figure 2-1.



A private core image library can only be used to *supplement* the system core image library, which must always be present on SYSRES. Several private libraries may reside on the same disk as illustrated.

Figure 2-2. Alternative Locations of the Libraries



The compilers and assemblers are kept in a private core image library (PCIL1). Phases that have been tested and are ready for production processing are cataloged into another private core image library (PCIL2).

For production-time processing, the compiler/assembler libraries are no longer required and therefore not defined in this partition. Instead, a data file is assigned.

CIL	= system core image library
PL	= system procedure library
PCIL	private core image library
PRL	private relocatable library
PSSL	private source statement library

Figure 2-3. Example of Library Organization

Planning the Size and Contents of the Libraries

When planning the libraries for an operational system, you must decide on their precise contents and size for daily use. Although you can change the size of your system libraries at any time after system generation (by means of the librarian programs), you should try to anticipate future space requirements and, if possible, provide this space. Such detailed planning can eliminate the need for a complete reorganization of the libraries which would be necessary if the extension of a library results in an overflow on just one disk pack. Careful planning of the private libraries will save you additional work because you cannot easily redefine the extents of a private library once it has been created. To change the size of a private library you must create a new private library and copy the contents of the old library into it.

Consider the following factors before deciding on the contents and size of the libraries:

- The number of phases, books, modules and/or procedures you want on-line and how you plan to group them (for example, group by application).
- The average size of phases, books, modules, and procedures in your installation.
- The amount of space and devices available.

The core image library, for example, is the library in which you normally keep most of your programs. (Otherwise, each program must be submitted to the linkage editor and placed in the core image library temporarily before it can be executed.) Therefore, ensure that your core image library is large enough to accommodate all programs that must be on-line; this includes your own programs as well as IBM-supplied components.

The system relocatable and source statement libraries initially contain more (IBM-supplied) members than you normally use for daily operation. By deleting from your system libraries those members which you do not need daily you are creating *operational libraries*. This reduces the disk space requirement of the SYSRES extent. In planning the contents and size of an operational relocatable library, determine which of the IBM-supplied modules can be deleted and how much space you need to store your own object modules on-line.

With one disk pack available for system files, you may prefer to maintain only enough free space in the relocatable library of the operational pack to contain the modules for the largest component in the system. This small relocatable library permits temporary insertion of any component in relocatable format. The component can then be immediately link edited into the core image library and deleted from the relocatable library.

Similar considerations apply to an operational source statement library. Determine which of the IBM-supplied components you need on-line, which should be transferred to a backup volume for future extensions of your system, and which can be deleted entirely.

If you intend to use procedures, you should allocate sufficient space for either the system procedure library or your private procedure libraries. In estimating the amount of space required, consider the number of IPL commands, job control statements and SYSIPT data records (source modules, utility control statements, etc.) you expect to store in your procedure libraries. Note that ASI procedures (if you have any) must be contained in the *system* procedure library.

After you have determined the space requirements for your libraries in terms of number and size of programs, you must define and allocate the amount of disk space needed to accommodate these programs. A set of formulas is available to calculate the disk space required for each library. These formulas are contained in *VSE/Advanced Functions System Generation.*

The contents of the libraries are identified in the *Program Directory* (shipped with the distributed VSE/Advanced Functions system). The storage requirements (sizes) for these components and macro definitions are identified in the section for each component.

System and Work Files

The SYSRES file is only one of the system files that must be planned. The location of the other system and work files and their sizes deserves some thought. The system files besides SYSRES are:

Page data set

Recorder file (SYSREC)

Hard copy file (SYSREC)

History file (SYSREC)

Alternate dump files (SYSDMP)

A description of these files follows below. Another system file is required if data on DASD devices is shared across computing systems: the lock communication file. This file is discussed in section *DASD Sharing by Multiple VSE Systems* in chapter *Using the Facilities and Options of VSE/Advanced Functions.*

Page Data Set

The page data set, a sequentially organized set of records on a direct access device, is required to accommodate paged-out pages of programs that are being executed in virtual mode. The size of the page data set depends on the amount of virtual storage.

You define the page data set through the IPL command DPD. This command is discussed in section *IPL commands* in *Chapter 3, Using the System.* Among other items, you can specify the channel and unit number of the device, whether you want to treat the page data set as a data secured file, the size of a particular extent, and the lower limit address of the extent.

The page data set can reside on any disk device that is supported by VSE/Advanced Functions as a system residence device.

Your page data set may be spread over up to 15 extents. These extents may be allocated on different volumes, a maximum of three per volume; you must, however, stay within one disk architecture: FBA or CKD.

For all but the last extent, the size must be specified in the corresponding DPD command. If a command does not include the size specification, the command is considered to be the last one of a series. As a result, the system calculates the upper limit address according to the amount of pageable storage defined for your system. The usage of disk space is shown below:

Disk Device Type	Pages per Cylinder
2314	60
3330	114
3340	36
3350	240
FBA	see note

Note: Four FBA blocks contain one page of virtual storage; hence a 2M byte system (2048K) requires 4096 FBA blocks (2048K ÷ 2K x 4 blocks).

In *ECPS:VSE mode*, the virtual storage size to be mapped on the page data set, is a function of the hardware. The default system size is 16M bytes (16,384K). The default may be altered during Initial Microprogram Load (IML) to: 2048K, 4096K or 8192K. How to perform IML is described in the IBM-provided *Operator's Guide* manual for your central processor. If disk space is a concern, you might consider reducing the virtual storage size. For example, a 16M (16,384K) system requires 32,768 FBA blocks whereas a 4M (4096K) system requires 8192 FBA blocks.

In *370 mode*, there is always a default virtual storage size defined according to the selected supervisor options. You may override this value through the VSIZE parameter when you begin to IPL your system. The operating system uses the value to calculate the disk space requirements. If your supervisor includes pageable routines, space is automatically reserved on the page data set for these routines.

If you have the licensed program VSE/POWER installed, the page data set should not be placed on the same drive as the VSE/POWER data files if this can be avoided. You should attempt to place the page data set on a pack that has relatively low activity yet is on-line all the time. Normal data files are not conducive to this approach as you probably do not want to leave these files on-line when they are not needed. In many cases the best place for the page data set is on the same pack that contains the SYSRES file. A user with only two disk drives should place the page data set on the pack that contains SYSRES.

Recorder File

The recorder file contains recovery management support statistics provided primarily for IBM service personnel to analyze the performance of your system. The information collected is related, for example, to:

- I/O errors
- CPU errors
- IPL reason codes

The system logical name used for the recorder file is SYSREC. The file name is IJSYSRC. The SYSREC file must be defined as a disk extent on a DASD type that is supported by VSE/Advanced Functions as SYSRES.

The recorder file is created immediately after the first IPL for your system with the SET RF=CREATE command. The file is opened by the first occurrence of a // JOB statement after IPL. No // JOB statement may be submitted prior to the SET RF=CREATE command. See also *Starting the System* in *Chapter 3, Using the System.*

Hard Copy File

The hard copy file, a disk extent, must be on the same device as the recorder file SYSREC. The system logical name is SYSREC and the file name is IJSYSCN.

The hard copy file contains all of the messages displayed on the display operator console (DOC). These messages can be retrieved on SYSLOG by using the operator redisplay (D) command, or on SYSLST by using program PRINTLOG. The hard copy file is created immediately after the first IPL with the SET HC=CREATE command. The file is opened by the occurrence of the first // JOB statement after IPL. See also *Starting the System* in *Chapter 3, Using the System.*

History File

An operating system needs a history file containing information about the components of the system and the program fixes applied to those components. The history file is used by MSHP (Maintain System History Program) for the recording of information about your installed components. When VSE/Advanced Functions is shipped to you, a history file is also shipped. This file reflects the change level of the supplied VSE/Advanced Functions components. An up-to-date history file eases maintenance of your system.

The history file is a disk extent and must be on the same device as the recorder and hard copy files. The system logical name is SYSREC and the file name is IJSYSHF.

For information on installing the supplied history file consult *VSE/Advanced Functions System Generation.* How MSHP uses the history file is described in *VSE/Advanced Functions Maintain System*

History Program User's Guide. You should also consult *VSE/Advanced Functions System Utilities* for information on BACKUP/RESTORE and those programs' relationship with the history file.

Alternate Dump Files

Instead of SYSLST, one or two dump files on a direct access volume may be used to receive dumps. A dump may be produced, for example, when a program cancels.

The first (or only) dump file has the file name DOSDMPF. If you choose to have a second dump file (its file name is DOSDMPG), the two dump files are used alternatingly: while one is being filled, the other one could be processed by the DOSVSDMP program. Note that the two dump files must reside on the same DASD volume. Each dump file is a single extent file.

At the time of IPL, you must assign the dump file using the DEF command with the specification SYSDMP=cuu. The assignment cannot be changed until the next IPL. If you fail to assign the dump file, the dump will be printed on SYSLST.

You create the dump file(s) through the DOSVSDMP program. This program is also used for printing the dump from the dump file. For details on the usage of the DOSVSDMP program, refer to the publication *VSE/Advanced Functions Serviceability Aids and Debugging Procedures*.

DLBL and EXTENT job control information must be provided each time the dump file is to be accessed, that is, when

- the file is created,
- a dump is written into the dump file,
- a dump is printed with the dump file as input.

For each of these three cases, the EXTENT statement must specify the logical unit name SYS006.

Work Files

Work files are temporary files that are used by a program during the execution of a given application. User-written programs as well as IBM-supplied programs can use work files. Work files used by your own programs must be defined, created, and named individually by you. They are not discussed here.

System work files are used in compiling (assembling) source statements and preparing input for the linkage editor. System work file naming uses the following conventions:

Symbolic Name	File Name
SYSLNK	IJSYSLN
SYS001	IJSYS01
SYS002	IJSYS02
SYS003	IJSYS03
SYS004	IJSYS04
SYS005	IJSYS05
SYS006	IJSYS06

For example, the assembler requires three work files to translate source input and one work file (SYSLNK) to prepare linkage editor input.

The work files are defined via // DLBL and // EXTENT statements. They are opened and created when needed.

Listed below are the symbolic device requirements for the Assembler, DOS/VS COBOL, and DOS/VS RPG II, the language translators, most frequently used under VSE.

	SYSLNK	SYS001	SYS002	SYS003	SYS004	SYS005	SYS006
Assembler	L	M	M	M			
DOS/VS COBOL	L	M	M	M	M	O	O
DOS/VS RPG II	L	M	M				

M	=	Mandatory
O	=	Optional
L	=	Required when link editing

The size requirements of these files vary. Refer to *VSE/Advanced Functions System Generation* which gives the formulas for calculating the size requirements of the assembler and linkage editor work files. DOS/VS COBOL and DOS/VS RPG II work file sizes are described in their respective installation guides.

To compile and link in two or more partitions simultaneously you will need a set of work files for each partition in which you plan to compile and link programs. A method for handling this situation is given in section *Label Information Area* which follows.

A simpler method is available if you have the *VSE/VSAM Space Management for SAM Feature* installed: you can place IJSYSLN and the linkage editor work file IJSYS01 in VSAM-managed space. This renders the allocation of work file space more flexible; you save a considerable amount of space, in particular if you assemble and/or link edit in more than one partition.

Section *Linkage Editor Work Files in VSAM-managed Space* in Chapter *Using the System* describes briefly how you address, in your job control, linkage editor work files in VSAM-managed space. For more information, refer to the publication *Using the VSE/VSAM Space Management for SAM Feature.*

Label Information Area

The label information area is part of the SYSRES file and follows the last library in SYSRES. If SYSRES is on an FBA device, the label information area comprises 200 blocks. For CKD devices the area is two cylinders. (For the 3340 disk, it is 3 cylinders and for the 3350 it is 1 cylinder).

For FBA devices, but not for CKD devices, you may change the size of the label information area using the RESTORE program. See *VSE/Advanced Functions System Utilities* for details on this program.

Using the DLA command during IPL, you may define or reference an additional label information area. This area is separate from the SYSRES file; it may be located on or outside the volume containing the SYSRES file. The need to define such an area may arise when two CPUs or two VSE systems under VM/370 share one SYSRES file. More information on the DLA command is provided in chapter *Using the System* under section *IPL commands.*

The size of a label information area that you define via the DLA command can deviate from the default size, regardless whether it is located on an FBA device or a CKD device.

Usage of the label information area is described in *Chapter 3, Using the System.*

Entries in the label information area point the operating system to the appropriate files on a given disk pack. IBM provides standard label procedures in the system procedure library for placing standard label information into the label information area for the following files:

File Name	File-ID	Symbolic Name
IJSYSRS	A5746XE9.SYSRES.FILE	SYSRES
IJSYSRC	VSE/AF.RECORDER.FILE	SYSREC
IJSYSCN	VSE/AF.HARDCOPY.FILE	SYSREC
IJSYSHF	A5746XE9.SYSTEM.HISTORY.FILE	SYSREC
IJSYSLN	VSE/AF.SYSLNK.FILE	SYSLNK
IJSYS01	VSE/AF.WORK-FILE.1	SYS001
IJSYS02	VSE/AF.WORK-FILE.2	SYS002
IJSYS03	VSE/AF.WORK-FILE.3	SYS003
IJSYS04	VSE/AF.WORK-FILE.4	SYS004
IJSYSIN*	DTTEPTF	SYSIN

* SYSIN labels for diskette cardless system.

The label information assumes you have taken the default library allocations when you restored your system from tape to disk. If you use different library allocations or if your page data set size is larger than the default, prepare your own label information and execute your own // OPTION STDLABEL run. If you wish to add standard label information, run the supplied standard label procedure(s) (or your own) and supply also the new entries.

The *Program Directory* shipped with VSE/Advanced Functions lists the standard label procedure names and the contents of those procedures.

Planning for Compiling in More Than One Partition

Once the standard label area contains label information for the work files you can now assign the symbolic names (SYSnnn) to some physical drive and start compiling. Initially there is only one set of // DLBL and // EXTENT statements for each work file (IJSYS01, IJSYS02, etc.), so you cannot run compiles simultaneously in two different partitions.

The open routines of VSE/Advanced Functions always look for the label information in the label storage area in the following sequence:

1. partition userlabel area

2. partition standard label area

3. system standard label area

To cause each partition to have its own set of work files, place the necessary label information in the partition standard label area associated with that partition.

The job control program will write label information to the partition standard label area of the partition in which job control is running when it encounters the // OPTION PARSTD statement.

```
(a)    // OPTION PARSTD
       // DLBL IJSYS01,'BG-WORKFILE-1',0,SD
       // EXTENT SYS001,,1,0,12,12
       // DLBL IJSYS02,'BG-WORKFILE-2',0,SD
       // EXTENT SYS002,,1,0,24,12
       // DLBL IJSYSLN,'BG-SYSLNK',0,SD
       // EXTENT SYSLNK,,1,0,36,12

(b)    // OPTION PARSTD
       // DLBL IJSYS01,'F2-WORKFILE-1',0,SD
       // EXTENT SYS001,,1,0,48,12
       // DLBL IJSYS02,'F2-WORKFILE-2',0,SD
       // EXTENT SYS002,,1,0,60,12
       // DLBL IJSYSLN,'F2-SYSLNK',0,SD
       // EXTENT SYSLNK,,1,0,72,12
       // DLBL IJSYSCL,'PCIL-FOR-F2',0
       // EXTENT SYSCLB,,1,0,84,24
```

Job streams (a) and (b) above, when run in the BG and F2 partitions with appropriate ASSGN statements, will enable simultaneous use of the DOS/VS RPG II compiler in both partitions. When running the compiler in either partition, the OPEN routines will search for file names IJSYS01, IJSYS02, IJSYSLN. In the BG partition the compiler will use cylinder 1 through cylinder 3 of a 3340, and in the F2 partition cylinders 4 through 6.

Note: Label information for a private core image library (PCIL) has been provided in job stream (b). See *Creating and Working with Private Libraries* in *Chapter 3, Using the System* for information on creating private libraries.

Tailoring the Supervisor

The IBM-shipped VSE/Advanced Functions includes three supervisors, one of which is used during system generation. Part of your system generation procedure is to plan and assemble your tailored supervisor. You may generate a system to run either in ECPS:VSE or 370 mode for the 4300 processor, or in 370 mode for the System /370 CPUs.

This section describes the optional and required parameters of the supervisor generation macros in a topical sequence; that is, such that related options are presented together regardless of the macros in which they are contained. For the exact formats of these macros, refer to *VSE/Advanced Functions System Generation*. This section discusses, in addition, the advantages or necessity of specifying the support for the various facilities of the supervisor.

In tailoring your supervisor to the requirements of your installation, you can take into consideration future plans to add functions that require supervisor options by including their requirements in your supervisor generation macros. This allows you to upgrade your installation without having to regenerate your supervisor. In your library planning, you should include space for modules or components that will be required by a planned future configuration or functional upgrades. The storage cost of additional supervisor options may be estimated by consulting section *Storage Requirements* in *VSE/Advanced Functions System Generation*.

Virtual Storage Size

No supervisor generation option is available to set the size of your virtual storage; this can be done only at system start-up time. Nevertheless, already when you plan your system, you should give some thought to the virtual storage size you are going to use.

The method of defining virtual storage is different for ECPS:VSE mode and 370 mode.

ECPS:VSE Mode Virtual Storage Definition.
In ECPS:VSE mode, the default value for the total size of your virtual storage is 16M (16,777,216) bytes. The operator may change this value at IML (Initial Microprogram Load). For details about IML on a 4300 processor, see the Operator's Guide manual provided by IBM for the pertinent processor model. The value is used by the system to determine the size of the page data set. How to define the page data set has been discussed in section *Page Data Set,* earlier in this chapter.

370 Mode Virtual Storage Definition.
In 370 mode, virtual storage is composed of virtual address space and real address space. The size of the real address space is determined automatically when you execute the Initial Program Load (IPL) program. You may leave it up to the system to calculate the size of the virtual address space. Depending on the chosen supervisor options, the system will establish a sufficiently large default size. At the time of IPL, you may override that value when the system prompts you for the specification of VSIZE. The value you specify for VSIZE is equal to the sum of the

virtual address space allocated to the defined partitions and the size of the shared virtual area.

The maximum size of virtual storage is 16M (16,777,216) bytes. The maximum value you can specify for VSIZE is 16M minus the size of the real address space.

The defined virtual storage size is used by VSE/Advanced Functions to determine the size of the page data set.

The Shared Virtual Area

The shared virtual area (SVA) is divided into subareas as follows; a system directory list (SDL), an area for phases, a system GETVIS area (see Figure 2-4).

You cannot define the SVA size at the time of supervisor generation; VSE/Advanced Functions determines the size during IPL, at which time you may allocate additional space. Because the SVA space shortens the amount of virtual storage that is left to the partitions, you should take the SVA and its size into your planning considerations.

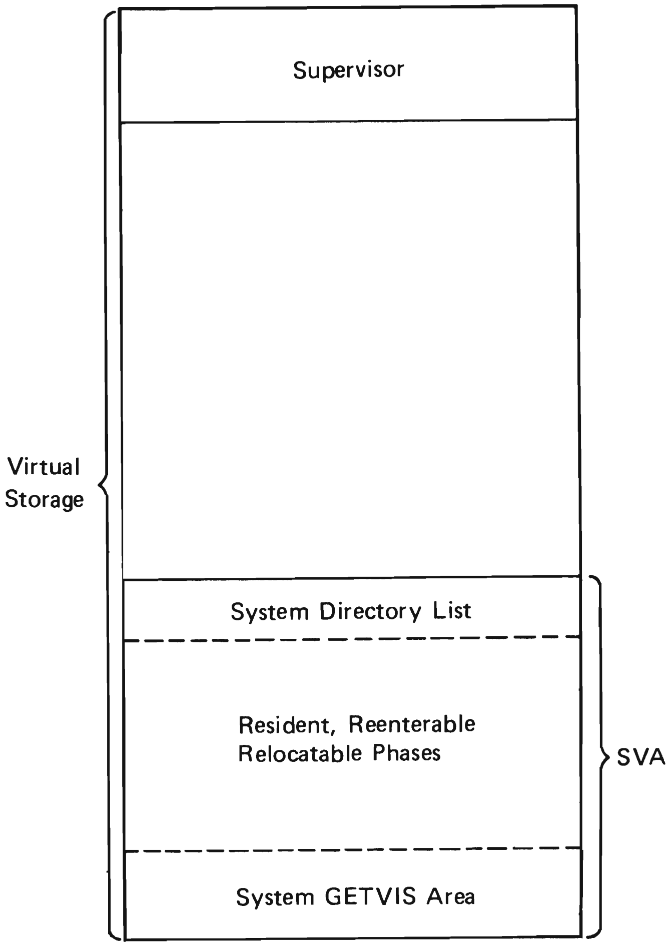
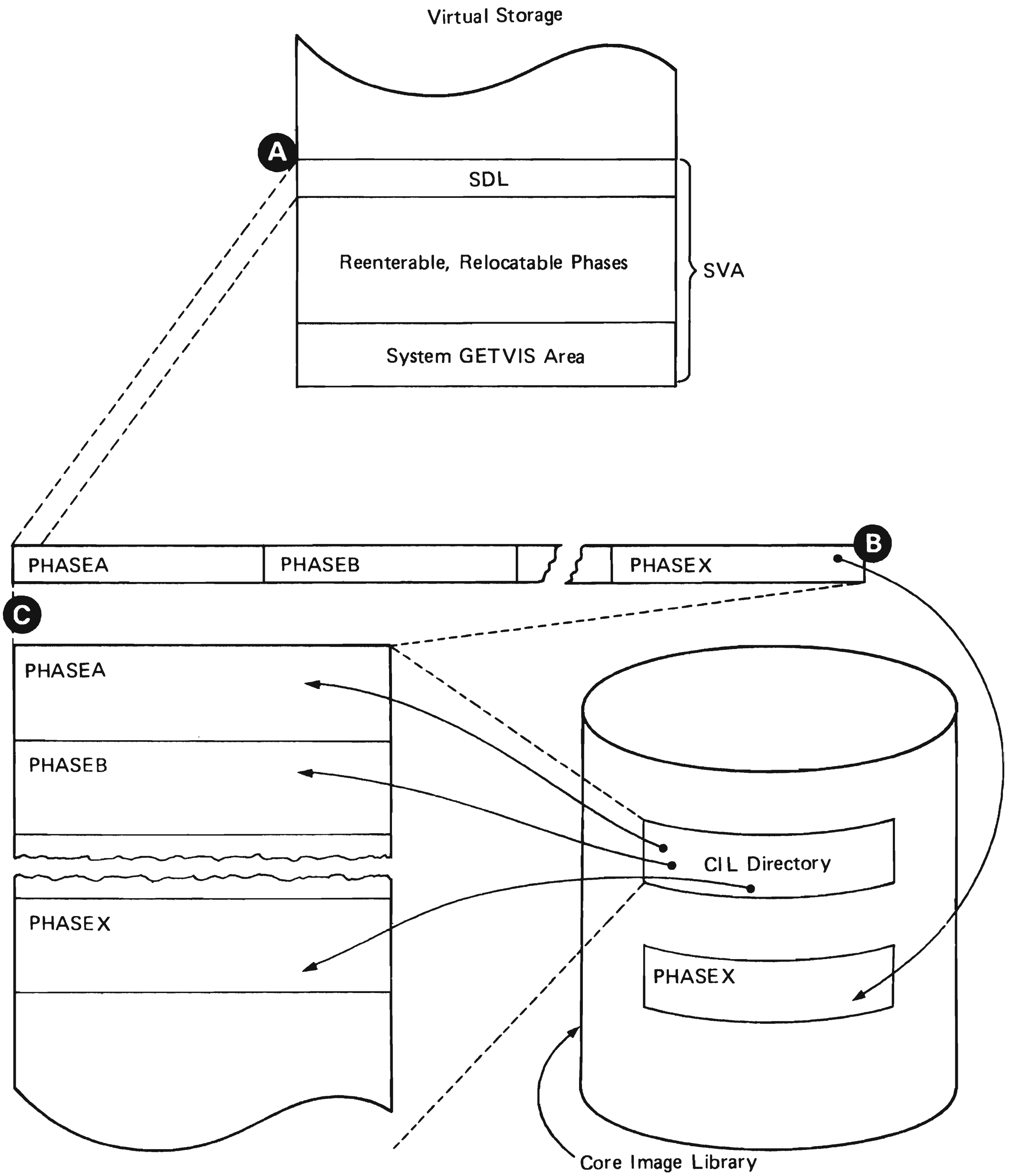


Figure 2-4. Layout of the Shared Virtual Area

The System Directory List. The system directory list (SDL) contains copies of selected entries of core image library directories. This provides for fast retrieval of frequently used phases. (These phases may be resident in the SVA or in any core image library.) Having SDL entries avoids searching a core image directory (on disk) for each phase load request. Figure 2-5 shows the SDL and its relationship to the core image library.



A The system directory list (SDL), built by the operating system, provides for fast locating of frequently used phases either in the SVA or in a core image library.

B The SDL entries point directly to a phase's location on disk.

C The SDL entries are copies of selected Core Image Library Directory entries.

Figure 2-5. System Directory List

The SVA Phase Area. The SVA phase area always contains VSE/Advanced Functions system phases; the area may, in addition, contain IBM licensed program phases and user-written phases.

Phases that are in the SVA may be used concurrently by more than one partition if the phases are reenterable and relocatable. Having phases in the SVA speeds processing by:

- *eliminating loading from a core image library* – When a phase is resident in the SVA, it does not have to be loaded from the library for each execution. This saves the disk I/O, even if the phase was *paged out* to the page data set as paging is generally faster than loading from a core image library.
- *reducing processor storage demands* – If the phase is being shared between two or more partitions, the impact on the page pool is less than if two or more copies of the phase were loaded into storage.

The System GETVIS Area. The system GETVIS area is used by VSE/Advanced Functions to dynamically acquire virtual storage for its own use.

An example of the GETVIS area use is the initialization of the SDAID program. The SDAID program normally requires approximately 100K of system GETVIS space when it is being initialized. For more details on the SDAID program see *VSE/Advanced Functions Serviceability Aids and Debugging Procedures*.

Size of the SVA. The IPL program calculates, based upon the chosen supervisor options, the SVA size. The supervisor options and their cost in SVA space are shown in the manual *VSE/Advanced Functions System Generation*. Additional space requirements for installed licensed programs such as VSE/VSAM or DOS/VS SORT/MERGE are also automatically calculated by the IPL program. The space requirements for each licensed program are shown in the appropriate licensed program documentation. To support user-written programs in the SVA you must indicate the required SVA space. The parameters SDL, PSIZE and GETVIS of the IPL command SVA are used to increase the SVA size beyond the defaults set by the system.

The loading of certain system phases into the SVA, and the creation of SDL entries for them, occur automatically at IPL. For information on how to increase the size of the SVA as well as loading items not automatically included by the IPL program, see the section *Starting the System* in *Chapter 3, Using the System*.

Defining the Number of Partitions and Subtasks

In the NPARTS parameter of the SUPVR generation macro, you define the maximum number of partitions for your system.

In selecting the appropriate number of partitions for your particular installation, you should consider the type of processing you require. Assume you want to run concurrently the following types of programs:

- Test cases (assemble/compile, link edit, and execute)
- Daily application programs
- A spooling program, such as VSE/POWER
- Telecommunication application programs.

For this case, you should generate a system with at least five partitions, depending on the volume of application program processing. If, for example, your system includes the licensed program ACF/VTAM, at least two partitions must be specified: one for ACF/VTAM and one for your VTAM application programs.

Because you cannot alter the NPARTS specification unless you regenerate the supervisor, it may be advantageous to specify more partitions than you see an immediate need for.

Number of Subtasks. Any function within your computing system is performed as a 'task'. A task can create one or more subtasks, and each subtask, in turn, may create other subtasks. The concept of multitasking was briefly discussed in Chapter 1, *VSE/Advanced Functions Overview.*

The operating system itself employs, sometimes to a large extent, this multitasking tool. Interactive processing (as performed, for example, within VSE/ICCF) adds to the usage of subtasks.

There is, of course, a limit for the number of subtasks that may be active at a given time within the entire computing system. VSE/Advanced Functions sets a default maximum. You may override this default in the NTASKS parameter of the SUPVR generation macro. The maximum you may specify varies with the number of partitions (NPARTS) defined for your system: the more partitions you define, the higher the allowed maximum number of subtasks.

Library Options

You can choose the maximum number of libraries you want to concatenate per partition and the amount of space you want to reserve for storage-resident directories to achieve better fetching performance. These options are described below.

Library Chaining

When IBM programs access the libraries to retrieve procedures, books, modules, or phases (for example, during assemblies, linkage editing, or procedure execution), they expect job control information on which particular libraries to access, and in what order.

In your job control, you may define chains of libraries. This allows not only to define more than one library to be accessed, but also to direct the system to search through the library directories in a given order.

Support for chaining (concatenation) of libraries is always provided. There is a default for the maximum number of libraries allowed per search chain. You may use the LCONCAT parameter of the FOPT generation macro in order to override the default.

Second Level Directory for Core Image Libraries

The directory entries for phases in the core image library are sorted by phase name in alphameric sequence.

An index of the directory entries is kept in the supervisor in a second level directory (SLD). The SLD speeds the retrieval of phases from the system core image library. You may specify the number of entries the SLD will contain through the SLD parameter of the FOPT generation macro. The value specified depends on the type of disk device that contains the system core image library:

For CKD devices – the number of directory tracks.
For FBA devices – the number of directory blocks.

There are also second level directories for private core image libraries: private second level directories (PSDL). A PSLD is provided for each private core image library defined in a partition (if defined in more than one partition, one PSLD suffices for all those definitions).

Storage for five entries per PSLD is automatically reserved. You may override this default via the SVA command at IPL time. If you do so, specify a PSLD value that accommodates for your largest private core image library; the size of each PSLD will be based on one value: either the default or the specification in the SVA command.

Telecommunication

VSE/Advanced Functions provides facilities for telecommunication, the interchange of data between an application in the system and terminals connected via telecommunication lines. These facilities provide the ability to define such lines for supervisor assembly and to specify one or more access methods for input/output services between an application and terminals.

Telecommunication devices (terminals) are normally attached to the CPU through transmission control units or communications controllers. The control unit must be defined via the IPL command ADD. In some cases there is a direct local attachment.

The access methods, defined in the TP parameter of the SUPVR generation macro, are the licensed programs:

- Advanced Communication Function/VTAM (ACF/VTAM)
- Basic Telecommunication Access Method – Extended Support (BTAM-ES)

Supervisor support for BTAM-ES is standard, also the support for TP balancing (telecommunication balancing).

For detailed information on generating and using a telecommunication access method, refer to the appropriate telecommunication publications. Teleprocessing users should also pay particular attention to section *I/O Options* later in this chapter and read section *Balancing Telecommunication* in *Chapter 4, Using the Facilities and Options of VSE/Advanced Functions.*

BTAM-ES Support

Applications using BTAM-ES can execute in either virtual or real mode. If you have used BTAM under DOS or DOS/VS in the past, you have to reassemble and catalog BTMOD before submitting your applications to VSE/Advanced Functions for execution. If BTMOD and the application program were assembled together, the application program must also be reassembled and re-link edited.

ACF/VTAM Support

ACF/VTAM executes in virtual mode in its own partition.

As ACF/VTAM uses the PFIX macro, processor storage page frames must be allocated to the partition in which ACF/VTAM is to run. A separate partition is required for VTAM application programs. For information on installing this licensed program refer to the ACF/VTAM documentation.

Note: On an IBM 4331 processor, you use ACF/VTAME instead of ACF/VTAM.

Linkage between VSE/Advanced Functions and VM/370

Your VSE system can run in a virtual machine under VM/370. VSE/Advanced Functions offers programming support (called the VM/370 Linkage facility) to adjust program execution for the special conditions prevalent in a virtual machine. Under VM/370 Linkage, the operating system does not, for example, execute instructions that are redundant in a VM/370 environment; it avoids functions such as load leveling and paging as well as page fixing and page freeing. In ECPS:VSE mode, the VM/370 Linkage facility causes direct address translation (DAT) to be bypassed.

In order to generate that support, you specify VM=YES in the SUPVR generation macro. You can generate a supervisor for execution in 370 mode with VM=NO and still run it under VM/370; of course, you do not receive the advantages of the VM/370 Linkage facility.

Specification of VM=YES is requred in order to obtain support for FBA DASDs in 370 mode.

Note that a supervisor generated with VM=YES can operate only on a virtual machine under VM/370.

Interactive Computing and Control

The licensed program VSE/Interactive Computing and Control Facility (VSE/ICCF) offers interactive timeshared computing and control services to terminal users.

VSE/ICCF provides a collection of tools for

- Online library maintenance
- Context editing and text manipulation
- Development and execution of interactive problem programs
- Job entry
- Monitoring of time-shared job processing.

VSE/ICCF runs in a VSE partition. Support for VSE/ICCF is always provided; it is a prerequisite for the Access Control service of VSE/Advanced Functions which is described in the following section.

Access Authorization Checking and Security Event Logging

VSE/Advanced Functions provides a service to check against unauthorized usage of your data and your programs.

Support for this function is available if you assigned a positive value to the SEC parameter in the FOPT generation macro.

Access Control

VSE/Advanced Functions provides access control for the following resources:

- your data
- your private libraries
- individual programs (phases) within any of the core image libraries.

Access control is not available for VSE system libraries. However, it is available for phases of the system core image library.

Security profiles. To do this checking, VSE/Advanced Functions uses the 'Access Control Table'. You build this table through the DTSECTAB macro; usage of this macro is described in the manual *Data Security Under the VSE System*. This table is loaded into the SVA at the time of IPL.

The access control table has two groups of entries:

- *User profile entries*. Anyone who uses your data processing installation and wants to access secured programs or data or both must submit a user-id and a password; the batch user through the // ID job control statement, the terminal user through logon procedures. User-id and password have to match the corresponding parameters within one particular user profile entry. In addition, each user profile entry may contain up to 32 security classes.

- *Resource profile entries*. There is one entry for each named resource which is defined as 'protected'. Such a resource may be a file name, a library name, or the phase name of a program.

  Associated with each resource is a security class. When a user program attempts to access a protected resource, the operating system compares the security class in that user's profile with the security class assigned to the resource. If the security classes don't match, access to the particular resource is denied to the user program.

For more information about access control implementation, refer to the manual *Data Security Under the VSE System.*

Logging and Reporting

If you have the licensed program *VSE Access Control – Logging and Reporting* installed, the security related events are recorded on the logging file. For details on the creation of and access to the logging file, refer to the documentation available with that program.

What constitutes a *security related event*, is determined at the time you build the resource profile entry. Depending on your installation's requirements, you may want to trace only security *violations* of a protected resource; or, you may want to trace all permitted accesses to that resource.

Use the Reporting Program to get a formatted listing of the logging file.

Job Accounting

The job accounting interface facility provides job and job step information that can be used for charging system use, supervising system operation, planning new applications, etc.

When this option is selected (JA=YES in the FOPT generation macro), job accounting tables are built in the supervisor to accumulate accounting information. One job accounting table is maintained per partition. The format of these tables and information on how to write a job accounting routine is given in *Chapter 4, Using the Facilities and Options of VSE/Advanced Functions.*

To utilize this job accounting information, you must write a routine to store or print the desired portions of the table. This routine must be cataloged in the core image library under the name $JOBACCT.

If the user I/O routine ($JOBACCT) is written using LIOCS with label processing, the JALIOCS parameter of the FOPT macro must be specified in addition to the JA parameter. JALIOCS indicates that a user save area and a label area in the supervisor are to be reserved. The label area replaces the one normally used by LIOCS label processing routines.

If the licensed program VSE/POWER job accounting is desired, support for the job accounting interface is required. No user-written data collection routine is then necessary. Refer to the *VSE/POWER* documentation.

Timer Services

The following timer services are available to users of VSE/Advanced Functions:

- Time-of-day clock
- Interval timer
- Task Timer

The time-of-day clock is a standard hardware feature, while the task timer and the interval timer require other hardware features (the clock comparator and the CPU timer) which are standard on all System/370 and 4300 processors, except the 370 models 135 and 145. Utilization of these timer services in VSE/Advanced Functions is briefly discussed below. Except for the task timer, the timer services are automatically provided in VSE/Advanced Functions. Support for the task timer is a supervisor generation option.

Time-of-Day Clock

The time-of-day (TOD) clock provides a consistent measure of elapsed time suitable for time-of-day indication.

The TOD clock support also enables programs to issue the GETIME macro instruction, which causes the exact time-of-day to be stored in general register 1. A description of the use of the GETIME macro instruction is given in *VSE/Advanced Functions Macro User's Guide*.

The time-of-day and the date are automatically included with each // JOB and /& job control statement that is printed on SYSLST or SYSLOG.

During the IPL procedure, if IPL is performed from SYSLOG, a message is printed on the operator console to inform the operator of the status of the date, clock, and zone. If necessary, the operator can correct this information in the SET command.

Interval Timer

The interval timer can be used by programs (main tasks or subtasks or both) that need to schedule certain processing based on discrete time intervals. If a problem program is written with the appropriate macros and routines, the interval timer causes an external interrupt when the time limit established by the program has elapsed.

Several problem program macros relate to interval timer support. For information about using these macros, refer to *VSE/Advanced Functions Macro User's Guide*.

Task Timer

The task timer can be used by the main task of the partition owning the task timer to escape from processing and enter an exit routine after a specified period of time. This discrete time interval is decremented only when the main task is executing. If support for the task timer is included in the supervisor and the owning partition's main task is written with the appropriate macro instructions and routines, the specified task timer routine is entered when the time interval has elapsed.

To include support for the task timer in the supervisor, specify the TTIME parameter in the FOPT generation macro.

If an exit routine is not specified in the STXIT TT macro, the interrupt is ignored. The SETT macro is used to set the time interval, and that interval can be tested or canceled by means of the TESTT macro. The EXIT TT macro is used to return control from a task timer exit routine.

Console Buffering

In an installation with a relatively slow console device, the entire system can be held up while messages are being issued to the operator. Console buffering support builds a queue of output messages and returns control immediately to the partition requesting the output. The messages are then written as soon as the console becomes available.

Console buffering is useful in two cases:

- when your console device is a 3210/3215 printer keyboard, or
- when your console is a display operator console and a printer is used to produce a hard copy of messages while they are displayed on the screen.

In an installation without such printers, a performance improvement cannot be obtained by requesting console buffering support. On the contrary, console buffering may, in that case, even work to your disadvantage: certain VSE/Advanced Functions tasks such as error recovery routines issue high priority messages. If your console is a display operator console, and a DASD rather than a printer is used as a hard copy file, then, depending on the size of your console buffer, messages may be issued to the screen in such rapid succession that a message like *INTERVENTION REQUIRED* ... can easily be overlooked by the operator.

Support for console buffering is indicated by the CBF=n parameter in the FOPT generation macro (where n is the number of I/O requests to be buffered). If you decide to use console buffering, at least one buffer should be specified for each partition or task issuing messages so that buffers are available and the task can continue processing while the message is being printed. Two per partition is recommended. Console buffering is not split per partition, but used by the whole system.

Asynchronous Operator Communication

With asynchronous operator communication, operator action requests (action or decision messages) and the corresponding replies need no longer be in series. They can be asynchronous; that is, the operator can defer replies to messages while the system continues processing. One reply per active task in the system may be outstanding at a time.

To enter a reply, the operator must key in the reply-ID that the system has assigned to the corresponding message. The asynchronous operator communication support is activated by specifying ASYNOC=YES in the FOPT generation macro. For details, refer to *VSE/Advanced Functions Operating Procedures*.

Disk Options

Options are provided for some DASD devices. These options are:

- DASD sharing across systems
- DASD file protection
- Track hold
- Rotational position sensing

DASD Sharing Across Systems

Two or more VSE systems may be linked in such a way that they use common disk files.

In order for this setup to be sensible, it must be ensured that resources while being used by one system are protected against unallowed access from other systems.

Support for this kind of resource control is established if each sharing system runs under a supervisor generated with DASDSHR=YES in the FOPT supervisor generation macro.

The concept of DASD sharing across systems is further discussed in section *DASD Sharing by Multiple VSE System*, within chapter *Using the Facilities and Options of VSE/Advanced Functions*.

DASD File Protection

This feature is provided to prevent user programs utilizing DAM or user-written channel programs for writing onto DASD from writing data outside of the limits of the DASD file currently being accessed. This might happen if, for example, a randomizing algorithm produces an unexpected DASD address which is outside the file limits.

DASD file protection support is indicated in the DASDFP parameter of the FOPT generation macro.

DASDFP gives protection on the basis of programmer logical units. If two DASD files are open in the same partition and use the same programmer logical unit, the DASDFP option does not give any protection to either of the two files.

If you are using physical IOCS, you must use the DTFPH macro to define the file. The file must be opened using the OPEN or OPENR macro, and each channel program must commence with a long seek (X'07') command or a define extent (X'03') command, and contain no chained long seeks.

Specifying DASDFP does not prevent file contention between partitions, or within partitions if the same symbolic unit is used. Thus, more than one partition may access the same file at the same time and may even attempt to update the same record simultaneously. The track hold option (TRKHLD) is provided to solve this problem. Note, however, that all DASD writes (DAM and others) will be checked for being within the file-protect range.

Note that, for CKD devices, no protection is given to partially allocated cylinders; files to be protected should begin and end on cylinder boundaries.

Track Hold Option

The track hold option is used to ensure that, while data in a DASD file is being modified by one task, no other task in the system can access that data. The facility is available to most VSE disk access methods.

The track hold option can be selected by specifying the TRKHLD parameter in the FOPT generation macro.

Additionally, user programs must invoke the track hold facility. For the track hold feature to be effective all programs accessing the same file must request its use. The track hold facility is requested in the DTF of the user program by specifying HOLD=YES.

For FBA devices, the track hold facility protects the range of blocks which contains the accessed data. For CKD devices, the facility protects the track that contains the data being accessed.

Deadlock occurs if one task is waiting for a DASD area held by a second task and the second task is waiting for a DASD area held by the first. This can be prevented by establishing the convention that every task must be programmed so that it will not attempt to hold more than one DASD area at a time. Deadlock may also occur if the maximum number of DASD areas demanded to be held by all tasks combined exceeds the maximum specified in the TRKHLD parameter.

Rotational Position Sensing

Rotational Position Sensing (RPS) is a feature on all IBM CKD disk storage devices except 2311, 2314, and 2319; it is optionally available on IBM 3340. It provides the ability to overlap positioning operations on one device with service requests for other devices on a block multiplexer channel (or its equivalent on System/370 Model 115 or 125).

The operating system makes use of the feature if you specify RPS=YES in the FOPT generation macro. However, you should not request RPS support if you use the 23xx emulator on a Model 115 or 125.

Better channel utilization can increase system throughput, especially in large multiprogramming systems with heavy concurrent I/O activity. Because a selector channel is monopolized once a channel program has been initiated, no other device on this channel can be accessed until the data has been transferred. With block multiplexer channels and the RPS feature of DASD devices, however, the device can disconnect from the channel during positioning operations. The channel is then available for other requests so that other devices on the channel can be accessed.

Overlap of positioning to a record on a track requires adding RPS CCWs to the direct access storage device channel programs. VSE/Advanced Functions system control and service programs that support RPS, dynamically build these CCWs during program execution provided that the supervisor is generated with RPS support and that the direct access storage device has the feature.

RPS support within VSE/Advanced Functions is provided in all access methods which support RPS DASD devices and in the VSE/Advanced Functions system control and service programs where the implementation benefits total system performance. Implementation of RPS support in VSE/Advanced Functions utilizes virtual storage to enable you to use RPS to avoid recompiling or relink editing your problem programs. The partition GETVIS area is used to generate an extension to the DTF, and the shared virtual area is used to hold the RPS phases which are used in lieu of the logic modules of LIOCS.

Efficient use of RPS depends on each channel program's ability to free that channel so that it can service requests for other devices. Programs using VSE/Advanced Functions DASD LIOCS access methods will have RPS channel programs built by the access method. Programs using PIOCS for DASD access have to be recoded to include Set Sector CCWs and to establish arguments for the CCWs. If this is not done, these programs will destroy the effectiveness of RPS by monopolizing the channel.

The RPS phases are loaded into the SVA by IPL if you have specified RPS=YES in the FOPT generation macro.

Figure 2-6 shows the organization of a user's program running in virtual storage without RPS support.

Figure 2-7 shows how, with RPS support, this organization will be modified when the pertinent file is opened to put the DTF extension in the partition GETVIS area. The pointers to the RPS phases which are used in lieu of the logic module and channel program will be put into the DTF while the non-RPS logic module and channel program addresses will be saved in the DTF extension. The DTF extension will be freed and the pointers restored to their original values when the file is closed.

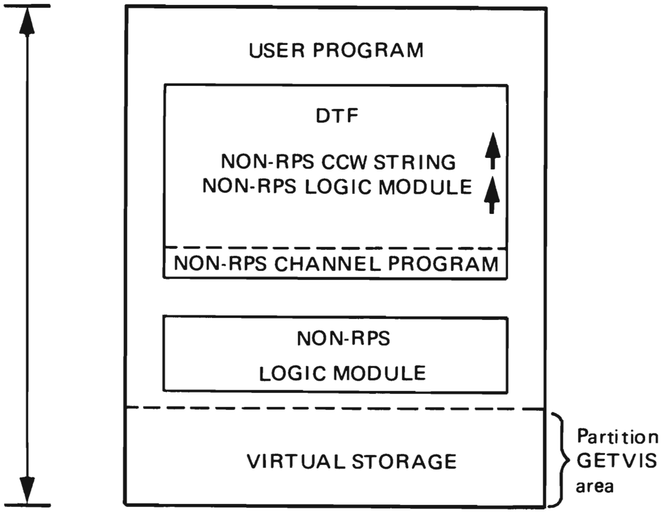


Figure 2-6. User Program Running in Virtual Storage without RPS Support

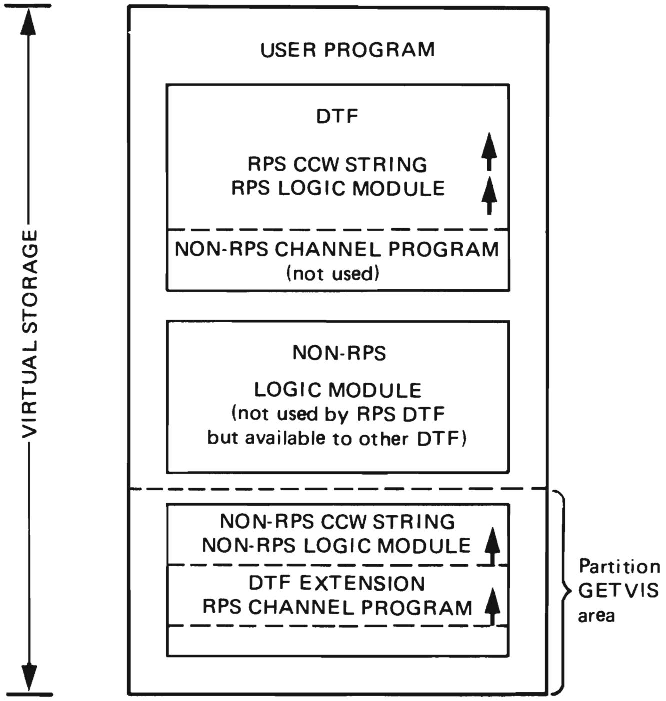


Figure 2-7. User Program Running in Virtual Storage using RPS Version of Logic Module and Channel Program

I/O Options

Channel Queue

The channel queue (CHANQ) is used by VSE/Advanced Functions to schedule I/O operations. The system builds an entry in the channel queue whenever a request is made for an I/O operation and the entry remains in the queue until the operation has completed. Thus, at any point in time, the queue consists of entries for I/O operations in progress and I/O operations waiting for initiation. Whenever an I/O event completes, the queue is examined to see if another entry exists for the channel, and if so, the operation is initiated. The number of channel queue entries to be allocated in the supervisor can be specified in the CHANQ parameter of the IOTAB macro.

The number of occupied entries in the channel queue depends on the activity in the system and no accurate formulas for determining the optimum size can be given.

Specifying too small a channel queue may cause performance degradation, too large a channel queue value will waste storage space.

Tasks or programs that request an I/O operation when the channel queue is full will be set in the wait state until an entry becomes free.

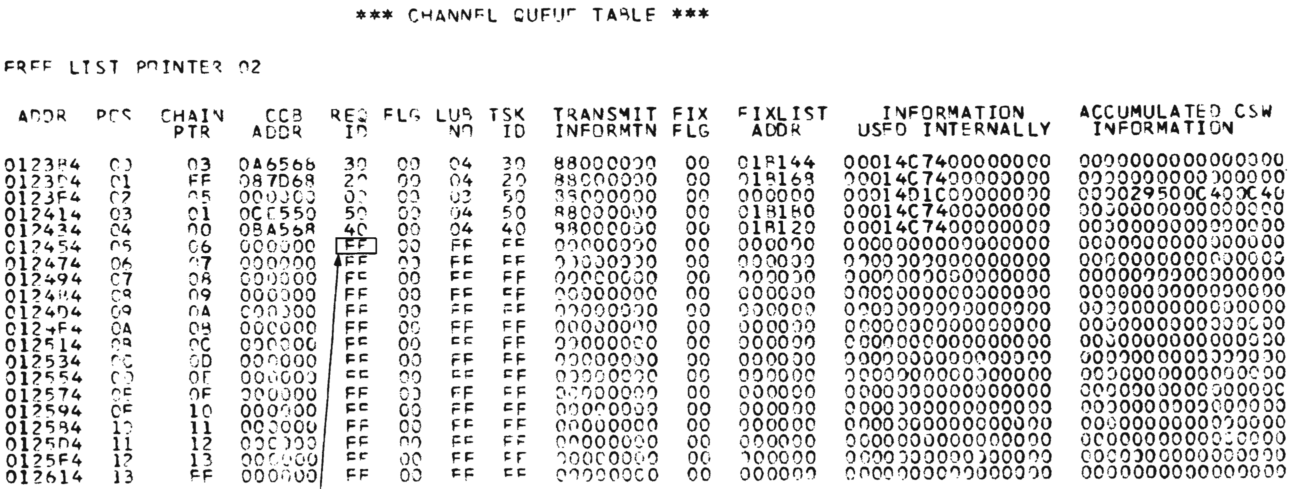
To avoid performance degradation it is better initially to specify ample channel queue space, and reduce the allotted space later, if desired. Given below is a *rule-of-thumb* that you may follow:

- Specify at least one queue entry for each I/O request that can be issued concurrently (open files per job step per partition).
- Specify one entry for the SYSRES file and one for the page data set.
- Specify one entry for each task or partition in the system.
- Specify one entry for each console buffer in the system.
- If multiple volume files are used on the system, specify one entry for each file being accessed at the same time.
- Add two entries per tape drive.
- Specify one entry for each telecommunication line that could solicit input. If IBM 2260 local or 3270 local video display units are to be supported by BTAM-ES, specify one entry for each display.
- Add five entries to the total for contingencies.

When the system has been generated, run as many programs as represent the heaviest work load; in particular, run any telecommunication programs. Then, before the next IPL, obtain a formatted dump of virtual storage.

An analysis of the channel queue should show that entries near the beginning of the table have been used, whereas those near the end are unused. Although the unused entries are normally redundant, a few surplus entries should be retained to allow for exceptional cases. If all the entries have been used, then the channel queue was almost certainly too small, and a process of experimentation will show the correct size.

Figure 2-8 shows the channel queue as displayed in a formatted dump. Refer to *VSE/Advanced Functions Serviceability Aids and Debugging Procedures* for information on obtaining a formatted dump.



```
                                        *** CHANNEL QUEUE TABLE ***

FREE LIST POINTER 02

 ADDR    POS    CHAIN    CCB    REQ FLG LUB TSK  TRANSMIT FIX  FIXLIST     INFORMATION       ACCUMULATED CSW
                 PTR     ADDR   ID       NO  ID  INFORMTN FLG   ADDR    USED INTERNALLY       INFORMATION

0123B4   00      03    0A6566   30  00  04  30  88000000  00  01B144  00014C7400000000   0000000000000000
0123D4   01      FF    087D68   20  00  04  20  88000000  00  01B168  00014C7400000000   0000000000000000
0123F4   02      05    000000   00  00  03  50  88000000  00  000000  00014D1C00000000   000029500C400C40
012414   03      01    0CC550   50  00  04  50  88000000  00  01B180  00014C7400000000   0000000000000000
012434   04      00    0BA568   40  00  04  40  88000000  00  01B120  00014C7400000000   0000000000000000
012454   05      06    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012474   06      07    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012494   07      08    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
0124B4   08      09    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
0124D4   09      0A    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
0124F4   0A      0B    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012514   0B      0C    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012534   0C      0D    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012554   0D      0E    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012574   0E      0F    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012594   0F      10    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
0125B4   10      11    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
0125D4   11      12    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
0125F4   12      13    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
012614   13      FF    000000   FF  00  FF  FF  00000000  00  000000  0000000000000000   0000000000000000
```

An unused entry will have an FF in this location

Figure 2-8. Channel Queue Table

Supervisor Buffers for I/O Processing

Supervisor buffer space is used for the handling of I/O requests from programs that execute in virtual mode. You specify the number of buffers via the BUFSIZE parameter of the IOTAB generation macro.

The amount of buffer space required is dependent on the number and type of concurrent I/O requests. The number of entries that you specify in the channel queue table can be used as a guide. Generally three times the number of channel queue table entries will give a sufficient number of buffers. If ISAM is the predominant access method used or if you have generated RPS support, you should increase the number of buffers by 20%.

Because your supervisor must end on a 2K boundary, any space between the end of the supervisor and the next 2K boundary will be used for I/O buffers in addition to the amount you specify in the IOTAB generation macro.

To determine whether or not you specified a sufficient number of buffers, use (but only if FASTTR is not active) a technique similar to the one suggested for an analysis of the channel queue. While running as many programs as represent your heaviest work load, issue the DUMP command specifying the begin and end addresses of the buffer area in the supervisor; if all blocks have been used, then probably too few buffers were specified.

The use of the buffers is different in ECPS:VSE and 370 mode.

ECPS:VSE Mode. The buffers are called work blocks, and they have a size of 36 bytes each. VSE/Advanced Functions uses the work blocks to store information about your channel program and the I/O areas for that channel program. The information will be used to fix in processor storage your I/O areas, channel program and control blocks until the I/O request has been satisfied. The information stored is referred to as a *fixlist*. For example, the system needs one workblock per I/O request for an FBA type DASD and two or more such blocks per I/O request for a CKD type DASD.

If you are writing your own channel programs it is suggested that you use the IORB macro rather than the CCB so that your channel program will contain a fixlist; processing will then be faster. For more information about these two macros, refer to *VSE/Advanced Functions Macro Reference*.

370 Mode. In 370 mode the buffers are called copyblocks and have a size of 72 bytes each. VSE/Advanced Functions uses the copy blocks to keep a copy of your channel program and control blocks in the supervisor area.

Your channel program refers to virtual addresses and these addresses must be translated to reflect the processor storage locations that your I/O area(s) actually occupy. (The translation is necessary since 370 mode does not support relocating channels which can do the address translation.) Once your channel program is translated, the I/O area(s) are fixed in processor storage and the translated channel program is given to the channel for execution. If you have installed the licensed program VSE/VSAM the minimum number of buffers you should specify is 40. To execute VSE/Advanced Functions system utility programs, up to 38 copy blocks are needed.

Bypassing System Translation of I/O Addresses. In most instances, double buffering techniques and an increase in block size can significantly reduce the system overhead associated with channel program translation. However, in extreme cases, you may wish to perform your own translation of channel programs and thereby avoid system CCW translation overhead. Programs that might require this are EXCP programs that have very high start I/O rates and that repeatedly use the same channel programs.

VSE/Advanced Functions provides support that assists in the translation of channel programs. This support allows you to use the VIRTAD and REALAD macros as well as the REAL parameter of the EXCP macro. You must obtain processor storage by means of the PFIX macro and then translate the channel program. For detailed information see *VSE/Advanced Functions Macro User's Guide* and *VSE/Advanced Functions Macro Reference*.

The Fast Translate or Fast Function Option. You may specify FASTTR=YES in the FOPT generation macro. This creates a supervisor with *fast-function* support in ECPS:VSE mode and *fast-translate* support in 370 mode.

The feature works essentially the same way in both ECPS:VSE and 370 mode. That is, the supervisor buffers used for an I/O request are not released when the I/O request is completed. The buffers are saved and the referenced I/O areas are fixed in processor storage until the end of job. This can speed I/O processing if your program has frequent repetitive I/O requests. The overall effect on your system is subjective, however.

The page pool is decreased in size because the I/O areas remain fixed. Additionally, more supervisor buffers are required than without this support. In ECPS:VSE mode specify, as a rule of thumb, a number of buffers that is 9 times the number of channel queue entries and in 370 mode 6 times the number of channel queue entries.

If you do not specify enough buffers or the page pool becomes too small, the saved buffers and fixed I/O areas are released as required by the system.

Specification of FASTTR=YES may cause degradation of performance when CICS/VS accesses SAM, ISAM and DAM files.

FASTTR can be switched off for the duration of a job by specifying NOFASTTR in the OPTION job control statement. Specifying this option is meaningful if, for a job, it is unlikely that buffers and fixed I/O areas will be reused.

Error Queue

The error queue option is of value to installations using a large number of I/O devices, for instance, telecommunication systems. The ERRQ parameter of the FOPT generation macro allows you to specify the number of error queue entries within the error recovery block of the supervisor. These entries are used to record information on I/O device errors, and this information is used by the ERP and RMSR routines.

Display Operator Console Support

In ECPS:VSE mode, 3277 is the standard operator console support. In 370 mode,this is the default, too; however, the DOC parameter of the FOPT generation macro can be used to override that default. For example, in an installation with a /370 model 115 or 125, it is usually required to ask for DOC=125D support. DOC=NO gives a supervisor that is generated with console support in printer keyboard mode.

The IOTAB generation macro, in general, directs the system to allocate I/O related tables. The parameters involved refer to:

- The number of programmer logical units for each partition defined by the NPARTS parameter in the SUPVR macro.
- The number of job information blocks for the system. One is required whenever a temporary or alternate assignment is made.
- The estimated number of physical I/O devices.
- The number of named resources that may be held in a locked status at any one time.
- The number of I/O buffer blocks.

Before you can actually use your I/O devices, you must define each unit to the system, specifying its characteristics such as channel and unit address, device type, its mode (if applicable). You do this via the ADD command at the time of Initial Program Load (IPL).

A supervisor generation macro is not available for this purpose. Nevertheless, because the definition of your I/O devices is likely to remain stable over a longer period, you should already at the time of system generation give some thought to the sequence of ADD commands you are going to use. The total number of ADD commands must not exceed the total number of devices specified in the IODEV parameter of the IOTAB generation macro.

Furthermore, physical I/O device addresses must be assigned to logical unit names, via the // ASSGN job control statement or job control command (no //). You cannot make these assignments at the time of supervisor generation, even though you may want to have them remain unchanged for a longer period of time.

The Automated System Initialization (ASI) facility allows you to place all your IPL commands in a procedure. This procedure is automatically invoked each time you IPL the system. Additionally the ASI facility allows you to place job control commands in a procedure which would be automatically invoked whenever the pertinent partition is started.

Definition and assignment of I/O devices is described in sections *Starting the System* and *Controlling Jobs* within *Chapter 3, Using the System.*

Chapter 3: Using the System

This chapter is intended primarily for programmers who are responsible for optimum system throughput and for servicing the installation's libraries. The topics discussed are:

Starting the System — describes the initial program load (IPL) procedure. It also describes how to create the file required for recording error information, how to allocate storage to a partition, and how to start a foreground partition.

Controlling Jobs — describes the required input to the job control program, which controls the execution of a job; it includes a brief discussion of label processing.

Linking Programs — describes the input to the linkage editor program, which links the modules produced by language translators, produces executable phases and places them in the core image library.

Using the Libraries — provides the information on how to alter, copy, and inspect the contents of the libraries. It also describes how to allocate space to the libraries and how to create private libraries.

Starting the System

Before a job can be submitted for execution, the supervisor must be read into processor storage, and the job control program must be loaded into the background partition. To do this, the operator starts the system by following the initial program load (IPL) procedure.

On a 4300 processor the amount of virtual storage available can be altered during IML (Initial Microprogram Load) which is done prior to the IPL procedure. Refer to section *Virtual Storage Size* in *Chapter 2, Planning the System*, and also to the Operator's Guide manual for the pertinent CPU model.

This section describes the use of the IPL commands. The exact formats of these commands are contained in *VSE/Advanced Functions System Control Statements* and *VSE/Advanced Functions Operating Procedures*. This section also provides a summary of the automatic functions of IPL; descriptions of how to load the shared virtual area, and how to create the system recorder file (SYSREC) and the hard copy file; a section on the optional user exit routine for user-defined processing after IPL; and a section on entering data into SYSREC.

You must perform the IPL procedure each time you have to do one of the following:

- Load a new supervisor (for normal system start-up, for different supervisor options, or to recover from a system malfunction. For the last, refer to *VSE/Advanced Functions Serviceability Aids and Debugging Procedures*).

- Modify the shared virtual area size.
- Add devices to or delete them from the system configuration.
- Set or change the time-of-day clock value.
- Set or change the system's time zone value.
- Change the channel and unit assignment of the system residence (SYSRES), the VSE/VSAM master catalog (SYSCAT), SYSREC, or the page data set due to hardware problems with the channel or disk drive.
- Create SYSREC (for the first time or because of hardware problems).
- Replace SYSRES or the page data set because of a hardware problem with the pack.
- Switch to a different label information area.
- Reallocate the lock communication file.

Initial Program Loading (IPL)

For IPL, you place the system residence disk pack on a disk drive and set the address of that drive in the load unit switches, ready SYSLOG and the device containing the page data set and press LOAD on the console (on the video display/keyboard console, type in the address of the drive and press ENTER).

Now, the Automated System Initialization (ASI) is ready to control the IPL process. If you want to prevent ASI from executing your cataloged IPL procedure, press the INTERRUPT key immediately after you pressed LOAD. This allows you either to specify different ASI procedures or to leave ASI and continue with an interactive IPL. ASI is discussed in more detail under *Automated System Initialization (ASI)*, below. The remainder of this section describes the interactive IPL process.

Next, the system enters the wait state. You now must indicate the device that is to be used as the operator console (SYSLOG). To do so, press the Request key (or END/ENTER) on the selected device. This causes an interrupt and automatically transmits the address of this device to the system. (If you have installed an IPL communication device list, the system accepts the interrupt only if the address of the device is contained in the list). IPL assigns SYSLOG to the device. This assignment remains valid until the next IPL or until SYSLOG gets reassigned.

At this point, you are requested to specify the supervisor you want to be used. You indicate this by one of the following:

- pressing ENTER or the Request key
- entering supervisorname[,P | N][,VSIZE=nK][,LOG | NOLOG]

Pressing ENTER or the Request key indicates that the pageable default supervisor is to be loaded ($$A$SUP1,P,LOG).

Specifying P causes the loaded supervisor (default or your own) to have certain routines pageable; specifying N causes the loaded supervisor (default or your own) to be non-pageable. If, on entering the supervisor name, you specify neither P nor N, P will be assumed.

The VSIZE parameter applies only to a supervisor generated for 370 mode. You use this parameter if you want to override the default value as determined by the system.

By setting the list-option to NOLOG, you can prevent IPL from listing the IPL commands on SYSLOG. If you don't specify the list-option, LOG will be taken as default; that is, all IPL commands are listed on SYSLOG. Invalid commands are always listed.

IPL now reads the supervisor into low processor storage from the core image library. If an irrecoverable error is sensed while reading the supervisor, an error message is displayed on SYSLOG; the hard wait status is entered and an error code is set in the first four bytes of processor storage. The IPL procedure must then be restarted. For more information on wait states, refer to *VSE/Advanced Functions Serviceability Aids and Debugging Procedures*.

Establishing the Communication Device for IPL

The system again goes into a wait state with all interrupts enabled (see Note). At this time you must indicate which device is to be used to communicate the IPL commands to the system. The specific manual operation you must perform depends on the selected device:

- If you wish to use the console (SYSLOG), press the Request key on the console. (On the video display/keyboard console, you can press the Enter key, the Request key, or the Cancel key.)
- If you wish to use a card reader, ready this card reader. The system then assigns SYSRDR to this device for the duration of IPL.
- If you wish to use an IBM 3540 Diskette I/O Unit, ready it. The IPL program assumes that the file IJIPL is part of the diskette and that it contains the IPL commands in card image format (unblocked 80 byte records).

Note: Because any interrupt will (on a first-come basis) establish the issuing device as the IPL communication device, it is advisable that TP installations and terminal-oriented installations with locally attached terminals, (for example, IBM 3277) install the IPL-phase $$A$CDL0. (See *IPL Communication Device List* later in this section.)

IPL commands serve to set or change various characteristics of your system. They operate on the following items:

I/O configuration	–	ADD and DEL commands
System date and time	–	SET command
System disk file assignments	–	DEF command
Page data set	–	DPD command
Label information area outside of SYSRES	–	DLA command
Options relating to PAGEIN requests and DASD file protection	–	SYS command
Lock communication file	–	DLF command
Shared Virtual Area size	–	SVA command

ADD and DEL commands precede all other commands. The DLF command (if any) must immediately follow all ADD/DEL commands. The SVA command is the last command to be submitted.

The ADD Command. Use the ADD command to define all your input and output devices to your system. This definition specifies for a device the channel and unit address, the device type, the mode (if applicable), and whether automatic channel switching is desired.

Each individual drive of a DASD (of a 3333/3330 or 3310, for example) requires a specification in an ADD command. Note that if one physical spindle contains two or more logical spindles, ADD commands must be issued for each of these logical spindles.

The following requirement should be kept in mind: you can add a device only if the number of devices specified in the IODEV parameter of the IOTAB generation macro is not exhausted. If this requirement is not satisfied, you will get an appropriate error message. You must then provide space in the control blocks for the additional device by:

- deleting unnecessary devices of the type you want to add and then re-issuing the ADD command, or
- re-assembling the supervisor.

Note: For an IBM 3031 CPU, one service record file 7443 must be defined. This allows the operating system to access the system diskette on the service support console. After having created the system recorder (SYSREC) file and encountered the first // JOB statement, the system reads machine check frames and channel check frames from the service record file and writes them onto the SYSREC file. Those frame records will be available as input for the Environmental Recording Editing and Printing (EREP) program when that program is executed.

The DEL Command. Use the DEL command to drop an I/O device from the configuration you had established via ADD commands; this may be necessary if, for example, you defined (ADDed) more devices than you had allowed yourself in the IOTAB generation macro, or if you want to correct the device type for one of the preceding ADD commands. Because all references to the device are removed, any subsequent ASSGN job control statement that refers to a deleted device will not be accepted.

The Set Command. You can use the SET command to set the system date, the time-of-day clock, and the system time zone. If you specify a time-of-day clock setting, set the time-of-day clock switch to the "enable set" position at the exact time specified in the SET command. The SET command is required only if the time-of-day clock has not been set. If this is the case, a message at IPL will prompt the operator.

The DEF Command. You use the DEF command to assign the SYSCAT, SYSDMP, and SYSREC files. This command is mandatory.

The SYSCAT file, the VSAM master catalog, is required if you have the licensed program VSE/VSAM installed. If you don't have VSE/VSAM installed, specify DEF SYSCAT=UA. SYSREC is the symbolic name used for the *system recorder file*, the *hard copy file* and the *system history file*. As described in section *System and Workfiles* of *Chapter 2, Planning the System*, the SYSDMP file can be used instead of SYSLST to hold system dumps, dump command output, and the output of your installation's stand-alone dump program.

The DEF command must be submitted after any ADD and DEL commands and prior to the SVA command. The ASSGN job control statement or command is not valid for SYSDMP, SYSCAT or SYSREC assignments.

The DPD Command. The DPD command is used to define the disk attributes of your page data set. The operands of the command allow you to specify

- a device address.
- whether the page data set resides on multiple extents.
- the size of a particular extent.
- whether the page data set is treated as a data secured file.
- the beginning address of the disk extent.
- the disk volume ID.
- whether or not the page data set should be formatted.

Because formatting the page data set is time-consuming, you should request it only if the pack was damaged. The first time you use the page data set, it will be formatted automatically.

The page data set can reside on any DASD supported by VSE/Advanced Functions as a system residence device. To help ensure better performance, the page data set should not reside on a pack that is subject to heavy I/O requests.

The DPD command is mandatory (except when your supervisor was generated with VM=YES in which case the DPD command is invalid). It must be submitted after any ADD and DEL commands and prior to the SVA command.

If your page data set is to be allocated to multiple extents, you submit the corresponding number of DPD commands. After accepting the first DPD command, the IPL program prompts for additional DPD commands until either the entire virtual storage is covered by the specified extents or you submitted a total of 15 commands which is the maximum.

The DLA Command. Use the DLA command to define or reference a label information area separate from the one within the SYSRES file. When, for example, two CPUs or two VSE systems under VM/370 share a SYSRES file, two separate label information areas enable the two systems to distinguish between dedicated system file names.

The additional label information area may be located on a volume different from the one that contains the SYSRES file; you would then have to specify the UNIT parameter. Its format and layout are identical to the format and layout of the SYSRES label information area.

When you define the area, you specify its beginning address by the CYL or BLK parameter of the DLA command. By specifying NCYL or NBLK you may deviate from the default size of a SYSRES label information area. At the time of definition you supply a name by which this label area is referenced during subsequent IPLs.

To define a label area of 300 blocks on an FBA device, you might submit the following DLA command:

```
DLA NAME=MYLABEL,UNIT=280,BLK=125000,NBLK=300
```

At subsequent IPLs, you may refer to this area by issuing the command

```
DLA NAME=MYLABEL,UNIT=280
```

In the above example, the SYSRES file resides on a different volume; therefore, the UNIT parameter is requred.

If the DLA command is used, it must be submitted after any ADD and DEL commands and prior to the SVA command.

The DLF Command. This command serves to either newly define or to reference a cross-system communication file (also called *lock file*). This file must be present when two or more VSE systems share data on disk.

To define a lock file, you specify

- its physical device address
- the beginning address on the volume that is to contain the file.

You may also indicate whether the file should become a data secured file or not.

After the file has been allocated, it may later, at subsequent IPLs, be referred to by simply giving its physical device address; for example:

```
DLF UNIT=131
```

The DLF command is required whenever your supervisor was generated with DASD sharing support and, at the time of IPL, DASD devices are present which are defined with the SHR option in the ADD command. The DLF command (if given at all) must immediately follow any ADD and DEL commands.

For a more comprehensive description of DASD sharing, refer to section *DASD Sharing by Multiple VSE Systems* in chapter *Using the Facilities and Options of VSE/Advanced Functions.*

The SYS Command. This command is used for two purposes:
By issuing the PAGEIN macro, a program may request to have one or more pages brought into processor storage 'in-advance', that is, ahead of the time when they actually need to be in processor storage. Use of the PAGEIN macro helps to reduce page faults. The system assumes a (default) number of page-in requests that can be queued at any one time. You may deviate from this number by specifying an appropriate value in the PAGEIN parameter of the SYS command.

EXTENT, the second parameter of the SYS command, is used in connection with DASD file protection. For a supervisor generated with DASDFP=YES, the IPL program allocates a so-called extent block area in the system GETVIS area. The IBM-set default value of 4K may prove to be insufficient after a large number of DASD files (some of them with multiple extents perhaps) have been opened. In this case, you should specify a larger EXTENT value next time you IPL the system.

The SYS command is optional. If used, it is accepted any time after the DLF command and any time prior to the SVA command.

The SVA Command. This command must be the last IPL command submitted. The SVA command may be given with or without parameters.

The command's parameters (SDL, PSIZE, GETVIS, PSLD) are used to increase the SVA size beyond the size set by the IPL program. They serve to add space for

- System Directory List (SDL) entries
- phases that you want to have loaded into the SVA
- the system GETVIS area
- second level directory entries for private core image libraries.

If the parameters are not specified during IPL, no user SDL or phase space is reserved in the SVA for user phases. An SVA will be allocated which is large enough to contain:

- Phases required for use by VSE/Advanced Functions.
- Phases required for installed licensed programs.
- The default system GETVIS area.
- Required SDL entries.

The PSLD parameter is useful if you anticipate a need for more than the minimum of 5 entries per private core image library. The value you specify should equal the largest number of actually used directory entries for any private core image library, up to a maximum of 32 entries.

Automated System Initialization (ASI)

The facility allows you to place all your IPL commands into a procedure. In addition to IPL commands, you include a specification of your SYSLOG device and optionally, among other things, the supervisor name you intend to use. After you have cataloged this procedure into the (system) procedure library, you may let the IPL program execute the procedure whenever you IPL your system. Figure 3-1 shows a typical ASI IPL procedure (the first record specifies SYSLOG and a supervisor name; the ADD command preceding the DEF command defines the SYSLOG device type):

```
01F,$$A$SUP3,P,NOLOG
ADD 280,3420T9
ADD 281,3420T9
   .
   .
   .
ADD 162,3330
ADD 163,3330
ADD 00C,3505
ADD 00E,1403U
ADD 00D,3525P
ADD 01F,125D
DEF SYSREC=160,SYSCAT=160,SYSDMP=161
DPD UNIT=161,VOLID=PDSWRK,CYL=300,DSF=N
SVA SDL=100,PSIZE=150K,GETVIS=150K
/+  END OF IPL PROCEDURE
```

Figure 3-1. Example of an ASI IPL Procedure

Other ASI procedures contain job control information that serves to prepare partitions for operation: they allocate partition space, store label information, assign devices to logical units etc. Therefore, the entire system initialization may proceed without your intervention.

A detailed description of how to set up ASI procedures is given in section *Automated System Initialization* later in this section.

Automatic Functions of IPL

Apart from the Automated System Initialization, IPL performs the following operations automatically:

- Builds the required control blocks and device tables.
- Determines the size of the real and virtual address space.
- Unassigns any DASD assignments for devices that are not operational at this time (so as to prevent the error recovery routines from trying to establish error recording statistics for these devices).
- Loads the printer-control buffers with the installation defined standard buffer images.
- Initializes the VSE/Advanced Functions RMS routines.
- Loads into the SVA required system phases and licensed program phases.

After IPL completes these operations, the system loader loads the job control program into the background partition and places the system in the problem program state. The message "READY FOR COMMUNICATIONS" appears on the console immediately after IPL is complete.

IPL Communication Device List

For telecommunication installations and for installations with locally attached terminals (such as the IBM 3277), devices allowed to present an interrupt during IPL should be restricted because an unsolicited interrupt might interfere with your system start-up procedures. By installing an IPL communication device list, you can avoid that a device outside the operator's control establishes itself as the device used for submitting IPL commands.

To build a restrictive pool of IPL communication devices, you assemble an IPL communication device list (CDL) and catalog the list under the phasename $$A$CDL0 in the system core image library. During IPL, this phase (if present) is loaded into storage. When the system enters the wait state and an interrupt occurs, the CDL can now be searched for the address of the device issuing the interrupt. If the address is listed, the interrupting device is accepted as an IPL communication device and processing continues. If the address is not found, the system remains in the wait state. Installation of the CDL is optional.

For IPL to be successful, once $$A$CDL0 is installed, the SYSLOG device address must be present in the CDL. If you intend to submit IPL commands from card reader or diskette, you must enter their addresses in the CDL as well. To ensure backup in case of hardware errors during IPL, consider stand-by devices, such as another card reader, diskette, or even an additional SYSLOG device in the CDL.

The CDL may have up to eight entries each of which is four bytes long:

	reserved	cc	uu
Bytes	0	2	3

where: cc = channel number
       uu = unit number

You create the CDL by submitting a job that catalogs $$A$CDL0 into the system core image library. The example in Figure 3-2 creates a CDL with five entries.

```
// JOB CATALOG CDL
// OPTION CATAL,NODECK
   PHASE $$A$CDL0,+0
// EXEC ASSEMBLY
$$A$CDL0 CSECT
                DC   XL4'00C'      card reader
                DC   XL4'009'      1052
                DC   XL4'01F'      SYSLOG (DOC)
                DC   XL4'0BD'      3277
                DC   XL4'240'      diskette
                END
/*
// EXEC LNKEDT
/&
```

Figure 3-2. Example for the Creation of a CDL

Once phase $$A$CDL0 has been cataloged, the CDL addresses remain effective for subsequent IPLs. However, you may:

- Replace the phase by another one, either by assembling and link editing a new phase or by using the MAINT librarian program to rename an already cataloged CDL that has a name other than $$A$CDL0.

- Override any CDL entry by manual intervention, which is the suggested approach should an erroneous CDL be cataloged in the core image library. The procedure for manually overriding the CDL is given in *VSE/Advanced Functions Serviceability Aids and Debugging Procedures.*

Building the SDL and Loading the SVA

Automatic SVA Loading

A fresh copy of the SVA is built at each IPL. The IPL program loads phases into the SVA from the system core image library. It uses pre-defined load lists to find the appropriate phases. The load lists that identify required system phases are shipped in the system core image library ready for use at IPL. *VSE/Advanced Functions System Generation* contains a listing of the required system phases.

If you install an IBM licensed program that includes SVA eligible phases, you must catalog a load list for that licensed program. The licensed program documentation will describe this procedure and tell you how much space in the SVA the loaded phases require. Although the IPL program automatically allocates sufficient SVA space (by checking the load lists), you should know how much virtual storage will remain to be allocated to the partitions. (In 370 mode, your specification in the VSIZE parameter at the beginning of IPL is dependent on this information.)

The IPL program builds entries in the system directory list (SDL) for each phase that it automatically loads into the SVA. Each of those entries contains a pointer to the associated phase in the SVA.

Entries in the SDL are copies of specific (system or private) core image library directory entries. Having entries in the SDL speeds up the loading of the corresponding phases.

SDL Procedure at IPL

You should build SDL entries for certain frequently used system phases that are not SVA eligible. VSE/Advanced Functions provides a procedure (its name is SDL) that you should execute at the time of IPL. In order to create entries for those phases they must reside in the *system* core image library. For a listing of the phases referenced by procedure SDL, refer to *VSE/Advanced Functions System Generation*. SVA space for those SDL entries is not automatically reserved. In order to do that, you must define space with the IPL command SVA.

User Options for the SVA

In order to load user chosen elements into the SVA (phases or SDL entries or both) the SVA space must be made large enough to accommodate the new entries. Space for user entries may be defined at IPL via the SVA command (see *The SVA Command* earlier in this section). The SET SDL command is available for building SDL entries and loading phases into the SVA.

Processing of the SET SDL command involves, for each specified phase, a search through one or more directories of the core image libraries that you have concatenated to your background partition. The search order for concatenated libraries is described in section *Using Private Libraries* later in this chapter. If a search chain is not defined (which is the case immediately after IPL), only the system core image library will be searched.

Building an SDL entry and loading into the SVA may only be done from libraries that are not defined as access control protected to the Access Control facility of VSE/Advanced Functions.

A phase that you want to load into the SVA must be SVA eligible, that is: it must have been cataloged with the SVA parameter specified in the linkage editor PHASE statement. Link editing for inclusion in the SVA is further discussed in *Linking Programs* in this chapter.

As mentioned before, you can build SDL entries for phases that are not SVA eligible. Note, however, that these phases must be in the *system* core image library in order to receive an SDL entry.

The SET SDL Command. The command used to create SDL entries and to load phases in the SVA is the SET SDL job control command. This command can be given only in the background (BG) partition. The command may be given at any time after IPL. There is no limit to the number of times it may be given.

Following the SET SDL command the input should be in the format of:

```
name[,SVA]
```

where name is any valid phase name and SVA indicates whether or not the phase is to be loaded into the SVA. If you specify SVA and the phase is SVA eligible, the job control program loads that phase.

If the requested phase is not found, the job control program issues a message on SYSLST (or SYSLOG if SYSLST is not available); the SDL receives a dummy entry indicating that the phase is uncataloged (inactive). If you subsequently catalog a phase into the *system* core image library under a name listed in the SDL as uncataloged, the entry in the SDL is activated. Additionally, the phase is immediately loaded into the SVA if you had specified name,SVA under the SET SDL command *and* cataloged the phase as SVA eligible.

Duplicate phase names within one SET SDL command are ignored. Note that a fresh copy of the phase is loaded each time a SET SDL command for that phase is issued; multiple specifications may thus lead to an 'SVA full' condition.

It is recommended that you create a SET SDL job stream, catalog it as a procedure in a procedure library and run that procedure immediately after IPL. For compatibility with DOS/VS or DOS/VSE, SET SDL=CREATE will be accepted by VSE/Advanced Functions. If the SET SDL job stream is not being entered through a procedure, it may be submitted to job control through SYSRDR or SYSLOG (depending on the device from which job control is reading). This job stream can be entered via the IPL communication device. Figure 3-3 illustrates such a job stream.

Make sure that prior to execution of the SET SDL command/procedure the proper chain of libraries is established.

It is recommended that you run the librarian program DSERV after a SET SDL job stream to be certain that all entries have been entered the way you wish. Include the DSERV control statement DSPLY SDL.

Fast B/C-transient Fetch. You have to issue the SET SDL command if you want to utilize the Fast B/C-transient Fetch facility. Normally, a request to load or fetch a logical transient routine results in an I/O operation. The Fast B/C-transient Fetch avoids this I/O operation by obtaining a copy from the SVA and moving it into the supervisor's logical transient area. Even if this action necessitates a page I/O operation, a performance improvement can be gained because no directory search operation is involved.

The transient routine must be self-relocating, the first character of *its* name must be a '$', and it must have been loaded into the SVA by the SET SDL command. To build an SDL entry for the transient and to load it into the SVA, supply the following statement (behind a SET SDL statement):

```
phasename,MOVE
```

VSE/Advanced Functions provides a SET SDL procedure, called 'FASTFTCH', which performs the above operation for certain B- and C-transients.

Replacing Phases Stored in the SVA. Occasionally, a phase stored in the SVA needs to be changed; that is, it must be replaced by an updated version. To replace a phase in the SVA, link edit the updated version of the phase to the *system* core image library. Link editing to a library other than the system core image library does not cause an update in the SVA (the same applies to a deletion or a renaming of a phase). Immediately after the link edit operation, the updated phase is loaded into the SVA. The old version of the phase remains in the SVA, but is not addressable.

The change or resetting of a search chain that was used for the processing of a SET SDL command has no effect on the SVA. Therefore, phases loaded from a concatenated library will stay in the SVA.

Creating the System Recorder File

The recovery management support of VSE/Advanced Functions requires a disk extent on which to record statistical information about machine errors and environmental information. This disk extent is called the system recorder file and is identified by the symbolic name SYSREC. The SYSREC file must exist before job control encounters the first // JOB statement after IPL. Usually, you create the SYSREC file only after the first IPL following a system generation (not after each IPL). If the SYSREC file has been damaged, however, you must re-IPL and re-create SYSREC.

If your system is running on an IBM 3031, the SYSREC file must be evaluated (via program IFCEREP1) and recreated each time a hardware (microcode) change is installed which affects the frame records on the 3031's Service Record File. For details on IFCEREP1, refer to *OS/VS, DOS/VSE, VM/370 Environmental Recording Editing and Printing (EREP) Program*.

On a CKD device the SYSREC file requires a minimum of ten tracks (not including an alternate track), and it cannot be a split cylinder file. On an FBA device the SYSREC file requires a minimum of 72 blocks of 512 bytes each. You must define SYSREC as an extent of a permanently online disk device that VSE/ADvanced Functions supports as a system residence device.

The IBM 3031 requires additional space on the recorder file to accommodate machine check frames and channel check frames (these frames are peculiar to the IBM 3031). On an IBM 3330, for example, this space amounts to approximately 9 tracks. If the SYSREC file resides on an FBA device with blocksize of 512 bytes, add 164 blocks. The exact amount of additional space needed for the recording of those frames can be calculated after the first // JOB statement has been processed and message '1I93I RECORDER FILE IS nnn% FULL' is issued.

The SYSREC file label information must be included in the standard label portion of the label information area. Therefore, submit a // OPTION STDLABEL statement when you create the SYSREC file. A more detailed description of preparing standard label information is given under section *Controlling Jobs* later in this chapter.

Figure 3-3 illustrates a job stream (via SYSLOG) to create the system recorder file. The IPL commands are included in the figure to show the proper placement of the statements that create the SYSREC file. Be sure that you do not submit a // JOB statement until you have supplied all the information applicable to SYSREC. This is because the SYSREC file is opened when the first // JOB statement is encountered. Note that the file name IJSYSRC is required in the DLBL job control statement.

```
0130I DATE=../../..,CLOCK=../../..,ZONE=../../..
0I10A GIVE IPL CONTROL COMMANDS
ADD...
ADD...
   .
   .
   .
ADD...
SET...
DEF SYSREC=190
DPD
SVA
0I20I IPL COMPLETE FOR...
BG 1I00A READY FOR COMMUNICATIONS
BG SET SDL
1S51I ENTER PHASE NAME OR /*
BG USERONE
1S51I ENTER PHASE NAME OR /*
BG USERTWO,SVA
1S51I ENTER PHASE NAME OR /*
BG   ...
BG   ...
BG   ...
BG /*
BG ASSGN
   .
   .
   .
BG SET RF-CREATE
BG // OPTION STDLABEL                              )
BG // DLBL IJSYSRC,'VSE/AF.RECORDER.FILE'          }------> Submit with the rest of the
BG // EXTENT SYSREC,,,,1700,43                     )        STDLABEL statements
   .
   .
   .
BG /*
BG // JOB FIRST
   .
   .
```

Figure 3-3. Example for the Creation of the SYSREC File and for Loading User Phases in the SVA

When the system is to be shut down, you should issue the Record On Demand (ROD) command to ensure that no statistical data is lost. For a 370 Model 115 or 125, the U command of the mode select display, should also be issued to save disk usage statistics on the system diskette. These commands are not valid for recording statistics on telecommunication operation; refer to the appropriate telecommunication guides for more information.

To obtain a listing of the SYSREC file, run the EREP program as described in *OS/VS, DOS/VSE, VM/370 Environmental Recording Editing and Printing (EREP) Program*. During execution of the EREP program, recording on SYSREC is suppressed.

Creating the Hard Copy File

On a system that supports a video display/keyboard console, all messages displayed on the screen and all information typed in by the operator are saved in a file on the device assigned to SYSREC. This file, called the hard copy file, can be used to obtain hard (printed) copies of the file whenever required.

You must create the hard copy file after the first IPL and before you submit the first // JOB statement.

The control statements and commands needed to create the hard copy file are the same as those shown in Figure 3-3 for the SYSREC file with the exception that you specify HC=CREATE in the SET command, and the filename IJSYSCN in the DLBL job control statement. More information about creating and printing the hard copy file is given in *VSE/Advanced Functions Operating Procedures* and *VSE/Advanced Functions System Utilities*.

User-Defined Processing after IPL

At large VSE installations, it may be desirable to perform certain processing at the end of an IPL procedure. It may, for instance, be important to know who performed the procedure, whether the right system pack was mounted, and whether the correct date was entered for the new work session. Moreover, if you work with labeled data files it is important that they bear the correct creation date, so as to guarantee that data files are protected until their expiration date.

After the IPL procedure has been completed, control can be passed to a user exit routine (phase name = $SYSOPEN) that you may include for the purpose of checking system security and integrity. This routine is entered once after every IPL procedure. The VSE/Advanced Functions distribution volume contains a dummy phase $SYSOPEN in the system core image library. If you do not use the facility, that phase has no effect on your system. Conventions for writing this kind of user exit routine, together with an example, are contained in the section *Writing an IPL User Exit Routine* in *Chapter 4, Using the Facilities and Options of VSE/Advanced Functions.*

Entering RDE Data

Standard VSE/Advanced Functions support includes the reliability data extractor (RDE). In an interactive (that is: nonautomated) IPL, you are asked by a message to SYSLOG to provide a 2-character IPL reason code when the first // JOB statement after IPL is processed. The system may have been started at the beginning of normal operation or restarted because of a machine error, a program error, an operator error, etc. In addition, the system requests you to supply a subsystem identifier, a code which identifies the device type or program type that failed. On the basis of these replies job control will build a record for SYSREC.

Before shutting down at the end of the day (or processing period), you must ensure that no environmental data is lost, by issuing the ROD command. This command also causes the RDE end-of-day record to be written on the disk assigned to SYSREC. To obtain a listing of this file, run the EREP program as described in *OS/VS, DOS/VSE, VM/370 Environmental Recording Editing and Printing (EREP) Program.*

RDE information can be very valuable to your operations management. By replying with the exact reason code that applies in each case, you are in fact ensuring a permanent record of the reason why you had to re-IPL.

Refer to the *VSE/Advanced Functions Operating Procedures*, for more information on the RDE messages and the valid replies to them.

Allocating Address Space to the Partitions

For each partition specified in the NPARTS parameter of the SUPVR generation macro, address space must be allocated. The address space available to the partitions is all of the address space from the end of the supervisor area (in ECPS:VSE mode) or the end of the real address space (in 370 mode) to the beginning of the SVA. The minimum size of that address space is 512K.

Allocation of address space to a foreground partition must be done explicitly. Space not allocated to a foreground partition belongs to the BG partition. If no allocations are made, for example immediately after IPL, then all available address space belongs to the BG partition. In this case, the BG partition has the following size:

ECPS:VSE mode:	Virtual storage size (16M default or as specified at Initial Microprogram Load) minus supervisor size minus SVA size;
370 mode:	Virtual address space size (system default or VSIZE value as specified at the start of IPL) minus SVA size.

Through the use of the job control ALLOC command you allocate the foreground partitions. Address space allocations are in multiples of 2K. The minimum amount of address space that may be allocated to a partition (explicitly or implied) for execution in virtual mode is 128K. This 128K size includes a minimum partition GETVIS area of 48K.

If a foreground partition is defined (via the NPARTS parameter of the SUPVR generation macro), but not needed for a while, you can set its size to 0K by submitting an appropriate ALLOC command.

During certain periods of processing, the operator can modify the allocations to the individual partitions, again by using the ALLOC command. Details on the ALLOC command are given in *VSE/Advanced Functions Operating Procedures.*

Allocating Processor Storage to the Partitions

Processor storage is allocated to the partitions to enable the following:

- Program execution in real mode.
- Fixing pages by means of the PFIX/PFREE macros.

When processor storage is used for running,a program in real mode or for fixing pages of a program running in virtual mode (for example, VSE/POWER), the page pool is reduced by the number of page frames required for real mode execution or page fixing, respectively. Because reducing the page pool may reduce total system throughput, the use of real mode execution and PFIX/PFREE macros should be carefully considered.

Processor storage is allocated to the partitions via the ALLOCR command. For a partition's allocation to be affected, the partition identifier (BG, F1, F2, ...) must be specified. The allocation is made in multiples of 2K, with 2K being the smallest allocation permissible. Absence of the partition identifier means: do not change the current allocation. An allocation of 2K allocates one page frame, 20K allocates 10 page frames etc.

Note: In 370 mode, when the ALLOCR command is issued, the system delineates real address space as well as allocating processor storage frames. In 370 mode, programs executing real execute in the real address space.

The size of a given processor storage allocation for a partition is determined either by the largest program you must run in real mode, or by the maximum number of pages a program may fix. The number of pages that can be fixed by the PFIX macro is limited by the amount of processor storage allocated to that partiton.

With an allocation of

```
ALLOCR BG=20K, F3=10K
```

you could PFIX 10 pages in BG (while executing in BG) or 5 pages in F3 (while executing in F3). You could not PFIX 15 pages from one program in either partition without reallocating processor storage.

Page Pool. The page pool is all processor storage beyond the resident supervisor routines. When you use the ALLOCR command you are potentially reducing the size of the page pool. The page pool is not reduced until the processor storage page frames are taken for real mode execution or for PFIX use in virtual mode. The minimum page pool size is 24K. If you allocate processor storage to partitions you must ensure that at least 24K remain unallocated. A program running in virtual mode that needs more than 6K for its I/O processing requires a corresponding increase of the minimum page pool size.

Initiating Foreground Partitions

An Automated System Initialization (ASI) procedure may be used to start foreground partitions by including, in the appropriate procedure, the required partition start-up statements.

In order to initiate a foreground partition, at least 128K of virtual storage must be allocated to that partition. The allocation is made after IPL with the ALLOC job control command.

Since the IPL program automatically determines the size of the SVA, it is recommended that you issue the MAP command prior to any virtual storage allocation. The MAP command will display the current allocations and you can determine the amount of virtual storage available for allocation to the foreground partitions.

The ALLOC command is both a job control and an attention routine command. (The attention routine is loaded when you press the Request key on the console keyboard; that routine is in control of the system *when* AR is displayed on SYSLOG.) When the ALLOC command is given through the attention routine it cannot decrease the size of an active partition.

The initial allocation of foreground partitions decreases the size of the BG partition because all available virtual storage is allocated to BG at IPL. Since, after IPL, the BG partition is active, the ALLOC command must be given through job control.

Once virtual storage is allocated to the foregound partitions, they may be made "active" through the attention routine. Issuing the BATCH or START command, specifying a foreground partition, causes that foreground partition to be initiated. For example:

```
AR BATCH F1
```

causes the job control program to be loaded into the virtual storage allocated to the F1 partition.

Input may now be submitted to the F1 partition. Submitting jobs is described in section, *Controlling Jobs*, later in this chapter.

Automated System Initialization (ASI)

During IPL and during the subsequent setting up of the system environment, normally the same commands, the same prompting messages and replies, the same job control information are processed.

ASI allows to place the required control information in procedures that are cataloged in the (system) procedure library and to let the system execute those procedures, without operator intervention, each time an IPL and a partition start-up occur. The ASI procedures can be reused as long as your system environment remains unchanged. Thus, your effort for a total system bring-up is reduced to merely activating the initial microcode load. In exceptional situations, you may have to bypass ASI and perform a nonautomated, that is: an interactive system initialization.

The Procedure Library. Your system residence (SYSRES) file must contain the procedure library because you may catalog the ASI procedures only into the *system* procedure library. Use the librarian program MAINT and its CATALP function. The librarian programs are described in Section *Using the Libraries*, later in this chapter.

The Set of Procedures. ASI requires one procedure for IPL (ASI IPL procedure), and one job control procedure per partition (ASI JCL procedure) if this partition is to be started under control of ASI.

Procedure Names. ASI assumes certain default names unless you instruct it to use different names. The defaults are:

IPL:	$IPL370	(for 370 mode)
	$IPLE	(for ECPS:VSE mode)
JCL:	$0JCL370	(for 370 mode)
	$1JCL370	
	$2JCL370	
	.	
	.	
	.	
	$0JCLE	(for ECPS:VSE mode)
	$1JCLE	
	$2JCLE	
	.	
	.	
	.	

You might want to use different names. For example, the initialization of your system during the day deviates from that of the night shift: the day shift runs a 5-partition VSE (including VSE/POWER, ACF/VTAM, CICS/VS) whereas the night shift runs only simple batch jobs in 3 partitions. In this case, you might prefer to use procedure names as follows: $IPLD, $0JCLD, $1JCLD, $2JCLD, $3JCLD, $4JCLD for the day shift, and $IPLN, $0JCLN, $1JCLN, $2JCLN for the night shift.

If you catalog ASI procedures by names other than ASI's default names, be sure to delete procedures with ASI's default names if they are cataloged; ASI looks for those names first and, upon finding them, executes the pertinent procedure. When the default procedures are not present, ASI prompts the operator to specify an ASI procedure; in the above example, he may then enter $IPLD and $$JCLD, or $IPLN and $$JCLN.

When you catalog your ASI JCL procedures, you must observe the same naming rule as when you catalog a partition-related procedure. The first character must be a $. The second character identifies the partition: 0 for the BG-partition, 1 for the F1-partition etc. The remaining characters must be identical for all procedures belonging to one set.

ASI Master Procedure. If two or more CPU's share one SYSRES file, it may be advisable to have a separate set of procedures cataloged for each

CPU by a separate set of procedure names. ASI still performs a completely automated system initialization if you have the ASI master procedure $ASIPROC cataloged. Each record within this procedure describes the ASI procedure set to be used for a specific CPU and the processing mode of that CPU.

An ASI master procedure is also useful

- if you have only one procedure set, but want to use other than default names, or
- if you plan to use the ASI STOP facility; for example when you are still 'debugging' your ASI procedures.

The STOP facility allows you to specify, via the STOP parameter (see below), up to four different IPL commands. Upon encountering the first of a particular command type, the automatic IPL process interrupts itself and gives the operator a chance to enter or update IPL commands via SYSLOG.

To build the master procedure, submit one statement per procedure set. The statement allows you to specify the following parameters, separated by commas and terminated by a blank.

CPU=cpu-id — specifies 12 hexadecimal digits to identify the CPU on which an ASI procedure is to be run. The CPU-id should be taken from message 0I04I which is issued during an interactive IPL. The format of the CPU-id corresponds to the first 6 bytes of the result field from execution of an STIDP (Store CPU ID) assembler instruction and can be looked up in the applicable *Principles of Operations* manual.

IPL=proc-name — specifies the ASI IPL procedure.

JCL=proc-name — specifies the name of the JCL procedure set; the name must start with $$.
Default: $$JCLE in ECPS:VSE mode
$$JCL370 in 370 mode.

MODE=370 | E — indicates the processing mode of CPU.
Default: 370.

STOP=stoplist — a list of up to four different IPL commands, in arbitrary sequence. If more than one is specified, the commands must be enclosed within parentheses and separated by a comma. The first of a specified command type that is encountered during IPL initiates an interrupt; before the command is processed, the operator may enter additional IPL commands.

The parameters may be specified in any sequence. Parameters CPU and IPL are mandatory. proc-name starts with an alphabetic character and may consist of up to eight alphameric characters.

Following is an example of how to catalog the master procedure:

```
// JOB CATALP $ASIPROC
// EXEC MAINT
   CATALP $ASIPROC
CPU=000713800138,IPL=IPLX,JCL=$$JCLX,STOP=(DEF,DPD)
CPU=FF0713800138,IPL=IPLE,MODE=E
/+
/&
```

The 'FF' in the second CPU-id indicates a virtual machine.

Contents of ASI IPL Procedures

The ASI IPL procedure contains all IPL commands that you want to have executed by the IPL routines. Use the same format as in an interactive IPL.

In addition to IPL commands, you must submit a first record which specifies in

- columns 1 through 3: SYSLOG device address
- beginning in column 4: (optionally) ,supervisor name, paging option, virtual storage size, list option (for a description of these parameters, refer to section *Initial Program Loading* at the beginning of this chapter.)

The address you specify in columns 1 through 3 must be a VSE/Advanced Functions supported console device. Specification of an address which does not represent a VSE/Advanced Functions supported console device may produce unpredictable results. The address is meaningful only

- in IPL procedures referenced in $ASIPROC
- in procedure $IPL370 or $IPLE.

All other situations cause ASI to prompt for a procedure name from SYSLOG. This can be done only when SYSLOG has been defined via REQUEST/ENTER; the SYSLOG device address specified in the ASI procedure will be ignored then.

Following is an example of a skeleton ASI IPL procedure:

```
01F,$$A$SUPX,N,NOLOG
ADD 180,3330
ADD 04C,2540R
.
.
.
DPD UNIT=180,CYL=400,DSF=N
.
.
.
DEF SYSREC=180
SVA
```

If your page data set is allocated to multiple extents, you should *place all* DPD commands necessary to define the extents into the procedure. This prevents the IPL program from prompting the operator to define the remaining extents.

The SET command should not be part of the ASI IPL procedure. The command must be given only if the time-of-day clock is inoperative or is not set; if this is the case, the operator will be prompted to provide the actual date values.

Contents of ASI JCL Procedures

ASI JCL procedures should contain all those job control commands or statements that you would normally submit during an interactive system start-up. Complete conceptional information on the use of job control commands is given in section *Controlling Jobs*, later in this chapter.

ASI Background Procedure. This procedure must contain all job control statements and commands necessary to initialize the BG partition and the system as a whole.

- ALLOC and ALLOCR commands to allocate space to the foreground partitions you intend to start.
- All permanent library definitions or assignments of logical units needed in the BG partition.
- The SIZE command if needed.
- // STDOPT command for the definition of standard (permanent) options (see Note 2, below).
- // OPTION STDLABEL, together with label information, to set up the system standard label subarea if it was not set up during a previous system initialization.
- // OPTION PARSTD, together with label information, to set up (background or foreground) partition standard label subareas if they were not set up during a previous system initialization.
- // JOB jobname for the initialization of RSMR recording and of the hard copy file.
- START Fn for each foreground partition to be started from this BG partition.
- STOP if the BG partition is to be spooled by VSE/POWER. The STOP command should immediately follow the START command for the VSE/POWER partition.

Notes: (1) The placement of the STOP and START commands, as given here for VSE/POWER, applies also to other permanently running programs such as VSE/ICCF or CICS/VS.

(2) It is advisable to place a // PAUSE statement before the following // OPTION statement (if any). This would give you a chance to enter the SET command if the recorder file or the hardcopy file needs to be (re)created. Or, you could enter CANCEL to bypass the writing of labels whenever you are sure that the label information is already set up the way you want.

ASI Foreground Procedure. This procedure must contain job control statements and commands necessary to initialize a particular foreground partition:

- // OPTION PARSTD, followed by label information, to set up the foreground partition standard label subarea if it was not set up during a previous system initialization or from the background partition.
- All permanent library definitions or assignments of logical units needed in the particular foreground partition.

Note that a foreground partition can be started through execution of the ASI BG-procedure or via VSE/POWER or via an attention routine START command.

SYSRDR or SYSIN cannot be assigned within a procedure. To cause automatic assignment of these logical units, specify the required ASSGN statement in the comment portion of the end-of-procedure statement:

```
/+ // ASSGN SYSIN,...
/+ // ASSGN SYSRDR,...
```

Only one // ASSGN statement can be specified as a comment. The command form (no //) is not allowed.

Example of an ASI JCL Procedure Set

Figure 3-4 shows a skeleton example of an ASI JCL procedure set. It assumes a 3-partition system with VSE/POWER running in the F1-partition. Figure 3-5 shows the associated sequence of VSE/POWER AUTOSTART commands on SYSIPT.

```
    * ASI PROCEDURE FOR BG
    ALLOC F1=300K,F2=200K
    ALLOCR F1R=80K,F2R=24K
    ASSGN SYSLNK,131
    ASSGN SYS001,131
    ASSGN SYS002,131
    ASSGN SYS003,131
    // PAUSE SET RF/HC ?
    // OPTION STDLABEL
    // DLBL IJSYSRS
    // EXTENT SYSRES,...
    // ...
    // OPTION PARSTD
    // DLBL IJSYS01
    // EXTENT SYS001,...
    // ...
1   // OPTION PARSTD=F1
    // DLBL IJSYSIN
    // EXTENT SYSIPT,SYSRES,,,4000,2
    // ...
2   // JOB ADAM
3   START F1
4   STOP
8   ASSGN SYSLST,PRINTER
    ASSGN SYSPCH,PUNCH
9   /+ // ASSGN SYSIN,00C,PERM
```

```
5   *  ASI PROCEDURE FOR F1
6   ASSGN SYSIPT,SYSRES
    ASSGN ...
7   // EXEC POWER
    /+
```

```
    * ASI PROCEDURE FOR F2
    // OPTION PARSTD
    // DLBL IJSYS01
    // EXTENT SYS001,...
    // ...
    ASSGN SYSLNK,130
    ASSGN SYS001,130
10  /+ // ASSGN SYSIN,00C,PERM
```

1 Label information is written to the F1 partition standard label subarea.

2 This // JOB statement initializes RSMR recording, and the hard copy file (if applicable).

3 Activates the F1 partition where VSE/POWER is to run.

4 Deactivates the BG partition which is to be spooled by VSE/POWER.

5 When the F1 partition becomes active, the ASI JCL procedure for F1 is called automatically.

6 Assigns SYSIPT to a disk file in which VSE/POWER AUTOSTART statements had been recorded in an earlier run of the OBJMAINT system utility.

7 Calls VSE/POWER which starts to read the AUTOSTART statements from the SYSIPT file. VSE/POWER starts the F2 partition at which point the F2 JCL procedure is executed. VSE/POWER also reactivates the BG partition.

8 The BG partition continues under control of VSE/POWER.

9 SYSIN is assigned to a spool device. The same happens

10 at the end of the F2 JCL procedure.

Figure 3-4. Example of an ASI JCL Procedure Set

```
     PSTART RDR,00C
     PSTART LST,00E
     PSTART PUN,00D
  1  PSTART F2,2        *** F2 ***
     READER=00C
     PRINTERS=00E
     PUNCHES=00D
  2  PSTART BG,0        *** BG ***
     READER=00C
     PRINTERS=00E
     PUNCHES=00D
     /*
```

1 Starts the F2 partition.

2 Reactivates the BG partition from where the VSE/POWER partition was started.

Figure 3-5. Example of VSE/POWER AUTOSTART Statements

Invoking VM/370 Linkage Support

You can generate a supervisor with the high performance VM/370 Linkage facility (VM=YES specified in the SUPVR generation macro as described in the preceding chapter). In order to invoke the support during VM/370 start-up, proceed as follows:

1. Log on in the normal way.

2. Prepare your virtual machine on which VSE is to operate (you may omit this step if your VM directory entries are already set):

   - If you use a supervisor with VM=YES in 370 mode, make sure that the storage size of the virtual machine is equal to or greater than the sum of 200K plus the VSIZE value as determined during IPL. The real address space available to the VSE system is given by the size that you defined for the virtual machine minus VSIZE. If you use a supervisor generated with VM=YES in ECPS:VSE mode, the entire virtual machine storage is available as VSE address space.

   - Set EC mode on by issuing the VM/370 command:

     ```
     SET EC ON
     ```

3. Perform IPL using as the virtual machine's load unit the device that contains your VSE. The IPL program already issued the commands:

   ```
   SET PAGEX ON
   SET RUN ON
   ```

4. If you wish to turn off the pseudo-page-fault handling support (only useful with more than one partition and processing multi-tasking applications), wait for message 0I20I, indicating that the IPL is completed, and then enter the VM/370 command:

   ```
   SET PAGEX OFF
   ```

   PAGEX should be used with care, especially in a high-paging environment where its use can aggravate the thrashing condition.

   Note: Some programs (such as VSE/ICCF or SDAID) need PAGEX to be set OFF. These programs automatically set PAGEX OFF. Therefore, be sure not to set it ON again.

Controlling Jobs

After the system has been successfully started by means of the IPL program, the following messages are displayed on the console:

```
BG 1I00A READY FOR COMMUNICATIONS
BG
```

This shows that the job control program is in the background partition ready to accept input.

At this point, the job control program will accept commands submitted through the console (SYSLOG). Job control's normal input source, however, is the logical unit SYSRDR.

Job control reads from SYSRDR if, at this point, you depress the ENTER key on the console without entering any commands. Normally, SYSRDR is assigned to a card reader or diskette device.

The unit of work that is submitted to the system for execution is called a *job*. A job, and the environment in which it is to run, must be defined to the system through job control statements and commands. These job control statements and commands are processed by the job control program which is automatically loaded into storage as required.

The job control program runs in virtual mode in any partition. It performs its functions only between jobs and job steps, and is not present in the partition while a problem program is being executed.

After each job control statement or command is read, control can be given to a user exit routine for examining and altering the input before it is processed by the system. For a description of this facility refer to *Chapter 4, Using the Facilities and Options of VSE/Advanced Functions.*

The difference between job control statements and commands are not discussed here because there is no need for a distinction in this section. Whenever applicable, it is simply stated whether the function can be performed using statements, commands, or both. The description of the job control statements and commands in this section is limited to their use and functions; formats and characteristics of statements and commands are detailed in *VSE/Advanced Functions System Control Statements.*

This section describes how to define a job, how to relate files to a program, and how to work with cataloged procedures.

Defining a Job

The beginning and end of a job are defined by the JOB and /& (end-of-job) statements.

If you have the Access Control facility of VSE/Advanced Functions implemented, you must also submit an ID statement which specifies your user identifier together with a password. For more information about this service, see the publication *Data Security Under the VSE System.*

The program to be executed in a job is requested through an EXEC statement. The occurrence of an EXEC statement is called a *job step*. Each job may consist of one or more job steps.

You may include as many job steps in a job as you wish. However, it is not advisable to execute, in one job, several programs that are completely independent of one another because, if one step terminates abnormally (and a // JOB statement was provided), the job control program ignores the remaining job steps up to the next /& or // JOB statement. A typical example of related job steps that should form a single job are assembling, link editing, and executing a program, where correct execution of one job step depends on successful completion of the preceding one. Figure 3-6 shows an example of a multistep job.

```
1  // JOB jobname
   .
2  .
   .
3  // EXEC PAYROLL
   .
   .
   .
3  // EXEC CHEX
   .
   .
   .
4  /&
```

1 Defines the beginning of a job. For jobname, you may specify a name of your own choosing.

2 Additional job control statements if required.

3 The two job steps. Job control is reloaded into storage at the end of each job step, enabling the reading of subsequent job control statements.

4 At the end of the CHEX program's execution job control is reloaded and reads the end-of-job indicator.

Figure 3-6. Control Statements Defining a Job Consisting of Two Job Steps

Following are some additional details about the job and end-of-job (/&) statements. The EXEC statement is discussed later in this chapter.

The JOB Statement. The JOB statement indicates the beginning of control information for a job. The specified job name is stored in the communication region of the corresponding partition and is used, for example, by job accounting and to identify listings produced during the execution of the job.

If the JOB statement is omitted, the system uses NO NAME as the job name. If the JOB statement is without a job name it is rejected by job control as an invalid statement. The JOB statement should not be omitted, as many VSE/Advanced Functions functions assume its presence. If, for example, the operator cancels a job using the attention routine CANCEL command, the job control program normally bypasses all statements on SYSRDR until encountering a /&. However, if the job in question was submitted without a JOB statement, no statements in the job stream are bypassed even though job NO NAME was canceled.

Having JOB statements with specific job names is useful when you issue the MAP command in a multiprogramming environment. The MAP command displays on SYSLOG the storage allocations for each partition, together with the name of a job that is currently active in the corresponding partition.

The JOB statement is always printed in positions 1 through 72 on SYSLST and SYSLOG; also, the time of day is printed. The JOB statement causes a skip to a new page before printing is started on SYSLST.

The End-of-Job (/&) Statement. This statement is the last one for each job (not job step). It signals the end of the input stream for the job. When job control encounters /& on SYSRDR during normal operation, the permanent assignment for SYSIPT becomes effective and SYSIPT is checked for an end-of-file condition.

If the /& statement is omitted, the next JOB statement will cause control to be transferred to the end-of-job routine to simulate the /& statement.

When a /& statement is encountered, the job control program performs such operations as the following:

- Resets all job control options for the partition to standard: either as established by the STDOPT command, or the system default if the particular option was not set through a STDOPT command.
- Resets all system and programmer logical unit assignments for the partition to the permanent assignment established by job control commands. Logical unit assignment is discussed under *Relating Files to Your Program* later in this chapter.
- Deactivates all temporary library chains for the partition.
- Modifies the communication region as follows:
  1. Resets the date from the DATE statement to the one specified in the SET command during IPL.
  2. Stores the job name NO NAME.
  3. Sets the user area and the UPSI byte to zero.

•

- Displays an end-of-job (EOJ) message on SYSLST and SYSLOG with the time and duration of the job.

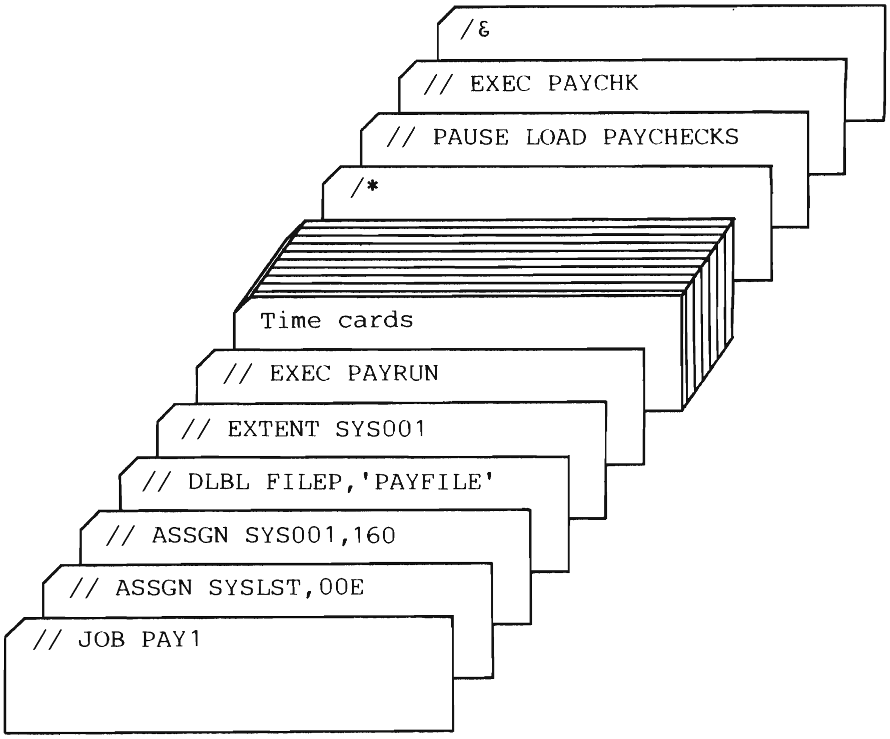
- Ensures that end-of-file has been reached on SYSIPT.

- Deletes the temporary labels in the label information area on SYSRES. (See *Storing Label Information*, later in this chapter.)

- Checks whether the condense limits of any of the libraries have been reached (if library maintenance has been done in the job).

Job Streams

The job control program provides automatic job-to-job transition. In other words, an unlimited number of jobs can be submitted to the system in one batch, and job control processes one job after the other without requiring intervention by the operator. The job or jobs submitted are referred to as a *job stream* (see Figure 3-7 for an example of a payroll jobstream).



```
// JOB PAY1
// ASSGN SYSLST,00E
// ASSGN SYS001,160
// DLBL FILEP,'PAYFILE'
// EXTENT SYS001
// EXEC PAYRUN
Time cards
/*
// PAUSE LOAD PAYCHECKS
// EXEC PAYCHK
/&
```

Figure 3-7. Example of a Job Stream

When setting up a job stream for a partition, you should bear in mind that all jobs will get the priority of that partition. The selection of the jobs for a particular partition in a multiprogramming system can help to improve the efficiency of your installation. For example, jobs which have a relatively low CPU usage and a relatively high rate of I/O activity, and which therefore spend most of their time waiting for the completion of

I/O operations, should run in a high priority partition. Conversely, CPU-bound jobs should be in a partition with a lower priority.

The operator may interrupt the processing of a job stream in any partition to make last-minute changes to one of the jobs or to squeeze in a special rush job. He does this by using the PAUSE statement or command.

A PAUSE statement may be included anywhere among the job control statements of a job stream (see Figure 3-7). It becomes effective at the point where it was inserted; processing is suspended in the affected partition, and the operator console is unlocked for input. The PAUSE statement can contain instructions to the operator and is always displayed on SYSLOG.

The PAUSE statement may also be helpful when SYSIN is assigned to a 5424 or 5425 card reader (neither of which have an end-of-file button). Place the // PAUSE card after the last /& card; this will force control to be given to the console-keyboard, which enables the console operator to control subsequent system operation.

A PAUSE command may be entered either through the operator console (after pressing the request key), or within a job stream together with the job control statements for a job. If entered through the console to the attention routine, the command must specify the partition that is to pause (if the background partition is intended, however, no operand is required). After encountering a PAUSE command, the system passes control to the operator (through the console) into the specified partition, at the end of the current job step (which may also be the end of the job). If that PAUSE command specifies the EOJ operand, control passes to the operator at the end of the current job, regardless of the number of steps needed to reach that point.

The macro JOBCOM allows you to do job-to-job communication. You may store information (up to 256 bytes) in one job to be passed to and retrieved by a subsequent job running in the same partition. *VSE/Advanced Functions Macro Reference* provides a detailed description of the JOBCOM macro.

Relating Files to Your Program

Most programs perform some kind of input/output operation (that is, they process files) on auxiliary storage devices. Before such files can be processed, certain information about them must be provided to the system. This information includes:

- The address of the I/O device on which each of the files resides.

- For files on direct access storage devices (DASD), the exact location of the file on the storage medium.

- For files on DASD, on diskette, or on labeled magnetic tape, a description of the file, called a label, which is used for checking and protection purposes.

The above information, specified in job control statements, is stored in the system by the job control program for use by the data management routines. How this is done is described below.

Symbolic I/O Assignment

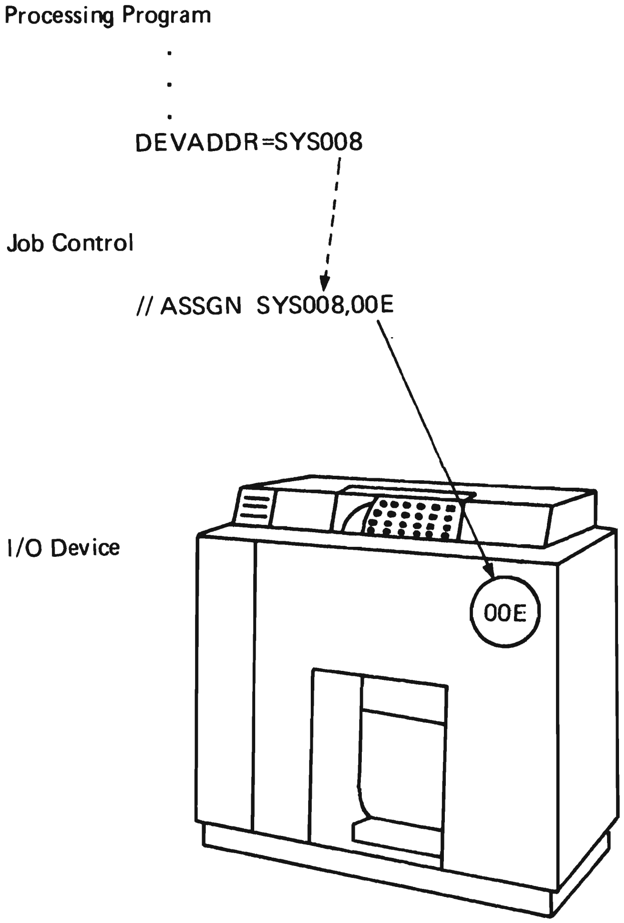
Whenever a processing program needs access to a file on auxiliary storage the program need not specify an actual device address, but only a symbolic name which refers to a logical, rather than physical, unit. Before the program is executed that logical unit must be associated with an actual device. This is done by the operating system when it executes an ASSGN job control statement or command which specifies the symbolic name of the logical unit and one of the following:

- A general device class or specific device type, with or without volume serial number.
- The physical address (channel and unit number) of the I/O device.
- A list of physical addresses.
- Another logical unit.

See Figure 3-8 for an illustration of some of these combinations.

ASSGN statements may be submitted as part of ASI JCL procedures or between jobs or job steps.

Another way of relating a file to a physical device can be employed if the file is a VSE library and is defined by the LIBDEF job control statement. Here the key parameter is the volume identifier (VOLID) of the library pack rather than the logical unit name; the operating system automatically finds the physical device address on which the volume with that particular VOLID is mounted. The LIBDEF statement and its use for defining libraries is described in section *Job Control for Library Definition*, later in this chapter.



1. The logical unit specified in the processing program (via DTF or CCB or IORB) is a print file referred to by the symbolic device name SYSLST.
2. An ASSGN statement is used to associate SYSLST with the physical address 00E of a printer. This information is stored in the system by job control and can be accessed when a program is executed.

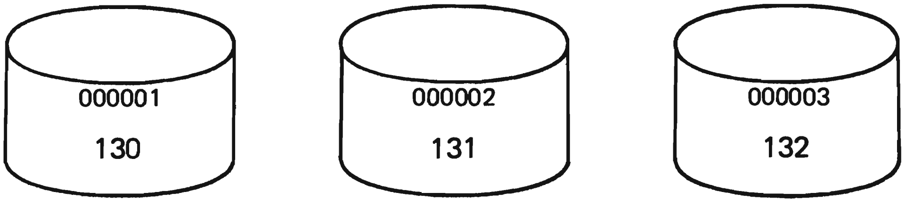
Figure 3-8. Example of Symbolic I/O Assignment (Part 1 of 2)

Processing Program

```
      .
      .
      .
DEVADDR=SYS002
```

Job Control

```
// ASSGN SYS002,(130,131) Ⓐ
// ASSGN SYS003,3330,VOL=000003 Ⓑ
// ASSGN SYS004,TAPE Ⓒ
```



Ⓐ Device list — if drive 130 is unassigned SYS002 will be assigned to it, if it is assigned the operating system tries 131.

Ⓑ Device type — the operating system searches for the device type (3330 in this case) that is available and has the volume-id 000003.

Ⓒ Device class — the operating system searches for an available tape device.

Figure 3-8. Example of Symbolic I/O Assignment (Part 2 of 2)

Logical Units

There are two types of logical units: *system logical units,* primarily used by the system control and service programs, and *programmer logical units,* primarily used by the processing programs. The following list shows the names, logical units and the I/O devices that each of these logical units can represent. In the case of disk devices, the logical unit is not assigned to the entire volume mounted on the device but only to the referenced extent(s).

Logical unit name	Type of I/O device
SYSRDR	Card reader, magnetic tape unit, disk device, or diskette used as input unit for job control statements or commands.
SYSIPT	Card reader, magnetic tape unit (single volume), disk, or diskette extent used as input unit for programs.
SYSPCH	Card punch, magnetic tape unit, disk, or diskette extent used as the unit for punched output.
SYSLST	Printer, magnetic tape unit, disk, or diskette extent used as the unit for printed output.
SYSLOG	Operator console used for communication between the system and the operator.
SYSLNK	Disk extent used as input to the linkage editor.
SYSRES	System residence extent on a disk pack.
SYSCLB	Disk extent used for a private core image library.
SYSSLB	Disk extent used for a private source statement library.
SYSRLB	Disk extent used for a private relocatable library.
SYSREC	Disk extent used to store error records collected by the recovery management support recorder (RMSR) function. If a display operator console (DOC) is installed, messages to or from the operator are stored in the hard copy file, a separate SYSREC extent so that a hard copy listing of these messages can be produced. A third SYSREC extent holds the system history file.
SYSDMP	Disk extent(s) for alternate dump file(s).
SYSCAT	Disk extent used to hold the VSAM master catalog.
SYSCTL	For system use.
SYSnnn	Format for coding programmer logical units which are discussed later in this section.

System Logical Units. All of the above logical unit names, except SYSnnn, represent system logical units. Of these system logical units, user-written programs may use SYSIPT and SYSRDR for input, SYSLST and SYSPCH for output, and SYSLOG for communication with the operator. All other system logical units may not be used within user-written programs (or EXTENT statements, which are discussed later in this section).

Two additional symbolic names, SYSIN and SYSOUT, are used under certain conditions:

SYSIN *Can* be used if you want to assign SYSRDR and SYSIPT to the same card reader or magnetic tape unit. You should not assign SYSRDR and SYSIPT to the same disk or diskette extent, assign SYSIN to that extent instead.

SYSOUT *Must* be used if you want to assign SYSPCH and SYSLST to the same magnetic tape unit. SYSOUT *cannot* be used to assign SYSPCH and SYSLST to disk or diskette because these two units must refer to separate extents.

SYSIN and SYSOUT are valid only to job control and cannot be referenced in a user-written program. Examples for the use of SYSIN and SYSOUT are given in the section *System Files on Tape, Disk, or Diskette* later in this chapter.

Programmer Logical Units. Programmer logical units may be assigned to any device installed on the system used for processing program input and output. Each partition has a minimum of 5 programmer logical units (except for the background partition where the minimum is 10) and a maximum of 255 (SYS000–SYS254). The number of programmer logical units is a supervisor generation option.

Types of Device Assignments

Device assignments are either permanent or temporary, depending on the time of the assignment and the type of ASSGN statement or command used.

Permanent Device Assignments. A permanent assignment is set up between jobs or job steps any time after IPL by the ASSGN job control command (no //) or the // ASSGN job control statement with the PERM operand. It is valid until the next IPL procedure unless superseded by another ASSGN job control command. A permanent assignment can be changed for the duration of a job or job step by a // ASSGN statement or by an ASSGN command with the TEMP option.

Temporary Device Assignments. A temporary assignment is established either by a // ASSGN statement or by an ASSGN command with the TEMP option. It is valid for a single job only, unless superseded by another temporary or permanent assignment. Temporary assignments are reset to permanent by

- a /& or JOB statement, whichever occurs first, or by
- a RESET job control statement or command.

Restrictions: The type of device assignment is restricted under certain conditions:

1. If one of the system logical units SYSRDR, SYSIPT, SYSLST, or SYSPCH is assigned to a disk device or diskette, the assignment must be permanent. If SYSCLB is assigned, its assignment must also be permanent.
2. If SYSRDR and SYSIPT are to be assigned to the same disk or diskette extent, SYSIN should be assigned instead, and this assignment must be permanent.
3. SYSOUT, if used, must be a permanent assignment.
4. The SYSLOG assignment is restricted when IPL was done from either a 125D or 3277 device. You may not assign SYSLOG to a 125D if IPL was done from a 3277 and vice-versa.

Device Assignments in a Multiprogramming System

Each partition has its own set of system logical units. For example, the BG partition has a SYSRDR, SYSLST, SYSIPT etc. as do all the other generated partitions. As each partition is started, assignments must be made for the system logical units. Some assignments need be made only in one partition and are valid for all partitions. These are logical units that service the system rather than one partition. The page data set and the lock communication file (defined via the DPD and DLF commands, respectively) and the following units fall into this category:

logical name	how assigned
SYSLOG	ASSGN job control commana
SYSREC	DEF IPL command
SYSDMP	DEF IPL command
SYSCTL	automatically assigned by the system
SYSRES	disk address entered at IPL
SYSCAT	DEF IPL command

All of the other system logical unit assignments must be made for each individual partition.

Each partition also has its own set of programmer logical units (SYS000 through SYSnnn) where nnn is the number of programmer logical units specified for the partition minus 1.

You must make assignments of the programmer logical units as needed by the programs running in each partition. Certain IBM supplied programs require specific programmer logical unit assignments. For example the linkage editor requires SYS001 and the assembler requires SYS001, SYS002, and SYS003.

Sharing Assignments. Within the same partition, different logical units may be assigned to the same physical device. For example:

```
   // ASSGN SYSLST,00E
   // ASSGN SYS007,00E
```

Both logical names SYSLST and SYS007 are assigned to the device at address 00E.

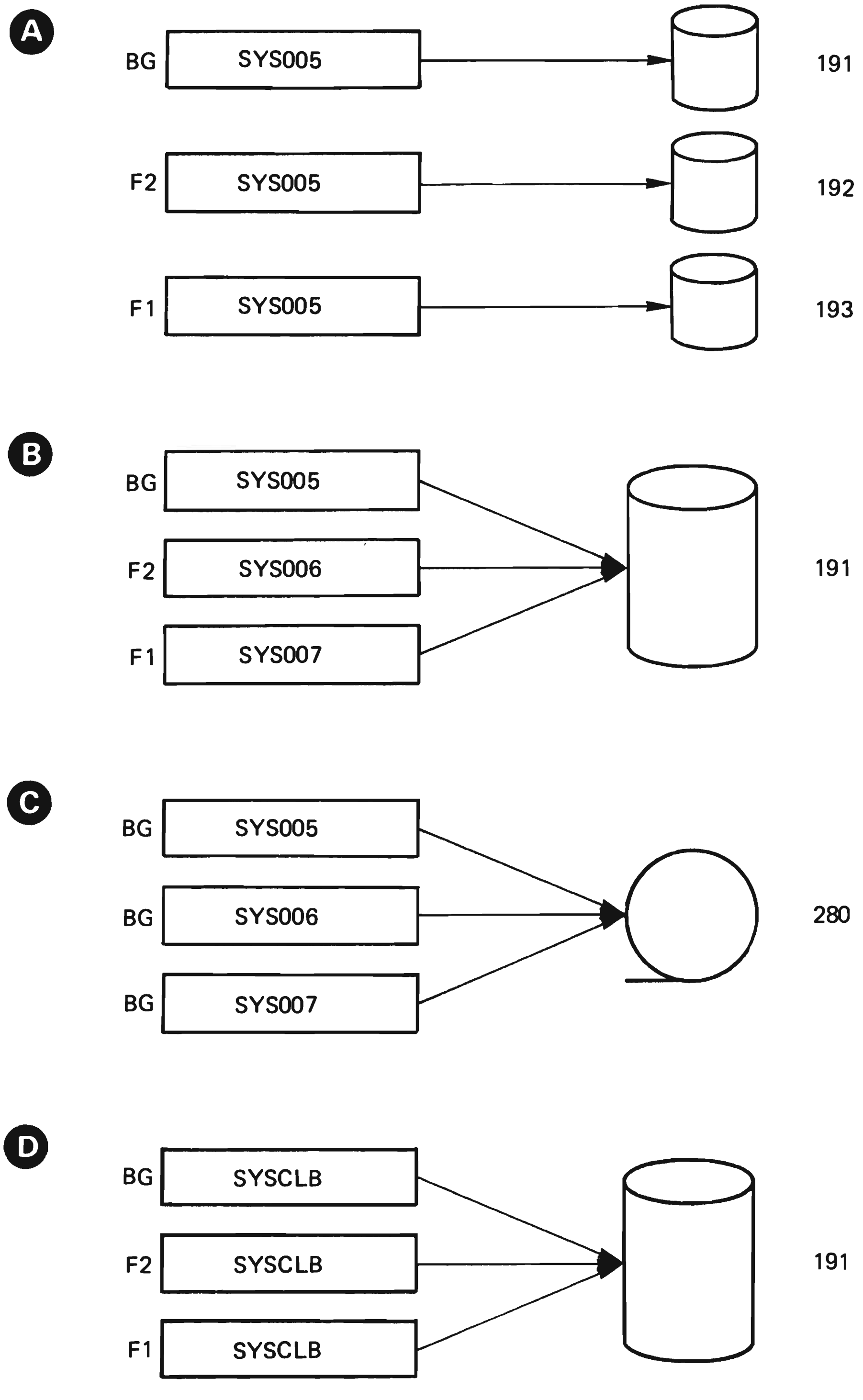
Normally it is not possible to share physical devices (except DASD) between partitions. For example if you have a tape drive assigned to the BG partition, but not used by that partition, you must first unassign it in BG before attempting to assign it in F2. If, however, you use a spooling package, such as the licensed program VSE/POWER, you can share unit record devices (card reader, card punch, for example) and diskette between partitions (see the licensed program VSE/POWER documentation for more details).

With direct access devices this problem does not exist because each extent on a disk can be thought of as a separate device.

Furthermore, if programs in several partitions need only to read and not to update a file on disk, the one extent may be assigned to all of those partitions. Certain VSE service programs (for example, the librarian programs) are allowed to share a library even for updating. A library is not defined as a disk volume, only as an extent on the disk volume. The assignment from each partition where a librarian program is running is to the same extent. Extents are discussed under *Processing of File Labels* in this chapter.

It is not possible to share a diskette between partitions.

Figure 3-9 illustrates possible device assignments.



Ⓐ Each partition has its own set of programmer logical units.

Ⓑ Each assignment must be for a separate extent on the disk unless the partitions only have to read a file and not update it.

Ⓒ These assignments allow access to the tape volume by three different logical unit names. No assignments to this tape are valid from a partition other than BG at this time.

Ⓓ This example assumes that librarian programs update the same library; the assignments are for one extent.

Figure 3-9. Possible Device Assignments

Figure 3-10 shows the logical units needed for an assembly. The illustration shows that the ASSGN statements must always precede the EXEC statement of the job step for which they are to be effective. (The device assignments for compilers are similar to the device assignments shown in this assembler example; any variations are documented in the applicable programmer's guides.)

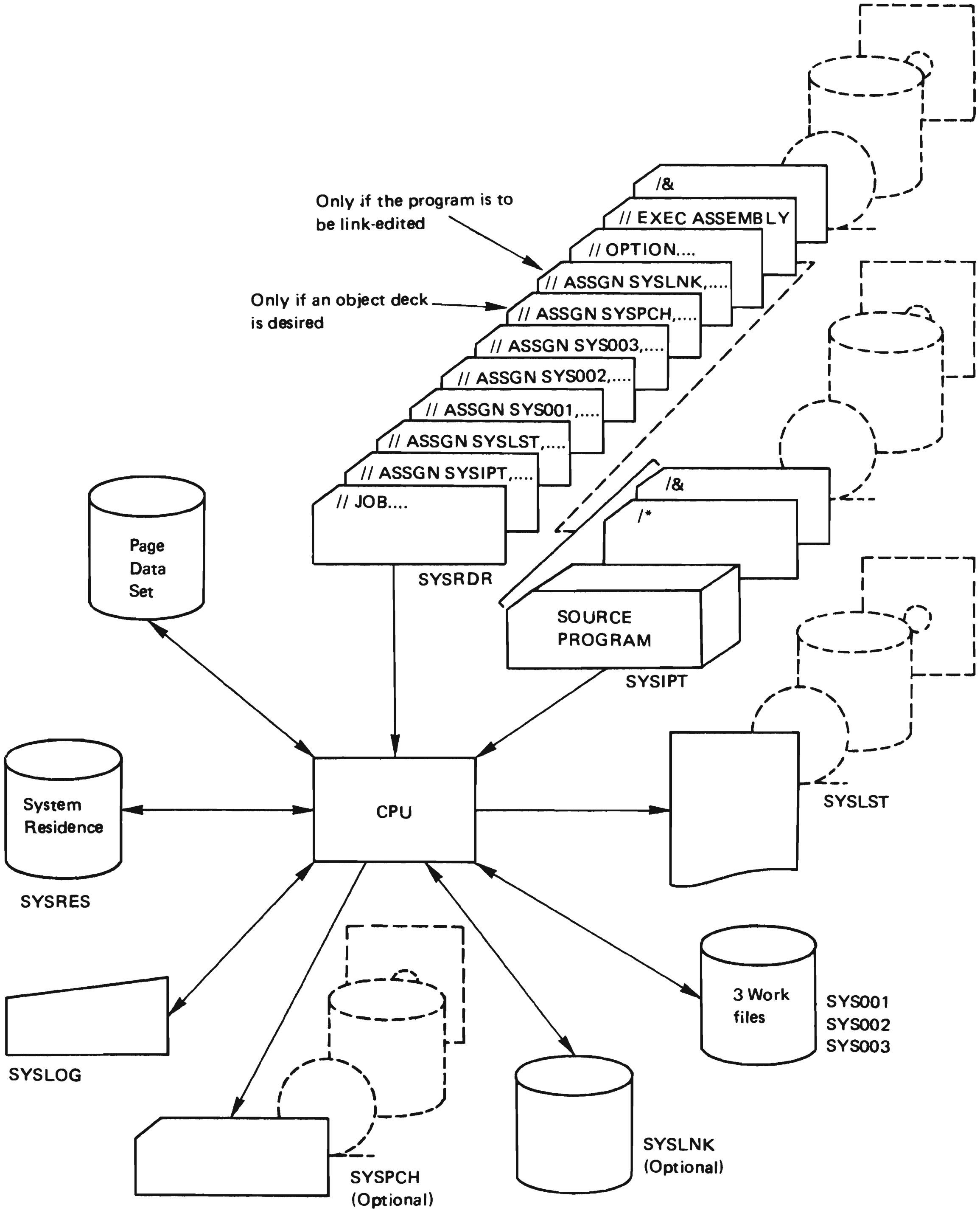


Figure 3-10. Device Assignments Required for an Assembly

Additional Assignment Considerations

The following summarizes the functions of the job control ASSGN statement (or command). Also included are statements (commands) that can be used with logical unit assignments.

The ASSGN Statement/Command. The ASSGN statement or command is used to connect a logical I/O unit to a general device class, a specific device type, a physical device or a list of physical devices, or another logical unit. An ASSGN statement or command can also be used:

- to specify a temporary or permanent assignment.
- to specify a volume serial number for a tape, disk, or diskette.
- to specify that a disk is shareable by more than one partition or logical unit.
- to unassign a logical unit to free it for assignment to another partition.
- to ignore the assignment of a logical unit, that is, program references to the logical unit are ignored (useful in testing and certain rerun situations).
- to specify an alternate tape unit to be used when the capacity of the original is reached.

The assignment routines check the operands of the ASSGN statement/ command for the relationship between the physical device, the logical unit, the type of assignment (permanent or temporary), etc. The following list summarizes the most pertinent items to remember when making assignments:

- Assignments are effective only for the partition in which they are issued.
- Apart from the operator console, no physical device except DASD can be assigned to more than one active partition at the same time.
- All system input and output file assignments to disk or diskette must be permanent.
- SYSIN must be assigned if both SYSRDR and SYSIPT are to be assigned to the same extent.
- SYSOUT cannot be assigned to disk or diskette; it must be a permanent assignment if assigned to tape.
- SYSLNK must be assigned before issuing the LINK or CATAL option in an OPTION statement; otherwise, the option is ignored and the message 'PLEASE ASSIGN SYSLNK' is issued to the operator.
- Before a tape unit is assigned to SYSLST, SYSPCH, or SYSOUT, all previous assignments to this tape unit must be permanently unassigned. This may be done by using a DVCDN command as discussed below.

- The assignment of SYSLOG cannot be changed while a foreground partition is active.
- SYSRES, SYSCAT, SYSREC, SYSDMP, the page data set and the lock communication file can never be assigned by an ASSGN statement or command. An IPL is required to change these assignments.

The RESET Statement/Command. The RESET statement or command can be used to reset temporary assignments of a partition to permanent. With one RESET statement or command you can reset

- all logical units.
- all system logical units.
- all programmer logical units.
- one specific system or programmer logical unit.

The LISTIO Statement/Command. With the LISTIO statement or command you can obtain a listing of the current status of the I/O assignments in your system. This may be done for all devices or individual devices as required. If the LISTIO command is used (no //), the output goes to SYSLOG, otherwise the output is on SYSLST.

The DVCDN Command. The DVCDN (device down) command informs the system that a device is no longer physically available for system operations. This command releases all logical assignments to the device.

When the device becomes available again for system operations, a DVCUP (device up) command must be given and new assignments made, before the device may be used.

The DVCUP Command. The DVCUP (device up) command informs the system that a device is available for system operations after it has been down.

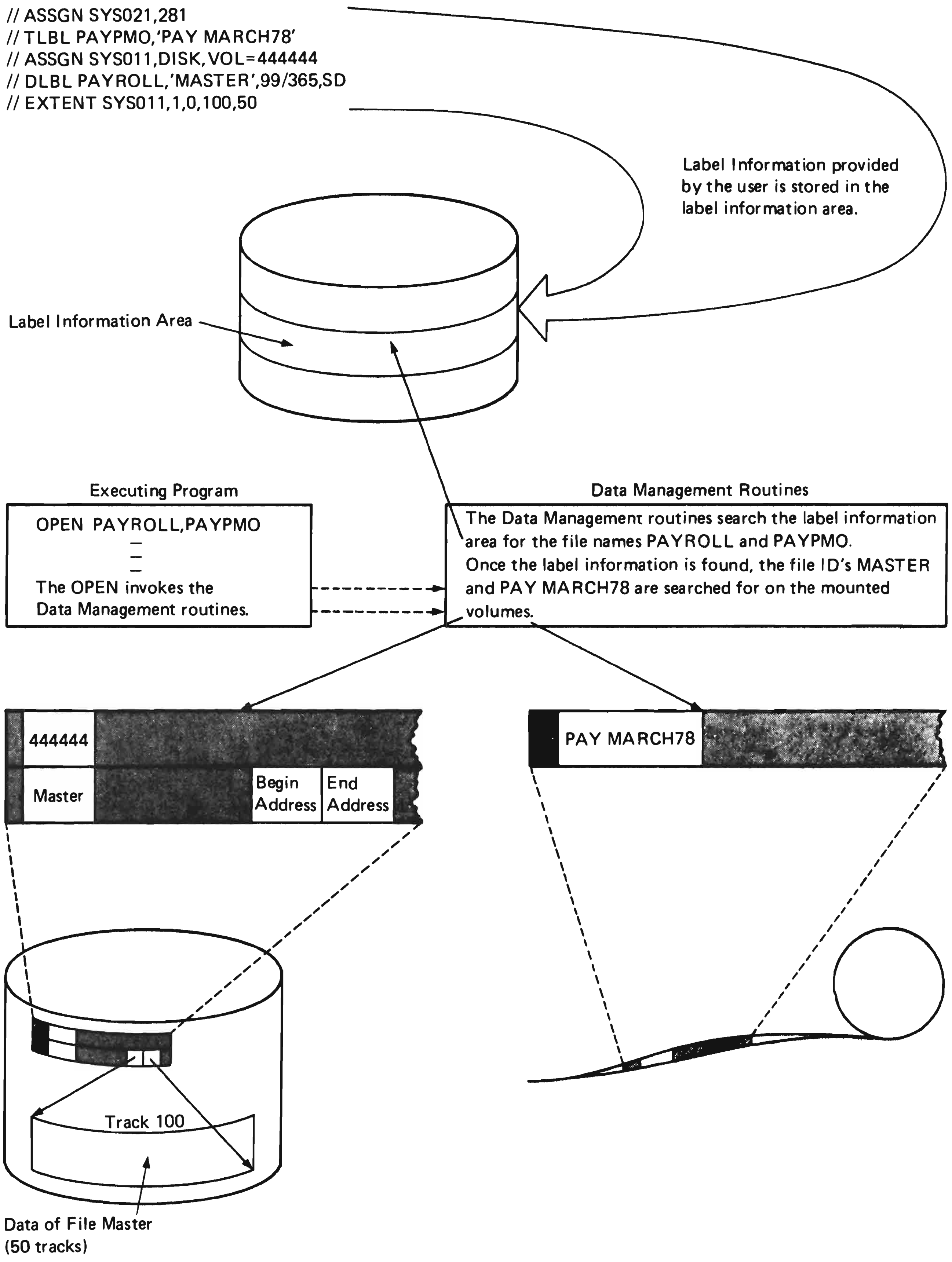
Processing of File Labels

As shown above, the operating system relates physical devices to logical names, used in programs, via the ASSGN job control statement (or command). Certain device types (magnetic tape, disk, and diskette) have removable volumes. It is important to ensure that the volume(s) containing the file(s) to be processed are present on the assigned device(s). Magnetic tape, disk and diskette files are identified through file *labels* which are processed by the data management routines. Magnetic tape file labels are optional, though desirable for reasons of data integrity. Disk and diskette file labels are required.

File labels are written when a file is created based on label information submitted through job control statements.

To write a file label on magnetic tape, job control uses the // TLBL statement. This label is written immediately preceding the associated file.

To write a file label on disk or on diskette, job control uses the // DLBL and // EXTENT statements. The label is written into the volume table of contents (VTOC), and a utility program, LVTOC, is available to list all labels included in this VTOC. Details on the DLBL and EXTENT statements are given in *VSE/Advanced Functions System Control Statements*. When a labeled file is to be processed, the required // TLBL, // DLBL and // EXTENT information must be available, so that job control can perform the desired label checking on your existing file. Figure 3-11 shows the relationship of label information that you provide by the above mentioned statements to file labels and programs. For a detailed discussion of label processing, refer to *VSE/Advanced Functions DASD Labels* and *VSE/Advanced Functions Tape Labels*.



```
// ASSGN SYS021,281
// TLBL PAYPMO,'PAY MARCH78'
// ASSGN SYS011,DISK,VOL=444444
// DLBL PAYROLL,'MASTER',99/365,SD
// EXTENT SYS011,1,0,100,50
```

Label Information provided by the user is stored in the label information area.

Executing Program

```
OPEN PAYROLL,PAYPMO
        –
        –
        –
```

The OPEN invokes the Data Management routines.

Data Management Routines

The Data Management routines search the label information area for the file names PAYROLL and PAYPMO. Once the label information is found, the file ID's MASTER and PAY MARCH78 are searched for on the mounted volumes.

Figure 3-11. File Label Processing

The // TLBL, // DLBL, and // EXTENT job control statements may be submitted with each execution of a given program that processes labeled files. Job control temporarily stores these statements in the label information area. A recommended alternative for frequently accessed files is to permanently store the label information in the label information area. The section *Storing Label Information* later in this chapter describes how to permanently store label information.

When the program that processes the file is executed, the data management routines access the label information

- to write the appropriate labels onto the storage volume, and to check that no unexpired files are overwritten, if the file is to be created, or
- if an existing file is to be processed, to check the contents of the label information area against the label(s) of the file to ensure, for example that the correct volume is mounted.

The first two parameters of both the // TLBL and // DLBL statements are the same:

```
// TLBL filename,'file-id'
// DLBL filename,'file-id'
```

The filename is *not* part of the file label. You code a filename in your program to identify your file.

- In assembler language it is the DTF (Define The File) name.
- In DOS/VS RPG II it is the FILENAME.
- In DOS/VS COBOL it is the name specified in the SELECT clause.
- In PL/I it is the identifier (with the FILE attribute) in the DECLARE statement.
- In FORTRAN it is the file name associated with the data set reference number.

The filename from your program is used as a search argument by the data management routines in searching for label information in the label information area. Accordingly you must code a matching filename in your // TLBL or // DLBL statements.

The file-id *is* part of the file label. After the DLBL or TLBL statements are located (based on filename), the file-id is used to:

- create a label for an output file.
- locate and check the labels of an input file.

Example of label checking:

```
// JOB UPDATE
// ASSGN SYS007,00C
// ASSGN SYS008,280
*   PLEASE MOUNT CURRENT ACCOUNTS RECEIVABLE TAPE
// PAUSE
// TLBL ACCT,'ACCTS.REC.FILE'
// EXEC UPDATE
data cards
/*
// MTC REW,SYS008
// ASSGN SYS010,280
// ASSGN SYS007,00E
// TLBL ARFILE,'ACCTS.REC.FILE'
// EXEC ARREPORT
/&
```

The two programs UPDATE and ARREPORT access the same file 'ACCTS.REC.FILE'. The two programs happen to use different file names and different programmer logical units.

UPDATE opens a file named ACCT on logical unit SYS008 and ARREPORT opens a file named ARFILE on SYS010. In both cases the file accessed is 'ACCTS.REC.FILE'. If the two programs had used the same file name and programmer logical units, one ASSGN statement and one // TLBL statement permanently stored in the label information area would suffice.

Label Information for Files on Diskette Devices

After you have informed the system, via the ASSGN statement or command, on which physical device the file is to reside, you must supply the following information to allow the creation and checking of diskette labels:

1. A description of the characteristics of the file. You specify this in the DLBL job control statement.

2. The volume(s) the file is contained on. You specify this in one or more EXTENT job control statements.

The label information you supply in the DLBL job control statement may include the following:

- The name of the file. This name must be identical to the corresponding file name specified in your program. For programs written in assembler language, this would be the name of the DTF.

- An identification of the file. This name is the one contained in the file label on the diskette. It is associated with the file name via the DLBL statement.

- The expiration date of the file.

- The type of access method used to process the file; always coded as DU.

A diskette file consists of a data area on one or more volumes; each volume contains only one data area for a particular file. For each of these data areas, called extents, you must supply the following information on an EXTENT job control statement:

- The symbolic name of the device on which the volume containing the file is mounted.
- The serial number of the volume.
- The type of extent; always coded as 1.

In the following example, the program CREATE creates a diskette (DU) file named SALES that has a file-id of MONTHLY and is to be retained for 30 days. The file comprises up to three diskettes. The diskettes have the volume serial numbers 111111, 111112, and 111113, and are mounted on the drive assigned to the symbolic device named SYS005.

```
// JOB EXAMPLE
// ASSGN SYS005,060
// DLBL SALES,'MONTHLY',30,DU
// EXTENT SYS005,111111,1
// EXTENT SYS005,111112,1
// EXTENT SYS005,111113,1
// EXEC CREATE
/&
```

The job control program checks the DLBL and EXTENT statements for correctness and stores the supplied information in the label information area for the duration of the job (see *Storing Label Information* later in this chapter).

Label Information for Files on Direct Access Devices

After you have informed the system, via the ASSGN job control statement or command, which volume or physical device you want, you must supply the following information to allow the creation and checking of DASD labels:

1. A description of the characteristics of the file. You specify this in the DLBL job control statement.
2. The exact location of the file on the storage medium. You specify this in one or more EXTENT job control statements.

The label information you supply in the DLBL job control statement may include the following:

- The name of the file. This name must be identical to the corresponding file name specified in your program. For programs written in assembler language this would be the name of the DTF.
- An identification of the file which may include generation and version numbers of the file. This name is the one contained in the file label on the storage device. It is associated with the file name via the DLBL statement.

- The expiration date of the file.

- The type of access method used to process the file.

- An indication of whether or not a data secured file is to be created.

- The blocksize to be used for this file on an IBM 3330-11 or 3350 device.

- The control interval size (CISIZE) if your file is a sequential disk file and resides on an FBA device.

A DASD file can consist of one or more data areas on one or more volumes. For each of these data areas, called extents, you supply the following information on an EXTENT job control statement:

- The symbolic name of the device on which the volume containing the file extent is mounted.

- The serial number of this volume.

- The type of the extent. An indexed sequential file, for instance, can consist of data areas, index areas, and overflow areas. For each of these areas an extent must be defined, and its type (data, index, or overflow) must be specified.

- The sequence number of the extent within the file.

- For CKD devices:

  The number of the track (relative to zero) on which the file extent begins.

  The amount of space (in tracks) the file occupies.

- For FBA devices:

  The block number on which the file extent begins.

  The amount of space (in blocks) the file occupies.

Examples for Submitting Label Information for DASD Files. Here are a number of examples of how to code the job control statements required to create or access the labels for the various types and organizations of DASD files. It is helpful if you are familiar with the formats of the DLBL and EXTENT job control statements as described in *VSE/Advanced Functions System Control Statements*. Detailed information on the possible organizations and access methods for DASD files is given in *VSE System Data Management Concepts*.

Sequentially Organized Disk Files (Single Drive, Single Volume). In the following example, the program CREATE creates a sequential disk (SD) file named SALES that is to be retained until the end of 1980. The file comprises one extent of 190 tracks on a CKD device, starting on relative track number 1320. The disk pack has the volume serial number 111111 and is mounted on the drive assigned to the symbolic device name SYS005:

```
// JOB EXAMPLE
// ASSGN SYS005,DISK,VOL=111111,SHR
// DLBL SALES,'ANNUAL SALES RECORDS',80/365,SD
// EXTENT SYS005,111111,1,0,1320,190
// EXEC CREATE
/&
```

The job control program checks the DLBL and EXTENT statements for correctness and stores the supplied information in the label information area for the duration of the job or job step.

Sequentially Organized Disk Files (Single Drive, Multivolume). Assume that a program PROG100 needs a sequential disk file located on three different disk packs that are to be mounted successively on the same device (SYS005). The file consists of four extents on an FBA device: two on the pack with serial number 000020, one on pack 000100, and one on pack 000006. The following job stream shows the label statements required:

```
   // JOB SAMLABEL
   // ASSGN SYS005,DISK,VOL=000020,SHR
1  // DLBL FILNAME,'FILE ID',99/365,SD
   // EXTENT SYS005,000020,1,0,10,2010
   // EXTENT SYS005,000020,1,1,4000,1510
   // EXTENT SYS005,000100,1,2,64,1300
   // EXTENT SYS005,000006,1,3,50,636
2  // EXEC PROG100
3  /&
```

1 Only one DLBL statement is required. For each extent one EXTENT statement must be supplied in the sequence in which the extents are processed.

2 Logical IOCS in PROG100 opens the first extent using the file name and file ID in the DLBL statement, and the logical unit and volume serial number in the first EXTENT statement to locate the actual label on the disk pack. After PROG100 has processed the first extent, logical IOCS opens the second extent, based on the extent sequence number.

For the third extent, volume serial number 000100 is specified while the volume currently mounted on SYS005 has the number 000020. The OPEN routine of LIOCS notifies the operator of this discrepancy, and the operator can mount the correct volume, at which time the OPEN routine regains control. The same is true for the fourth extent.

3 The /& statement causes the label information stored in the label information area to be cleared. Thus, if the next job requires the same file, the label statements must be resubmitted (see *Storing Label Information* later in this chapter).

Sequentially Organized Disk Files (Multiple Drives). This example has the same requirements as the preceding 'Single Drive' example except that the three volumes are mounted on three different drives. The required job control statements are as follows:

```
   // JOB SAMLABEL
   // ASSGN SYS005,DISK,VOL=000020,SHR
   // ASSGN SYS006,DISK,VOL=000100,SHR
   // ASSGN SYS007,DISK,VOL=000006,SHR
1  // DLBL FILNAME,'FILE ID',99/365,SD
   // EXTENT SYS005,000020,1,0,10,2010
   // EXTENT SYS005,000020,1,1,4000,1510
   // EXTENT SYS006,000100,1,2,64,1300
   // EXTENT SYS007,000006,1,3,50,636
2  // EXEC PROG100
   /&
```

1 All label statements submitted are identical to the 'Single Drive' example except for SYSnnn in the EXTENT statements.

2 Logical IOCS opens each extent in the same way as described in the 'Single Drive' example except that processing does not stop for removal and mounting of packs, because enough devices are online to contain the file. A combination of this and the 'Single Drive' example could be used to reduce handling time without excessively increasing the total drive requirements.

DA Files. The program PROG101 processes a direct access file consisting of four extents contained on three CKD disk packs. The three packs must be ready at the same time. The following job stream shows the label statements required to process the file:

```
   // JOB DALABEL
   // ASSGN SYS005,DISK,VOL=000065,SHR
   // ASSGN SYS006,DISK,VOL=000025,SHR
   // ASSGN SYS007,DISK,VOL=000002,SHR
1  // DLBL FILNAME,'FILE ID',99/365,DA
   // EXTENT SYS005,000065,1,0,1320,190
   // EXTENT SYS005,000065,1,1,80,740
   // EXTENT SYS006,000025,1,2,50,906
   // EXTENT SYS007,000002,1,3,1275,64
   // EXEC PROG101
   /&
```

1 The label statements follow the same pattern as for sequential files (described in the preceding examples) except that the DLBL statement must specify DA to indicate direct access.

Note: Library files are single extent, single drive files. You specify the label information as for sequentially organized disk files, but you must never include the CISIZE or BLKSIZE parameter.

Label Information for Files on Magnetic Tape

Files on magnetic tape can be processed with or without labels. For tape files with IBM standard labels, the label information must be submitted through the TLBL job control statement. (A tape file can also have standard-user or non-standard labels; for these labels no job control statements are required. More information on tape labels is given in *VSE System Data Management Concepts*).

The standard label information submitted in the TLBL statement may include the following:

- The name of the file. This name must be identical to the corresponding filename (DTF name) specified in your program.

- An identification of the file.

- Creation date for input and expiration date (or retention period) for output files.

- The volume serial number of the tape reel that contains the file.

- For files that extend over more than one volume, the sequence number of the volume.

- For volumes that contain more than one file, sequence number of the file.

- The version and modification number of the file.

As with DASD files, the label information you supply in the TLBL job control statement is checked and stored in the label information area (see *Storing Label Information*, below).

Storing Label Information

Job control stores label information in the label information area. The label information is stored temporarily (for the duration of one job or job step) or permanently.

As label information is submitted, the job control program acquires a portion of the label information area which is referred to as a label subarea.

The minimum size of a label subarea is one track for a CKD device and 2K for an FBA device, the maximum size is the entire label information area. There are three types of label subareas:

- partition temporary subarea

- partition standard subarea

- system standard subarea

Label information stored in either of the two types of *partition* subareas may be accessed only from one particular partition. Label information stored in the *system* subarea may be accessed from all partitions. The type of subarea used is controlled by the following three options of the OPTION job control statement:

USRLABEL causes all DASD, diskette, and tape label information to be stored temporarily for one job or job step. Label information submitted between job steps overlays the label information from the former job step. The label information is written to a partition temporary subarea (one per partition) and is accessible only by the partition in which it was submitted. It is a good idea to include all TLBL, DLBL, and EXTENT statements in the first step of a job (preceding the // EXEC statement). If no option is specified, or if the OPTION statement is omitted, USRLABEL is assumed.

PARSTD causes DASD, diskette, and tape label information to be stored permanently for all subsequent jobs. The label information is written to a partition standard subarea (one per partition) and is accessible only by the partition for which it was submitted.

Partition standard labels can be submitted in the partition to which they belong. *Foreground* partition standard labels can also be submitted through a job running in the background partition. The job stream must contain the following statement:

```
// OPTION PARSTD=Fn
```

All label information following this statement is put into the partition standard subarea of partition Fn (n is the number of the foreground partition). The above statement can be given only when partition Fn is inactive.

STDLABEL causes DASD, diskette, and tape label information to be stored permanently for all subsequent jobs. The label information is written to *the* system standard subarea and is accessible by all partitions, but can only be submitted in the background partition. This ensures that the system standard label information is not updated simultaneously by two partitions. Logical unit numbers contained in the submitted label information must not be greater than the highest logical unit number specified for background at system generation.

When PARSTD or STDLABEL is given without an operand, any label information currently in the respective subarea is completely overwritten by the newly supplied data. If you want to retain the old label information and only add more labels to it, code the parameter as PARSTD=ADD or STDLABEL=ADD, respectively.

Specifying

```
// OPTION PARSTD=DELETE  or

// OPTION STDLABEL=DELETE
```

causes labels to be deleted from the respective subarea. Such a statement must be followed by one or more statements of the form

```
filename
```

where filename indicates which label is to be deleted. The last filename statement must be followed by a /*. A DELETE operation is somewhat time-consuming because the label is physically deleted from the label area, and the label area space is condensed each time a DELETE request is processed.

An ADD or DELETE specification can only be given from a job running in the pertinent partition; therefore, ADD and DELETE are not allowed in conjunction with PARSTD=Fn.

Note: When the label information area is located on an FBA disk device, the operating system blocks user-supplied label information before writing that information to disk. Therefore, you should terminate your // OPTION PARSTD or // OPTION STDLABEL job stream with a // OPTION USRLABEL statement. This ensures that all label information is actually written to the label information area as permanent partition or system standard labels. Labels in the system standard subarea are accessible from other partitions only after they have been written completely. The OPTION statement with USRLABEL specified indicates to the operating system that no further partition or system standard labels will follow. The same effect is accomplished by a /&, // JOB, or // EXEC statement.

A partition can have only *one* temporary and *one* standard subarea at any point in time. As the subareas are variable in size it is possible that disk space is not available in the label information area when job control attempts to write label information. When this occurs, a message will be displayed on the console stating that the label area is exhausted. To clear a subarea (in order to run the current job), you can do one of the following:

- Submit a /& in another partition to clear that partition's temporary subarea.
- Submit a // OPTION PARSTD followed by a /& in any partition to clear that partition's standard subarea.

Do not clear the system standard subarea. If you find that the system standard subarea is using more disk space than you want, reorganize your label information area. For example if you have an application that always runs in the same partition (such as the licensed program VSE/POWER) the labels for that application should be put on that partition's standard label subarea, not the system standard subarea.

During program execution, the data management routines search the label information area in the following sequence:

(1) user label information (partition temporary subarea)

(2) partition standard information (partition standard subarea)

(3) system standard information (system standard subarea).

It is important to distinguish between the conditions under which a label *option* remains in effect and the conditions that govern the retention of the label *data* in the label information area. For example, the label data submitted following an OPTION statement with the PARSTD option is retained for all subsequent jobs until overwritten by another PARSTD option, but the PARSTD option is canceled at the end of the job or job step in which it was specified. This is shown in the summary of label options in Figure 3-12.

Option in search sequence	Type of label information	Option in effect until	Label information retained	For
USRLABEL[1]	temporary	STDLABEL or PARSTD is specified.	for one job. The / & statement causes the temporary label area to be cleared.[4]	the partition in which the option was specified.
PARSTD	permanent	a) end of job step b) end of job c) USRLABEL or STDLABEL is specified.[5]	for all subsequent jobs until deleted.[2]	the partition in which the option was specified, or as specified in PARSTD=Fn.
STDLABEL	permanent	a) end of job step b) end of job c) USRLABEL or PARSTD is specified.[5]	for all subsequent jobs until deleted.[2]	all partitions.[3]

[1] If no option is given or if the OPTION statement is omitted, USRLABEL is assumed.

[2] Either explicitly deleted (=DELETE) or by giving the option without an operand.

[3] Label information stored with the STDLABEL option is available to all partitions but can be submitted only through the background partition.

[4] Additional label information from a subsequent job step will overlay previous label information.

[5] It is recommended that a USRLABEL option be submitted following the PARSTD or STDLABEL job stream when SYSRES is on an FBA device.

Figure 3-12. Summary of Label Option Functions

By permanently storing the label information for a disk file in the label information area, the operating system relates that file to the type of the device which is assigned to the pertinent logical unit when this file is processed for the first time. A later attempt to use this label information for the same file (and extent) on a different device type causes the job to be canceled. If a different device type has to be used for this file, the label statements must be resubmitted and the pertinent logical unit assigned to the device of the new type.

Stored label information may be displayed using program LSERV as follows:

```
// JOB
// EXEC LSERV
/*
/&
```

Job Control for Library Definitions

Libraries must be defined to job control. One means of defining a library is the job control ASSGN (statement or command) together with DLBL/EXTENT information. If you include, for example,

```
ASSGN SYSCLB,cuu
```

in a linkage editor job stream, you tell the linkage editor program to place a phase into a private core image library.

Establishing a Library Definition

The ASSGN statement is applicable to any file. For libraries only, a more versatile job control statement is available to define the libraries to be accessed: the LIBDEF statement.

A LIBDEF definition may be established permanently, that is, for all succeeding jobs (parameter PERM specified) or only for the duration of the job (by default or parameter TEMP specified). As with the ASSGN statement, DLBL and EXTENT information must be available when the LIBDEF statement is processed.

Each parameter in the LIBDEF statement addresses a particular library access:

Library Chaining (Concatenation). The SEARCH parameter allows to establish a chain of libraries. The chain is given through a list of file names that correspond to file names in DLBL statements, for example:

```
// DLBL YOURLIB,...
// EXTENT ,111111,...
// DLBL MYLIB,...
// EXTENT ,222222,...
// LIBDEF CL,SEARCH=(YOURLIB,MYLIB)
```

The position within the list determines the sequence in which libraries are searched for a given member. When, in the above example, a phase is to be FETCHed or LOADed, two private core image libraries are searched for that phase: first the library YOURLIB, and then, if the phase is not found there, library MYLIB.

Each type of library requires its own LIBDEF, with a corresponding identifier:

CL – for a FETCH or LOAD, or the processing of a SET SDL command from a core image library

RL – for retrieval of object modules by the linkage editor

SL – for retrieval of source statements by a language translator

PL – for retrieval of cataloged procedures.

When you define, for a particular library type, two chains, one temporary and one permanent, the temporary chain will be searched prior to the permanent chain. The system library is always assumed to be the last member of the chain; of the permanent chain if one is defined, otherwise of the temporary chain. You don't have to explicitly include it in the SEARCH list. If you want to place the system library at a different position within the chain, you include that library in the list of file names at the desired position. Whatever the library type, you identify the system library by the name IJSYSRS.

Special conditions apply to the search order of core image libraries. They are discussed in section *Using Private Libraries*, later in this chapter.

The number of file names you can give per SEARCH chain depends on what you specified in the LCONCAT parameter of the FOPT supervisor generation macro; 15 is the maximum. With that maximum, the following library chain could be set up:

- 15 libraries defined as temporary
- 15 libraries defined as permanent
- the system library at the end of the chain.

Librarian Input. In the FROM parameter you define the library that is to be used as input by

- the librarian service programs such as SSERV, DSERV etc.
- the CORGZ librarian program.

Output Libraries. In the TO parameter you define the library that is to be used as output by

- the linkage editor program when it catalogs a phase into a (private or system) core image library
- the MAINT librarian program
- the CORGZ librarian program for a MERGE function.

A Newly Created Library. The NEW parameter defines a private library to be created by the CORGZ librarian program. NEW can only be used for a temporary library definition. The NEW library name must not appear within the SEARCH, TO or FROM parameters of the same LIBDEF statement.

The following example shows a job stream with two job steps: one linkage editor step followed by an execution step. Permanent and temporary library chains are defined: two chains for relocatable libraries and two chains for core image libraries. Also, a private core image library (file name TESTCIL) is defined for the linkage editor output.

```
// DLBL PRELO1,'PRIVATE RELO LIB 1',...
// EXTENT ,VOLIDA,...
// DLBL PRELO2,'PRIVATE RELO LIB 2',...
// EXTENT ,VOLIDB,...
// DLBL PCIL1,'PRIVATE CIL 1',...
// EXTENT ,VOLIDA,...
LIBDEF RL,SEARCH=(PRELO1,PRELO2),PERM
LIBDEF CL,SEARCH=PCIL1,PERM
// JOB TEST
// DLBL TESTRLB,'TEST RELO LIB',...
// EXTENT ,VOLID1,...
// DLBL PRELO3,'PRIVATE RELO LIB 3',...
// EXTENT ,VOLID2,...
// DLBL TESTCIL,'TEST CIL FOR APARS',...
// EXTENT ,VOLID1,...
// DLBL PRODCIL,'PRODUCTION/HISTORY CIL',...
// EXTENT ,VOLID3,...
LIBDEF RL,SEARCH=(TESTRLB,PRELO3),TEMP
LIBDEF CL,SEARCH=(TESTCIL,PRODCIL),TO=TESTCIL,TEMP
// OPTION LINK
   INCLUDE LINKBOOK
// EXEC LNKEDT
// EXEC
/&
```

You may catalog part of the above job stream into a procedure library. If, for example, all DLBL and EXTENT statements and the permanent library definitions were cataloged as procedure PARCONCA, the above job stream might look as follows:

```
// JOB TEST
// EXEC PROC=PARCONCA
LIBDEF RL,SEARCH=(TESTRLB,PRELO3),TEMP
LIBDEF CL,SEARCH=(TESTCIL,PRODCIL),TO=TESTCIL,TEMP
// OPTION LINK
   INCLUDE LINKBOOK
// EXEC LNKEDT
// EXEC
/&
```

The above example contains library definitions valid for one partition. Similar definitions can be established for other partitions. A particular library may appear in chains of several partitions.

One cannot mix, within a partition and for a particular library type, library definitions via ASSGN and those via LIBDEF. It is conceivable, however, to use an ASSGN for one library type and a LIBDEF for another, as in the following skeleton example:

```
// DLBL IJSYSCL,'OLD PRIVATE CIL',...
// EXTENT SYSCLB,VOLIDC,...
// DLBL PRVPROC,'NEW PRIVATE PROC',...
// EXTENT ,VOLIDP,...
    ASSGN SYSCLB,...
LIBDEF PL,SEARCH=PRVPROC
   .
   .
// EXEC PROC=...
```

You will notice that the second EXTENT statement has the first parameter, the logical unit name omitted. For one thing, no system logical unit name exists for a private procedure library. Secondly, whenever libraries are defined via LIBDEF, the operating system does not need the SYSxxx specification; it is capable of determining the physical device address via the volume identification in the EXTENT statement (the vol id's must be unique within the system). If, however, you do include the SYSxxx number, a corresponding ASSGN statement is required.

Note: A private library that is defined as access control protected may appear only in a temporary LIBDEF definition. A permanent ASSGN for a secured private source statement or relocatable library is allowed, but not for a private core image library.

Resetting a Library Definition

The LIBDROP statement resets, for a particular library type, a definition that had been given through a LIBDEF statement. The usage of parameters is similar to the one in the LIBDEF statement. By specifying ALL you may drop all library definitions for one library type within a partition.

A library definition is reset also when one LIBDEF specification overrides a preceding one that is still active.

If not reset explicitly, all temporary library definitions will be reset at end-of-job. A permanent library definition will be automatically reset when the partition is deactivated (via UNBATCH). If a HOLD command was given before, the permanent library definitions are not deactivated and are available again when the partition is restarted. The UNBATCH and HOLD commands are described in *VSE/Advanced Functions Operating Procedures*.

Displaying Library Definitions

Through the LIBLIST statement, you request a display of the currently active library definitions, for a particular library type. Only those definitions are listed which had been given through a LIBDEF statement. The display may cover one partition only or all partitions. And you may choose to direct the display to the system console or to SYSLST.

For a detailed description of the LIBDEF, LIBDROP and LIBLIST statements, refer to *VSE/Advanced Functions System Control Statements*.

Tape and Print Operations

Controlling Magnetic Tape

The MTC job control statement or command controls certain magnetic tape operations, for example, file positioning. Files on magnetic tape are almost invariably processed sequentially. This means, for example, that if you have five files on one tape reel and you want to process the last one, you have to read four files before you can access the one you need. You can, however, instruct the job control program to position the tape at a particular file.

The MTC job control statement or command controls operations such as:

- Spacing the tape backward or forward to the required file.
- Spacing the tape backward or forward a specified number of records.
- Rewinding the tape to the beginning.
- Writing a tapemark to indicate the end of a file.

In the following example, program PROGA creates a labeled tape file named RATES on tape volume 222222. At the end of the first job step, an MTC job control statement is used to rewind (REW) the tape to the beginning of the tape volume so that the newly created file can be processed by PROGB.

```
// JOB TAPE
// ASSGN SYS004,TAPE,VOL=222222
// TLBL RATES,'MASTER',75/365,222222
// EXEC PROGA
// MTC REW,SYS004
// EXEC PROGB
/&
```

Controlling Printed Output

Most of the VSE/Advanced Functions supported printers use a forms control buffer (FCB) to control the length of forms skips. In addition, printers may be equipped with the universal character set feature, which is controlled by a universal character set buffer (UCB). Examples of printers equipped with these buffers are the 3203 and 3211 printers.

The buffers of these printers must be loaded during or immediately after IPL, and they may have to be reloaded later between job steps or, occasionally, while a job step using the printer is being executed.

The following methods for loading the buffers are available:

To load the FCB

- Automatic loading during IPL
- Using the SYSBUFLD program between job steps or immediately after IPL
- Using the LFCB command
- Using the LFCB macro in the problem program
- Using the FCB parameter in the VSE/POWER * $$ LST statement.

To load the UCB

- Automatic loading during IPL (applies to PRT1 and 5203U printers)
- Using the SYSBUFLD program between job steps or immediately after IPL
- Using the LUCB command
- Using the UCS command (applies only to a 1403 UCS printer).

The method of loading the buffers by using the SYSBUFLD program offers the advantage that hardly any operator activity is involved; on the other hand, loading the buffers by using the LFCB or LUCB command does not require the operator to wait for a partition to finish processing.

When the contents of an FCB or a UCB are replaced by a new buffer image, the system uses this new image to control printed output until the buffer is reloaded (or until the next IPL). None of the above methods provides automatic resetting of the buffer load to the original contents. It may be necessary to reset the buffer to the original contents before taking a storage dump, to ensure that the dump is printed in the correct format, without any part of it being left out.

Details on how to load the FCB and UCB are contained in *VSE/Advanced Functions System Control Statements.*

The 3800 Printing Subsystem. The 3800 Printing Subsystem is a nonimpact, high-speed, general-purpose system printer that uses an electrophotographic technique with a low-powered laser to print output. It provides more features than current impact printers.

The following methods of controlling the 3800 are available:

- The SETPRT job control statement or command, which allows you to set the 3800 with user-specified control values. These values are reset at the end of the current job to the installation's default control values as specified in the SETDF operator command, or to the hardware defaults if SETDF is not specified.
- The SETDF operator command, which allows the operator to set and/or reset default control values for the 3800. A SETDF command can set default control values for the following:
  - One character arrangement table
  - The forms control buffer
  - The copy modification phase
  - The paper forms identifier
  - The forms overlay name
  - Bursting and trimming or continuous forms stacking
  - The setting of all hardware defaults with one command.
- The SETPRT macro instruction, which is generally invoked via the preceding statements but can also be used directly by the programmer to initialize or dynamically change the setup of the 3800.

For information on available techniques for controlling the 3800, see *DOS/VSE IBM 3800 Printing Subsystem Programmer's Guide.*

Executing a Program

After you have properly defined the I/O requirements of your program to the system you can instruct job control to prepare your program for execution. How this is done and how the supplied information is processed is described in the following section.

Assembling/Compiling, Link Editing, and Executing a Program

In VSE/Advanced Functions, three processing steps are necessary to obtain results from a problem program once the source program has been written:

1. Assembly or compiling of the source program into an object module. (Object modules are discussed in section *Linking Programs* later in this chapter.)

2. Link editing of the object module to form an executable program phase.

3. Execution of the program phase.

Each of these steps is initiated by the job control program in response to an EXEC job control statement. The EXEC statement must be the last of the job control statements submitted for any one job step. Figure 3-13 shows an example of the job control statements needed to assemble, link edit, and execute a source program.

```
   // JOB EXECUTE
1  // OPTION LINK
2  // EXEC ASSEMBLY
3  // EXEC LNKEDT
4  // EXEC
   /&
```

1 To link edit a program, the LINK option must be set ON.

2 The assembler is fetched from the core image library and starts execution.

3 The linkage editor is fetched from the core image library and starts execution.

4 When an EXEC statement without a program name is encountered, the program last stored (if stored within the same job) in a core image library by the linkage editor is fetched for execution.

Figure 3-13. Job Control Statements to Assemble, Link Edit, and Execute a Program in One Job

Instead of submitting three EXEC statements, you may invoke all three steps by one EXEC statement. Specifying the GO parameter in the statement which invokes the assembler (compiler) causes the linkage editor and your executable program to be invoked automatically once the assembly (compilation) is finished. Only the source program and any additional data required by your program must be submitted.

Language translators read their input from SYSIPT. If SYSRDR and SYSIPT are assigned to the same device, the source statements of your program must follow the corresponding EXEC job control statement. In this example, the assembler language statements would have to follow the // EXEC ASSEMBLY statement. The end of the input data submitted for one program must be indicated by a /* (end-of-data) statement. The /* statement is not processed by job control; it is read by the logical IOCS routines of VSE/Advanced Functions. (Note: For an input file on an IBM 5424 MFCU, the /* card must be followed by a blank card.) The placement of input data and the /* statement is shown in Figure 3-14.

```
// JOB INPUT
// OPTION LINK
// EXEC ASSEMBLY
    .
    .
source program
    .
    .
/*
// EXEC LNKEDT
// EXEC
    .
    .
input data for user program
    .
    .
/*
/&
```

Figure 3-14. Submitting Input Data on SYSIPT

How the job shown in Figure 3-14 is processed by the system is illustrated in Figure 3-15. The numbers to the left of the subsequent paragraphs refer to the encircled numbers in that illustration. The inclusion of SYSIPT data in job streams in the procedure library is described under *SYSIPT Data in Cataloged Procedures,* later this section.

1 Job control reads the JOB statement and stores the job name in the supervisor. Other functions of the JOB statement are described under *Defining a Job,* earlier in this chapter.

2 Job control reads the OPTION statement with the LINK option and sets the LINK bit in the supervisor. This indicates

a) to the assembler, that the assembled object module is to be written onto SYSLNK,

b) to job control that link editing is allowed in this job,

c) to the linkage editor, that the executable program is to be stored in the core image library only temporarily for execution in the same job.

3 On encountering the // EXEC ASSEMBLY statement, job control transfers control to the supervisor passing it the name of the assembler program.

4 The supervisor loads the assembler into the partition, replacing job control.

5 The assembler reads the source program, assembles it, and stores the object module on SYSLNK (not shown).

6 The assembler transfers control to the supervisor.

7 The supervisor loads job control into storage, replacing the assembler.

8 Job control reads the // EXEC LNKEDT statement, as well as any preceding linkage editor statements, and transfers control to the supervisor, passing it the name of the linkage editor.

9 The supervisor loads the linkage editor into storage, replacing job control.

10 The linkage editor reads the object module from SYSLNK and link edits it.

11 The linkage editor stores the executable program in the core image library.

12 The linkage editor transfers control to the supervisor.

13 The supervisor loads job control into storage.

14 Job control reads an EXEC statement without a program name and transfers control to the supervisor.

15 The supervisor loads the program last stored in the core image library by the linkage editor replacing job control.

16 The user program is executed. It reads and processes the data from SYSIPT and, at end-of-job, returns control to the supervisor.

17 The supervisor loads job control.

18 When job control reads the /& statement, it turns off the LINK option and replaces the jobname stored in the supervisor by NO NAME. Other functions of the /& statement are described under *Defining a Job*, earlier in this chapter.

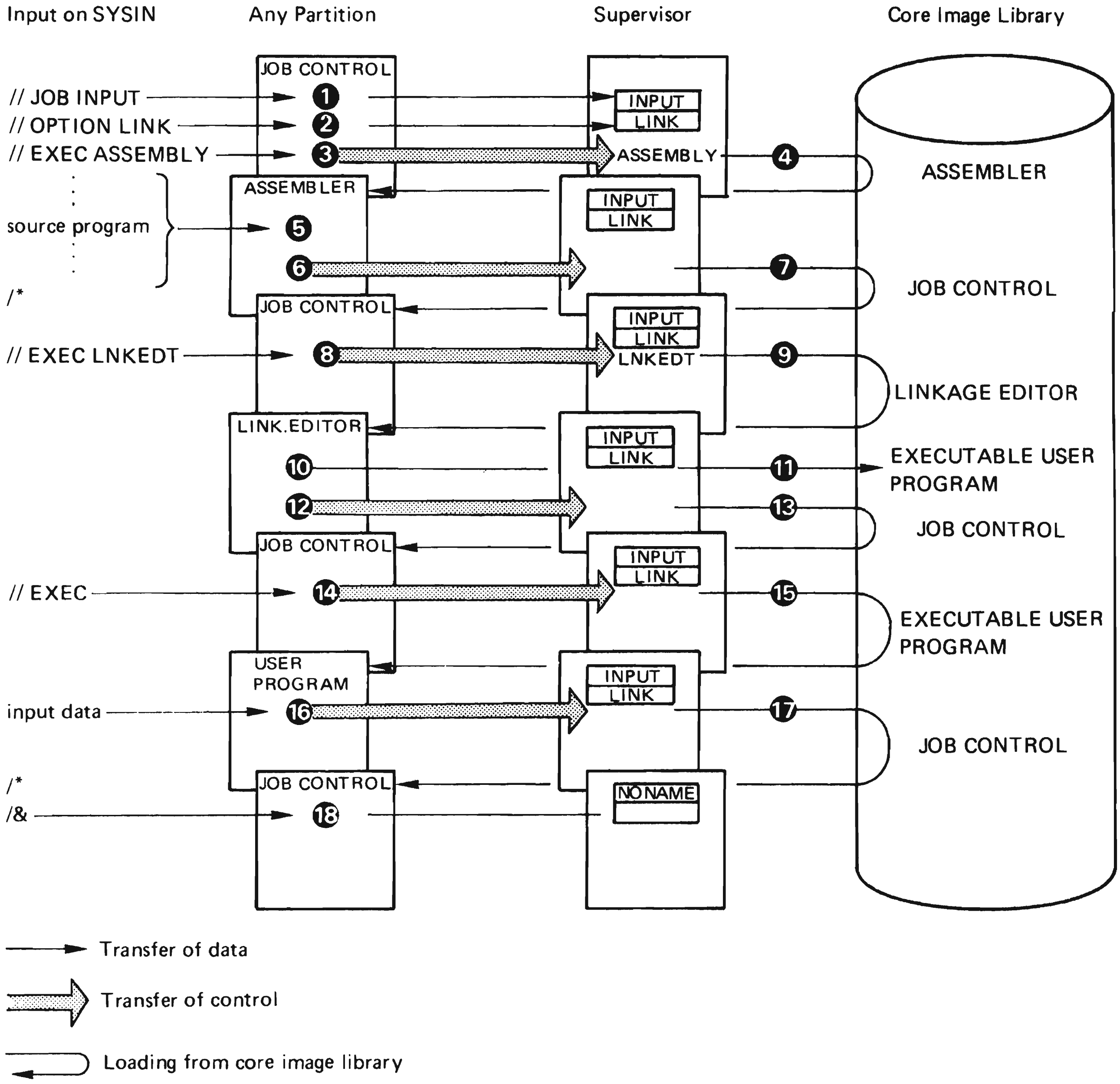


Figure 3-15. System Operation of an Assemble, Link Edit and Execute Job

Executing Cataloged Programs. Programs may be cataloged permanently in a core image library after they have been assembled and link edited. This saves assembling and link editing a program for every run.

Cataloging into a core image library is done by the linkage editor in response to an OPTION job control statement with the CATAL option (see *Linking Programs* later in this chapter).

To execute a cataloged program you use an EXEC job control statement specifying the name under which the program was cataloged (as shown for the assembler and linkage editor in the preceding example).

For example, the following job executes a program that was cataloged in a core image library under the name PROGA; data cards are submitted on SYSIPT:

```
// JOB CAT
    .
    .
assignment, label statements,
and library definition, if required
    .
    .
// EXEC PROGA
    .
    .
input data
    .
    .
/*
/&
```

Defining Options for Program Execution

In the preceding section, it was shown how the OPTION job control statement can be used

- to specify the type of label information to be stored for a file (USRLABEL, PARSTD, STDLABEL options), and
- to define whether a program is to be link edited (LINK option).

There are a number of additional functions which you can invoke through the OPTION job control statement. The most important ones are:

// OPTION LOG
Logs all job control statements submitted to the system on SYSLST. This facilitates diagnosing the job control statements in case of an error.

// OPTION PARTDUMP
Dumps the contents of the registers, a formatted portion of the supervisor area, and the current partition on SYSLST in case of abnormal program termination. To obtain the entire supervisor area unformatted, // OPTION DUMP may be used.

// OPTION DECK
Puts an object module on SYSPCH. The object module can then be combined with other object modules by the linkage editor to form one executable program, or it can be used as input to the library maintenance program to catalog it into a relocatable library.

// OPTION LIST, LISTX, SYM, XREF, ERRS
Prints various listings produced by the language translators (compilers) on SYSLST. These listings include object code, symbol table, cross-reference, and error lists which are useful debugging aids during the test period of a

program. SXREF may be specified instead of XREF to obtain a cross reference listing that includes only the referenced labels in the assembled program.

These (and other) options may be permanently set by using the STDOPT command. The specified options become effective after the next / & or // JOB statement.

Permanent options are valid for all jobs unless overridden by an OPTION job control statement. Options specified in an OPTION statement remain in effect until (1) a contrary option is read or (2) a JOB or / & statement is encountered which resets the options to permanent.

Certain of these options can be suppressed by specifying the prefix NO (for example, NOLIST, NODUMP). A complete list of the available options is given in *VSE/Advanced Functions System Control Statements.*

Communicating with Problem Programs via Job Control

Via job control a program can be instructed to take a specific path of action. This instruction is given by setting program switches which can be tested by the problem program at the time of program execution.

These program switches, called UPSI (user program switch indicator), can be set "on" (1) or "off" (0). They are set by job control in response to the UPSI job control statement. The specific meaning attached to each bit in the UPSI byte depends on the design of the program. The statement

```
// UPSI 10000001
```

for example, sets bits 0 and 7 of the UPSI byte to 1, and bits 2 through 6 to zero. A program can inspect these switches and take a specific path based on their setting. Since the // JOB statement sets the eight bits of the UPSI byte to zero, the // UPSI statement should follow the // JOB statement.

UPSI switches might be useful, for example, in an accounting application that prepares reports of daily, weekly, and monthly accounts. Through the program switches, the application can be instructed as to when the daily, weekly, or monthly reports are due.

For more details on the UPSI statement see *VSE/Advanced Functions System Control Statements.*

Executing in Virtual or Real Mode

All programs invoked for execution through an EXEC job control statement are normally executed in virtual mode. To run a program in real mode, you specify the REAL operand in the EXEC statement.

Example:

```
// JOB NAME
     .
     .
// EXEC PROGA,REAL
/&
```

If, for the above example, job control runs in partition F2, then the program PROGA will be loaded and executed in real mode provided there is sufficient processor storage allocated to the F2 partition to hold the entire program PROGA.

If a program executing in real mode is smaller than the allocated processor storage, the unused allocated processor storage should remain part of the page pool. Specifying the size of the program in the SIZE operand of the EXEC statement accomplishes this. Example:

```
// JOB NAME
     .
     .
// EXEC PROGA,REAL,SIZE=30K
/&
```

If the F2 partition has 50K of processor storage allocated and the program PROGA has a size of 30K bytes, the remaining 20K bytes of that partition will remain in the page pool.

If you specify SIZE=AUTO, job control automatically uses the information in the program's core image directory entry to calculate the size of the program to be loaded.

Running programs in real mode implies temporarily forfeiting a number of page frames in the page pool, which may lead to degradation of system throughput. Therefore, real mode execution should be used sparingly.

With a few exceptions, all IBM-supplied and user-written programs can be executed under VSE/Advanced Functions either in virtual or real mode. These exceptions are listed in the following section.

Programs that Must Run in Real Mode. The IBM-supplied program OLTEP (On-line Test Executive Program) must be executed in real mode.

User-written programs must be executed in real mode if they contain channel programs for devices not supported by VSE/Advanced Functions.

User-written programs must be executed in real mode or modified if they

- contain MICR stacker selection routines or other time-dependent code for execution of I/O requests.

- contain channel programs that are modified during command execution.

- contain I/O appendage routines causing page faults.

A program may request to obtain additional storage from the partition GETVIS area (this area is described in the following section, *Dynamic Allocation of Storage*). During real mode execution, that storage is obtained from the unused allocated processor storage. Specifying a SIZE value, therefore, allows you to issue GETVIS requests from a program running in real mode (contrary to execution in virtual mode, DOS/VSE does not provide a default partition GETVIS area for real mode execution). For a program that is executed in real mode, allow 16K per open file, and allow additional processor storage if double buffering is used or if FBA files with large CI-sizes or VSE/VSAM files are opened. For most IBM-supplied programs that you want to run real, an allocation of 48K for GETVIS requests suffices.

Note that the FREEVIS macro releases GETVIS space which was obtained through a GETVIS macro; that space is again available for subsequent GETVIS requests. When issued from a program running in real mode, however, the space is not returned to the page pool until the execution of the particular job is finished.

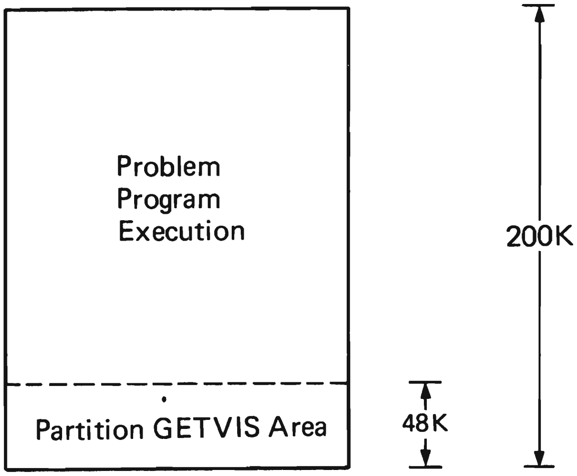
Dynamic Allocation of Storage

VSE dynamic storage areas, called GETVIS areas, are part of the virtual storage. The system GETVIS area is located in the SVA and used only be the operating system. Each partition has an area called the partition GETVIS area. These areas occupy the high address space of a partition's virtual storage. The minimum GETVIS area for a partition is 48K, which is the IBM-set default. This default is not applicable to real mode execution; in this case, you have to reserve storage yourself (as described in the preceding section).

The partition GETVIS area is used by certain VSE/Advanced Functions system components for functions such as opening of files, label processing etc. Programs using rotational positional sensing (RPS) require 256 to 512 bytes in the partition GETVIS area for each open file. This value should be added to the minimum system requirement of 48K.

Programmers writing in assembler language may request space from the partition GETVIS area via the GETVIS macro. When no longer needed by the requesting program, area so acquired can be released by issuing the FREEVIS macro. For details about using these macros, refer to the publication *VSE/Advanced Functions Macro User's Guide*.

Figure 3-16 shows the virtual storage layout of a 200K partition with a default-size partition GETVIS area.



The largest size program that could execute in the shown partition is one that is 152K.

Figure 3-16. Storage Layout of a Partition With Default GETVIS Area

You may increase the size of a partition GETVIS area through:

- the SIZE job control or attention routine command.
- the SIZE parameter of the job control EXEC statement.

With the SIZE command, you specify the amount of virtual storage available for program execution in a given partition. The balance of that partition's allocation is the partition GETVIS area.

Given SIZE BG=140K, the result is a storage layout for the partition as shown in Figure 3-17.

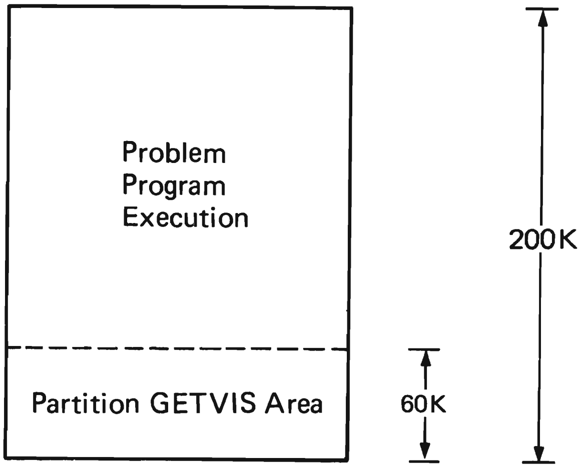


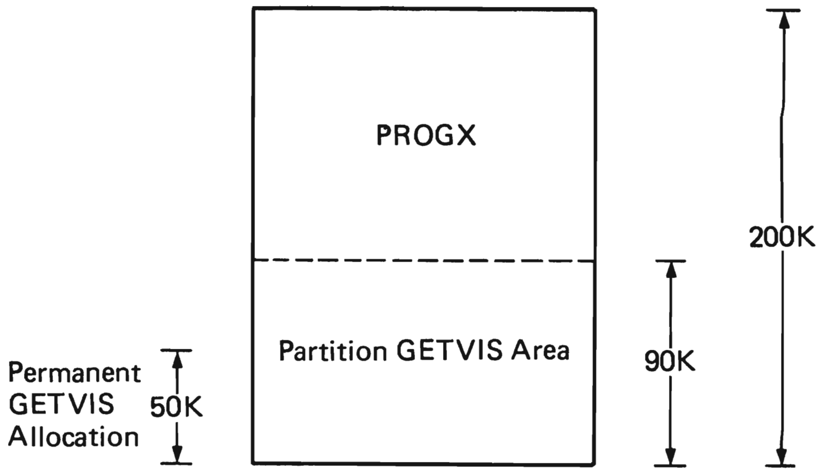
Figure 3-17. Storage Layout of a Partition After the SIZE Command is Given

The boundaries set by the SIZE command are permanent until (1) another SIZE command for the same partition or (2) the next IPL.

You may temporarily alter the partition GETVIS area by using the SIZE parameter on the job control EXEC statement. The SIZE parameter establishes boundaries in the same way as the SIZE command, except that the parameter value holds only for one job step (the EXEC). At the end of the job step, the GETVIS size is set to the system default (48K) or the amount established by a preceding SIZE command. See Figure 3-18.

Given:

```
// EXEC PROGX,SIZE=110K
```



When PROGX is finished executing the partition GETVIS area size returns to its permanent allocation.

Figure 3-18. Program Execution with the SIZE Parameter

With the SIZE parameter you may also specify SIZE=AUTO, in which case job control uses the information available in the associated core image library directory to determine the amount of storage needed by the program and then allocates the remainder of the partition as GETVIS area.

IBM licensed programming support (for example VSE/VSAM) may have partition GETVIS requirements beyond 48K bytes. Consult the appropriate licensed program documentation to determine the partition GETVIS area size requirements.

System Files on Tape, Disk or Diskette

As mentioned earlier in this chapter, I/O devices (except DASD) cannot be assigned to more than one active partition at the same time. This means that, in an installation with only one card reader, for instance, the input job stream on SYSRDR and SYSIPT for one partition must have been completely processed by job control and unassigned for that partition before job streams can be read by another partition. This also applies accordingly to the system output on SYSLST and SYSPCH if only one printer and one card punch are available.

Since this situation can cause a considerable decrease of system throughput, VSE/Advanced Functions permits storing the input job streams and the system output on a direct access device or, if enough tape units are available, on magnetic tape. This allows several partitions simultaneously to read system input from or to write system output to high-speed devices, thus increasing system throughput and, due to reduced CPU wait time, improving the overall performance.

Note: If system logical units (SYSIPT, SYSLST, SYSPCH, SYSRDR) are to be device independent, DTFDI must be used in application programs that refer to any of these system logical units.

The following section describes how to store system input and output on high-speed devices and to read and process the job streams from these devices.

The same improvements as those gained by having system files on high-speed devices - but far more efficient and easier to use - can be achieved by using a spooling program such as VSE/POWER. The spooling program stores the job streams on disk, transfers the jobs to the partitions for execution, and stores list and punch output on disk before it is finally printed or punched.

System Files on Tape

If the system input units SYSRDR and SYSIPT are assigned to the same magnetic tape unit, they may (but need not) be referred to as SYSIN. If the system output units SYSLST and SYSPCH are assigned to the same magnetic tape they must be referred to as SYSOUT. The tapes may be unlabeled or they may have standard labels. If SYSLST or SYSPCH is assigned to a standard label tape and no new label information is supplied, the old labels will remain on the tape. SYSIPT assigned to a magnetic tape cannot be a multiple-volume file.

To store the input stream on magnetic tape you must write your own program that transfers the job stream to the tape. Assume, in the following example, that you have written such a program and cataloged it in the core image library under the name CDTOTP; the program CDTOTP uses SYS004 to read the input job stream, and SYS005 for the tape onto which the job stream is to be written; the end of input data for CDTOTP is indicated by **. The example in Figure 3-19 shows how to use the program CDTOTP to create a combined system input file on tape.

```
  // JOB BUILDIN
1 // ASSGN SYS004,00C
2 // ASSGN SYS005,182          read from SYSRDR
3 // EXEC CDTOTP
  // JOB A
       .
       .
  /&
  // JOB B                             job stream
       .
       .                               read from SYS004
  /&
4 **
  /&
```

1 SYS004 is assigned to the card reader from which CDTOTP reads the job stream.

2 SYS005 is assigned to the tape which is to receive the job stream.

3 The CDTOTP program is executed and writes the job stream onto tape.

4 ** (or any other significant character combination) signals end-of-data to CDTOTP

Figure 3-19. Creation of SYSIN on Tape

After completion of the job BUILDIN shown in Figure 3-19 you can assign SYSIN to the tape containing the job stream; job control will then read and process the jobs A and B from the tape just as it would have done from the card reader.

In the same way you can direct the system output on SYSLST and SYSPCH to go on magnetic tape and then use your own or an IBM-supplied program to print or punch the contents of the tape on the printer or card punch, respectively.

System Files on Disk

When both SYSRDR and SYSIPT are assigned to disk, they *must* refer to the same disk extent, and should be referred to as SYSIN. Since the output units SYSLST and SYSPCH have different record lengths, they must be assigned to separate disk extents; SYSOUT therefore *cannot* be used if SYSLST and SYSPCH are assigned to disk. Note that only single extent system files are supported.

For system files on disk, you must provide the required label information by means of DLBL and EXTENT job control statements. In those statements, use the following predefined file names:

IJSYSIN for SYSRDR, SYSIPT, SYSIN
IJSYSPH for SYSPCH
IJSYSLS for SYSLST

For example, the label information for SYSIN assigned to a disk extent could be submitted by the following job control statements:

```
// DLBL IJSYSIN,'DISKINFILE'
// EXTENT SYSIN,DOSRES,1,0,1260,30
```

The assignment of a system file to a disk extent must always be permanent, and it must follow the DLBL and EXTENT statement.

Example:

```
// DLBL IJSYSIN,'DISKINFILE'
// EXTENT SYSIN,DOSRES,1,0,1260,30
   ASSGN SYSIN,131
```

After a system file on disk has been processed, it must be closed by a CLOSE job control command (no //). The second (optional) operand of the CLOSE command can be used to unassign a system logical unit or reassign it to another device. The following command closes the SYSIN file on disk and reassigns SYSIN to the card reader at address 00C:

```
CLOSE SYSIN,00C
```

The CLOSE command can either be entered on SYSLOG by the operator or it can be included at the end of the job stream on disk.

If SYSIPT is assigned to a disk extent, the CLOSE command must precede the /&. Multiple SYSIPT data files can be read via multiple job steps with one /& at the end of the job stream.

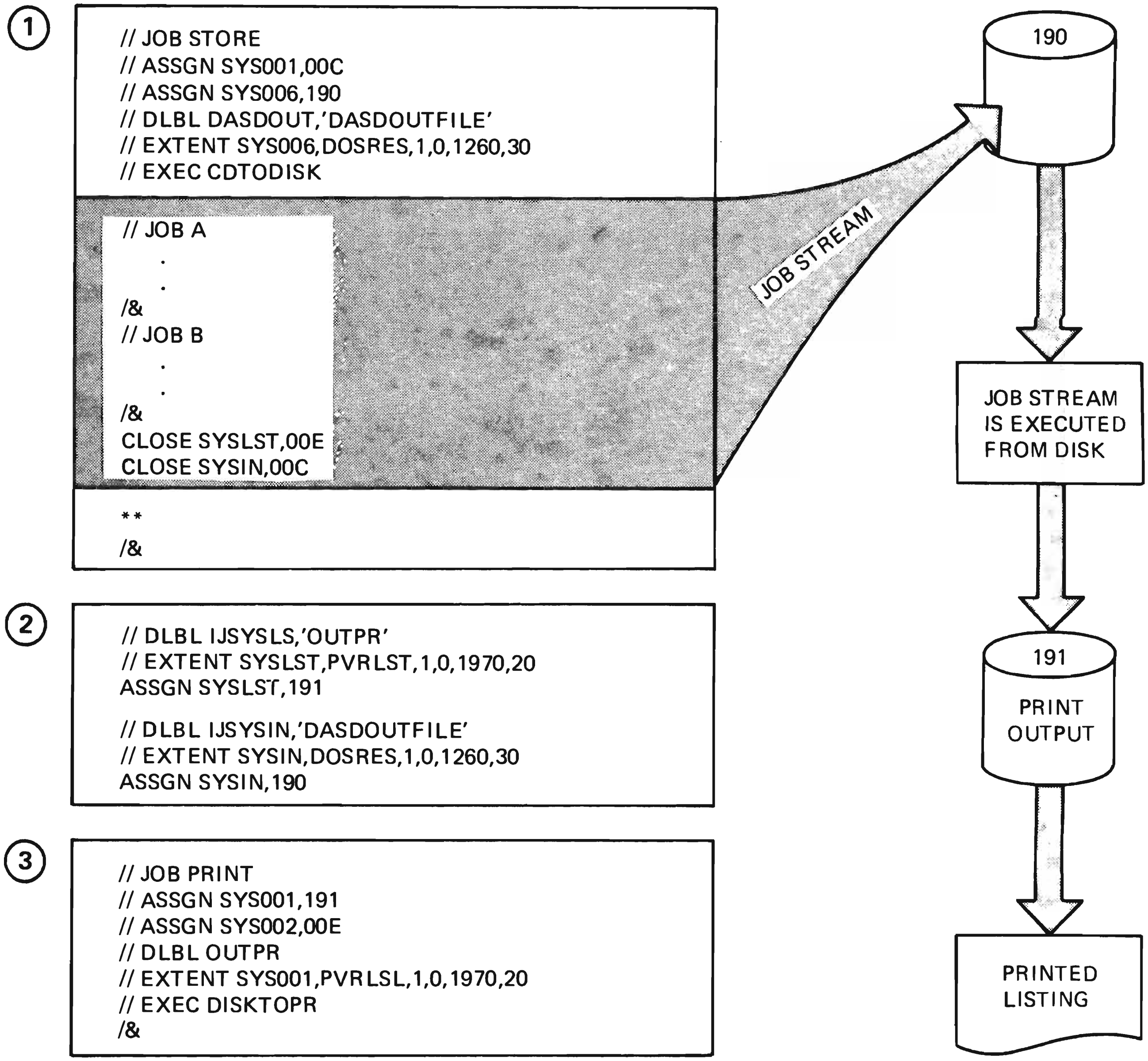
The example in Figure 3-20 shows the job control statements needed to

1. write a job stream on disk,
2. execute the job stream from disk and store the print output on disk, and
3. print the output from disk on the printer.

The example assumes that you have written your own programs to write the job stream on disk (CDTODISK) and to list on the printer the print output stored on disk (DISKTOPR).

System Files on Fixed Block Architecture (FBA) DASD. If an FBA DASD has a system logical unit assigned to it, the supervisor will block and deblock system file records into the FBA Control Interval-based data format, handle all special conditions, and update the Disk Information Block (DIB). This permits existing DTFDI and DTFCP programs to process system files on FBA devices without making logic changes to handle the FBA blocking.

Note, however, that the DTFSD support for system files on disk is limited to sequential GET or PUT for fixed unblocked records. (That is, the UPDATE=YES parameter is not supported.)



①

```
// JOB STORE
// ASSGN SYS001,00C
// ASSGN SYS006,190
// DLBL DASDOUT,'DASDOUTFILE'
// EXTENT SYS006,DOSRES,1,0,1260,30
// EXEC CDTODISK

// JOB A
      .
      .
/&
// JOB B
      .
      .
/&
CLOSE SYSLST,00E
CLOSE SYSIN,00C

**
/&
```

②

```
// DLBL IJSYSLS,'OUTPR'
// EXTENT SYSLST,PVRLST,1,0,1970,20
ASSGN SYSLST,191

// DLBL IJSYSIN,'DASDOUTFILE'
// EXTENT SYSIN,DOSRES,1,0,1260,30
ASSGN SYSIN,190
```

③

```
// JOB PRINT
// ASSGN SYS001,191
// ASSGN SYS002,00E
// DLBL OUTPR
// EXTENT SYS001,PVRLSL,1,0,1970,20
// EXEC DISKTOPR
/&
```

① The program CDTODISK reads the following job stream from the card reader (SYS001) and stores it on disk (SYS006). The end of the job stream is indicated to CDTODISK by **.

② SYSLST and SYSIN are switched to disk. Job control now reads the job stream from the disk on device 190. The job stream is executed and the print output is stored on the disk on device 191. The CLOSE commands at the end of the job stream will close the system files on disk and reassign them to the printer and card reader, respectively.

③ The program DISKTOPR reads the print output from disk (SYS001) and lists it on the printer (SYS002).

Figure 3-20. Processing System Input and Output Files on Disk

System Files on Diskette

If the system input units SYSRDR and SYSIPT are assigned to a diskette extent, they *must* be referred to as SYSIN. Since the output units SYSLST and SYSPCH have different record lengths, they must be assigned to separate diskette extents; SYSOUT therefore *cannot* be used if SYSLST and SYSPCH are assigned to diskette.

For system files on diskette, you must provide the required label information by means of DLBL and EXTENT job control statements. In those statements, use the following predefined file names:

IJSYSIN for SYSRDR, SYSIPT, SYSIN
IJSYSPH for SYSPCH
IJSYSLS for SYSLST

For example, the label information for SYSIN assigned to a diskette extent could be submitted by the following job control statements:

```
// DLBL IJSYSIN,'DISKETTE',,DU
// EXTENT SYSIN,DSKETE,1
```

The assignment of a system file to a diskette extent must always be permanent, and it must follow the DLBL and EXTENT statement.

Example:

```
// DLBL IJSYSIN,'DISKETTE',,DU
// EXTENT SYSIN,DSKETE,1
     ASSGN SYSIN,060
```

After a system file on diskette has been processed, it must be closed by a CLOSE job control command (no //). The second (optional) operand of the CLOSE command can be used to unassign a system logical unit or reassign it to another device. The following command closes the SYSIN file on diskette and reassigns SYSIN to the card reader at address 00C.

```
CLOSE SYSIN,00C
```

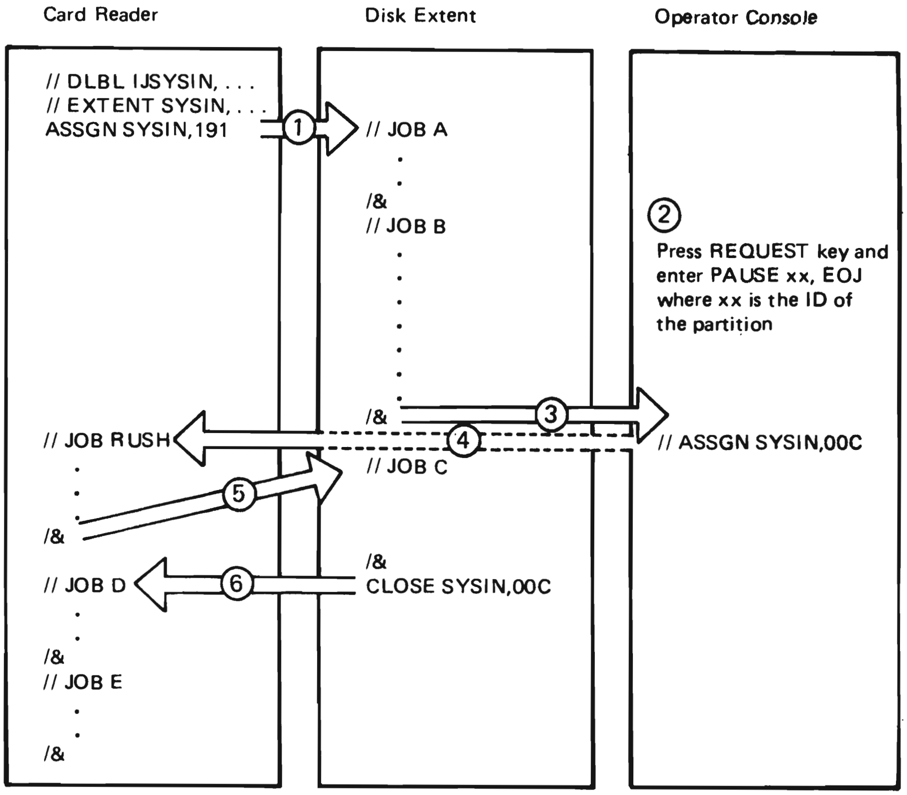
The CLOSE command can either be entered on SYSLOG by the operator or it can be included at the end of the job stream on diskette.

If SYSIPT is assigned to a 3540 diskette, the CLOSE command must precede the /&. Multiple input data files can be read via multiple job steps with one /& at the end of the job stream.

When job control encounters /& on SYSRDR during normal operation, the standard assignment for SYSIPT becomes effective and SYSIPT is checked for an end-of-file condition. If the standard assignments for SYSRDR and SYSIPT are not to the same device, SYSIPT is advanced to the next /* statement.

Interrupting SYSIN Job Streams on Disk, Diskette, or Tape

After a SYSIN or SYSRDR job stream has been prepared on tape, diskette, or disk, it may be necessary to interrupt the normal schedule to execute a rush job. To do this, press the Request key on the operator console and enter a PAUSE command with the EOJ operand causing the corresponding partition to suspend processing at the end of the current job. At this point you can make a temporary assignment for SYSIN to a card reader to execute the rush job. At the end of this job, processing of the job stream on disk, diskette, or tape will resume at the point of interruption. This is illustrated in Figure 3-21. Starting an urgent job that uses a cataloged procedure by means of a single EXEC statement is discussed under *Partition-Related Cataloged Procedures* later in this section.



(1) SYSIN is assigned to disk and processing of the jobstream on disk begins.

(2) While job B is being executed a PAUSE command is entered at the operator console.

(3) At the end of job B control comes to the operator who can now enter a temporary assignment for SYSIN to the card reader.

(4) The job RUSH is read and processed from the card reader. Note that the temporary assignment of SYSIN is not reset by the //JOB RUSH statement but is retained to end of the job.

(5) The /& statement resets the temporary assignment of SYSIN to permanent (190) and the next job in the stream on disk is read and executed.

(6) The CLOSE command closes the system file on disk and reassigns SYSIN to the card reader to process jobs D and E.

Figure 3-21. Interrupting a Job Stream on Disk

Record Formats of System Files

SYSLST records are 121 characters and SYSPCH records 81 characters in length. From SYSRDR and SYSIPT, job control accepts either 80- or 81-character records.

The first character of the SYSLST and SYSPCH records is assumed to be an ASA carriage control or stacker selection character. SYSIPT, SYSRDR, SYSPCH, and SYSLST records assigned to DASD have no keys, and record lengths are the same as stated above. (For CKD devices the records are unblocked; for FBA devices, the operating system automatically blocks records into the FBA format and also deblocks them.)

Using Cataloged Procedures

This section describes how to retrieve a cataloged procedure from a procedure library and how to modify the contents of a cataloged procedure. How a procedure is cataloged in a procedure library is discussed in *Using the Libraries* later in this chapter.

Retrieving Cataloged Procedures

To retrieve a cataloged procedure from the procedure library you use the PROC parameter in the EXEC job control statement, specifying the name of the cataloged procedure. Assume that a program called PAYROLL uses the following job control statements (in addition to the // JOB and /& statements) and that these statements have been cataloged in a procedure library under the name PAY.

```
// ASSGN SYS017,SYSRDR
// ASSGN SYS018,SYSPCH
// ASSGN SYS019,00E
// ASSGN SYS020,TAPE
// ASSGN SYS021,DISK,VOL=111111
// TLBL TAPFLE,'FILE-IN'
// DLBL DSKFLE,'FILE-OUT',99/365,SD
// EXTENT SYS021,111111,1,0,200,400
// EXEC PAYROLL
```

If the program PAYROLL is to be executed, the programmer or operator would simply prepare the following job control statements:

```
// JOB USER1
// EXEC PROC=PAY
/&
```

When the job control program starts reading the job control statements in the input stream on SYSRDR and finds the EXEC statement, it knows by the operand PROC that a cataloged procedure is to be inserted. It takes the name of the procedure to be used (PAY) and retrieves the procedure with that name from the procedure library.

You may have cataloged some or all of your procedures into *private* procedure libraries. Whether the job control program uses the system procedure library and/or private procedure libraries for retrieval depends on your library definitions. The LIBDEF job control statement (or command) allows you to define a chain of libraries to be searched. For example, if you wanted job control to search in the following order

1. system procedure library
2. private procedure library with filename 'PROLIB1'
3. private procedure library with filename 'PROLIB2'

your library chain definition might look as follows:

```
// LIBDEF PL,SEARCH=(IJSYSRS,PROLIB1,PROLIB2),PERM
```

If no LIBDEF definition is active, job control searches the system procedure library only. For a more detailed description of the LIBDEF statement, refer to section *Job Control for Library Definitions,* earlier in this chapter.

After the procedure (PAY) has been retrieved, SYSRDR is temporarily assigned to the procedure library. Job control reads and processes the job control statements in its normal fashion. The statement

```
// EXEC PAYROLL
```

causes the program PAYROLL to be loaded and given control. When execution of PAYROLL is complete, the job control program reads the next statement from the procedure library and, in this example, would find an end of procedure indicator (/+). The end of procedure indicator returns the SYSRDR assignment to its permanent device, where the job control program finds the /& statement and performs end-of-job processing as usual.

Note: The listing of job control statements on SYSLOG and/or SYSLST will show the message EOP PAY at the end of the inserted procedure.

Temporarily Modifying Cataloged Procedures

The preceding example is the simplest case of the use of cataloged procedures. It will work as long as the requirements of the program do not change.

It may happen, however, that some of the statements in a cataloged procedure must be modified for a specific run of a program. For example, the printer normally used (00E in the preceding example) may be temporarily unavailable and a different printer must be assigned. It does not make much sense to delete the old procedure and to catalog a new one because the old procedure will be needed again as soon as the normal printer becomes operational again.

Likewise, it may be necessary to add or remove certain statements to or from a cataloged procedure for a specific run of a program. You may wish, for example, to process a different copy of the file FILE-OUT (see the preceding example). You must therefore temporarily suppress the corresponding DLBL and EXTENT statements in the cataloged procedure and replace them by statements that identify the file you want to process instead.

For cases like this, one or more statements in a cataloged procedure may be

- temporarily modified (thus, overriding what was present).
- temporarily suppressed (deleted) without modifying them.
- temporarily incorporated at desired locations in a cataloged procedure.

You can request temporary modification of statements in a cataloged procedure by supplying the corresponding modifier statements in the input stream.

Since normally not all statements need be modified, you must establish an exact correspondence between the statement to be modified and the modifier statement by giving them the same symbolic name. This symbolic name may have from one to seven characters, and must be specified in columns 73 through 79 of both statements.

Note: An unnamed statement cannot be modified. Therefore, to be able to modify any statement in a cataloged procedure for any usage of the procedure you should name each statement when cataloging. Moreover, the modifier statements must be in the sequence in which modification is to be performed on the cataloged statements. The JOB statement cannot be modified; also, job control continuation statements cannot be overridden.

A single character in column 80 of the modifier statement specifies which function is to be performed:

A - indicates that the statement is to be inserted *after* the statement in the cataloged procedure that has the same name.

B - indicates that the statement is to be inserted *before* the statement in the cataloged procedure that has the same name.

D - indicates that the statement in the cataloged procedure that has the same name is to be *deleted.*

Any other character or a blank in column 80 of the modifier statement indicates that the statement is to replace (override) the statement in the cataloged procedure that has the same name.

If the LOG function is active (by having issued the LOG job control command), statements to be deleted are printed, with a D in column 80, on the console, but not 'executed'.

In addition to naming the statements and indicating the function to be performed, you must inform the job control program that it has to carry out a procedure modification. This is done

(1) by specifying an additional parameter (OV for overriding) in the EXEC statement that calls the procedure, and

(2) by using the statement // OVEND to indicate the end of the modifier statements.

Placement of the // OVEND statement is as follows:

- directly behind the last modifier statement or,

- if the last modifier statement overwrites a // EXEC statement and is followed by data input, between the /* and the /&.

The following examples show how you can temporarily modify a cataloged procedure.

Assume that a procedure named PROC5 for the program PAYROLL contains the following statements:

```
                                                    73--79
// ASSGN SYS017,SYSRDR                              PAY0001
// ASSGN SYS018,SYSPCH                              PAY0002
// ASSGN SYS019,SYSLST                              PAY0003
// ASSGN SYS020,181                                 PAY0004
// ASSGN SYS021,DISK,VOL=111111,SHR                 PAY0005
// TLBL TAPFLE,'FILE-IN'                            PAY0006
// DLBL DSKFLE,'FILE-OUT'                           PAY0007
// EXTENT SYS021,111111,1,0,200,200                 PAY0008
// EXEC PAYROLL                                     PAY0009
/+
```

Assume further that the programmer wants to use tape unit 183 instead of 181. The input stream on SYSRDR, in this case, would have to be as follows:

```
                                                    73--80
// JOB USER
// EXEC PROC=PROC5,OV
// ASSGN SYS020,183                                 PAY0004R
// OVEND
/&
```

The form of the EXEC statement in the input stream indicates that (1) the procedure PROC5 is to be used and (2) this procedure is to be modified in some way. The first three procedure statements are processed without change. The procedure statement named PAY0004 is replaced by the corresponding statement in the input stream. (As any character other than A, B, or D specifies override, an R was used to indicate this.) The remaining procedure statements are again processed without change.

As another example, assume that the program PAYROLL is to use file FILE-OUT1 instead of FILE-OUT and that this file resides on two extents of a disk pack that has the volume serial number 111112. The input stream might then look as follows:

```
                                                  Col.73--80
// JOB USER
// EXEC PROC=PROC5,OV
// ASSGN SYS021,DISK,VOL=111112,SHR                 PAY0005R
// DLBL DSKFLE,'FILE-OUT1'                          PAY0007R
// EXTENT SYS021,111112,1,0,100,200                 PAY0008R
// EXTENT SYS021,111112,1,1,500,200                 PAY0008A
// OVEND
/&
```

Processing would be as follows: The JOB statement and all procedure statements up to the statement named PAY0004 are processed without modification. The procedure statements labeled PAY0005, PAY0007, and PAY0008 are replaced by the corresponding statements in the input stream. The second EXTENT statement in the input stream has the character A in column 80, which indicates that the statement is to be inserted after the (replaced) statement named PAY0008. The procedure statement named PAY0009 is processed without modification.

The possibility of modification as described above makes the use of cataloged procedures more flexible. Often, however, it is simpler and more economical to have different procedures for the same program than to have a single procedure and modify it.

SYSIPT data in a cataloged procedure cannot be overridden by the procedure override facility.

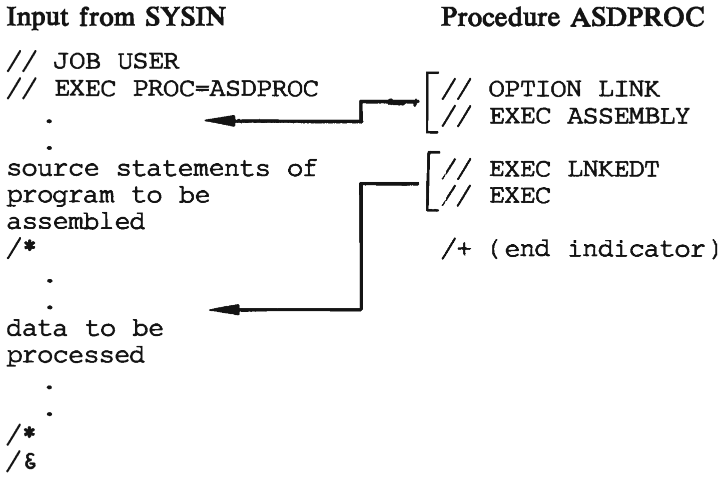
Several Job Steps in One Procedure

A cataloged procedure may contain more than one EXEC statement, that is, it may contain control statements for more than one job step (within the same job). However, as the number of job steps in a procedure increases, so does the time required to re-execute the whole procedure after an error occurs.

A program written in assembler language, for instance, requires three job steps to assemble, link edit, and execute the program. For the use of a cataloged procedure, your input stream for the entire job (on SYSIN for simplicity) would contain the following:

```
// JOB USER
// OPTION LINK
// EXEC ASSEMBLY
source deck of program to be assembled
/*
// EXEC LNKEDT
// EXEC
data for program to be executed
/*
/&
```

If the OPTION statement and the three EXEC statements were cataloged under the name ASDPROC, the input stream could be simplified as shown below.



Input from SYSIN

```
// JOB USER
// EXEC PROC=ASDPROC
   .
   .
source statements of
program to be
assembled
/*
   .
   .
data to be
processed
   .
   .
/*
/&
```

Procedure ASDPROC

```
// OPTION LINK
// EXEC ASSEMBLY

// EXEC LNKEDT
// EXEC

/+ (end indicator)
```

The same can be done for any number of job steps that logically belong together and are frequently executed. A stock control program STOCK, for instance, may be run daily to compile statistics that can be used to prepare the following lists:

1. An exception list that shows which items are low in stock. Required daily.
2. A list that shows the sales in currency for a certain item or group of items. Required weekly.
3. A list that shows the sales in number of units for each item *or group* of items. Required monthly.
4. An inventory list. Required semiannually.

To simplify processing, four procedures may have been cataloged:

STKPR1 - two job steps: the first to execute STOCK, the second to prepare list 1.

STKPR2 - three job steps: the first two are the same as for STKPR1, the third to prepare list 2.

STKPR3 - four job steps: the first three the same as for STKPR2, the fourth to prepare list 3.

STKPR4 - five job steps: the first four the same as for STKPR3, the fifth to prepare list 4.

Which lists are printed after every run of STOCK then depends on what cataloged procedure is used.

Modifying Multistep Procedures

Multistep procedures may be modified in the same way as the single-step procedure described earlier. However, a number of considerations apply to the ordering of the modification statements in the input stream when a logical unit used for data input is assigned to the same physical unit as SYSRDR.

- It is advisable to avoid using identical symbolic names for the statements in the procedure.
- The modifier statements must be in the same sequence as the statements in the referenced procedure.
- Modifier statements are normally placed immediately following the EXEC PROC=procedure,OV statement. When input data is read by a job step (EXEC statement) executed from the procedure, the following cautions should be observed:
  1. The first statement following the EXEC PROC=procedure,OV must be a modifier statement (see "1" in Figure 3-22).
  2. Modifier statements that take affect after the input data is read are placed following the input data *except for the first modifier which must precede the input data* (see "1" and the modifier statement ASSGN SYSSLB,UA in Figure 3-22).

3. An exception to point 2 above is when the input data is processed by a job step that itself was modified (see "3" and "4" in Figure 3-22). In this case the next modifier must follow the data (see statement "3" and the modifier ASSGN SYSCLB,UA in Figure 3-22).

Figure 3-22 shows an example of modifying the second and third steps of a three-step procedure.

In the example given in Figure 3-22, it is assumed that SYSRDR and SYSIPT are assigned to the same physical unit.

```
    SYSIN Input Stream                            | Procedure CAT01 Containing JCL Only
    ----------------------------------------------+-----------------------------------------------
                             Column 73-79         |                                 Column 73-79
                                    |             |                                       |
    // JOB EXAMPLE                  |             |                                       |
    // EXEC PROC=CAT01,OV           v             |                                       v
❶   // ASSGN SYSRLB,UA             STMT3          | // EXEC PSERV                        STMT1
❷    DSPLY CAT01                                  |
    /*                                            | ASSGN SYSCLB,130                     STMT2
                                                  | // ASSGN SYSRLB,130                  STMT3
    // ASSGN SYSSLB,UA             STMT4          | // ASSGN SYSSLB,130                  STMT4
❸   // EXEC DSERV,REAL             STMT5          | // EXEC DSERV                        STMT5
❹    DSPLY CD,RD,SD                               |
    /*                                            |
    ASSGN SYSCLB,UA                STMT6          | // ASSGN SYSSLB,UA                   STMT6
    // OVEND                                      | // EXEC DSERV,REAL                   STMT7
❺    DSPLY CD, PD                                 | /+
    /*                                            |
    /&                                            |
```

❶ This is the first modifier statement. It refers to the second job step.

❷ This statement provides SYSIPT data for PSERV.

❸ This modification overwrites the EXEC statement.

❹ This statement provides SYSIPT data for DSERV (STMT5).

❺ This statement provides SYSIPT data for DSERV (STMT7).

Figure 3-22. Example of Modifying a Three-Step Procedure

SYSIPT Data in Cataloged Procedures

In the example shown in Figure 3-22 the librarian service programs PSERV and DSERV accessed data from the logical unit SYSIPT. This 'SYSIPT' data may be made part of your cataloged procedure. System utility, system service programs, and language translators all read their input from SYSIPT.

When you catalog a procedure containing SYSIPT data, the directory entry for the procedure indicates this. When you execute such a procedure, job control checks to see whether or not it contains SYSIPT data. If it does, both SYSRDR and SYSIPT are assigned to the procedure library until the end of the procedure. SYSIPT data in a cataloged procedure cannot be overriden by the procedure library override facility.

SYSIPT inline data in procedures may also be any data that is processed under control of the device independent IOCS used by your program or IBM-supplied programs. Normally, though, you would not catalog source programs or data for your problem programs in a procedure library.

SYSIPT inline data in procedures is useful and convenient mainly in the case of control information for system utility and service programs.

A job stream for an initialize disk utility run could, for instance, contain the following control statements (the statements are shown in skeleton format only):

```
// ASSGN ...
// EXEC INTDK
// UID IR,C1,R=(0027003)
// VTOC STANDARD
VOL1111111
// END
/&
```

The job control statements are read from SYSRDR, the utility control statements are read from SYSIPT. If, however, both the job control and utility control statements had been cataloged (for example, under the name INITDK), only the following statements would be required on SYSRDR:

```
// JOB NAME
// EXEC PROC=INITDK
/&
```

If two or more programs in a procedure read SYSIPT data, the SYSIPT data must be handled in a consistent manner, that is, if the SYSIPT data is included in the procedure for one job step, it must be included for all job steps in that procedure which require SYSIPT data.

Partition-Related Cataloged Procedures

Although a given procedure may be executed in any partition, a particular job may need a specific set of job control statements, dependent on the partition of execution. For example, you may want to run a job to store DLBL and EXTENT statements in the partition label subarea for each partition (OPTION PARSTD). Since each partition requires a different set of label information, you would need a cataloged procedure for each of your partitions. Partition-related cataloged procedures then allow you to retrieve and execute the appropriate procedure with one version of the EXEC statement, no matter which partition you are running in. One benefit of this feature lies in the ease with which unscheduled jobs can be started.

To use the feature, you must first create separate procedures that conform to the specific partitions in your system. Most probably, the difference in these procedures will be in the EXTENT and DLBL statements because of the different device and DASD space assignments from partition to partition. Next, in order to distinguish between the procedures and relate them to the appropriate partitions, the following naming convention must be used for cataloging these procedures:

First character of name	–	$
Second character	–	0 for BG partition
	–	1 for F1 partition, 2 for F2 partition, etc.
	–	A for FA partition (partition 10)
	–	B for FB partition (partition 11)
Third-eighth characters	–	any alphameric character

In the EXEC statement used to start the job, the first two characters of the procedure name must be $$, with the remaining characters identical to the last six characters of the cataloged name.

To continue the previous example, the procedures may be named $0PARSTD for the BG partition, $1PARSTD for the F1 partition and so on. The statement thus needed to invoke the appropriate procedure is // EXEC PROC=$$PARSTD.

Partition related procedures or procedures for the starting of urgent jobs are of great help to the operator. Full details on the use of cataloged procedures by the operator are given in *VSE/Advanced Functions Operating Procedures*.

Linking Programs

Prior to execution in storage, all programs must be placed in a core image library by the linkage editor. This section describes the role of the linkage editor and how you can communicate with it through control statements.

The name *linkage editor* appropriately reflects the editing and the linking operations that this program performs. The linkage editor prepares a program for execution by editing the output of a language translator into one or more executable phases. The linkage editor also combines separately assembled or compiled program sections or subprograms (called *object modules*) into phases. This process is referred to as linking.

A program can be link edited into one or more phases and

- cataloged permanently,
- cataloged permanently and executed immediately, or
- cataloged temporarily and executed immediately.

When a phase is cataloged permanently into a core image library, the linkage editor is no longer required for that phase, because the supervisor can load it directly from the library in response to an EXEC job control statement, or a FETCH or LOAD macro. On the other hand, if the phase is cataloged temporarily and executed immediately, the linkage editor is required again the next time the phase is to be run.

Phases are stored either temporarily or permanently, depending on the option specified in the OPTION job control statement:

```
// OPTION LINK
```

If the LINK option is specified, the phase is stored temporarily for immediate execution in the same job. This phase will be overwritten in the core image library by the next phase that is link edited.

```
// OPTION CATAL
```

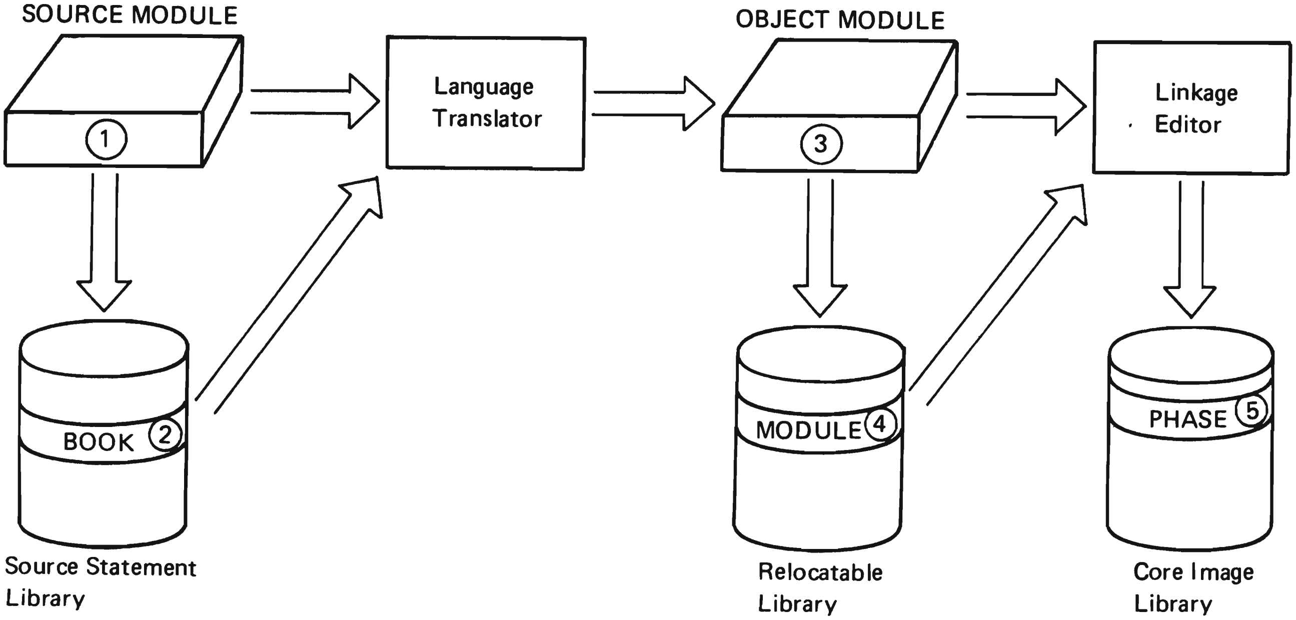
If the CATAL option is specified, the phase is stored permanently and can be executed any time after the link edit run.

The linkage editor runs in any partition, and the phases produced by the linkage editor are executable in any partition. The linkage editor can at the same time run in more than one partition without endangering the integrity of your program data. This holds true even if each executing linkage editor program updates (that is, catalogs into) the same core image library.

Note, however, that updating from multiple partitions is sequential, not concurrent: the particular core image library is locked by one partition. When linking in this partition is completed, the linkage editor program running in another partition becomes eligible for updating the core image library.

Structure of a Program

To understand the functions of the linkage editor, you must understand the structure of a program during the various stages of its development. Figure 3-23 summarizes the three sections that follow, which discuss source modules, object modules, and program phases.



A set of source statements, or source module (1), must be processed by a language translator, but can first be cataloged as a book (2) into the source statement library. The output of the language translator is called an object module (3), which must be processed by the linkage editor, but can first be cataloged as a module (4) into the relocatable library. The output of the linkage editor is called a phase (5), which is cataloged into a core image library temporarily or permanently, and can also be loaded into the shared virtual area.

Figure 3-23. Stages of Program Development

Source Modules

After planning the most logical approach to your application, you write a set of source statements in a programming language. Your set of source statements, called a source module, is processed by a language translator. The language translator *assembles* source modules written in assembler language, or it *compiles* source modules written in a high-level language (for instance, COBOL, PL/I, or RPG II). The language translator transforms the source module into an object module, which is in machine language.

You can either submit your source module directly to the language translator for processing, or you can catalog it into a sublibrary of the source statement library for processing at a later time by the language translator.

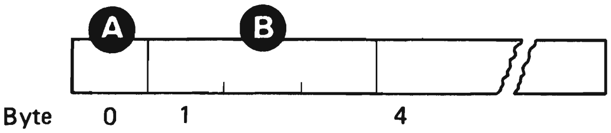
Source modules are written in one or more control sections (CSECTs). Using assembler language the programmer defines the control sections.

Source modules written in a high-level language have their control sections defined by the various compiler options used.

Object Modules

An object module, the output of a language translator, consists of the dictionaries and text of one or more control sections. The dictionaries contain the information needed by the linkage editor to modify portions of the text for relocation and to resolve cross-references between different object modules. The text consists of the actual instructions and data fields of the object module. You can either submit your object module directly to the linkage editor for processing, or catalog it into a relocatable library for later inclusion in a linkage editor job stream.

For each object module the language translator produces four types of records as illustrated and summarized in Figure 3-24. For more information about these records see *VSE/Advanced Functions System Control Statements*.



A Contains X'02'. Identifies the record as one of an object module.

B Indicates the record type and can be one of the following:

C'ESD' -- External symbol dictionary. Contains symbols defined in this module and referred to by one or more other modules and symbols referred to in this module but defined in another module.

C'TXT' -- Text. Contains actual code plus control information needed by the linkage editor.

C'RLD' -- Relocation list dictionary. Identifies those portions of the text which must be modified when the program is relocated for execution.

C'END' -- End of module. Indicates the end of a module. The record may contain an address where execution is to begin (transfer address) or the length of the control section or both.

Figure 3-24. Record Types of an Object Module

If you want to change information in a TXT record, you can prepare a REP record (user replace record) and submit it with your object module for cataloging into the relocatable library or for linkage editor processing. A REP record must be submitted between the TXT record it modifies and the END record; otherwise, the TXT record is not modified. Usually, you place the REP record(s) immediately before the END record.

Program Phases

The linkage editor produces a program phase from the object module(s) you identify in linkage editor control statements. A phase is the functional unit (consisting of one or more control sections) that the system loader can load into a partition in response to a single EXEC job control statement (or a FETCH or a LOAD macro instruction in an assembler language program).

In the PHASE control statement you instruct the linkage editor to produce one of three types of phases: relocatable, self-relocating, or non-relocatable.

Relocatable Phases. A phase is relocatable if it can be loaded for execution in any partition's address area. The linkage editor produces a relocatable phase unless you specify an absolute origin (load) address instead of a relative address. However, IBM recommends that you always specify a relative origin address. An address, in order to be relative, is represented by a symbol with or without a displacement; for details see *VSE/Advanced Functions System Control Statements.*

If a relocatable phase is also designed as a reenterable phase, it is eligible to be loaded into the shared virtual area (SVA). Phases resident in the SVA can be shared concurrently by programs running in either real or virtual mode.

Self-Relocating Phases. Prior to the availability of a loader with the relocating capability some users coded self-relocating programs in order to gain the advantages of relocatability. If you have to perform maintenance on such a program, you must write this program in assembler language according to the rules described in *VSE/Advanced Functions Macro User's Guide*. In the PHASE control statement you indicate an origin address of +0. The program must relocate all its addresses at execution time to correspond with the addresses available in the partition where the program is loaded.

Non-Relocatable Phases. A non-relocatable phase is link edited to be loaded at a specific location (absolute address) associated with a partition. When you request execution of a non-relocatable phase in a given partition, the starting and ending addresses of the phase must be included within that partition. Otherwise, the job is canceled. If you wish to execute a non-relocatable phase in more than one partition, you must catalog a separate copy of the phase for each partition.

The Three Basic Applications of the Linkage Editor

The three basic applications of the linkage editor are referred to as:

- cataloging phases into the core image library
- link edit and execute
- assemble (or compile), link edit, and execute.

The following sections include a discussion of the system flow during each of these applications.

Cataloging Phases into the Core Image Library

When you have an operational program (as an object deck in cards or on tape, for example) and you expect to use that program frequently, you should catalog it into a core image library. You can do this in a single job step, which is shown in Figure 3-25, and described below.

Job control copies, onto SYSLNK, the linkage editor control statements present on SYSRDR. The INCLUDE statement, without operands, signals job control to read any object modules that are to be included from SYSIPT. If an ENTRY statement is not encountered before the // EXEC LNKEDT statement, job control writes one on SYSLNK. An ENTRY statement signals termination of the input to the linkage editor.

The linkage editor is loaded into the partition where the job stream was submitted; it uses SYS001 as a work file.

Because the CATAL operand of the OPTION statement was specified, the linkage editor places the executable program permanently into a core image library. Which particular core image library serves as target library depends on your library definition to job control (see *Processing Requirements for the Linkage Editor,* later in this section.). The library descriptor entry in the core image directory for cataloged phases is updated.

If the phase is already in the shared virtual area (SVA) or (via the SET SDL command) has been requested to be loaded into the SVA, the phase is also loaded into the SVA after it has been cataloged to the *system* core image library as SVA eligible. Also, if the phase has an entry in the system directory list, the entry is updated.

Cataloging a Supervisor. Supervisors may also be cataloged permanently into the core image library as described above. Be sure, when doing this, to specify a unique name (eight alphameric characters) for each supervisor.

Link Edit and Execute

You do not always need to catalog a permanent copy of your program into the core image library in order to execute the program. For instance, you have modified parts of your program and want to test these modifications with the entire program. In this case, you can specify the LINK option, which requests that the linkage editor place a temporary copy of the program into the core image library. Again, the INCLUDE statement signals job control to read the following input from SYSIPT. The shaded portions of Figure 3-26 illustrate how this job stream differs from Figure 3-25.

By specifying an EXEC statement without a program name operand after the EXEC LNKEDT statement, the program just link edited is loaded for execution. The space temporarily occupied by this program in the core image library is overwritten the next time a program is link edited.

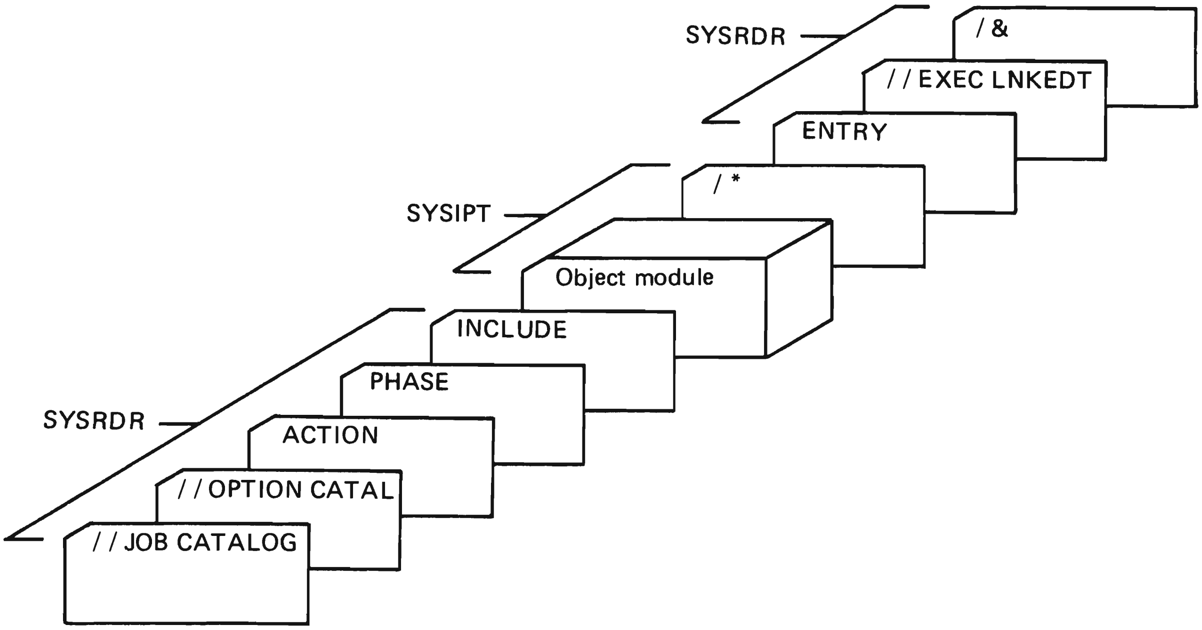


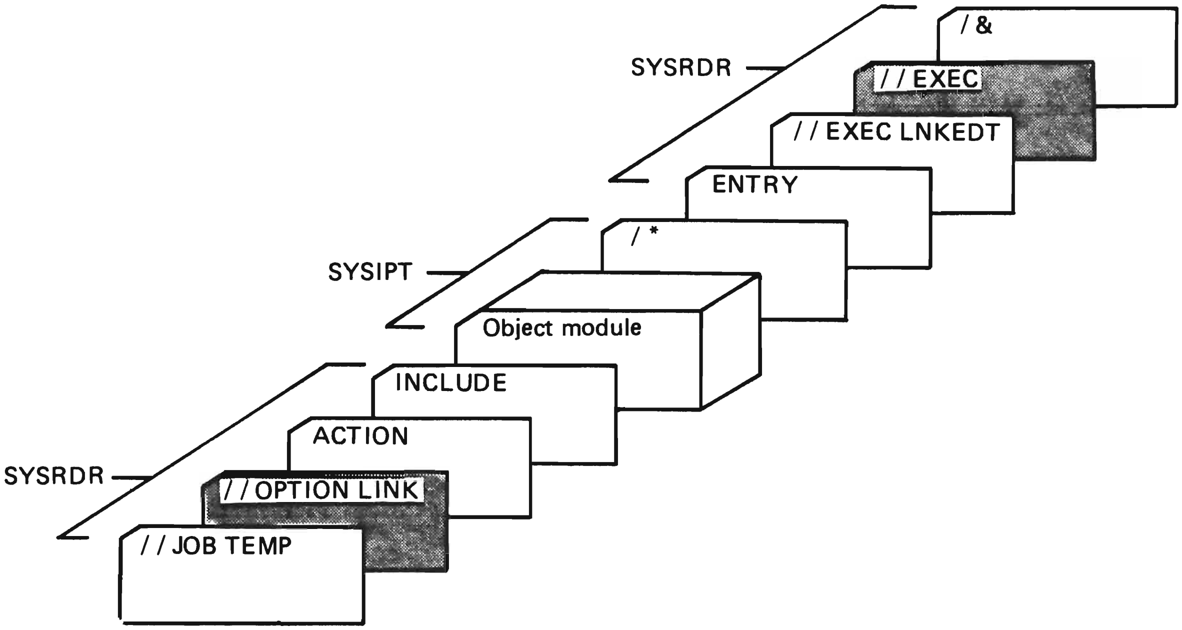
Figure 3-25. A Job Stream to Catalog a Program into the Core Image Library

Assemble (or Compile), Link Edit, and Execute

You can also combine the job steps described above with a job step for assembly (or compilation) of your source program. This is especially useful when you are developing a program. Figure 3-27 shows how your job stream should be set up. The shaded portions of the figure illustrate how this job stream differs from that shown in Figure 3-26. Linkage editor control statements are not required when linking single-phase programs temporarily into the core image library.

You direct the language translator to write the object module directly onto SYSLNK by specifying the LINK option at the beginning of the job. After the linkage editor processed the input from SYSLNK, your program is loaded for execution.

Instead of submitting three job steps, you may specify the GO parameter in the EXEC statement that invokes the assembler (compiler). This causes the linkage editor and your executable program to be invoked automatically. Only the source program and any additional data for the go step are required. For multiple assemblies (compilations), an OPTION LINK statement must precede the first EXEC statement for an assembly or compilation. This is true also when linkage editor control statements like INCLUDE or PHASE are used. If no LINK option is set, the GO parameter will be in effect only for the EXEC statement it appears on, and the ACTION default will be set to NOMAP (linkage editor control statements are described below, in *Preparing Input for the Linkage Editor,* later in this section).



The // EXEC statement (without a program name operand) causes this program to be loaded for execution immediately.

The // OPTION CATAL statement may also be used in this job stream. In this case, the program that was cataloged (permanently) is executed immediately. When // OPTION CATAL is specified a PHASE statement is required.

Figure 3-26. A Job Stream to Link Edit a Program for Immediate Execution

When you make use of the GO parameter, your executable program has to run in virtual mode, and the partition GETVIS area available to this program will be of the IBM set default size unless you overrode that value through the SIZE command.

If errors occur in one job step causing an abnormal termination, the remaining job steps are ignored. Certain linkage editor errors do not cause job step termination. If you do not want to execute the program when these errors occur, you may specify ACTION CANCEL after the // OPTION LINK.

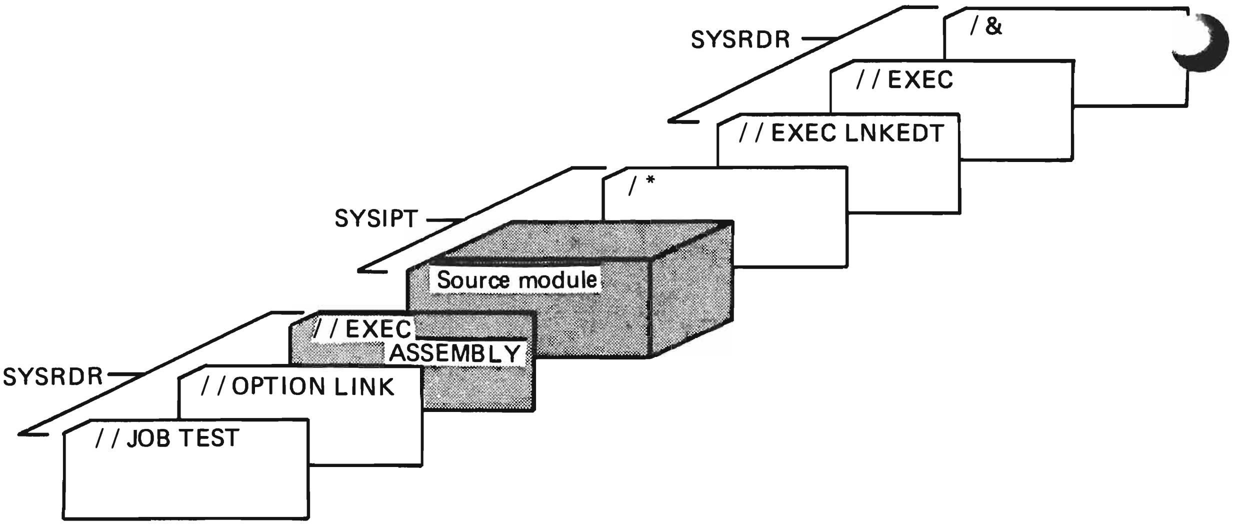


Figure 3-27. A Job Stream to Assemble, Link Edit, and Execute

Processing Requirements for the Linkage Editor

Library Definitions

Relocatable Library. Job control statements (commands) are available to define one or more private relocatable libraries. It is from these libraries that the linkage editor retrieves object modules whenever an INCLUDE or the AUTOLINK function request such a retrieval.

The LIBDEF job control statement defines a chain of relocatable libraries (note that this 'chain' may consist of only one library). For example, if you want to instruct the linkage editor to search, in that sequence, the two private relocatable libraries with filenames MYRELO1 and MYRELO2, you would specify

```
// LIBDEF RL,SEARCH=(MYRELO1,MYRELO2)
```

This chain implicitly includes as a third member the system relocatable library. If you wanted the linkage editor to search first the system library and then the other libraries, the SEARCH parameter would look as follows:

```
SEARCH=(IJSYSRS,MYRELO1,MYRELO2)
```

The LIBDEF statement is discussed in more detail in the last section of this chapter *Using the Libraries.*

Your job stream may start with an assemble/compile step. What has been said about the relocatable library definition holds equally true for the source statement library: you may define a chain of source statement libraries. The LIBDEF statement would contain the parameter SL instead of RL.

If only one private relocatable library needs to be defined, you may simply use the ASSGN job control statement

```
// ASSGN SYSRLB,cuu
```

Note that both ASSGN and LIBDEF need matching DLBL/EXTENT information.

Core Image Library. The link edited phase is placed into one of the following:

- the core image library in a (temporary or permanent) library definition of the form

  ```
  LIBDEF CL,TO=filename,...
  ```

- the system core image library if no LIBDEF definition is present.

An ASSGN of SYSCLB will be treated as a

```
LIBDEF CL,SEARCH=(IJSYSCL).FROM=IJSYSCL,TO=IJSYSCL,PERM
```

Note: If a LIBDEF CL definition is present, but no TO library specified, the system core image library will not be taken as default; the link edit job is canceled, instead.

When OPTION LINK is in effect, the execution step retrieves the phase to be executed from the library that served as target library in the link edit step.

Symbolic Units Required

The linkage editor requires the following symbolic units:

SYSIPT	Module input (if any)
SYSLST	Programmer messages and listings (if SYSLST is not assigned, no map is printed and programmer messages appear on SYSLOG)
SYSLOG	Operator messages
SYSRDR	Control statement input (via job control)
SYSLNK	Input to the linkage editor
SYS001	Work file.

Note that SYSRDR and SYSIPT may contain input for the linkage editor. This input is written on SYSLNK by job control.

If output from the linkage editor is to be placed in a private core image library and you don't use the LIBDEF statement, the following symbolic unit is required:

SYSCLB The private core image library. It may be assigned anywhere in the job stream but before job control reads the // EXEC LNKEDT statement.

If object modules from a private relocatable library are to be link edited and you do not use the LIBDEF statement, the symbolic unit SYSRLB must be assigned.

Linkage Editor Work Files in VSAM-managed Space

Linkage editor work files may be placed in VSAM-managed space if you have the *VSE/VSAM Space Management for SAM* feature installed. How you address those files in your job control depends on whether the work files are defined explicitly or implicitly. A file is defined explicitly via the DEFINE CLUSTER command of VSAM's Access Method Services (for a detailed description refer to the publication *Using the VSE/VSAM Space Management for SAM Feature*). If not defined explicitly, the file is defined implicitly when the linkage editor opens the IJSYSLN (SYSLNK) and IJSYS01 (SYS001) files.

Assume you had explicitly defined the two files with file-id's %FILE.LINK and %FILE.ONE. The corresponding job control statements would look as follows:

```
// DLBL IJSYS01,'%FILE.ONE',,VSAM
// DLBL IJSYSLN,'%FILE.LINK',,VSAM
```

If the files are defined implicitly, you must also supply information on space allocations, record sizes and volume id's, as in the following example:

```
// DLBL IJSYS01,'%FILE.ONE',,VSAM,RECORDS=10,RECSIZE=4089
// EXTENT ,volid
// DLBL IJSYSLN,'%FILE.LINK',,VSAM,RECORDS=100,RECSIZE=322
// EXTENT ,volid
```

The EXTENT statements may be omitted if a default SAM ESDS model has been defined into the VSAM catalog.

Note that these job control statements use partition independent file-id's so that if they are placed in the system standard label area or with the job, concurrent linkage editor execution in multiple partitions would not cause interference between linkage editor files.

Also note that RECORDS and RECSIZE specify the primary allocation. On the average, 800 RLD items can be stored in a 4089 bytes long record on IJSYS01. Two text cards or one single control card can be stored in a 322-byte record on IJSYSLN.

Preparing Input for the Linkage Editor

The input you prepare for the linkage editor consists of job control statements, linkage editor control statements, and object modules. Job control reads the job control statements and the linkage editor control statements from the device assigned to SYSRDR and object modules from SYSIPT. The linkage editor control statements and object modules are copied onto the disk extent assigned to SYSLNK.

The linkage editor control statements direct the execution of the linkage editor. The statements are: ACTION, ENTRY, INCLUDE, and PHASE. A description of how to prepare these control statements is given on the following pages. Here, the various operands of the control statements are described under headings that indicate their function.

Assigning a Name to a Program Phase

Each program phase the linkage editor is to produce should have a name, which you specify in the PHASE statement. When a phase is cataloged in the core image library, the phase name identifies that phase for subsequent retrieval. In other words, the same phase name you supplied in the PHASE statement when permanently cataloging the initial or only phase of a program must be used as the operand in the EXEC job control statement or in a FETCH or a LOAD macro instruction.

When you catalog a phase with the same name as a phase already residing in the core image library, the earlier entry with the same phase name is deleted from the core image directory (and, if applicable, the system directory list in the SVA) and cannot be accessed again.

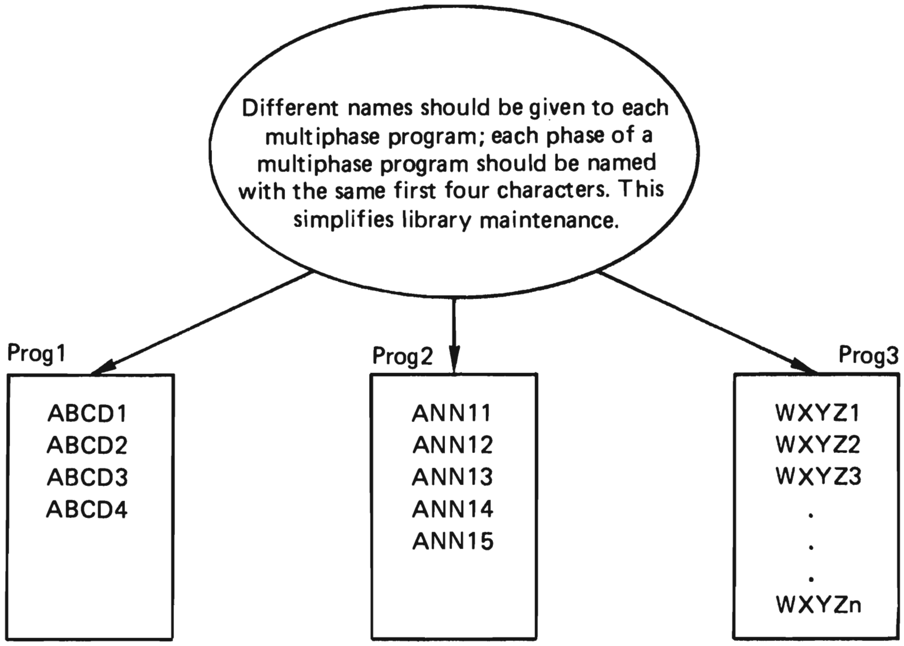
The choice of a phase name has a bearing on retrieval efficiency and the subsequent use of the librarian programs. Job control scans the directory of the appropriate library for all phases starting with the same four characters as the program name specified in the EXEC statement.

Any phases with the same first four characters of their phase name will be classified as a multiphase program. When a phase of a multiphase program is fetched, the available address space must be large enough to contain the largest of those phases even if that phase is not part of the program which is being executed.

Phase names may be formed only from characters 0-9, A-Z, /, #, $, and @. Otherwise, the phase statement is invalid. The names "S", "ALL", and "ROOT" are invalid phase names.

In choosing a name for any multiphase program, make sure that the first four characters are the same for all phases of that program but different from those of other programs. Such names simplify the deleting, displaying, punching, merging, and copying of the entire program. Figure 3-28 summarizes the above recommendations.

Note: A phase name "//" cannot be placed into the System Directory List via the job control command SET SDL.

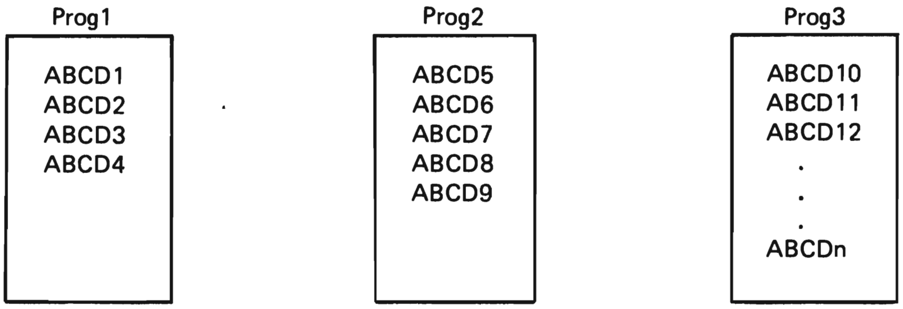


Different names should be given to each multiphase program; each phase of a multiphase program should be named with the same first four characters. This simplifies library maintenance.

Simplified library maintenance means, for example, that one simple control statement deletes all phases of Prog1:

```
DELETC ABCD.ALL
```

If the programs had been named:



the statement required to delete Prog1 would be:

```
DELETC ABCD1, ABCD2, ABCD3, ABCD4
```

Figure 3-28. Naming Multiphase Programs

Defining a Load Address for a Phase

For link editing, you specify where your program is to be loaded for execution. You have several choices.

A phase can be link edited to be loaded into and executed from:

- a partition's address area
- the shared virtual area
- an absolute address.

A phase can be link edited as a relocatable phase, a self-relocating phase, or a non-relocatable phase.

The load address you specify in the PHASE statement determines the relocatability status of the link edited phase:

- For a phase to be relocatable, specify a symbolic address with or without a displacement.
- For a phase to be non-relocatable, specify an absolute address.
- For a phase which you wrote to be self-relocating, specify +0.

Full details on possible load address (also called origin address) specifications are given in *VSE/Advanced Functions System Control Statements*.

Link Editing for Execution at Any Address. If the linkage editor determines that a phase is to be given the relocatable format, it flags the core image directory entry for that phase, and inserts the relocation information behind the text of the phase in the core image library.

When a relocatable phase is link edited, it is assigned a load address relative to the partition's address area in which the linkage editor was executed. When executing the phase from the same partition, relocation is not required. (This assumes that virtual storage allocations were not changed between link editing and executing the phase.)

Executing the phase from a different partition requires relocation by the operating system. Loading and relocating a phase takes more processing time than just loading.

Link Editing for Inclusion in the Shared Virtual Area. If a relocatable phase is also reenterable, it can be included in the shared virtual area (SVA). Phases resident in the SVA can be shared concurrently by more than one partition. It is advantageous to include frequently-used phases in the SVA because these are then resident when requested for execution (they are not reloaded from the core image library).

To indicate that a phase should reside in the SVA, you must specify the SVA operand in the PHASE statement when cataloging the phase. This operand is ignored if the phase is not relocatable; otherwise, the SVA operand is accepted and the phase is said to be SVA-eligible.

The linkage editor cannot check whether a phase is reenterable; however, a protection check can occur when executing a phase from the SVA that modifies itself and therefore is not reenterable. Because the system directory list (SDL) is sorted prior to the loading of phases into the SVA, the packaging of phases to be executed together should be done using the linkage editor.

Immediately after a phase is cataloged as SVA eligible into the system core image library, it is loaded into the SVA *if* this phase either is already in the SVA or (via the SET SDL command) has been requested to be loaded into the SVA. See the section *Building the SDL and Loading the SVA* earlier in this chapter.

Link Editing for Execution at an Absolute Address. If you specify an absolute address in the PHASE statement, your program can be loaded only at this address at the time of program execution. Not only must the address you specify be within the address range of your installation's virtual storage, but also the entire program must be included within the boundaries of the area allocated to the partition where you request the program to be executed.

In 370 mode, if you wish to force a phase to be executed in real mode, you may link edit that phase with the absolute address of a given partition's real address space.

Using Self-Relocating Programs. You should identify self-relocating programs by a PHASE statement with an origin point of +0:

```
PHASE PROGA,+0
```

The linkage editor assumes that the program is loaded at location zero, and computes all addresses accordingly. The job control EXEC function recognizes a zero phase address and adjusts the origin address to compensate for the current partition boundary save area and label area. It then gives control to the updated entry address of the phase.

Building Phases from Object Modules with the INCLUDE Statement

You indicate which object modules or parts of object modules are to be included in a phase by specifying the INCLUDE statement. The format of the INCLUDE statement indicates the location of the modules. The object modules can be either on the card reader, tape unit, disk or diskette device assigned to SYSIPT, or in a relocatable library, or on the disk device assigned to SYSLNK. The modules are extracted in the same order as the INCLUDE statements are issued.

Including Modules from SYSIPT. If the object modules you want to include in a phase are on the SYSIPT file, specify the INCLUDE statement without operands. Job control copies the data from SYSIPT until it encounters end-of-data (/*).

Including Modules from a Relocatable Library. You may want to include in a phase object modules or parts of an object module that are cataloged in a relocatable library. To include an entire module, specify the module name in the INCLUDE statement. To include part of a module, specify the name of the module followed by the names of the control section(s) you wish to be included.

Including Parts of Modules from SYSLNK. You do not need an INCLUDE statement unless you want to change the sequence of control sections or to extract certain control sections from an object module. For either of these cases, specify the names of the control sections in an INCLUDE statement.

Linkage Editor Storage Requirements

The storage requirements for a link edit run depend on the number of PHASE statements and number of ESD items processed during a *link edit* run.

In a minimum size virtual partition of 128K the linkage editor can process for example 10 phases with a total number of 380 unique ESD items.

A unique ESD item is defined as being an occurrence in the control dictionary. All symbols that appear in the MAP are unique occurrences. A symbol that occurs several times in the input stream is normally incorporated into a unique ESD item. However, if the same symbol occurs in different phases (for example, control sections), each resolved occurrence of the symbol within a different phase is a unique ESD item.

You can use the following formula for storage estimates:

$$56{,}000 + 40 * x + 20 * y \le P$$

x = number of PHASE statements

y = total number of unique ESD items

P = storage available to the partition, excluding GETVIS space.

To execute the linkage editor in real mode requires an allocation of processor storage:

- for the linkage editor program itself 64K
- for the GETVIS area an amount that varies with the number of work files and their associated device types; 48K should suffice in most cases.

A larger allocation allows for larger I/O buffers thus reducing the number of I/O operations and leading to a better performance.

The AUTOLINK Feature

For each phase the automatic library look-up feature (referred to as AUTOLINK) collects any external references and attempts to resolve them. An external reference is an ER item in the control dictionary that has not been matched with an entry point. AUTOLINK searches any defined private relocatable directory and then the system relocatable directory until a cataloged module with the same name as the external reference is found (or the end of the directory is reached). If found, the module is included in the phase (autolinked). This retrieved module must have an entry point matching the external reference in order to resolve its address.

When you have a chain of relocatable libraries defined, use of AUTOLINK may give you a performance gain: the directories (of the libraries in the SEARCH chain) will in most cases be searched only once. On the other hand, when using INCLUDE statements, a search through the directories occurs each time an INCLUDE statement is processed.

The following examples show how the AUTOLINK feature works.

Assume that the relocatable library contains the following:

Module Name	Entry Names	External References
A	A, B, C	
D		A
E		B
F		A, C

Examples:

In your linkage editor input stream you specify INCLUDE D. A will be autolinked (included with module D) because the external reference A is also a module name in the relocatable library.

If you specify INCLUDE E, then A will not be autolinked because the external reference B does not relate to a module name. In this case, you must also specify INCLUDE A, so that the external reference B can be resolved. No autolink is required.

If you specify INCLUDE D and INCLUDE E, then A will be autolinked by module D and the external reference B in module E can then be resolved.

If you specify INCLUDE F, then module A will be autolinked by the reference to A, and the reference to C will also be resolved.

Suppressing the AUTOLINK Feature. You can suppress the AUTOLINK feature in two ways:

- By specifying NOAUTO in a PHASE statement, AUTOLINK is canceled for that phase only.
- By specifying NOAUTO in the ACTION statement, AUTOLINK is canceled for this execution of the linkage editor. By writing a weak external reference (WXTRN), AUTOLINK is canceled for one symbol.

You can do this in assembler language by specifying for example:

```
DC    A(LABEL)
WXTRN    LABEL
```

or

```
DC    V(LABEL)
WXTRN    LABEL
```

For more information, refer to the assembler language publications.

NOAUTO can be used to force a CSECT into a specific phase within an overlay structure. For example, four phases of a program have a V-type address constant called PETE, but in the overlay structure you want the coding for PETE included only in the third phase.

```
PHASE PROGA,*,NOAUTO
PHASE PROGB,*,NOAUTO
PHASE PROGC,*
PHASE PROGD,*,NOAUTO
```

cause PETE to be included in PROGC only.

Specifying Linkage Editor Aids for Problem Determination or Prevention

You can specify that the linkage editor aid you in avoiding certain problems in your programs or determining what they are. The actions discussed below are CLEAR, MAP, and CANCEL, which may be specified as operands of the ACTION statement.

Clearing the Unused Portion of the Core Image Library

If you used DS (define storage) statements in your source module, it may be advantageous to fill these areas with binary zeros when the program is link edited. This eliminates the risk that residual data from a previously linked program be loaded with your program when it is executed. Such irrelevant data might disrupt your program considerably. By specifying CLEAR in the ACTION statement, you request that the unused portion of the core image library is to be set to binary zeros.

Because CLEAR is a time-consuming function, you might want to use DC statements instead of DS statements when designing future programs; but do use ACTION CLEAR when cataloging a supervisor.

Obtaining a Storage Map

You can obtain a linkage editor storage map and a listing of linkage editor error diagnostics, which assist you in determining the reasons for particular errors in your program. If SYSLST is assigned, ACTION MAP is the default. You can specify ACTION NOMAP if you are not interested in this service of the linkage editor.

The storage map contains such information as:

- The lowest and highest addresses that each phase occupies in the partition in which it is link edited.
- The starting disk address of the phase in the core image library.
- The names of all control sections and entry points, their load addresses and relocation factors.
- The names of relocatable modules from where CSECTs were inlcuded.
- The names of all external references that are unresolved.

- An indication whether the phase is relocatable, non-relocatable, self-relocating, or SVA eligible.

The error diagnostics warn you, for example, if:

- The ROOT phase has been overlaid.
- A control section has a length of zero.
- An address constant could not be resolved.

A sample storage map, together with a description of how to interpret it, is included in *VSE/Advanced Functions Serviceability Aids and Debugging Procedures*.

Terminating an Erroneous Job

If errors are present in the input to the linkage editor, the output of the linkage editor will most likely also be erroneous. If you specify CANCEL in the ACTION statement, the entire job is terminated when any of the type of errors represented by messages 2100I through 2170I occurs. Refer to these messages in *VSE/Advanced Functions Messages*.

Designing an Overlay Program

The nature of virtual storage makes it unnecessary to write programs in an overlay structure, because virtual partitions can be allocated to accommodate very large programs.

Overlay programs consist of control sections organized in an overlay tree structure. An example of an overlay tree structure is shown in Figure 3-29. This structure does not imply the order of execution, although the root phase is normally the first to receive control.

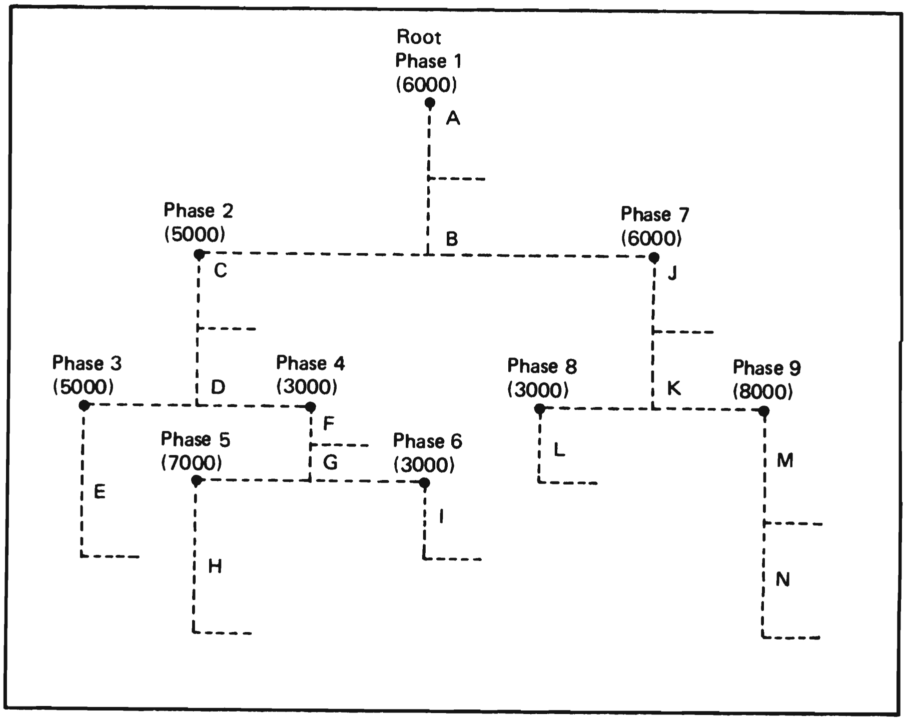
The manner in which control should pass between control sections is discussed below under *Using FETCH and LOAD Macros*.

Relating Control Sections to Phases

After having organized the control sections of your program into an overlay tree structure, you must prepare a corresponding set of linkage editor control statements.

Link edit your complete overlay program in a single job step, and conversely, do not include in this job step any phases that are not related to the overlay. Otherwise, the linkage editor may be unable to resolve external references correctly.

The PHASE and INCLUDE statements you prepare are critical to ensure the overlay tree structure you designed. Figure 3-30 is an example of the job stream that ensures the overlay tree structure shown in Figure 3-29.



The letters A through N represent control sections, which are organized to form nine phases in one program. The root phase resides in storage during the entire execution of the program. The remaining phases can overlay each other during execution.

You must guarantee a partition size that is equal to the longest combination of phases that can possibly reside in storage together, namely, phases 1, 2, 4, and 5, which total 21,000 bytes. If the program had not been organized in an overlay structure, it would have required an address space of 46,000 bytes.

Figure 3-29. Overlay Tree Structure

```
// JOB OVERLAY
// OPTION CATAL
   PHASE    PHASE1,ROOT        PHASE1 stays in storage during
   INCLUDE ,(CSECTA,CSECTB)    execution of the entire program.
   PHASE    PHASE2,*           PHASE2 is to be loaded
   INCLUDE ,(CSECTC,CSECTD)    immediately behind PHASE1.
   PHASE    PHASE3,*           Since PHASE3 needs PHASE2, PHASE3
   INCLUDE ,(CSECTE)           is not allowed to overlay PHASE2.
   PHASE    PHASE4,PHASE3      PHASE4 will occupy the same
   INCLUDE ,(CSECTF,CSECTG)    storage locations as PHASE3.
   PHASE    PHASE5,*           PHASE5 will be loaded
   INCLUDE ,(CSECTH)           immediately behind PHASE4.
   PHASE    PHASE6,PHASE5      PHASE6 will be loaded at the
   INCLUDE ,(CSECTI)           same address as PHASE5.
   PHASE    PHASE7,PHASE2      PHASE7 will be loaded at the
   INCLUDE ,(CSECTJ,CSECTK)    end of the root phase.
   PHASE    PHASE8,*           PHASE8 will be loaded at the
   INCLUDE ,(CSECTL)           end of PHASE7.
   PHASE    PHASE9,PHASE8      PHASE9 will overlay
   INCLUDE ,(CSECTM,CSECTN)    PHASE8.
   INCLUDE
       (Object modules containing CSECTs A through N)
/*
// EXEC LNKEDT
/&
```

Figure 3-30. Link Editing an Overlay Program

Using FETCH and LOAD Macros

During execution, an overlay program communicates with the supervisor to request that a subsequent phase be brought into the partition. You include FETCH or LOAD macros within your phases for this purpose.

Use a LOAD macro in a phase that is to remain in control after the requested phase is brought into the partition.

Use a FETCH macro if you want the requested phase to gain control immediately after it is brought into the partition. If a phase loaded by the FETCH macro is relocatable, it will be relocated if necessary. You cannot issue a FETCH macro for a self-relocating phase.

Parameters in FETCH and LOAD allow use of the LDL (local directory list), thereby reducing fetching and loading time.

VSE/Advanced Functions Macro Reference contains details on the format of the FETCH and LOAD macros.

Examples of Linkage Editor Applications

The linkage editor examples on the following pages illustrate the use of and relation between linkage editor and job control statements. After studying these examples, you should be able to set up a link edit job for your own purposes.

Catalog to the System Core Image Library Example

```
   // JOB CATALCIL
   *  LINK EDIT AND CATALOG TO SYSTEM CORE IMAGE LIBRARY
   *  SINGLE PHASE, ELIGIBLE FOR LOADING INTO SHARED
   *  VIRTUAL AREA, MULTIPLE OBJECT MODULES,
   *  MIXTURE OF CATALOGED AND UNCATALOGED
   *  MODULES
1  // ASSGN SYSLNK,190
2  // OPTION CATAL
3     PHASE PROGB,*,SVA
4     INCLUDE
      Object deck
   /*

      INCLUDE SUBRX
      INCLUDE SUBRY
      INCLUDE
      Object deck
   /*
5  // EXEC LNKEDT
   /&
```

Explanation for Catalog to the System Core Image Library. This example illustrates the cataloging of a single phase composed of multiple object modules. These modules are located in the input stream and the system relocatable library.

Statement 1: The statement is required, unless SYSLNK is permanently assigned. If the statement is included, it must precede the OPTION statement (Statement 2).

Statement 2: The OPTION CATAL statement sets the LINK switch, as well as the CATAL switch. If SYSLNK is not assigned, the statement is ignored. The linkage editor control statements are not accepted unless the OPTION statement is processed. Link-editing and cataloging to the system core image library is requested.

Statement 3: Only one PHASE is produced. It is cataloged to the system core image library and may be retrieved by the name PROGB. Because there is only one phase, the origin point * indicates that this phase originates at the starting address of the partition plus the length of the partition save area, and the COMMON pool (if any). The SVA operand indicates that the phase should be considered SVA-eligible. If the phase PROGB either is already loaded in the SVA or has been requested (via the SET SDL command) to be loaded into the SVA, PROGB is loaded into the shared virtual area immediately after it is cataloged into the system core image library. (This would not occur if PROGB is link edited with OPTION LINK.)

Note: COMMON is used by FORTRAN programs to store data shared by multiple programs.

Statement 4: Four modules make up this phase. The first and last are not cataloged in the relocatable library; therefore the object decks must be on SYSIPT, and each must be followed by the end-of-data record (/*). SUBRX and SUBRY were cataloged previously to the relocatable library by those names. Job control puts the uncataloged modules on SYSLNK in place of their INCLUDE statements. Job control copies onto SYSLNK the INCLUDE statements for the cataloged modules.

Statement 5: The EXEC LNKEDT statement causes the linkage editor program to be loaded. SYSLNK now becomes input to the linkage editor. It contains:

```
PHASE PROGB,*,SVA
First uncataloged relocatable deck
INCLUDE SUBRX
INCLUDE SUBRY
Second uncataloged relocatable deck
ENTRY
```

The modules are link edited into one phase so that they occupy contiguous addresses in the sequence in which they appear in the input stream. When the linkage editing is completed, cataloging to the core image libary occurs because of the CATAL option.

In addition, the linkage editor prints a status report that reflects the usage and available space in the core image library. (This does not occur in a LINK situation.)

The example can be modified to illustrate a catalog-and-execute operation by inserting the following statements between the EXEC LNKEDT and /& statements:

- Any job control statements required for execution of PROGB
- A // EXEC statement
- Card reader input for PROGB, if any.

The example does not include an ENTRY statement. Job control, therefore, writes an ENTRY statement on SYSLNK instructing the linkage editor that:

- There is no more input on SYSLNK.
- The entry point defined in the source program should be the entry point of the produced phase.

Catalog to a Private Core Image Library Example

```
   // JOB CATLCIL
   *  LINK EDIT AND CATALOG TO PRIVATE CORE IMAGE LIBRARY
   *  SINGLE PHASE, ALIGNED ON A PAGE BOUNDARY, MULTIPLE
   *  OBJECT MODULES,
   *  MIXTURE OF CATALOGED AND UNCATALOGED OBJECT MODULES
   LIBDEF RL,SEARCH=(RSUBLIB,PRVRELO)
1  LIBDEF CL,TO=PRIVCIL
2  // ASSGN SYSLNK,190
3  // OPTION CATAL
4     PHASE PROGB,S,PBDY
5     INCLUDE
      object deck
   /*
      INCLUDE SUBRX
```

```
       INCLUDE SUBRY
       INCLUDE
       Object deck
   /*
6  // EXEC LNKEDT
   /&
```

Explanation for Catalog to Private Core Image Library. This example illustrates how to define private libraries. Object modules SUBRX and SUBRY are to be included from private relocatable libraries whose filenames are RSUBLIB and PRVRELO. Phase PROGB, the output of the linkage editor is to be cataloged into a library with filename PRIVCIL.

Statement 1: These LIBDEF statements define the private libraries. Label information must have been stored in the label information area or, if appropriate, DLBL and EXTENT statements must precede the LIBDEF statements. Instead of the second LIBDEF statement, an ASSGN SYSCLB,cuu command could have been used.

Statements 2 through 6: They are the same as statements 1 through 5 in the preceding example (Catalog to the System Core Image Library).

Just like the preceding example, so can this example be modified to illustrate a catalog-and-execute operation.

Link Edit and Execute Example

```
   // JOB LINKEXEC
   *  LINK EDIT AND EXECUTE SINGLE PHASE, SINGLE OBJECT
   *  MODULE NOT CATALOGED
1  // ASSGN SYSLNK,190
2  // OPTION LINK
3        PHASE PROGA,*
4        INCLUDE
       object deck
   /*
5  // EXEC LNKEDT
6        Any job control statement required for execution
       such as ASSGN or label statements
7  // EXEC
       input data as required
   /*
   /&
```

Explanation for Link Edit and Execute. This example illustrates the basic concept of link editing and executing by using a single phase that is constructed from a single object module contained in punched cards.

Statement 1: No assignments are necessary because the system units required for link editing are assumed to be permanently assigned. An ASSGN for SYSLNK is included to illustrate its position relative to the OPTION statement in case an assignment is required!

Statement 2: The statement indicates that a link edit operation is to be performed. If SYSLNK has not been assigned, the statement is ignored.

Linkage editor control statements are not accepted until the OPTION statement is processed. Because the option is LINK, and not CATAL, only link editing will be performed.

Statement 3: The PHASE statement is copied on SYSLNK. Job control checks only the first operand; remaining operands are checked by the linkage editor when that program uses SYSLNK as input.

Only one phase is built by the linkage editor because only one PHASE statement is submitted for the entire run. The name of this phase is PROGA, as specified in the first operand. The second operand indicates the origin point for the phase. Because an * has been used, the phase begins in the next storage location available, with forced doubleword alignment. Because this is the first and only phase, it is located at the beginning of the partition plus the length of the save area plus the length of any area assigned to the COMMON pool (as designated by a CM entry in the object module).

A displacement, either plus or minus, may be used with the *, such as *+1024. This causes the origin point of the phase to be set relative to the * by the amount of the displacement.

Statement 4: The INCLUDE statement has no operands so the records are read from SYSIPT and written on SYSLNK until SYSIPT has an end-of-data (/*) record. The data on SYSIPT is expected to be the object module in card image format that is used in this linkage editor operation.

Statement 5: On encountering the EXEC LNKEDT statement, job control writes an ENTRY statement with no operand on SYSLNK and causes the linkage editor program to be loaded.

Using the data just placed on SYSLNK as input, the linkage editor produces executable code. The output is placed in the next available space of the core image library (immediately after the last cataloged phase). This is true regardless of whether the program is cataloged permanently (OPTION CATAL) or temporarily (OPTION LINK). However, if OPTION LINK is specified, the temporarily cataloged program is overlayed by the next program that is link edited. A program that is cataloged temporarily must be link edited each time it is used. No ACTION options are specified. Therefore, in resolving the external references, the system makes use of the AUTOLINK feature. Error diagnostics and a storage map are written on SYSLST, assuming that SYSLST is assigned.

Statement 6: Because the program is not cataloged, it must be executed immediately. Any pertinent job control statements are entered at this point.

Statement 7: An EXEC statement with no program name operand indicates that the phase to be executed was just link edited. Therefore, no search of the core image directory for linked phases is required. The program is brought into storage and control transferred to its entry point. Because the automatic ENTRY statement is in effect for this example, the entry point is the address specified in the program.

This example can be modified to illustrate the following:

1. *Catalog and execute.* To cause this phase to be cataloged permanently, change the OPTION statement (2) from LINK to CATAL.
2. *Catalog only.* To catalog only, change the OPTION statement (2) from LINK to CATAL and remove all statements following the EXEC LNKEDT statement (5) up to the /& statement.
3. *Include object module from relocatable library.* The name of the object module in the relocatable library must be supplied by an additional INCLUDE statement. If the name is RELOCA, the statement is INCLUDE RELOCA. This form of the INCLUDE statement is written on SYSLNK when it is read by job control. The linkage editor retrieves the object module when it encounters the INCLUDE statement because it uses SYSLNK for input.

Compile and Execute Example

```
   // JOB COMPEXEC
   *   COMPILE OR ASSEMBLE, LINK EDIT AND EXECUTE
   *   SINGLE PHASE, MULTIPLE OBJECT MODULES,
   *   INPUT TO LINKAGE EDITOR FROM LANGUAGE TRANSLATOR,
   *   SYSTEM RELOCATABLE LIBRARY AND SYSIPT
1  // ASSGN SYSLNK,190
2  // OPTION LINK
3       PHASE PROGA,S
4  // EXEC FCOBOL
       COBOL source statements
   /*
5      INCLUDE SUBRX
       INCLUDE
       object module
   /*
6      ENTRY BEGIN1
   // EXEC LNKEDT
       Any job control statements required for PROGA
       execution
   // EXEC
       Any input data required for PROGA execution
   /*
   /&
```

Explanation for Compile and Execute. The language translators provide the option of placing their output on SYSLNK. Because the linkage editor uses SYSLNK for input, a program can be assembled or compiled, link edited and executed, all in one job.

All three sources of object module input to the linkage editor are used: SYSIPT, the (system) relocatable library, and the output from a language translator. It is assumed that only sequential DASD files or unlabeled tape files are processed.

Statement 1: The SYSLNK assignment is given to show the position of ASSGN statements relative to the OPTION statement. ASSGN statements are not required if they are permanent assignments.

Statement 2: The statement is required.

Statement 3: The PHASE statement must always precede the relocatable modules to which it applies; it is written on SYSLNK first for later use by the linkage editor. S is the origin point, that is, the phase originates with the first doubleword in the partition plus the length of the partition save area and label area, plus the length of the area assigned to the COMMON pool (if any). This gives the same effect as * gives for a single phase or the first phase of a multiphase link edit run. As with the *, the S may be used with a relocation factor, for example, S+1024.

Statement 4: The appropriate language translator is called (in this case, DOS/VS COBOL). The normal rules for compiling are followed; the source deck must be on the unit assigned to SYSIPT and the /* defines the end of the source data. The output of the language translator is written on SYSLNK.

Statement 5: The INCLUDE SUBRX statement is written on SYSLNK. The linkage editor retrieves the named module from the system relocatable library. Because it has no operand, the next INCLUDE statement signifies that the relocatable module is on SYSIPT. The data on SYSIPT is copied on SYSLNK up to the /* statement.

Statement 6: The ENTRY statement is written on SYSLNK as the last linkage editor control statement. The symbol BEGIN1 must be the name of a CSECT or a label definition (which occurs in an ENTRY source statement) defined in the first or only phase. The address of BEGIN1 becomes the transfer address for the first or only phase of the program. The ENTRY is used to provide a specific entry point rather than to use the point specified in the program.

The rest of the statements follow the same pattern as discussed in the Link Edit and Execute example. The input from SYSLNK to the linkage editor is:

```
PHASE PROGA,S
Relocatable module produced by COBOL compilation
INCLUDE SUBRX
Relocatable module from SYSIPT
ENTRY BEGIN1
```

If certain types of errors are detected during compilation of a source program, the LINK option is suppressed. Under these circumstances the EXEC LNKEDT and EXEC statements are ignored and the message 'STATEMENT OUT OF SEQUENCE' results. This LINK option suppression should be kept in mind if a series of programs is to be compiled and cataloged as a single job. Failure of one job step would cause failure of all succeeding steps.

An OPTION LINK cannot be given if OPTION CATAL is in effect. The message 'STATEMENT OUT OF SEQUENCE' results.

Using the Libraries

After you have planned the size, contents, and location of the libraries (see *Chapter 2, Planning the System*), you need to know how to allocate space to a library, how to create private libraries and how to alter, copy, and inspect the contents of the libraries. All these functions are performed by a group of library processing programs, collectively referred to as the librarian.

Associated with each library is a directory that is located at the beginning of the space allocated to that library. For each element in a library, the corresponding directory contains a unique entry describing the element. A directory entry contains such information as name, disk address, size, load address (core image library only), and version number (relocatable, source statement, and procedure libraries only) of the element. These directory entries are used by the system to locate elements in and retrieve them from a library.

The begin addresses of the individual system library directories are stored in a separate directory, the system directory. At the beginning of each directory is a library descriptor. This entry contains information such as the address of the next available record, the number of active and deleted blocks, and the amount of space allocated to the library. The library descriptor entry comprises the first block of each directory on FBA devices. On CKD devices, the library descriptor information is in the first entry of the core image library directory, and the first five entries of the other library directories.

A core image library may contain a large number of program phases. Thus, searching for a specific phase can become rather time consuming. To reduce the search time, the core image library directory entries are in alphameric sequence. The second level directory contained in the supervisor assists in locating directory entries. This is discussed in *Second Level Directories for Core Image Libraries* in Chapter 2, *Planning the System.*

The organization of the directories on SYSRES is shown in Figure 3-31. A more detailed description of the complete SYSRES organization is given in *Appendix A: System Layout on Disk*.

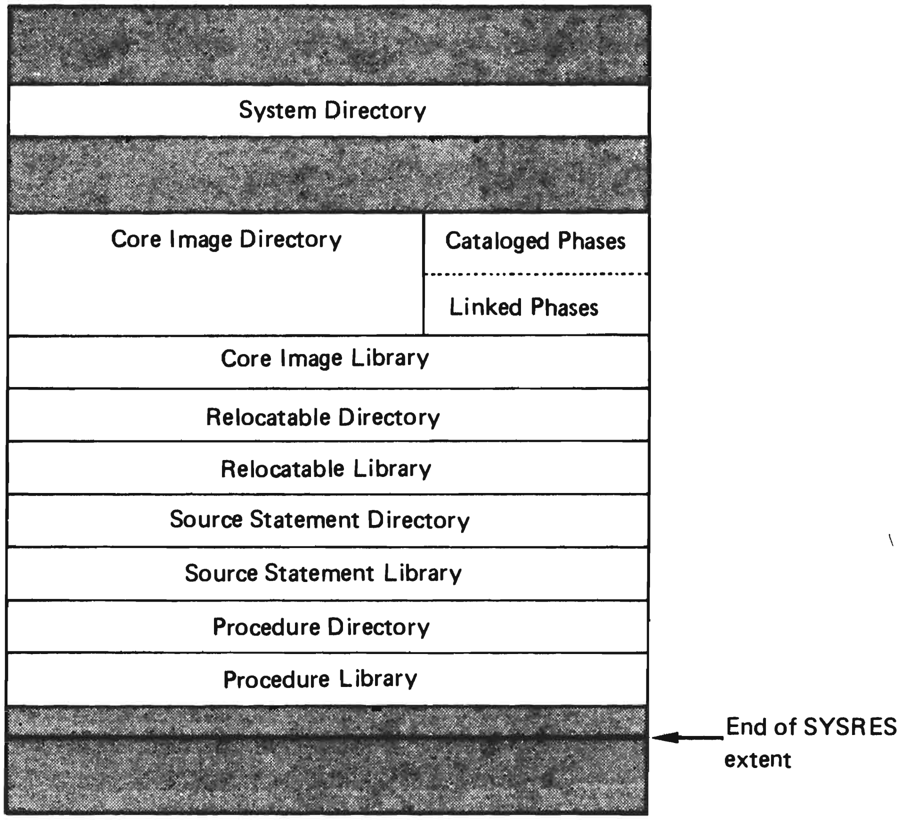


Figure 3-31. Organization of the Directories and Libraries on SYSRES

The Librarian Programs

This section describes how you can manage and control your libraries with the use of the librarian programs. The librarian programs fall into three functional groups: maintenance, organization, and service. The functions are applicable both to the system and private libraries. Figure 3-32 is a summary of the librarian programs and their functions. The figure also lists the storage requirements for real mode execution: a value (ALLOCR command) to allocate processor storage and a value (SIZE command or SIZE parameter in the EXEC statement) to reserve space for the partition GETVIS area. No special considerations apply to execution in virtual mode; any librarian program will fit into the minimum partition size (except for a CORGZ COPYC between 3350 devices where a partition size of 138K is required).

GROUP	PROGRAM NAME	FUNCTIONS	ALLOCR	SIZE
Maintenance	MAINT	Catalog Delete Rename Condense (Note 1) Establish Condense Limit Update for Source Statement Library	128K	80K
Organization	CORGZ	Allocate a new SYSRES Create private libraries Transfer elements between any two libraries of the same type	128K	80K (Note 2)
	COPYSERV	Compare library contents and generate input for CORGZ (Note 3)	68K	20K
Service	DSERV	Display the contents of the library directories	68K	20K (Note 4)
	CSERV RSERV SSERV PSERV	Display, punch, or display and punch the contents of the Core Image, Relocatable, Source Statement, or Procedure library	68K	20K
	ESERV	Convert edited macros to source format. Display and/or punch converted macros	112K	64K
Note 1	Refer to the discussion of the condense function for restrictions related to execution of the CONDS function of the MAINT program.			
Note 2	CORGZ COPYC between 3350 devices requires an allocation (ALLOCR) of 138K and a SIZE value of 90K.			
Note 3	COPYSERV does not support the LIBDEF job control statement, shared libraries and FBA devices.			
Note 4	When requesting sorted DSERV output, an allocation (ALLOCR) of 128K together with a specification of SIZE=80K in the EXEC statement will improve the performance.			

Figure 3-32. Summary of Librarian Programs, Their Functions, and Real Mode Requirements

You invoke the individual functions of the librarian programs by means of librarian control statements. The use of these control statements is described and demonstrated by examples in the following section. Their formats are contained in *VSE/Advanced Functions System Control Statements*.

Librarian control statements can be cataloged into a procedure library. This excludes maintenance functions for a procedure library itself.

The librarian programs run in any partition (an exception is the CONDS function of the MAINT program). Two or more librarian programs may run at any point in time, even if they update or catalog to the same library. When one librarian program attempts to update a given library while a second librarian program is already in the process of updating that library, the first program has to wait until the other finishes its update job. This kind of control is called 'locking' and 'unlocking' of a resource. If the resource being protected is a system library, locking is limited to the library; it does not extend over the entire SYSRES file.

Figure 3-33 shows to what extent libraries can be shared (for read or write access) by the librarian programs.

Function	Library of SYSRES	Private Library
MAINT		
CATAL	BG,FG	BG,FG
DELETE	BG,FG	BG,FG
RENAME	BG,FG	BG,FG
UPDATE	BG,FG	BG,FG
CONDL	BG,FG	BG,FG
CONDS	BG (Note 1)	BG,FG (Note 2)
CORGZ		
MERGE into SYSRES	BG,FG	not applicable
other functions	BG,FG	BG,FG
xSERV	BG,FG	BG,FG
linkage editor	BG,FG	BG,FG

Note 1: Foreground partitions must be inactive.
Note 2: The library to be condensed must be dedicated to the partition from where the condensing was requested.

Figure 3-33. Library Sharing Capabilities of Librarian Programs

In this context, the linkage editor may be considered as performing some kind of librarian function: when it places a phase into a core image library. Therefore, the linkage editor is included in the above chart. When OPTION LINK is in effect, the core image library which is locked by the linkage editor will not be unlocked until the associated execution steps are finished. If you foresee a longrunning execution step, try to avoid that other partitions compete for updating that same library at the same time. When OPTION CATAL is in effect, the core image library is locked only as long as the linkage editor executes.

The library sharing support described above uses the same facilities as the sharing of data across computing systems (which is presented in the following chapter) and, therefore, depends on the same hardware restrictions.

The examples in this section do not always show DLBL/EXTENT statements, assignments or library definitions. Wherever these are missing, it is assumed that the information is stored permanently.

Maintaining the Libraries

The maintenance functions of the librarian greatly facilitate frequent operations such as:

- Cataloging members to the libraries

- Deleting members from the libraries
- Condensing the libraries
- Establishing limits for condense
- Renaming members of the libraries
- Updating books in the source statement library.

The maintenance program is invoked by the job control statement:

```
// EXEC MAINT
```

The functions to be performed are specified in librarian control statements which must follow the EXEC MAINT statement on SYSIPT (If SYSIPT is assigned to a tape unit, it must be a single file and a single volume). Any combination of the maintenance functions can be performed in a single run. A sample maintenance job (in skeleton form) is shown below:

```
// JOB ANYMAINT
    .
    .
assignments, if necessary
    .
    .
// EXEC MAINT
    .
    .
librarian control statements
    .
    .
/*
/&
```

Whenever the maintenance on one library is completed, a status report of the library just updated is printed on SYSLST.

In order to identify a private library to the MAINT program, you either provide symbolic unit assignments via the ASSGN job control statement. Or you define the library through a LIBDEF job control statement; for example,

LIBDEF RL,TO=PRVRELO

for cataloging to a private relocatable library. The file name in the TO parameter can be freely determined, but it must agree with the file name in the corresponding DLBL statement. With the ASSGN statement, the following symbolic unit names must be used:

```
Private core image library . . . . . . SYSCLB
Private relocatable library  . . . . . SYSRLB
Private source statement library . . . SYSSLB
```

An ASSGN statement can never be used for a private procedure library.

The ASSGN and LIBDEF statements are explained in section *Controlling Jobs*, earlier in this chapter. The library definitions (or, if applicable, the symbolic unit assignments) required for the individual maintenance functions are described in *VSE/Advanced Functions System Control Statements*.

To perform maintenance on system libraries, you may supply a LIBDEF definition specifying IJSYSRS in the TO parameter. If no such definition is given, be sure to have the corresponding private library unassigned.

Cataloging Members into the Libraries. The catalog function adds a module to a relocatable library, a book to a source statement library, or a procedure to a procedure library. Phases are cataloged to the core image library by the linkage editor.

The catalog control statements specify the name of the member to be cataloged and, optionally, a change level number. The control statements are:

```
   Relocatable library . . . . . . . . . CATALR
   Source statement library  . . . . . . CATALS
   Procedure library . . . . . . . . . . CATALP
```

The catalog function implies a delete for members with the same name. Therefore, you should rename the existing member prior to cataloging the new member that has the same name should you wish to retain the existing member. Then, when the new member has been successfully tested, the old member may be deleted.

When you add to the contents of a library, watch the status of the system directory, which is printed at the end of the catalog run. If the libraries are becoming full, you may wish to condense them or to create larger libraries. (Condensing is described later in this section.)

Cataloging to the Relocatable Library. To catalog an object module to the relocatable library, you must submit the object module on SYSIPT immediately behind the CATALR control statement. The following job catalogs two object modules, named MOD1 and MOD2, to the relocatable library; the object modules were produced by language translators in previous jobs:

```
   // JOB CATREL
   // EXEC MAINT
       CATALR MOD1
       .
       .
   object module for MOD1
       .
       .
       CATALR MOD2
       .
       .
   object module for MOD2
       .
       .
   /*
   /&
```

You may compile or assemble a program and catalog the resulting object module in the relocatable library in the same job. In this case, you assign SYSPCH, which receives the output of the language translator, to a disk, diskette or tape and then use the object module on that device as input to the MAINT program. An example using a magnetic tape for SYSPCH is shown in Figure 3-34. To assign SYSPCH to a disk or diskette, you must supply the necessary DLBL and EXTENT job control statements.

```
  // JOB CATREL
  // OPTION DECK
1 // ASSGN SYSPCH,180
  // EXEC ASSEMBLY
2          PUNCH   'CATALR MODULE1'
  source module
3
  /*
4 // MTC WTM,SYSPCH,2
5 // MTC REW,SYSPCH
6 // RESET SYSPCH
7 // ASSGN SYSIPT,180
8 // EXEC MAINT
  /&
```

1 A magnetic tape device is assigned to SYSPCH to receive the assembler output.

2 The assembler will punch a CATALR statement on SYSPCH.

3 The assembler processes the source module and writes the object module onto SYSPCH following the CATALR statement.

4 Tapemarks are written on SYSPCH to indicate the end of the object module.

5 The tape is rewound to its load point.

6 The tape is unassigned as SYSPCH.

7 The tape is assigned to SYSIPT to serve as input for the MAINT program.

8 MAINT reads the object module from the tape and catalogs it in the relocatable library.

Figure 3-34. Assembling and Cataloging to the Relocatable Library in the Same Job

All modules in the relocatable library that have the first three characters of the module name in common are considered to belong to one program. This simplifies the control statements to delete, display, punch, merge, and copy an entire program. The names of IBM-supplied modules in the relocatable library begin with the letter I, which should therefore be considered reserved so that you can easily distinguish your modules from IBM's.

Cataloging to the Source Statement Library. To add a book to the source statement library, you use the CATALS statement specifying the name of the book and the sublibrary to which it belongs. A sublibrary is defined by an alphameric character preceding the bookname. For example, the statement

```
CATALS    L.NEWBOOK
```

adds the book NEWBOOK to sublibrary L. Note that the sublibraries in the range from A to I, P, R, and Z are reserved for IBM components.

A -- is the assembler copy sublibrary. It contains books of assembler source code and source macro definitions. See *VSE/Advanced Functions System Control Statements* for details.

B -- is the network definition sublibrary for ACF/VTAM.

C -- is the COBOL sublibrary.

D -- is the alternate assembler copy sublibrary. It contains non-edited macros and copy books for programs that are to be executed in a telecommunications network control unit.

E -- is the assembler macro sublibrary. It contains IBM-supplied and user-written macro definitions in an edited (partially processed) format. See *Guide to the DOS/VSE Assembler* for details.

F -- is the alternate assembler macro sublibrary. IBM uses it to distribute edited macros for use by programs that are to be executed in a telecommunications network control unit.

P -- is the PL/I sublibrary.

R -- is the RPG II sublibrary.

Z -- contains sample programs supplied by IBM.

The rest of the reserved characters (G, H, I) will be used by IBM for future additions to the source statement library. You should avoid, wherever possible, cataloging to one of the reserved sublibraries. If you must catalog to a sublibrary that is reserved for IBM components, ensure that you do not use duplicate names. You can obtain a listing of the contents of each sublibrary by means of the SSERV librarian program discussed later in this section. You can obtain a listing of the book names within each sublibrary by means of the DSERV librarian program.

Users of previous versions of DOS, who have books in a sublibrary which is reserved under VSE/Advanced Functions can easily transfer this sublibrary from the *IBM range* to the *user range* by means of the librarian rename function of the MAINT program.

Edited macro definitions that are to be cataloged in the assembler sublibrary must be preceded by a MACRO statement and followed by a MEND statement. Example:

```
// JOB CATMAC
// EXEC MAINT
    CATALS E.MBOOK
    MACRO
    .
edited macro definition statements
    .
    MEND
/*
/&
```

Books other than macro definitions that are to be cataloged must be preceded and followed by BKEND statements. Example:

```
// JOB CATBOOK
// EXEC MAINT
   CATALS L.SBOOK
   BKEND
   .
   .
source statements
   .
   .
   BKEND
/*
/&
```

The BKEND statement can have optional operands specifying that a sequence check or a card count be performed on the statements to be cataloged, or that the book to be cataloged is in compressed format. If you desire these functions when you catalog a macro definition, BKEND statements can be included in addition to the MACRO and MEND statements.

Cataloging to the Procedure Library. To catalog a procedure in a procedure library you submit a CATALP statement specifying the procedure name. Rules for the naming of procedures are given in *VSE/Advanced Functions System Control Statements*.

The control statements to be cataloged follow the CATALP statement; they can be job control or linkage editor control statements or both. The end of the control statements to be cataloged must be indicated by an end-of-procedure delimiter, which is normally a /+.

Each control statement cataloged in the procedure library should have a unique identity. This identity is required if you want to be able to modify the job stream at execution time. Therefore, when cataloging, identify each control statement in columns 73-79 (blanks may be embedded). Refer also to the section *Temporarily Modifying Cataloged Procedures* earlier in this chapter.

The following job catalogs the procedure PROCA in the procedure library:

```
// JOB CATPROC
// EXEC MAINT
   CATALP PROCA
   .
   .
control statements to be cataloged
   .
   .
/+ END OF PROCEDURE
/*
/&
```

You can include inline SYSIPT data in the cataloged procedure. The presence of SYSIPT data must be indicated to the MAINT program by the DATA parameter of the CATALP statement. In addition, you must indicate the end of inline data by the /* statement. The following example catalogs a procedure consisting of control statements and SYSIPT data:

```
// JOB CATPROC
// EXEC MAINT
    CATALP PROCA,DATA=YES
    .
    .
control statements
    .
    .
    SYSIPT data
    .
    .
/* END OF SYSIPT DATA
    .
    .
control statements
    .
    .
/+ END OF PROCEDURE
/*
/&
```

The following restrictions apply when you catalog procedures to the procedure library:

1. A cataloged procedure cannot contain control statements or SYSIPT data for more than one job.

2. If the cataloged control statements include the // JOB statement you must not have a // JOB statement when you retrieve the procedure through the EXEC statement.

3. A cataloged procedure must not include either of the following statements:

   ```
   [//] RESET SYS
   [//] RESET ALL
   ```

4. A cataloged procedure with DATA=YES must not include any of the following statements for SYSIN, SYSRDR, or SYSIPT:

   ```
   [//] ASSGN
   [//] CLOSE
   [//] RESET
   /&
   ```

5. A cataloged procedure without inline SYSIPT data must not include any of the following statements for SYSIN or SYSRDR:

   ```
   [//] ASSGN
   [//] CLOSE
   [//] RESET
   /&
   ```

6. Cataloged procedures cannot be nested, that is, a cataloged procedure cannot contain an EXEC statement that invokes another cataloged procedure.

7. When cataloging a procedure that contains an imbedded // JOB statement, in a partition controlled by VSE/POWER, use * $$ JOB and * $$ EOJ statements to define the cataloging job.

Assigning Change Levels. When you catalog a member in one of the libraries, you can assign a change level to the member, which will enable you to keep track of the current version of your programs. The change level is specified in the catalog control statement by a version and a modification number. The following statement catalogs version 1, modification 3, of module MOD1 in the relocatable library:

```
CATALR   MOD1,1.3
```

Change levels are stored in the directory entry for the member and can be displayed by the librarian service program DSERV. A change level is not used by the system for identification purposes, that is, a change level is *not* sufficient to allow two elements having the same name to coexist in a library.

For the source statement library only, you can request verification of *the* change level before a book is updated. This can prevent unintentional updating of the wrong version of a book in a particular sublibrary. Specify the character C in the CATALS statement to request change level verification. Example:

```
CATALS   M.BOOK1,1.1,C
```

To update the book you must supply the current change level of the book in the update control statement. This change level is then checked against the change level in the directory entry and, if they match, the book is updated and its change level is increased by one to reflect the new status of the book. If you want to overwrite the version and modification numbers of a book, supply the new change level information in the END statement of the update function. If change level verification is requested for a particular book, the letter C will appear in the column headed LEV CHK (level check) in the DSERV listing.

Deleting Members from the Libraries. You can delete an unwanted member from a library either by cataloging a new member with the same name or by means of the delete function of the librarian, using the following control statements:

```
Core image library . . . . . . . . . DELETC
Relocatable library  . . . . . . . . DELETR
Source statement library . . . . . . DELETS
Procedure library  . . . . . . . . . DELETP
```

To delete individual members from the libraries, you must specify each member name in full in the delete control statement. If a group of members is to be deleted, however, you can simplify the specification of the control statement provided that the recommended naming conventions were used:

- If all the phases of one program in the core image library were named with the same first four characters, you need to specify only these four characters to delete the entire program.
- You can delete all modules in the relocatable library that have the first three characters in common by specifying these three characters in one delete control statement.
- Similarly, you can delete an entire sublibrary from the source statement library by specifying the sublibrary name.

Since no special naming conventions apply to the procedure library, each cataloged procedure to be deleted must be specified individually.

You can also use the delete ALL function to remove all elements of a relocatable library, source statement library, procedure library, or *private* core image library. In this case, the system directory information is updated to show that all blocks of the library in question are available for cataloging programs; no condense operation is required. You cannot delete the entire *system* core image library, but only individual phases or programs.

The following job deletes (1) all phases whose name begin with PHAS from the core image library, (2) modules MOD1 and MOD2 from the relocatable library, (3) sublibrary P from the source statement library, and (4) all the elements of the procedure library:

```
// JOB DELETE
// EXEC MAINT
    DELETC PHAS.ALL
    DELETR MOD1,MOD2
    DELETS P.ALL
    DELETP ALL
/*
/&
```

When you request the deletion of a library member, the name of the member is no longer addressable in the corresponding directory entry. The system is then no longer able to recognize the member although it is still physically present in the library. The area taken up by such a member can be referred to as unavailable free space. To make such space available again for cataloging programs, use the condense function of the MAINT program. The delete and condense functions are illustrated in Figure 3-34.

In case an entire component is deleted, the component entry in the system history file should also be deleted using the service program MSHP (Maintain System History Program).

When a phase is deleted from the system core image library, it is also flagged as not present in the system directory list (if applicable). The shared virtual area cannot be condensed; it must be recreated. See *Building the SDL and Loading the SVA* under *Starting the System* earlier in this chapter.

Condensing the Libraries. When you delete a member from a library, the space occupied by the 'deleted' member is unavailable for cataloging new members (see Figure 3-35). The condense function of the MAINT program removes the corresponding entry from the directory and makes the space available for cataloging.

To condense any of the system libraries you use the CONDS control statement specifying which of the libraries is (are) to be condensed. The following job condenses the core image, relocatable, and source statement libraries after the deletion of members from the libraries:

```
// JOB DELCOND
// EXEC MAINT
   DELETC PHAS1,PHAS5,PROGA
   DELETR MOD.ALL
   DELETS P.ALL
   DELETP ALL
   CONDS CL
   CONDS RL
   CONDS SL
/*
/&
```

1 Assume that phases A, B, and C are cataloged in the core image library (c.i.l.). Each core image directory (c.i.d.) entry, which refers to one of these phases, points to the beginning disk address of the phase.

2 If phase B is no longer desired in the core image library, specify DELETC B, which deletes the name B from the directory.

3 To make full use of the core image library, eliminate the unavailable free spaces by specifying CONDS CL

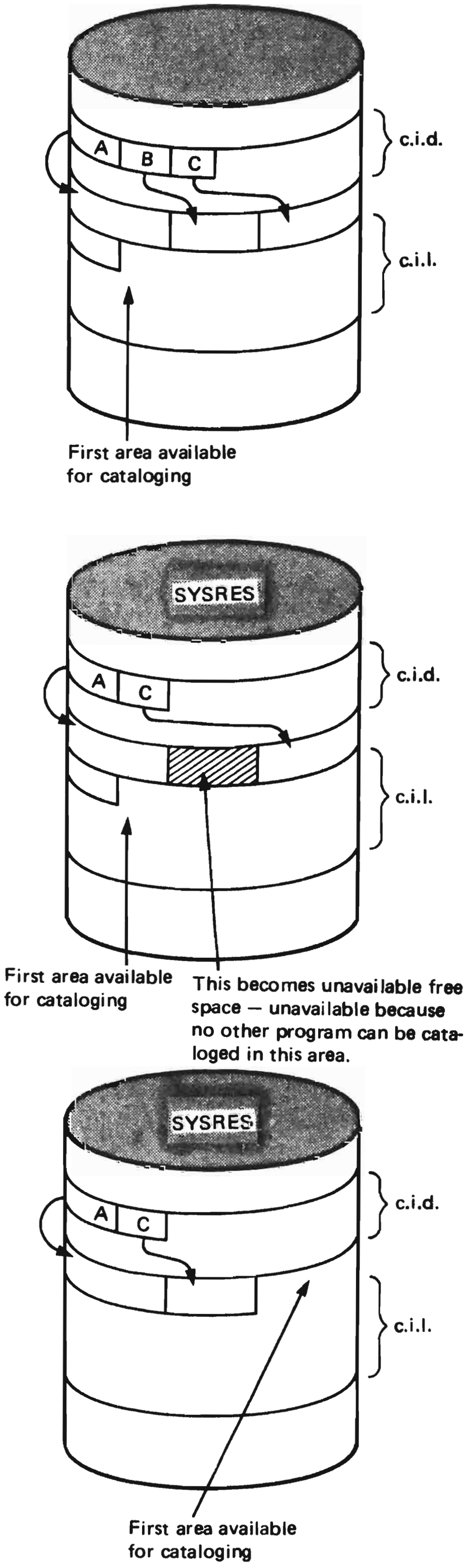

A
B
C
c.i.d.
c.i.l.
First area available for cataloging
SYSRES
A
C
c.i.d.
c.i.l.
First area available for cataloging
This becomes unavailable free space — unavailable because no other program can be cataloged in this area.
SYSRES
A
C
c.i.d.
c.i.l.
First area available for cataloging

Figure 3-35. Example of Deleting and Condensing

Note that you need not condense a library -- in the above example, the procedure library -- if that library is deleted entirely.

If a condense operation is interrupted by a hardware error or by an operator intervention before the next statement is read, the library being condensed is unusable and must be rebuilt. Note that the condense program shows all the symptoms of a looping program, but should never be canceled by the operator.

There are two methods for condensing libraries that do not use the MAINT program. Both methods involve copying only the undeleted library members to a new volume.

- The utility programs BACKUP and RESTORE can be used if your installation has magnetic tape drives installed. The BACKUP program copies libraries to tape but doesn't copy deleted members. The RESTORE program copies the tape volume to a disk recreating your libraries. For more details see *VSE/Advanced Functions System Utilities*.

- The Copy and Reorganize program (CORGZ) copies libraries from one disk extent to a different disk extent. Deleted members are not copied. See the section *Organizing the Libraries* later in this chapter for information on the CORGZ program.

Specifying the Condense Limit. You can specify that a message is to be delivered to the operator whenever the number of available blocks in a library drops below a specified minimum, which is referred to as the condense limit. Through the CONDL statement you specify the library or libraries and the condense limit(s).

Example:

```
// JOB CONDSLMT
// EXEC MAINT
   CONDL CL=10
/*
/&
```

In the above example, the CONDL statement specifies that, whenever the number of available library blocks falls below 10, a message is to be issued. (Note that the term 'block' as used here should not be confused with the block on an FBA device. A library block is a general physical entity and applies to both CKD and FBA devices.)

The condense limit should always be less than the number of blocks allocated to the library; otherwise this message is given after each maintenance function. The MAINT program stores the condense limits in the library descriptor, which can be displayed at the end of each librarian maintenance job. If a library has reached a condense limit, this is indicated in the status report by a note.

When Condense Can Be Performed. While the condense function is being executed, the library directories do not represent the actual status of the library. Thus, if a program in any partition were to attempt to use the library in any way, the results would be unpredictable. For this reason, various controls are provided to minimize the chances of unpredictable results:

- Condensing of a system library can only be done from the background partition, and no foreground partition may be active.
- A private library can be condensed from any partition; however, the library must be dedicated to that partition.
- A job stream to condense a procedure library cannot be executed from a cataloged procedure.

The CONDL control statement (which sets the condense limits) can be submitted with the MAINT program at any time.

A partition is inactive if it has never been activated with a START or BATCH command or has been deactivated with an UNBATCH command.

Even if a program such as VSE/POWER is not doing any work, if it is resident in a partition, that partition is considered to be active.

Renaming Members in the Libraries. To change the name of a library member, use the rename function. In a control statement, you supply the existing name and the name to which you want to change it. If the *new* name is identical to a name already cataloged in the library, an error message is issued. You must then select a different name and resubmit the job.

When you name a phase in the system core image library that is also listed in the system directory list, the old phase name in the SDL is replaced by the new one.

After a valid rename operation, the system recognizes only the new name. The version and modification level (change level) is not changed by the rename function.

Each type of library has a unique rename control statement:

Core image library	RENAMC
Relocatable library	RENAMR
Source statement library	RENAMS
Procedure library	RENAMP

The rename function can be used to establish naming conventions. All phases in the core image library that have the first four characters in common are considered to belong to one program. All modules in the relocatable library that have the first three characters in common are considered to belong to one program. Since the names of IBM-supplied relocatable modules begin with the letter I, it is of advantage to avoid this first character when naming user modules. Similarly, you should avoid the use of the first characters A through I, P, R, and Z when renaming sublibraries in the source statement library. These prefixes are reserved for IBM-supplied components. Names for procedures cataloged in a procedure library can consist of any combination of alphanumeric characters as long as they adhere to the naming rules for procedure names.

Renaming a member of a library can be advantageous in a testing environment. For instance, after making changes to your source deck, rename the previous version residing in the library and catalog the new source under the original name. This assures you of backup until your new program is in working order, at which time you can delete the old (renamed) version(s).

Updating Books in the Source Statement Library. The update function applies only to a source statement library. This function revises one or more source statements within a particular book. By using update you can make minor changes to a book, without having to catalog an entire new book.

Besides adding, deleting, or replacing a certain number of source statements within a book, the update function allows you to:

- resequence statements within a book.
- revise a change level (version and modification) of a book.
- add or remove the requirement for change level verification.
- copy an entire book and rename the old book (for backup purposes).

The UPDATE control statement identifies the update function. This statement may also be followed by one or more of these additional statements as required:

```
) ADD     -- To add source statements
) DEL     -- To delete source statements
) REP     -- To replace source statements.
```

The) END statement indicates the end of updates to the particular book specified in the UPDATE control statement.

If the requirement for change level verification was specified in the CATALS control statement when a book was cataloged, the version and modification level must be specified in the UPDATE control statement that refers to this book. This change level must agree with the current change level in the directory entry for that book. (Check the DSERV listing for the current change level and/or requirement for change level verification. For more information on the DSERV program, refer to the section *Displaying the Directories.*) The specification of the version and modification level in the UPDATE statement prevents you from inadvertently making an update based on a book with the wrong version and modification. Regardless of whether or not the requirement is in effect, the version and modification level are incremented by one after each update. If a version and modification level is specified in the) END statement, this overrides the current change level.

Organizing the Libraries

The Copy and Reorganize (CORGZ) program and the Copy Service (COPYSERV) program are tools for establishing and organizing your libraries during system generation or any time thereafter. The following discusses these programs, their functions, and their application to your library organization requirements.

Copy and Reorganize Program (CORGZ). The functions of the CORGZ program are to:

- Create a new system residence (SYSRES).
- Transfer members between any two existing libraries of the same type, as follows:
  - all members, or
  - some members, or
  - only those members which do not yet exist in the receiving library.
- Create private libraries.

The first two points are described in this section. The creation of private libraries is discussed in *Creating and Working with Private Libraries,* later in this chapter.

The CORGZ program can be executed in any partition. The program is invoked by the statement

```
// EXEC CORGZ
```

After an update of a library, a status report of the library just updated is printed on SYSLST.

Input and output devices must be of the same disk architecture (CKD or FBA). Given, for instance, a CKD device as input, output cannot be an FBA device.

The functions to be performed by the CORGZ program are specified in a set of librarian control statements, which are discussed below.

Creating a New System Residence. When system generation is completed, you will want a backup SYSRES, which can save you regenerating the system from your distribution medium if the operational pack is inadvertently destroyed. This backup SYSRES is usually kept on tape (from which it can be restored using the RESTORE utility program), but may also be kept on a disk of the same device type as the original SYSRES. If the backup SYSRES is to be on disk, use the CORGZ program with the ALLOC and COPY control statements to define the new SYSRES file and copy the entire contents of the original SYSRES file onto it.

You can also copy the SYSRES file selectively; that is, the new system residence will contain only part of the original SYSRES. This may be useful in an installation that uses certain components only during specific processing periods. For instance, if telecommunication and support for five partitions is required only during the prime shift, a different system configuration (for instance, no telecommunication and three partitions) could be used during the second shift. Therefore, you could copy onto a new SYSRES file only those components required for the second shift and add any additional components needed to that SYSRES. In this case, you must assemble a new supervisor and catalog it into the new SYSRES file. The effect is a smaller supervisor and smaller libraries on both system residence packs which means faster access to library elements and, thus, improved overall system performance.

When you create a new system residence, SYS002 must be assigned to the device on which the new SYSRES pack resides. The device types of SYS002 and SYSRES must be identical. Note that the IBM 3330-1 and 3330-11 are of the same device type; the same is true for the IBM 3340-35 MB and 3340-70MB. In addition, you must define the extents of the new SYSRES file by means of DLBL and EXTENT job control statements. The file name in the DLBL statement must be IJSYSRS. The lower extent limit must be relative track 1 for a CKD device or block 2 for an FBA device, and the upper extent limit must include the label information area.

The information to be copied from the original to the new SYSRES is specified in one or more of the following COPY control statements:

COPY ALL — to copy the entire system residence file. You can use this form of the COPY statement only if all four system libraries are allocated on the original SYSRES file; otherwise, you must use a combination of the following COPY statements.

COPYC — to copy one or more members, one or more
COPYR — groups of members, or all members of the
COPYS — Core image, Relocatable, Source statement
COPYP — or Procedure library.

If more than one copy control statement is submitted for several libraries, these statements should be grouped per library (for example, first all COPYC statements, then all COPYR statements, and so on). A COPY ALL or COPYx ALL statement must neither be preceded nor followed by any other copy statement for the same library.

Note: The names of all members copied are printed on SYSLST if you specify // UPSI 10000000.

The following job creates a backup SYSRES file on a 3330 disk drive. The example assumes that the original SYSRES file does not contain a procedure library:

```
// JOB BACKUP
// ASSGN SYS002,131
// DLBL IJSYSRS,'VSE SYSRES BACKUP',99/365,SD
// EXTENT SYS002,111111,1,0,0001,2127
// EXEC CORGZ
    ALLOC CL=50(5),RL=30(5),SL=30(5),PL=0(0)
    COPYC ALL
    COPYR ALL
    COPYS ALL
/*
/&
```

Since the 3330 is a CKD device, all space allocations in the ALLOC statement are in number of cylinders. The number of tracks in the EXTENT statement (2127) is the sum of: the library allocations (110 cylinders x 19 trks), minus 1 track (cylinder 0, trk 0); plus the label information area (2 cylinders x 19 trks). For FBA devices the space allocations are given in number of blocks.

For each CORGZ run to create a new SYSRES file, an ALLOC control statement is required, preceding any COPY statements. If you wish to exclude an entire library from being copied, specify a 'zero' allocation (for example, RL=0(0)). But note that you cannot eliminate the system core image library because it is required for system operation. Assume that you have a SYSRES file that contains all four system libraries and you want to create a second SYSRES file containing only selected information from the core image library and the entire relocatable library. The following job creates this new SYSRES file (device type FBA assumed):

```
// JOB SYSRES
// ASSGN SYS002,131
// DLBL IJSYSRS,'VSE SYSRES II',99/365,SD
// EXTENT SYS002,111111,1,0,0002,12708
// EXEC CORGZ
   ALLOC CL=7500(75),RL=5000(50),SL=0(0),PL=0(0)
   COPYC PHAS.ALL,PROG.ALL,ABCD.ALL
   COPYR ALL
/*
/&
```

The EXTENT statement reflects a SYSRES file beginning at block 2 comprising 12,708 blocks: 12,500 blocks make up the libraries, 200 blocks are allocated as the label information area, and the first 8 blocks are to be reserved for system information.

Phases whose names start with a '$' are automatically copied by the CORGZ program. This provides you with the essential components of VSE/Advanced Functions listed below:

- IBM supplied supervisor ($$A$SUPn)
- Initial program load (IPL)
- All logical and physical transients
- Job control
- Linkage editor

User created elements can also be copied automatically:

- Phases that you have cataloged with a '$' as the first character (such as a tailored supervisor)
- Partition and system standard labels (cataloged with the PARSTD and STDLABEL options) from the label information area (see Note).

Therefore you may execute the CORGZ program without any COPY statements, and the above items will be copied automatically onto the new SYSRES file.

Note: The CORGZ program does not copy an alternate label information area that you defined through the DLA command.

Changing the Size of the System Libraries. You can use the CORGZ program to

- increase the size of a system library for further additions
- decrease the size of a system library; for example, to provide space for extending other libraries.

The size changes appear only on the new SYSRES file.

When you increase the size of one library, you must consider the space remaining for the libraries that follow.

Figure 3-36 shows the available disk space by device type. FBA space requirements are in number of FBA blocks, all others are shown in number of cylinders.

Device Type	VTOC	Label information area	Disk space available
CKD:			
2314/2319	1	2	197
3330/3333	1	2	
Model I	1	2	401
Model II			803
3340	1	3	
w/3348 M35	1	3	344
w/3348 M70			692
3350	1	1	554
FBA (see note):			
3310	16	200	125798
3370	16	200	557782

Note: FBA space requirements show the default sizes in FBA blocks; the size of the VTOC may be changed by an Initialize Disk utility run and that of the label information area by a RESTORE utility run. For more information, see *VSE/Advanced Functions System Utilities.*

Figure 3-36. Disk Space Available for System Libraries

Assume, for example, that the SYSRES library space on a 2314 was allocated during system generation as

```
CL=90(5),RL=40(2),SL=60(3),PL=6(5)
```

An attempt to allocate 120 cylinders to the core image library on the new SYSRES pack would fail, because there is not enough space available for all of the following libraries. To avoid this, you must reduce one or more of these libraries to compensate for the increase. For example, reduce the combined sizes of the relocatable and source statement libraries by 29 cylinders. In this case, the ALLOC statement should read:

```
ALLOC CL=120(7),RL=30(2),SL=41(3),PL=6(5)
```

The following example shows the job control statements required to allocate the new system libraries as discussed above when the SYSRES device type is 2314/2319:

```
// JOB REALLOC
// ASSGN SYS002,131
// DLBL IJSYSRS,'VSE SYSTEM RESIDENCE II',99/365,SD
// EXTENT SYS002,111111,1,0,0001,3979
// EXEC CORGZ
   ALLOC CL=120(7),RL=30(2),SL=41(3),PL=6(5)
   COPY ALL
/*
/&
```

For CKD devices, like the 2314 in the above example, allocations are given in cylinders for the libraries. Because the SYSRES file begins at cylinder 0 track 1, the EXTENT statement must take the following into account:

CL = 120 cylinders x 20 tracks	=	2400
RL = 30 cylinders x 20 tracks	=	600
SL = 41 cylinders x 20 tracks	=	820
PL = 6 cylinders x 20 tracks	=	120
		3940
Label information area (2314/19) 2 cylinders x 20		40
		3980
Less cylinder 0, track 0		–1
		3979

This SYSRES file comprises 3979 tracks.

No special considerations apply for *reducing* the size of a library except that you must also supply the necessary label information for the new SYSRES extent. Reducing a library does not cause any gaps, that is, the libraries following the one that was reduced are 'moved up' to close the gap. If your allocations are too small for the existing library members, the job is canceled and an appropriate message is displayed. At this point in time, the libraries are still intact.

Transferring Members between Libraries. If you work with more than one system residence pack or private library, you may want to transfer members from one library to another. You can use the CORGZ program with a MERGE statement to transfer the elements. This is especially useful for system generation when a new version of the system is installed; you can then copy the library elements directly from the old version to the new one.

You use the MERGE control statement to define the characteristics of the libraries to be merged and the direction of transfer between the libraries. The operands of the MERGE control statement are:

RES -- For the system libraries on the system residence file.

NRS -- For the system libraries on a modified or duplicate system residence file that is not currently IPLed.

PRV -- For any private libraries.

For example, the statement MERGE RES,PRV indicates to the CORGZ program that elements are to be transferred from one or more libraries on the system residence file to the corresponding private libraries.

The device types of the input and output devices may be different, within the same disk architecture (CKD or FBA). However, when requesting

```
MERGE RES,NRS   or
MERGE NRS,RES
```

the device types must be the same.

Note that the IBM 3330-1 and 3330-11 are of the same device type, the same is true for the IBM 3340-35MB and 3340-70MB.

The type of library involved and the elements to be transferred are specified in COPY statements immediately following the MERGE statement. (The COPY statements are the same as those described under *Creating a New System Residence* earlier in this chapter.)

You must define the extents of the libraries involved in a merge operation by DLBL and EXTENT job control statements. The file names to be used and the necessary library definitions and symbolic unit assignments are described in detail in *VSE/Advanced Functions System Control Statements*.

When the CORGZ program performs a merge operation, it *does not* automatically copy the basic system components as it does when a new system residence is created (see preceding section). You must specify COPYC ALL to transfer the entire core image library or COPY ALL to transfer the entire SYSRES extent.

The job in the following example adds the contents of the core image library on a duplicate SYSRES file (NRS) to the elements in a private core image library (PRV). Any elements with duplicate names (supervisor, job control etc.) are deleted from the receiving library.

```
// ASSGN SYS002,130
// DLBL IJSYSRS,'VSE SYSRES II',99/365,SD
// EXTENT SYS002,111111,1,0,0001,2519
// DLBL NEWCIL,'PRIVATE CIL',99/365,SD
// EXTENT,222222,1,0,1600,200
   LIBDEF CL,TO=NEWCIL
// EXEC CORGZ
   MERGE NRS,PRV
   COPYC ALL
/*
/&
```

Alternatively, for the COPYC, COPYR, COPYS, and COPYP statements, the NEW operand can be used to copy only those members that do not already exist in the receiving library. However, for COPYC NEW:

- supervisor phases are never copied, and
- a number of system phases are always copied.

For a list of phases that are always copied see *VSE/Advanced Functions System Control Statements*. In addition, when using the NEW operand, ensure that your receiving library has sufficient space allocated to accommodate the library members that are copied from the other library.

The job in the following example also adds the phases of the core image library on a duplicate SYSRES file (NRS) to the phases in a private core image library (PRV). In this example, only nonduplicate elements are copied.

```
// JOB NRSPRV
// ASSGN SYS002,130
// DLBL IJSYSRS,'VSE SYSRES II',99/365,SD
// EXTENT SYS002,111111,1,0,0001,2519
// DLBL NEWCIL,'PRIVATE CIL',99/365,SD
// EXTENT,222222,1,0,1600,200
LIBDEF CL,TO=NEWCIL
// EXEC CORGZ
    MERGE NRS,PRV
    COPYC NEW
/*
/&
```

Each major CORGZ operand (ALLOC, MERGE, or NEWVOL) may be followed by several COPY statements. A mix of the major operands within one job step is not allowed; however, several MERGE operands may appear within one job step.

Copy Service Program (COPYSERV). This program compares library directories and, on finding differences in contents, produces corresponding COPY statements for use with the CORGZ program. It thus provides a similar function as a MERGE COPYx NEW of CORGZ.

The program allows comparison of both system and private libraries. The libraries you wish to have compared must be defined by the appropriate ASSGN, DLBL, and EXTENT statements.

The LIBDEF statement cannot be used. Moreover, if a private library had been created with a LIBDEF definition and predetermined file names had not been used, COPYSERV cannot access that library. The new (or target) library must be assigned to SYS003, with a file name of IJSYSNR. If private libraries are involved, it is necessary to provide an additional definition of your compare requirements by means of the UPSI statement.

The COPYSERV program supports CKD devices only.

COPYSERV can be executed in any partition; it is invoked by the statement // EXEC COPYSERV. At the completion of a COPYSERV run, you will receive the following types of statements on SYSPCH which you can include in a CORGZ job stream:

```
// EXEC CORGZ
    MERGE RES,PRV
    COPYC phasename
    .
    .
    .
/*
/&
```

For ease of correcting the output, you get this output sorted by member names.

COPYSERV, in addition, provides a printout with

- A listing of the punched output.
- The number of additional directory entries needed in the new library.
- The number of additional library blocks needed to accommodate the new library.

For a COPYSERV/CORGZ job stream example in the context of a system generation, refer to the *System Generation Procedures* in *VSE/Advanced Functions System Generation.*

With the job stream shown below, a comparison between a current and a new private source statement library is executed by COPYŞERV.

```
     // JOB COPYSERV
   ( // DLBL IJSYSSL,'OLD.PVT.SOURCE.STMT.LIBRARY'
 1 { // EXTENT SYSSLB
   ( // ASSGN SYSSLB,132
   ( // DLBL IJSYSNR,'NEW.PRV.SOURCE.STMT.LIBRARY'
 2 { // EXTENT SYS003
   ( // ASSGN SYS003,133
 3   // UPSI 00100010
     // EXEC COPYSERV
     /&
```

1 Label and assignment statements for the current (or source) library.

2 Label and assignment statements for the new (or target) library.

3 Required UPSI setting for comparing two private source statement libraries.

For more details on the COPYSERV program see *VSE/Advanced Functions System Control Statements.*

Using the Service Functions of the Librarian

The service functions of the librarian enable you

- to obtain reports on the contents of your libraries by displaying the directories on SYSLST.
- to print the contents of your libraries on SYSLST, to punch these contents on SYSPCH, or both (in order to transfer the library members to a different location or to correct them).
- to prepare macro definitions in the assembler macro (E) sublibrary for update.

If you use private libraries, the service functions apply only to the defined private libraries; 'defined' means: either you identified the library in the FROM parameter of a LIBDEF statement, or you ASSGNed the pertinent logical unit number. If you access a system library and do not identify it via LIBDEF, make sure that the corresponding private library is unassigned. A system library, if specified in the FROM parameter, is identified by the file name IJSYSRS, regardless of the type of library.

Displaying the Directories. Using the directory service program (DSERV), you can obtain a listing of the following directories:

- Core image directory, or the directory entry of a specific phase or group of phases in the core image library together with their change level, if present
- System directory list (SDL)
- Relocatable directory
- Source statement directory
- Procedure directory
- Status report. Size and level of contents of the defined private libraries and of the system libraries. (This directory is always listed before any of the directories is printed.)

Depending on the control statement used, the entries of a directory can be displayed in the order as they appear in the directory (DSPLY control statement) or sorted (DSPLYS control statement).

Note: The entries in the core image directory are always stored in alphameric sequence and therefore displayed in that sequence.

Within a single job step you can obtain multiple displays of the same directory, either sorted or unsorted, by supplying a separate control statement for each desired display. Similarly, any number of directories can be displayed within one job step, depending on the operands in the control statement. The following job produces a sorted listing of all $-phases and unsorted listings of the relocatable and source statement libraries:

```
// JOB DISPDIR
// EXEC DSERV
    DSPLYS TD
    DSPLY RD,SD
/*
/&
```

If you specify // EXEC DSERV without any control statements, a status report of all libraries present on SYSRES and all private libraries defined (if any) is printed on SYSLST.

Displaying and Punching the Contents of the Libraries. You can use the library service programs to obtain a listing, a card deck, or a card image copy of the elements in a library. There is a service program for each library:

CSERV -- Core image library
RSERV -- Relocatable library
SSERV -- Source statement library
PSERV -- Procedure library.

You request the library service functions by invoking (with // EXEC) the pertinent service program and one of the following control statements:

DSPLY to print entries of a directory or the members of a library on SYSLST.

PUNCH to punch the members of a library on SYSPCH.

DSPCH to print and punch the members of a library on SYSLST and SYSPCH, respectively.

Each of these statements can specify one or more individual members, one or more groups of members, or all members of a library to be printed or punched. The following job prints the entire sublibrary P and punches phases PHAS1 and PHAS3 of the core image library:

```
// JOB LIBSERV
// EXEC SSERV
    DSPLY P.ALL
/*
// EXEC CSERV
    PUNCH PHAS1,PHAS3
/*
/&
```

The SYSPCH output (in cards or on tape, diskette, or disk) of any service program can be used as input for recataloging into the type of library from which it was extracted.

With the PUNCH or DSPCH statements the CSERV program produces a PHASE statement, naming the output phase, as the first statement on SYSPCH. For the same operations the other service programs produce a CATALR, CATALS, CATALP statement immediately preceding each member on SYSPCH.

CSERV, RSERV and SSERV SYSPCH output is followed by a /*. PSERV SYSPCH output has the end-of-procedure delimiter (default /+) following each procedure and a /* following the last output procedure. Such output can therefore be submitted as is with a // EXEC MAINT statement for recataloging.

The SYSPCH output of the CSERV program is suitable as input to the linkage editor for recataloging to the core image library. The control statement stream would be as follows:

```
// JOB RECATAL
// OPTION CATAL
    INCLUDE
    .
    .      ----- CSERV output
    .
// EXEC LNKEDT
/&
```

The PHASE statement produced by the CSERV program reflects the status of the phase when it was first cataloged (relocatable, self-relocating, non-relocatable or SVA elegible). If you wish to change the status you must change the PHASE statement prior to re-linking.

Printed output from any of the service programs is useful for debugging purposes. For instance, after determining an error from a dump or source listing, you implement a change to the RSERV object deck by inserting the appropriate REP card(s) directly before the END card and run the MAINT program to recatalog the object module; then to verify that the REP card was correct, execute the RSERV program to obtain a listing. An SSERV listing may be necessary before a single statement update can be performed; after locating the statement in error in the listing, submit an UPDATE maintenance run to implement the change in the source statement library.

Preparing Edited Macros for Update. The assembler uses two sublibraries of the source statement library: the macro sublibrary (sublibrary E) and the copy sublibrary (sublibrary A). All macro definitions in the assembler macro (E) sublibrary have been preprocessed by the assembler; they are said to be edited. An edited macro definition cannot be directly updated; instead, the source macro, either in a card deck or in the copy (A) sublibrary is updated. After the changed macro has been tested and debugged, it must be edited again before it can be recataloged in the macro sublibrary.

If the macro to be updated is not available in source format, you can use the ESERV program to convert the edited macro back to source format: this is called de-editing. If the output of the ESERV program is to be used directly as input to the assembler, you can specify the GENEND control statement to cause the END card and a /* card to be included after the last macro. If the output is to be cataloged directly into the copy (A) sublibrary, you can specify the GENCATALS control statement. This causes a CATALS card to be generated before each macro in the run and a /* card after the last macro. If neither the GENEND nor the GENCATALS control statement is specified after the // EXEC ESERV statement, GENCATALS is assumed.

The remainder of the control statements that you can submit to the ESERV program are the same as for the other librarian service programs: DSPLY, PUNCH, and DSPCH. The following job de-edits the macro named MAC1:

```
// JOB DEEDIT
// EXEC ESERV
    GENEND
    PUNCH E.MAC1
/*
/&
```

The output of the above job is the macro MAC1 in source format on SYSPCH. An END card and a /* card is included after the macro. You can now update the macro, edit it, and catalog it back into the E sublibrary of the source statement library.

You can de-edit and update a macro in a single run by submitting the necessary update control statements. The following job de-edits and updates the macro MAC2. The result will be the updated macro in source format on SYSPCH and a listing of the updated macro on SYSLST:

```
// JOB EDTUPDTE
// EXEC ESERV
    GENCATALS
    DSPCH E.MAC2
    .
    .
    update control statements
    .
    .
/*
/&
```

The update function of the librarian is described in *Updating Books in the Source Statement Library,* earlier in this section. Detailed information on editing, de-editing, and updating macro definitions is given in *Guide to the DOS/VSE Assembler.*

Creating and Working with Private Libraries

Private libraries are created and maintained by the system librarian programs. All librarian functions are available for private libraries and performed in the same manner as for system libraries. To change the extents of a private library, create a new private library and copy the contents of the old library into it.

The following sections describe how to create private libraries and what you must consider when you use private libraries.

Private Library Creation

You can create private libraries either during system generation or at any time thereafter. Private libraries can reside on the SYSRES pack (outside the SYSRES extent) or on separate disk packs. You can define any number of private core image, relocatable, source statement, and procedure libraries.

You create private libraries with the CORGZ librarian program. The creation of an operational private library involves two stages:

1. Defining the extents of the library by means of a NEWVOL (new volume) control statement.

2. Transferring information to the library from an existing library by means of COPY and/or MERGE control statements. (Note that the NEWVOL and MERGE statements may not appear in one job step.)

To define the device on which a private library is to be created and the disk extents occupied by the library, you must supply a set of LIBDEF (or ASSGN), DLBL, and EXTENT job control statements. Use of the ASSGN requires the specification of the following predetermined symbolic unit names and file names (see Figure 3-37).

Private Library	Symbolic Unit Name	Filename
Core image	SYS003	IJSYSPC
Relocatable	SYSRLB	IJSYSRL
Source statement	SYSSLB	IJSYSSL

Figure 3-37. Symbolic Unit Names and Filenames Required to Create Private Libraries

You cannot use an ASSGN for the creation of a private *procedure* library.

If you use a LIBDEF statement, you need not be concerned about predetermined names: the logical unit number in the EXTENT statement should be left out altogether. And the file name of the TO parameter in the LIBDEF statement can be a name of your own choosing. It must, however, be identical to the file name in the corresponding DLBL statement.

You can store the label information submitted by DLBL and EXTENT statements either temporarily (option USRLABEL) or permanently (option PARSTD or STDLABEL). Temporary labels must be resubmitted with every job (or job step, if new labels are submitted in an intermediate job step) that accesses the corresponding library; permanent labels are valid for all subsequent jobs.

The following example shows the job control and librarian control statements necessary to define the extents of a private relocatable and a private source statement library on CKD devices. The NEWVOL control statement indicates the type of library to be created and the number of cylinders (tracks) to be allocated to each library (directory) and the number of tracks to be allocated to each directory.

```
// JOB DEFINE
// DLBL RELO111,'VSE PRIVATE RL',99/365,SD
// EXTENT ,111111,1,0,20,800
// DLBL SOURCE2,'VSE PRIVATE SSL',99/365,SD
// EXTENT ,222222,1,0,500,600
LIBDEF RL,NEW=RELO111
LIBDEF SL,NEW=SOURCE2
// EXEC CORGZ
   NEWVOL RL=40(5),SL=30(5)
/*
/&
```

Note that the EXTENT statements have the first parameter, the logical unit number omitted. When using ASSGN statements, the job stream would look as follows:

```
// JOB DEFINE
// ASSGN SYSRLB,191
// ASSGN SYSSLB,192
// DLBL IJSYSRL,'VSE PRIVATE RL',99/365,SD
// EXTENT SYSRLB,111111,1,0,20,800
// DLBL IJSYSSL,'VSE PRIVATE SSL',99/365,SD
// EXTENT SYSSLB,222222,1,0,500,600
// EXEC CORGZ
   NEWVOL RL=40(5),SL=30(5)
/*
/&
```

After you have defined the extents of the private libraries you can either use the merge function of the CORGZ program to transfer members from existing libraries or the catalog function of the MAINT program to store new members.

To create a private library and at the same time copy information into it from the corresponding system library, you submit a COPY statement following the NEWVOL statement. To transfer information from an existing private library, a MERGE statement must precede the COPY statement. Note that NEWVOL and MERGE statements must not appear within one job step. The following job creates a private relocatable library and copies into it the contents of the system relocatable library and of an existing private relocatable library:

```
// JOB CREATE
// DLBL IJSYSRL,'NEW PRIVATE RL',99/365,SD
// EXTENT ,111111,1,0,1700,1200
// DLBL IJSYSPR,'OLD PRIVATE RL',99/365,SD
// EXTENT ,222222,1,0,700,400
// LIBDEF RL,NEW=IJSYSRL
// EXEC CORGZ
   NEWVOL RL=60(8)
   COPYR ALL
/*
// LIBDEF RL,FROM=IJSYSPR,TO=IJSYSRL
// EXEC CORGZ
   MERGE PRV,PRV
   COPYR ALL
/*
/&
```

The LIBDEF statement illustrates that you may very well restrict yourself to predetermined file names, but you don't have to. Two job steps are required, because NEWVOL and MERGE may not appear in one job step.

Note: When using ASSGN statements, then in order to merge from a private relocatable library, you must assign SYS001 to the device containing the library and specify the file name IJSYSPR in the DLBL statement. The logical unit assignments and file names required for the various merge operations are described in VSE/Advanced Functions System Control Statements.

If after you have created a private library you want to change its extents, you have to create a new private library and copy the contents of the old library into it.

Private Core Image Library Creation. The organization of a private core image library is the same as that of the system core image library. A private core image library, however, may start on any track. The space requirements must be entered in the NEWVOL statement.

For example, on a 3330 device, the statement NEWVOL CL=20(5) creates a directory of five tracks and a library of 20 cylinders. To create this private core image library starting at relative track number 190, you submit the following control statements:

```
// JOB PCIL
// ASSGN SYS003,191
// DLBL IJSYSPC,'VSE PRIVATE CL',99/365,SD
// EXTENT SYS003,111111,1,0,0190,380
// EXEC CORGZ
   NEWVOL CL=20(5)
/*
/&
```

In the above example, the core image directory resides on cylinder 10 (tracks 0-4), and the private core image library on cylinders 10-29.

If you desire to start a private core image library on track 1 of cylinder 0 (of a CKD disk) and have it end on a cylinder boundary, the EXTENT statement specifies a number of tracks that is one less than in the corresponding NEWVOL specification. The EXTENT statement in the preceding example then reads:

```
// EXTENT SYS003,111111,1,0,1,379
```

Transferring phases from another core image library would require a second job step.

Using Private Libraries

In order to use private libraries, you must make them known to the various programs that access the libraries. This is done by LIBDEF or ASSGN job control statements.

Using the ASSGN Statement. When private libraries are defined to job control through ASSGN statements (or commands), the following rules should be observed:

To access the private libraries via ASSGN SYSxLB, you must assign the following symbolic unit names to the device(s) containing the libraries:

SYSCLB -- Private core image library
SYSRLB -- Private relocatable library
SYSSLB -- Private source statement library

To *create* a private core image library, the symbolic unit name is SYS003 and, in the DLBL statement, file name IJSYSPC must be specified. To *access* the private core image library, symbolic unit name and file name are SYSCLB and IJSYSCL, respectively. For private relocatable and source statement libraries, the symbolic unit names are the same for creation and subsequent access.

You can assign private relocatable libraries and private source statement libraries either temporarily or permanently by an ASSGN command or statement; you can assign private core image libraries only by an ASSGN command (that is, permanently). An ASSGN statement (or command) can never be used for a private procedure library.

Unless you have cataloged partition or system standard labels for the pertinent private library, you must submit DLBL and EXTENT statements

- when you assign a private core image library
- with every job that accesses a private source statement or private relocatable library.

The file names and file identifications in the DLBL statements must be identical to those specified when the libraries were created.

A private library must be unassigned if maintenance and service functions are to be performed on the corresponding system library because the librarian programs assume that the private library is intended whenever assigned. Therefore if, by mistake, your private relocatable library is assigned when you request changes in the system relocatable library, these changes will be performed on the private relocatable library, and you may have to rebuild this library, depending on the nature of the changes. The only system service programs that can access the system libraries when

SYSRLB and SYSSLB are assigned are the linkage editor and the CORGZ librarian program.

You can have an unlimited number of private libraries in your system; however, no more than one private core image, one private relocatable, and one private source statement library can be assigned at one time to the same partition.

Using the LIBDEF Function. Usage of LIBDEF library definition not only removes the above restrictions, but also helps you to expand on your private library setup. (The LIBDEF job control statement is introduced earlier in this chapter, in section *Controlling Jobs*; you find a detailed description in *VSE/Advanced Functions System Control Statements*.)

Over and above what is possible with the ASSGN statement, the LIBDEF statement allows

- to define private procedure libraries.
- to define private core image libraries temporarily, that is, for the duration of the current job only.
- to perform maintenance and service on system libraries while the corresponding private libraries are still assigned (via ASSGN) or defined (via LIBDEF).
- to have more than one private library of a given type defined at any point in time, within one partition, in a search chain.
- access a private library under a file name that is different from the one specified when the library was created (the file identifications, however, must always be identical).

The ability to concatenate libraries (by defining search chains) allows to distribute the contents of a given library type over several libraries. This gives more flexibility in allocating the entire disk space available at your installation. Also, smaller libraries allow for more economical library maintenance.

Defining a SEARCH chain makes the contents of several libraries appear as one library for search purposes. As a general rule, the search sequence is in the order that you indicated in the SEARCH parameter of the LIBDEF statement. Special considerations apply for searching of core image libraries; they are described below.

Concatenation of several libraries allows to tailor the library definition for a particular partition or for a particular application. Among other things, you may

- change the normal library definitions for a special-purpose run or for a test run. Assuming that you normally execute programs with a library definition of

  ```
  LIBDEF CL,SEARCH=(TRANSNT,PRODCIL),PERM
  ```

and you want to test a new version of a program before you catalog it into the production library (file name PRODCIL), you would define for the test run the following chain:

```
// DLBL TESTCIL,'UNTESTED PROGRAMS',...
// EXTENT ,VOL003,...
LIBDEF CL,SEARCH=(TRANSNT,TESTCIL,PRODCIL),TEMP
```

- add your own libraries to the ones supplied by IBM. For example, if you assemble a program for a telecommunication application and use
  - the system source statement library
  - CICS/VS macros
  - your own macros,

  a library chain definition might look as follows:

  ```
  LIBDEF SL,SEARCH=(MYMACRO,CICSSS)
  ```

Search Order for Private Core Image Libraries. When a phase is to be fetched or loaded or a SET SDL command is processed, various directories are searched until the phase is found. The sequence in which the directories are searched depends on the name of the phase and on the job control definition of libraries.

Figure 3-38 shows the search sequence for phases starting with $ and those starting without $, separated by library definition (LIBDEF versus ASSGN job control statements).

	LIBDEF		ASSGN	
	non-$ phase	$ phase	non-$ phase	$ phase
(1)	SDL	SDL	SDL	SDL
(2)	temporary search chain	system core image library	private core image library (if assigned)	system core image library
(3)	permanent search chain	temporary search chain	system core image library	private core image library (if assigned)
(4)	system core image library	permanent search chain		

Figure 3-38. Search Sequence for $ and non-$ Phases

By default, the system directory list (SDL) is searched first. You may override that default by placing the SDL anywhere in a *temporary* search chain. Specify 'SDL' at the appropriate position within the list of file names in the LIBDEF SEARCH parameter; for example:

```
LIBDEF CL,SEARCH=(PRODCL1,PRODCL2,SDL),TEMP
```

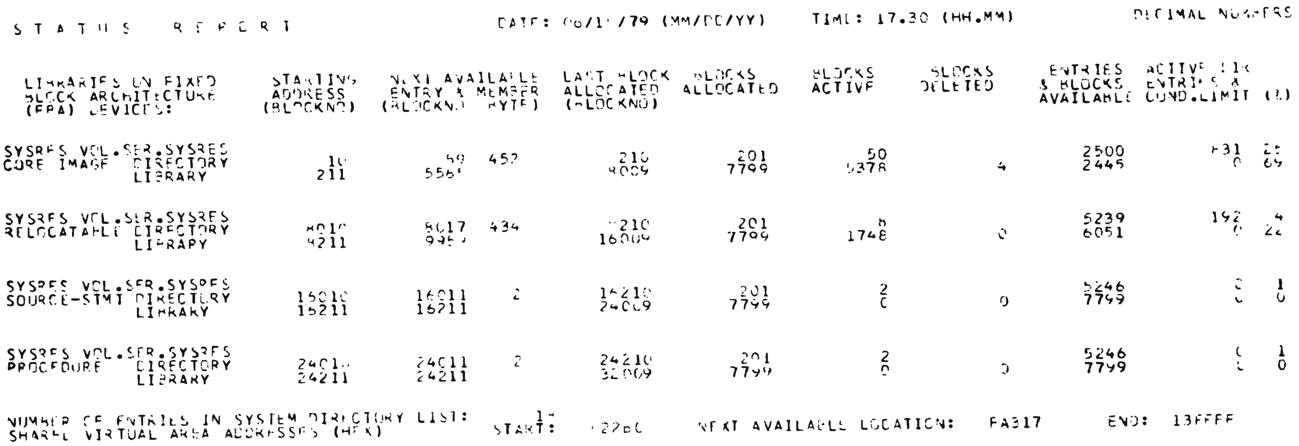
However, if you intend to explicitly include both SDL and IJSYSRS (for the system core image library) in the search chain, place SDL ahead of IJSYSRS. This ensures that linkage to an SVA resident phase is in fact established when a FETCH for that phase is requested. If you specified the two keywords the other way round, the phase would get loaded into your partition, and linkage to the SVA would not be set up.

If you link edit a non-$ phase with OPTION LINK and you request execution of the linked program, the link directory of the temporary TO-library (if provided) is searched first. If only a permanent TO-library is defined, *its* link directory will be searched first. These directories are searched last, if the phase link edited with OPTION LINK is a $ phase.

The search sequence during the processing of a SET SDL command is as described in figure 3-38; however, only the background partition is taken into account.

Using System Libraries as Private Libraries. It may be desirable to use the system libraries as private libraries for certain applications. This is a helpful technique when generating your system; you could, for example, assign system libraries of a follow-on release as private libraries.

In order to use any of the four eligible libraries as a private library you must know their begin and end locations on the disk volume. This information is found in the library status report which you can get by running the DSERV program. You should note that, when using the system core image library as a private library, that library does not begin at the low address of the SYSRES extent. For CKD disk devices, although the SYSRES extent begins at cylinder 0, track 1, the library begins at cylinder 0, track 2. For FBA devices SYSRES begins at block 2, and the library begins at block 10. Figure 3-39 is a sample of a status report produced for a SYSRES file on an FBA device.



```
S T A T U S   R E P O R T                DATE: 06/1 /79 (MM/DD/YY)    TIME: 17.30 (HH.MM)           DECIMAL NUMBERS

 LIBRARIES ON FIXED       STARTING    NEXT AVAILABLE   LAST BLOCK  BLOCKS      BLOCKS     BLOCKS     ENTRIES   ACTIVE DIR
 BLOCK ARCHITECTURE       ADDRESS     ENTRY & MEMBER   ALLOCATED   ALLOCATED   ACTIVE     DELETED   & BLOCKS   ENTRIES &
 (FBA) DEVICES:          (BLOCKNO)   (BLOCKNO  BYTE)  (BLOCKNO)                                    AVAILABLE  COND.LIMIT (%)

SYSRES VOL.SER.SYSRES
CORE IMAGE   DIRECTORY         10          59  452        210        201         50          4        2500        831  25
             LIBRARY          211        5568            8009       7799       5378                   2445          0  69

SYSRES VOL.SER.SYSRES
RELOCATABLE  DIRECTORY       8010        8017  434       8210        201          8          0        5239        192   4
             LIBRARY         8211        9954           16009       7799       1748                   6051          0  22

SYSRES VOL.SER.SYSRES
SOURCE-STMT  DIRECTORY      16010       16011    2      16210        201          2          0        5246          0   1
             LIBRARY        16211       16211           24009       7799          0                   7799          0   0

SYSRES VOL.SER.SYSRES
PROCEDURE    DIRECTORY      24010       24011    2      24210        201          2          0        5246          0   1
             LIBRARY        24211       24211           32009       7799          0                   7799          0   0

NUMBER OF ENTRIES IN SYSTEM DIRECTORY LIST:       1
SHARED VIRTUAL AREA ADDRESSES (HEX)           START:   226C      NEXT AVAILABLE LOCATION:   FA317       END:  13FFFF
```

Figure 3-39. Library Status Report for SYSRES on an FBA Device

When accessing a system file as a private library, the file name of the DLBL statement should reflect the private library name. The file-ID of the DLBL statement must be the original file-ID of the SYSRES file.

The following job stream would be used to merge from a system residence into a duplicate system residence whose 20 cylinder relocatable library is being used as a private library. (Assume the disk packs are 3330s).

```
// JOB MERGE
// DLBL DUPLSYS,'DOS.SYSRES.FILE'
// EXTENT ,SYSRES,1,0,570,380
// LIBDEF RL,TO=DUPLSYS
// EXEC CORGZ
    MERGE RES,PRV
    COPYR M001,M002
/*
/&
```

The DLBL/EXTENT statements refer to the target library. DLBL/EXTENT information describing the IPL SYSRES file is assumed to be in the standard label area.

As another example, you may want to create a backup copy of your system core image library as a private library on magnetic tape. The following job stream illustrates the use of the Backup System utility to achieve that. The system core image library takes up blocks 10 through 8009 of an FBA device (see the Status Report in Figure 3-39).

```
// JOB BACKUP
// ASSGN SYS005,UA
// DLBL IJSYSHF,'DOS.SYSTEM.HISTORY.FILE'
// EXTENT SYSREC,,1,0,5339,57         IBM 3330
// DLBL IJSYSCL,'DOS.SYSRES.FILE'
// EXTENT SYS007,,1,0,10,8000
// ASSGN SYS007,131                   SYSRES FILE ON
// ASSGN SYS006,281,C0               FBA BACKUP TAPE
// EXEC BACKUP
/*
/&
```

Using Private Libraries Created under DOS/VS or DOS/VSE. You may want to use private libraries that were created under DOS/VS (starting with Relase 30) or DOS/VSE. These were created and used with standard file names IJSYSPC, IJSYSCL, IJSYSRL or IJSYSSL. You can continue to use these names under VSE/Advanced Functions. The LIBDEF statement allows to specify a different file name; the file id in the DLBL information, however, must be identical to the one used under the earlier system.

When a core image library created under DOS/VS or DOS/VSE resides on a CKD device and is updated for the first time under VSE/Advanced Functions, the directory is reformatted to the format of VSE/Advanced Functions. The new directory will generally occupy more space.

Chapter 4: Using the Facilities and Options of VSE/Advanced Functions

This chapter discusses ways and means for monitoring certain activities of the system. This involves the coding of program exit routines and of user programs to be used as IPL and job control exit routines and the coding of a job accounting interface routine. In addition, this chapter discusses the checkpointing facility, DASD switching under VSE/Advanced Functions and designing program for virtual mode execution. The *SDAID* program which is an effective debugging and measurement tool is discussed in *VSE/Advanced Functions Serviceability Aids and Debugging Procedures*.

User-Written Exit Routines

Program Exit Routines

If required, the supervisor can permit user routines to gain control when any of the following types of events occurs:

- Interval Timer Interrupt (IT)
- Program Check Interrupt (PC)
- Abnormal Termination (AB)
- Operator Communication Interrupt (OC)
- Task Timer Interrupt (TT)
- Page Fault Handling Overlap (PHO)

Both the supervisor and the problem program that contains the user routine must have the proper code to establish an interface.

The problem program that wants to utilize the options must contain code to set up the interface. For the first five events, code can be generated by the STXIT macro. For the last event, code is generated by the SETPFA macro. This code is assembled in the main line of a problem program.

Figure 4-1 is a summary of the supervisor-determined conditions for which an exit routine may be coded and the operand to be coded in the STXIT macro.

The STXIT operands and their use are discussed in *VSE/Advanced Functions Macro Reference*.

Condition	Operand of the STXIT Macro
Abnormal termination of the problem program	AB
Interval timer external interrupt	IT
Operator communications interrupt	OC
Program check interrupt	PC
Task timer interrupt	TT

Figure 4-1. Summary of Program Exit Conditions

Short descriptions of the support for each of the types of program exit routines follow, indicating the associated problem program macros. For information on how multitasking affects this support and what happens if multiple events coincide, refer to *VSE/Advanced Functions Macro User's Guide*. Some high-level languages offer similar facilities, for details of which see the appropriate programmer's guide.

Interval Timer Exit

Suppose you want to take a checkpoint on a job at a certain time after it has started. Code the STXIT to set up the interface of your user-exit routine with the supervisor; use the SETIME macro to set a time interval. When that interval elapses, an interval timer interrupt occurs and control is given to your user routine. The user routine need not be entered immediately. For instance, if the user routine is in the background partition, and a foreground partition is active, the user routine will not be entered until the background partition becomes active.

To find out the time remaining in an interval, a program can issue the TTIMER macro instruction. The supervisor then loads this value in general register 0. This macro can also be used to cancel the remaining time in the interval.

Program Check Exit

Programs can establish linkage from the supervisor to a user program-check exit routine by coding an STXIT macro. If a program check occurs within the program, the supervisor gives control to the user routine instead of discontinuing the program. The user routine can analyze the program check and choose to ignore, to correct, or to accept it.

If the check is ignored, control can be given back to the supervisor by executing an EXIT PC macro; if the user routine can correct the error condition, the routine can request via the EXIT macro that processing of the main line program continue.

If the problem cannot be resolved, the program check is accepted as valid. The user routine can then terminate further processing of the program by issuing a CANCEL, DUMP, JDUMP, or EOJ macro.

The ability to include a user routine to process program checks can be especially advantageous when using LIOCS. In that case, I/O housekeeping such as closing files and freeing tracks can be performed before termination of the job or task.

Abnormal Termination Exit

Programs can establish linkage from the supervisor to an abnormal termination exit routine by issuing an STXIT AB macro.

The macro allows a user routine to get control from the supervisor before an abnormal end-of-job condition discontinues the processing of the program. The user routine normally ends with one of the termination macros (CANCEL, DUMP, JDUMP or EOJ) to terminate the problem program and to return control to the supervisor, rather than by initiating the continuation of the problem program.

Operator Communications Exit

VSE/Advanced Functions allows problem programs to provide a routine for handling external interrupts from the operator. This support is useful in a number of applications, for example:

- A change in the environment is needed. A message is then issued by the program. For example: MOUNT TAPE xxx ON UNIT xxx AND PRESS THE INTERRUPT KEY.
- In telecommunication, the OC exit allows the operator to start and stop activities on certain lines or terminals, or to invoke diagnostic procedures. In this case, program run sheets with explicit instructions may be required to ensure understanding between programmer and operator.

The external interrupt that links to an OC user exit routine is caused by pressing the request key and, when the attention routine identifier AR appears, replying *MSG* followed by the partition identifier (such as BG or F2).

Task Timer Exit

Task timer support is included in the supervisor by the TTIME parameter of the FOPT generation macro. This parameter also identifies the partition owning the task timer. Only the main task in the owning partition can utilize the task timer.

The time interval is specified in the SETT macro and is decremented only when the main task is executing. The exit routine specified in the STXIT TT macro is entered when the interval has elapsed, provided linkage between that routine and the supervisor has already been established, at that point of program execution.

To find out the time remaining in an interval, the task can issue a TESTT macro. This causes the time remaining in the interval to be returned in register 0. The task can also issue a TESTT CANCEL to cancel the remaining interval time. In this case the exit routine is not entered.

Page Fault Handling Overlap Exit

A user routine can continue processing during the time a page fault is being handled by the system, provided this page fault occurs in the same task and not in a supervisor routine invoked by this task. This support is of interest only for programs executed in virtual mode and making use of user-developed subtasking rather than IBM-supplied multitasking.

Such programs may issue the SETPFA macro instruction to establish linkage from the page management routines in the supervisor to a user routine, called the page fault appendage routine. Linkage can be established for only one task per partition. The usage of the SETPFA macro is described in *VSE/Advanced Functions Macro User's Guide*.

Writing an IPL User Exit Routine

The IPL Exit allows you to do some processing at the end of IPL and prior to execution of the job control program. You may want to check about the options of the loaded supervisor, for example whether support for job accounting or access control is included.

Before you start coding your exit routine, take account of any system requirements that should be met at the time the routine is to be executed. The exit routine and any routines that are called by your routine must be present in the system core image library.

Moreover, your routine must adhere to the following conventions:

- Register 15 contains the entry point of the routine.
- Register 14 contains the return address to job control.
- The format of the PHASE statement must be as follows:

```
PHASE $SYSOPEN.
```

After IPL, the job control program executes the exit routine as an overlay phase; an area of 4K has been reserved for the exit routine. While the routine is being executed, the job control program is unable to read any job control statements.

In your exit routine, you may issue SVCs and perform I/O operations to SYSLOG and/or SYSRES. To do so, you may only use the EXCP macro. Any use of LIOCS or of a DTFPH would obstruct proper execution of the job control program. If you code your routine in assembler language, use DC instructions instead of DS instructions.

Phase $SYSOPEN will be executed with a storage protect key of zero. If the phase is abnormally terminated, the job control program will be loaded for execution.

Figure 4-2 illustrates a user-written routine that is executed once each time the IPL procedure is performed.

Immediately after IPL, only a few system units are assigned, the most important ones being SYSLOG and SYSRES. If you want to open a job accounting file, place the necessary ASSGN statements, label information (if not already present in the system standard, the partition standard, or the user label area) and EXEC statement for the pertinent job in your ASI BG JCL procedure, ahead of the statements that activate the foreground partitions. This enables you to use the normal facilities of the system, including LIOCS.

```
*   THIS PROGRAM CHECKS WHETHER THE INSTALLATION INCLUDES
*   JOB ACCOUNTING SUPPORT. IPL OF A SUPERVISOR WITHOUT
*   THIS SUPPORT IS CONSIDERED AS NOT ALLOWED.
*   A MESSAGE INFORMS THE OPERATOR WHY HE/SHE HAS TO
*   REPEAT IPL. THEN A HARD WAIT IS FORCED.

         START    0
         USING    *,R15
BEGIN    ST       R14,RETURN             SAVE RETURN ADDRESS
         COMRG    REG=R2
         TM       56(R2),X'80'           JOB ACCOUNTING SUPPORTED?
         BZR      R14                    YES, RETURN TO JOB CONTROL
         LA       R1,LOGCCB              NO, WRITE MESSAGE TO
         EXCP     (1)                    OPERATOR
         WAIT     (1)
         L        R11,HWCODE             LOAD HARD WAIT CODE
         ST       R11,0                  STORE IT IN LOW CORE
         OI       SVCNPSW+1,X'02'        SET ON WAIT BIT
         SVC      7                      FORCE HARD WAIT
SVCNPSW  EQU      96                     LOCATION OF SVC NEW PSW
LOGCCB   CCB      SYSLOG,LOGCCW
LOGCCW   CCW      X'09',LOGMSG,X'20',L'LOGMSG             (column  72)
LOGMSG   DC       C'JOB ACCOUNTING SUPPORT MISSING, RE-IPL        C
                  CORRECT SUPERVISOR'
RETURN   DC       F'0'
HWCODE   DC       C'NOJA'
R0       EQU      0
R1       EQU      1
R2       EQU      2
R11      EQU      11
R12      EQU      12
R13      EQU      13
R14      EQU      14
R15      EQU      15
         END      BEGIN
```

Figure 4-2. IPL User Exit Example

Writing a Job Control User Exit Routine

It is often desirable to exercise certain control on how a job step is executed, thereby enhancing security, serviceability, and reliability. After a job control statement (or command) has been read, control can be passed to a user exit routine for the purpose of examining and altering the statement (or command) before it is processed by job control.

The VSE/Advanced Functions distribution volume contains a dummy phase $JOBEXIT in the system core image library which is automatically loaded into the SVA at IPL. If you do not use the Job-control-exit facility, it has no effect on your system.

In your routine you are free to modify the operands of the job control statement and to add comments. You must not, however, modify the operation field of the statement. For example, // EXEC IBM can be modified to // EXEC USER; the operation field (EXEC) cannot be modified. In your exit routine neither perform any I/O operations nor issue any SVCs nor request the system to cancel the job step.

Link-edit your routine to the system core image library using a PHASE statement as follows:

```
PHASE   $JOBEXIT,S[,NOAUTO],SVA[,PBDY]
```

Your routine must be coded reenterable; it must be SVA eligible, and it must reside in the SVA. The PHASE statement must include the SVA parameter. This ensures that when the phase is cataloged it will also be loaded into the SVA replacing the dummy phase provided by IBM.

Phase $JOBEXIT is executed with a storage protection key of zero. The code is shared between partitions.

When your routine receives control, registers contain control information as follows:

Register Number	Contents of Register
0	System identification characters 'SDOS'.
1	Address of partition communication region.
2	Address of system communication region.
3	Address of job control vector table.
4	Address of buffer that contains the currently processed job control statement.
14	Return address to job control.
15	Entry point to $JOBEXIT; at completion of the routine it contains the return code for job control.

Prior to returning control to job control, your routine must store a return code value into register 15:

a zero value – requests job control to continue processing the current statement.

a non-zero value – requests job control to print the statement on SYSLST, to display it on SYSLOG, and from then on to ignore it.

The vector table whose layout is given below shows which job control statement is being processed by job control. You must not modify its contents. Use it for comparison only. The size of the buffer into which the job control statement is loaded (left-justified) is 120 bytes, the first 71 bytes of which are printed on the console printer. The full length of 120 bytes is printed on the printer assigned to SYSLST. The /& and End-of-job statements are not displayed.

In the buffer, you may modify the statement up to and including byte 71, except for the operation field. Bytes 72-80 could contain a statement identification, such as for procedure overwrites, and therefore should not be modified. After having set the return code, your routine should pass control back to job control.

Layout of the vector table:

Bytes 0 through 6:	Operation field (name of job control statement)
Bytes 7 through 9:	Internal control information

Do not attempt to modify the table or modify the operation field in the buffer.

Note: Make sure your exit routine is free of errors that could cause abnormal termination in a production environment.

Figure 4-3 illustrates a job control user exit routine.

```
// JOB EXIT ROUTINE
// OPTION CATAL,NODECK
 PHASE $JOBEXIT,S,NOAUTO,SVA,PBDY
// EXEC ASSEMBLY
            EJECT
********************************************************************************
*           THIS PROGRAM, PHASE $JOBEXIT, EXAMINES ALL EXEC CONTROL STATEMENTS
*           AND EXEC COMMANDS WHETHER THEY WANT TO EXECUTE A PROGRAM NAMED:
*           IBM. THIS PROGRAM IS ASSUMED TO BE RESTRICTED FOR GENERAL USE AND
*           THE STATEMENT:
*     [//]  EXEC IBM
*           IS CHANGED TO:
*     [//]  EXEC USER
*           MESSAGE, 'PROG. IBM RESTRICTED FOR ALL USERS', IS PLACED INTO
*           THE EXEC CARD AND PRINTED ON SYSLOG (IF LOG IS ON) AND SYSLST.
*
*
*           THE PHASE NAMED USER MUST BE CATALOGED IN THE CIL
*
*           $JOBEXIT IS REENTERABLE AND SVA ELIGIBLE AND MUST BE
*           LOADED INTO THE SVA.
********************************************************************************
            EJECT
JOBEXIT     START   0
            BALR    R12,0                       ESTABLISH
            USING   *,R12                       ADDRESSABILITY
```

Figure 4-3. Job Control User Exit Example (Part 1 of 2)

```
*
*        CHECK FOR EXEC STATEMENT
*        REG.3 POINTS TO JOB CONTROL VECTOR TABLE
*
         CLC      EXECNAM,0(R3)         IS IT AN EXEC STATEMENT?
         BNE      RETURN                IF NOT RETURN
*
*        EXAMINE THE STATEMENT
*        REG.4 POINTS TO STATEMENT BUFFER
*
         L        R6,=F'1'              INCREMENT VALUE FOR SEARCH LOOP
         L        R7,=F'67'             COUNT MAXIMUM FOR SEARCH LOOP
         SR       R5,R5                 CLEAR R5, USED AS INDEXING REG.
*
*        FIND POSITION OF EXEC STATEMENT
*
SEARCHE  EQU      *
         LA       R8,0(R5,R4)           POINT TO INDEXED POS. IN STMNT. BUF
         CLC      EXECNAM,0(R8)         DETERMINE POSITION OF EXEC
         BE       EXFOUND               FOUND THE STATEMENT
         BXLE     R5,R6,SEARCHE         INCREMENT INDEX AND LOOP
         LA       R15,8                 NO EXEC FOUND, RETURN CODE=8
         BR       R14                   RETURN TO CALLER
EXFOUND  EQU      *
         LA       R5,5(R5)              SKIP OVER EXEC TO PROGNAME
SEARCHP  EQU      *
         LA       R8,0(R5,R4)           POINT TO INDEXED POS. IN STMNT. BUF
         CLC      PROGNAM,0(R8)         LOOK FOR PROGRAM-NAME IBM
         BE       PFOUND                PROGRAM-NAME FOUND
         BXLE     R5,R6,SEARCHP         INCREMENT INDEX AND LOOP
         B        RETURN                IF ANY OTHER OR NO PROG.-NAME RETURN
*
*        PROGRAM-NAME-IBM-FOUND PROCESSING
*
PFOUND   EQU      *
         LA       R4,0(R5,R4)           POINT TO PROG.-NAME IN BUFFER
         MVC      0(L'USERTXT,R4),USERTXT MOVE USERTXT TO BUFFER
*
*        PREVIOUS MVC CHANGED PROGRAM-NAME IBM INTO PROGRAM-NAME USER
*        AN ADDITIONAL MESSAGE IS MOVED INTO THE BUFFER
*
RETURN   EQU      *
         SR       R15,R15               RETURNCODE ZERO TO REG.15
         BR       R14                   RETURN TO CALLER
EXECNAM  DC       C'EXEC'
PROGNAM  DC       C'IBM'
USERTXT  DC       C'USER *** PROG. IBM RESTRICTED FOR ALL USERS'
R3       EQU      3
R4       EQU      4
R5       EQU      5
R6       EQU      6
R7       EQU      7
R8       EQU      8
R12      EQU      12
R14      EQU      14
R15      EQU      15
         END      JOBEXIT
/*
// EXEC LNKEDT
/&
```

Figure 4-3. Job Control User Exit Example (Part 2 of 2)

Writing a Job Accounting Interface Routine

A VSE/Advanced Functions supervisor generation option provides job accounting interface support for all partitions in the system. At the end of each job step or job, accounting information is accumulated in a table for that partition and can be processed by a user-written routine. This routine can extract data for such purposes as charging system usage and supervising system operation, or for planning new applications or changing the system configuration.

The routine must be relocatable, and it must be SVA eligible. With the distribution volume, IBM provides a dummy phase $JOBACCT as part of the system core image library. If you decide to use the job accounting facility, you must catalog your routine to the system core image library. At IPL, the phase is automatically loaded into the SVA.

When you catalog your routine, the PHASE statement must include the SVA parameter; this causes the phase, after it has been cataloged, to be loaded into the SVA replacing the dummy phase provided by IBM.

Since the processing of the information is an overhead element, the user routine should be efficient and avoid unnecessary reduction or reformatting of data.

If your installation uses VSE/POWER with the job accounting facility included, you do not need such a user routine. For more information about this facility under VSE/POWER, refer to the documentation for this licensed programming support.

Job Accounting Information

When support is generated for *basic job accounting*, a job accounting table comprising fourteen fields is included for each partition in the system. At the end of each job step and job, information is stored in fields 1 to 14 of the Job Accounting table (see Figure 4-4).

In addition, you may request (at the time of supervisor generation) to have included the *number of SIO* (Start I/O) *instructions* issued per device for each job step and job. The job accounting table for each partition is then extended to contain the additional fields 15 and 16 shown in Figure 4-4.

SIO accounting is performed for the number of devices specified to be supported by the facility for each partition. The maximum is 255 and has no relation to the number of devices specified for the total VSE system. If more devices are accessed than the number specified, SIOs on the excess devices will not be counted.

Field	Displacement	Byte Length	Contents
1	0 - 7	8	Job name. 8-byte character string taken from JOB statement.
2	8 - 23	16	User Information. 16 characters of information taken from the JOB statement.
3	24 - 25	2	Partition ID, BG, . . . , F2, or F1.
4	26	1	Cancel Code. Refer to *VSE/Advanced Functions Messages.*
5	27	1	Type of Record. S = job step; L = last step of job.
6	28 - 35	8	Date when job step started: mm/dd/yy or dd/mm/yy depending on supervisor option.
7	36 - 39	4	Job Step Start Time. 0hhmmssF, where h hours, m minutes, s seconds, F is a sign (in packed decimal format).
8	40 - 43	4	Job Step Stop Time (in same format as start time).
9	44 - 47	4	Reserved.
10	48 - 55	8	Phase Name. 8-byte character string taken from the EXEC card.
11	56 - 59	4	Real Mode Processing: Number of fixed pages, multiplied by 2K; equivalent to the partition's allocated processor storage minus the portion of the partition GETVIS area that was not used up by GETVIS requests. Virtual Mode Processing: Number of pages referenced in the partition, multiplied by 2K.
12	60 - 63	4	CPU Time. 4 binary bytes given in 300ths of a second. Time is calculated from exit of the user-written routine called during job control to next entry of the routine. Time used by the user-written output routine is charged to overhead of the next record.
13	64 - 67	4	Overhead Time. 4 binary bytes given in 300th of a second. Includes time taken by functions that cannot be charged readily to one partition (such as attention routine and error recovery). System overhead time is distributed to the partitions in proportion to the used CPU time.
14	68 - 71	4	All Bound Time. 4 binary bytes in 300th of a second. This is the time the system is in the wait state divided by the number of partitions running.
15	72 -		SIO Tables. Variable number of bytes. Six bytes are reserved for each device specified in the JA parameter. First two bytes are X'0cuu', next four are hex count of SIOs for job step. Unused entries contain X'10' followed by five bytes of zeros. Stacker select commands for MICR devices are not counted. Error recovery SIOs are not charged to the JOB Accounting Table. Devices are added to the table as they are used.
16		1	Overflow. Normally X'20'. Set to X'30' if more devices are used than set by the JA parameter at system generation time.

Note: The difference between Start and Stop times will not necessarily equal the sum of CPU, All Bound, and Overhead times. All Bound and Overhead times will vary, depending on the number of active partitions and the type of partition activity. CPU time is accurate for each partition, but it may not be reproducible. That is, the same job being executed under different system conditions (varying number of active partitions, logical transient available, etc.) may show differences in CPU time.

Figure 4-4. Job Accounting Table

Programming Considerations

If physical IOCS is used for printing, you must 'space after' to prevent overwriting of job control statements.

For efficiency, an overlay structure should be avoided and the length of the program should preferably not exceed one core image library block.

If the job accounting program is canceled as the result of an error condition, the current information cannot be retrieved, the job accounting information for the current job step is unreliable. However, provision is made that the job accounting information for any subsequent job steps will be correct, provided the cancellation was not caused by an error in the $JOBACCT routine itself. If there was an error in the $JOBACCT routine, it must be corrected first.

In order to avoid unintentional cancellation of the job accounting program by operator action, the operator should issue the MAP command and check the job name for the running partition. If the job name is 'JOB ACCT', the job accounting routine is active; the CANCEL command should not be issued until the original job name is displayed after another MAP command.

Register Usage. Important data for the user's job accounting routine are passed in the following general registers:

12 Base address for $JOBACCT
15 Address of the job accounting table
11 Length of the job accounting table
13 Address of the user save area
14 Return address to job control

If $JOBACCT uses LIOCS, the contents of general registers 14 and 15 must be saved (also registers 0 and 1 if necessary) because LIOCS uses these registers.

Save Area for the User's Routine. The address of a save area that can be used by the job accounting routine is passed in general register 13. This save area is 16 bytes long unless a greater length (up to 1024 bytes for saving DTF information for LIOCS) was specified at system generation time. However, CCBs and executable CCWs must not be included.

User's Area for LIOCS Label Processing. If your job accounting routine uses LIOCS for processing such items as standard tape labels, DTFDA, or DTFPH with MOUNTED=ALL, then a special label area must be specified at supervisor system generation.

Tailoring the Program

The requirements of the program may be simply to record the accounting information as part of the SYSLST output for each job step or job, or it may be to accumulate information to be used for equitably allocating the costs of a computing center.

If data is to be written out on a disk or tape, the save area can be used for communicating between job steps. Such information as the disk address for the next record or an indication that tape labels have been successfully processed, or even the DTF used to control the output, may be stored in the save area.

Figure 4-5 illustrates a job accounting program that writes records to disk without additional processing.

```
JAACT    CSECT
         USING    *,R12
         USING    JASAVE,R13            JOB ACCT SAVE AREA
         LR       R9,R15                SAVE ADDR OF TBL
         LA       R0,JADTFLNG+L'JABSAVE LENGTH FOR GETVIS
         GETVIS   LENGTH=(0)            GET SPACE IN PARTITION
         LTR      R15,R15               CHECK RETURN CODE
         BNZ      JARET1                NO GETVIS SPACE
         LA       R0,JABROUT            AB ROUTINE
         STXIT    AB,(0),(1)            SET ABNRML TERM EXIT
         LA       R1,L'JABSAVE(R1)      UPDATE GETVIS POINTER
         TM       JASTATSW,X'C0'        TEST STATUS
         BO       JARET                 DISK AREA FULL
         BM       JAOPEN                SAVE AREA INITIALIZED
* PERFORM LABEL PROCESSING AND INITIALIZE SAVE AREA
         MVC    0(JADTFLNG,R1),JADTF    MOVE DTF TO PARTITION
         OPENR    (R1)                  OPEN FILE (see Note)
         MVC      JACCB,0(R1)           MOVE CCB TO SAVE AREA
         MVC      JASEEK,58(R1)         EXTENT LOWER LIMIT
         MVI      JAR,X'01'             FIRST RECORD
         MVC      JAHIGH,JADTF+54       HIGH EXTENT LIMIT
* RELOCATE CCWS
         MVC      JASKCCW(32),JAMODCCW  PUT MOD CCWS IN SVE AREA
         LA       R10,JASEEK            SEEK ADDRESS
         STCM     R10,7,JASKCCW+1       PUT ADDRESS IN CCW
         LA       R10,JASRCH            SEARCH ADDRESS
         STCM     R10,7,JASRCCW+1       PUT ADDRESS IN CCW
         LA       R10,JASRCCW           SEARCH CCW ADDRESS
         STCM     R10,7,JATIC+1         PUT ADDRESS IN CCW
         LA       R10,JASKCCW           CHANNEL PROGRAM ADDR
         STCM     R10,7,JACCB+9         PUT ADDRESS IN CCB
         MVI      JASTATSW,X'80'        IND SAVE AREA INIT
* WRITE JOB ACCOUNTING TABLE TO DISK
JAOPEN   STCM     R9,7,JADATA+1         PUT ADDR OF TBL IN CCW
         MVC      0(16,R1),JACCB        MOVE CCB TO PARTITION
         EXCP     (1)                   WRITE DATA
         WAIT     (1)                   WAIT FOR COMPLETION
* UPDATE SEEK ADDRESS
         TR       JAR,JARECTAB          RECORD
         CLI      JAR,X'01'             NEW TRACK
         BNE      JARET                 NO
         TR       JAHEAD+1(1),JAHDTAB   HEAD
         CLI      JAHEAD+1,X'00'        NEW CYLINDER
         BNE      JAHTST                NO
         LH       R10,JA CYL            CYLINDER ADDRESS
         LA       R10,1(R10)            INCREMENT BY ONE
         STH      10,JACYL              REPLACE IN SEEK ADDR
JAHTST   CLC      JAHIGH,JASRCH         BEYOND UPPER LIMIT
         BH       JARET                 NO
         MVC      0(16,R1),JACCBL       MOVE CONSOLE CCB TO PARTITION
         LA       R2,JAMSG1             ERROR MESSAGE
         STCM     R2,7,9(R1)            PUT ADDRESS IN CCB
         EXCP     (1)                   INFORM OPERATOR
         WAIT     (1)                   WAIT FOR COMPLETION
         OI       JASTATSW,X'40'        INDICATE DISK FULL
JARET    FREEVIS  LENGTH=(0)            FREE PARTITION SPACE
         STXIT    AB                    RESET EXIT LINKAGE
JARET1   BR       R14                   RETURN
```

Note: As this example is self relocating, the self-relocating form of the OPEN macro (OPENR) is used; for a routine that will be linked relocatable, OPEN may be used instead.

Figure 4-5. Job Accounting Routine Example (Part 1 of 2)

```
JABROUT  LA       R1,L'JABSAVE(R1)     RESTORE ADDR IN GETVIS AREA
         MVC      0(16,R1),JACCBL      MOVE CONSOLE CCB TO PARTITION
         LA       R2,JAMSG2            ERROR MESSAGE
         STCM     R2,7,9(R1)           PUT ADDRESS IN CCB
         EXCP     (1)                  INFORM OPERATOR
         WAIT     (1)                  WAIT FOR COMPLETION
         EOJ
JAMODCCW CCW      X'07',*,X'60',6
         CCW      X'31',*,X'60',5
         CCW      X'08',*,X'00',1
         CCW      X'05',*,X'20',246
JACCBL   CCB      SYSLOG,*
JABSAVE  DS       0CL72
JADTF    DTFPH    TYPEFLE=INPUT,       MEANS CHECK LABELS
                  DEVICE=2314,
                  MOUNTED=SINGLE
JADTFLNG EQU      *-JADTF
         ORG      JADTF
         DC       X'00000B00'          SET CCB OPTION BITS
         ORG
JAMSG1   CCW      X'09',JAERR1,X'20',L'JAERR1
JAMSG2   CCW      X'09',JAERR2,X'20',L'JAERR2
JAERR1   DC       C'JOB ACCOUNTING DISK FULL'
JAERR2   DC       C'JOB ACCOUNTING ROUTINE CANCELED'
JARECTAB DC       X'0002030405060708090A0B0C0D0E0F101112131401'
JAHDTAB  DC       X'0102030405060708090A0B0C0D0E0F1011121300'
JASAVE   DSECT
JASEEK   DS       0XL6                 SEEK ADDRESS BBCCHH
JABB     DS       XL2                  BB
JASRCH   DS       0XL5                 SEARCH ADDRESS CCHHR
JACYL    DS       XL2                  CC
JAHEAD   DS       XL2                  HH
JAR      DS       X                    R
JASTATSW DS       X
JACCB    DS       XL16                 COMMAND CONTROL BLOCK
JAHIGH   DS       XL4                  HIGH EXTENT LIMIT
         DS       XL4
JASKCCW  CCW      X'07',JASEEK,X'60',6 SEEK CCW
JASRCCW  CCW      X'31',JASRCH,X'60',5 SEARCH CCW
JATIC    CCW      X'08',JASRCCW,X'00',1 TIC CCW
JADATA   CCW      X'05',*,X'20',246    WRITE DATA ASSUMING 29
*                                      SIO DEVICES TRACED
R0       EQU      0
R1       EQU      1
R2       EQU      2
R9       EQU      9
R10      EQU      10
R11      EQU      11
R12      EQU      12
R13      EQU      13
R14      EQU      14
R15      EQU      15
         END
```

Note: *The DSECT labeled JASAVE through JADATA defines the layout of the job accounting user-save area, which resides within the supervisor. The address of this area is passed, in register 13, to your job accounting phase. When generating your supervisor you must specify the desired length of this save area by substituting a value for s, the first operand of the JALIOCS parameter of the FOPT macro. If the operand is omitted or if JALIOCS=NO is specified, the length of the user save area is set to 16 bytes by default.*

Figure 4-5. Job Accounting Routine Example (Part 2 of 2)

Checkpointing Facility

The progress of a program that performs considerable processing in one job step should be protected against destruction in case the program is canceled. VSE/Advanced Functions provides support for taking up to 9999 checkpoint records in a job. Through this facility, information can be preserved at regular intervals and in sufficient quantity to allow restarting a program at an intermediate point.

The CHKPT macro (or the corresponding high-level language statement) causes the checkpoint record to be stored on a magnetic tape or disk. For more details about taking checkpoints, refer to *VSE/Advanced Functions Macro Reference* if you use assembler language or to the appropriate high-level language manual.

The RSTRT job control statement restarts the program from the last or any specified checkpoint taken before cancelation.

When a checkpointed program is to be restarted, the partition must start at the same location as when the program was checkpointed and its end address must not be lower than at that time unless a lower end address was specified in the CHKPT macro instruction. Unless the user reestablishes all linkages to SVA phases himself, the contents and location of the modules in the SVA when restarting must also be the same as when the program was checkpointed. The SDL must be identical if the restarted program uses a local directory list (for example, one that was generated by the assembler language macro GENL).

If any pages of a virtual mode program were fixed when the checkpoint record was taken, then, in 370 mode, the real address area allocation for the partition must also start at the same or a lower location and its end address must be at least as high as at that time. The pages that were fixed are refixed by the supervisor when the program is restarted.

Restarting a Program from a Checkpoint

To restart a program from a checkpoint the RSTRT job control statement is used. The sequence of job control statements that must be submitted to restart a program is as follows:

1. A JOB statement specifying the jobname used when the checkpoints were taken.
2. ASSGN statements, if necessary, to establish the I/O assignments for the program that is to be restarted.
3. A RSTRT statement specifying
   a) the symbolic name of the tape or disk device on which the checkpoint records are stored.
   b) the sequence number of the checkpoint record to be used for restart.
   c) for checkpoint records on disk the filename (DTF name) of the checkpoint file.

4. An end-of-job (/ &) statement.

Figure 4-6 shows the sequence of job control statements needed to restart a checkpointed program that ended abnormally due to, for example, a power failure. Following are the characteristics of the checkpointed program that must be considered for restart:

- The job name specified in the JOB statement was CHECKP; the same name must be used for restart.
- The checkpoint records were written on magnetic tape; therefore, no filename need be specified in the RSTRT statement.
- The symbolic device name SYS006 is used for the checkpoint file.
- The sequence number of the last checkpoint record written was 0013; this or any previous checkpoint record can be used for restart (the sequence numbers are printed by VSE/Advanced Functions on the SYSLOG device).

In reconstructing the job stream note that the // RSTRT statement physically and functionally replaces the // EXEC statement originally used.

Another important consideration is the repositioning of files on magnetic tape or disk. Assembler language users may consult *VSE/Advanced Functions Macro Reference*, which discusses the topic in context with using the CHKPT macro. High-level language users should consider printing a file processing status record for each checkpoint that is taken during the execution of a program. This record should indicate the name of the file(s) read or written on magnetic tape or disk when the checkpoint is taken.

```
// JOB CHECKP
// ASSGN SYS006,380      CHKPT TAPE
// ASSGN ...
// ASSGN ...
// RSTRT SYS006,0013
/&
```

Figure 4-6. Example of a RESTART Job

DASD Switching under VSE/Advanced Functions

The standard I/O interface between an I/O device and the CPU is a channel and a control unit.

Normally, this interface provides one, and only one, path by which a CPU communicates with an I/O device. However, it may be desirable to access a device, especially a DASD device, by more than one path. For example, a second CPU may be required to back-up the host CPU such that should the host CPU become inoperable, the attached DASD devices may be switched immediately to (made accessible by) the back-up CPU. Multiple CPUs may also need to access the same data base.

A single CPU may require back-up channels and control units, providing alternate paths to the same DASD devices.

In order to do this device sharing, the hardware provides a two-level switching mechanism that allows you to connect one or more DASDs either dynamically or manually to different I/O paths. This mechanism is known as channel switching and string switching.

Channel Switching. Channel switching provides the switching mechanism at the control unit level. The channel switch allows you to connect the control unit to up to four channels, which may belong to the same or different CPUs thus providing up to four distinct I/O paths. A maximum of two channels may connect to one CPU. The connection of any channel can be manually enabled or disabled. When enabled, the switch is dynamically controlled by the hardware.

String Switching. In the case of string switching, the switching mechanism is at the DASD string level. String switching allows you to connect a string of DASDs to two distinct control units, or integrated disk attachments. The two I/O paths may be connected to a single or two different CPUs.

Using DASD Switching. In both types of this hardware-supported switching, a desired I/O path may be selected in one of two ways. In the first case, connection is made dynamically when an I/O command is issued for a device. Provided that the control unit (in channel switching) and the DASD string (in string switching) are free for connection, the target DASD device can be accessed by the requesting CPU. Once a connection is established by one CPU, the other CPU receives device busy status if attempting to access a device on the string.

In the second case, the operator may manually switch the sharable devices to the desired CPU (via the Enable/Disable toggle switches). It should be noted that in this case an entire string of DASD is disconnected from the other CPU.

If, at your installation, a DASD switching feature is being used, it is your responsibility to resolve conflicting CPU references to shared devices (or files) and thus ensure data integrity. Following are two ways of preventing potential conflicts.

First, through scheduling of CPU file referencing, ensure that only one CPU that is updating the file is connected to the shared DASD. The operator needs only to switch the manual control to the updating CPU for that period of time.

Secondly, through scheduling and the use of the operator commands DVCUP and DVCDN (as described below), devices may be reserved for use by one CPU for for a particular period of time.

An individual device can be excluded from use by a particular CPU by entering a DVCDN command for that device via the operator console. The other system then has exclusive access to that device. The device can be made available again by issuing a DVCUP command for the device. However, the other system should then issue a DVCDN command for that device. To avoid conflicts, both system operators have to inform each other about the status of the reserved devices. It is therefore recommended that a job, which requires exclusive access to a file or device, notifies the operator when the device has to be reserved, and when it may be released.

Note that the DVCUP/DVCDN commands reserve the DASD at the device level, although the programmer may be interested in reserving only one file on that particular device. It is recommended that DVCUP and DVCDN commands be entered only via the console.

Further hardware details on channel or string switching may be found in the appropriate DASD hardware manuals, and also in the hardware manuals for the IBM 370/115 and 370/125.

DASD Sharing by Multiple VSE Systems

If your installation consists of more than one computing system, each running under VSE/Advanced Functions, you may consider to share some or all DASD devices between the different VSE systems. Rather than assigning a fixed amount of disk spindles to the different systems, you can combine the total number of available spindles into a disk pool which is shared by all VSE systems. DASD sharing between two or more VSE systems has several advantages:

- Library maintenance is easier, if only one set of libraries has to be maintained.
- Data Base duplication and the related update procedures can be avoided, if the sharing systems work on one copy of the data base.
- The total system throughput increases, when the VSE systems running under VSE/POWER share the POWER work files.
- Direct access storage space may be saved, as one copy of the data is required instead of multiple copies.

As long as the different VSE systems access the shared devices for reading only, the integrity of your data is preserved.

If, however, data on the shared DASD devices are accessed in write mode by more than one system at the same time, data integrity is no longer ensured, unless special precautions are taken. The Track Hold and DASD File protect functions (which are described in chapter 2 *Planning the System*) do not apply here because none of the sharing systems is aware of what the other is doing.

VSE/Advanced Functions provides programming support which allows to access a DASD device from different VSE systems in read and write mode. This programming support is based on the channel switching and/or the string switching feature and is available for the 33xx CKD devices and for the 3370 FBA device.

Reserving Devices for Exclusive Use

Channel command words (DEVICE RESERVE / DEVICE RELEASE) allow one I/O interface to reserve a disk drive for exclusive use. Any other I/O interface that attempts to access such a reserved disk drive will receive a 'device busy' indication.

Reserving DASD devices has several disadvantages:

- An entire disk pack has to be reserved even if only a single record is to be updated. This may lead to a severe performance degradation.
- If one CPU tries to access a volume which is already reserved by another CPU, no clear-cut indication is given that the volume is not available.
- When an application program terminates abnormally, the system does not automatically release reserved disk drives; the other VSE system(s) may have to wait indefinitely if they try to access data on the reserved disk drives.

VSE/Advanced Functions provides a method that avoids those risks. The sharing of data on disk is controlled on the resource level, not on the device level. This method, called 'resource locking', is described in the remainder of this section.

Resource Locking

A program running under VSE/Advanced Functions is capable of protecting data by reserving ('locking') and releasing ('unlocking') a named resource. This resource may, for example, be a table in storage, a phase name, a DASD volume identifier, or a library name.

Locking and unlocking occurs

- within a partition: the resource is shared between tasks belonging to the partition,
- within one computing system: the resource is shared between partitions, or
- within a multiple-CPU installation: the resource (a catalog or a data base, for example) is shared between VSE systems.

Locking within one computing system is called 'internal locking', locking across systems is called 'external locking' or 'cross-system locking'. All functions provided for internal locking are available for external locking as well.

Compared with the method of reserving of volumes, locking by named resource offers the following advantages:

- protection can be limited to a portion of an entire volume (a file, for example);

- data can be shared, comparable to shareoptions 1 and 2 of VSE/VSAM, that is, locking is not necessarily exclusive;

- if a lock request cannot be satisfied because the corresponding resource is already under exclusive control by another task (by another VSE system perhaps), the requestor can be immediately notified if so desired.

If you are just planning to switch from a one-system to a multiple-system setup and you have used the VSE/VSAM access method in the past, you do not have to change your source programs in order to utilize DASD sharing across systems. Resource protection across systems is accomplished by the VSAM open routine. For SAM files in VSAM-managed space, the open routine performs the cross-system locking, too.

If a VSAM file defined with shareoption 1 or 2 is opened for update by one program, then no other user (in another partition of the same VSE system or in another system) can open the file for update at the same time. Concurrent updating of a VSAM file defined with shareoption 4 is allowed for the programs running in one system, but not for those running in different systems: while that file is opened for update by one program, a second program runnning in another partition within the *same* system may open the file for update. A third program, this one running in another system, would not be able to open the file for update while the file is already opened for update in the first system; across computing systems, VSAM files defined with shareoption 4 are treated as files of shareoption 2 type.

Files of other types should be locked explicitly in order to have the file protected against concurrent update by other tasks.

IBM-supplied programs such as the linkage editor or the librarian programs do this locking whenever they are about to update a library. If you want to do your own resource locking, you must use the assembler language macros

- DTL, GENDTL, and/or MODDTL to define the named resource

- LOCK and UNLOCK to perform the actual locking control.

Via the resource definition macros, a resource lock control block is generated. Among other things, it defines

- the name of the resource

- the level of locking: exclusive or shared with other tasks

- the scope of locking: within one system or across systems

- the time of automatic unlocking: at the end of the job step or at end-of-job.

Note that the locking mechanism functions only if each task that shares a particular resource subjects itself to the lock control and uses one and only one name for the resource.

The following macro statement

```
EXAMPLE DTL NAME=SHAREFL,CONTROL=S,LOCKOPT=2,SCOPE=EXT
```

defines a lock control block for the resource SHAREFL. The SCOPE parameter indicates that the resource should be shared across systems. The combination of CONTROL=S and LOCKOPT=2 means: for a lock request to be granted, other tasks with a definition of CONTROL=S may have concurrent access, but not more than one task with a definition of CONTROL=E.

The LOCK macro requests access to a named resource. The requestor may specify which action the system is to take if the lock request cannot be granted. For the above DTL, the statement

```
    LOCK EXAMPLE,FAIL=WAIT
```

requests access to the resource with the name TOPSECRET. If the resource is locked such that no concurrent access is allowed, the requesting task should be set into the wait state until the access can be granted.

The use of the lock control macros is described in detail in *VSE/Advanced Functions Macro User's Guide* and *VSE/Advanced Functions Macro Reference.*

Lock Communication File

Resource protection across systems requires a special system file which reflects the system-wide locking status to all the sharing systems at any time. A resource which is locked across systems will be entered by the operating system into this lock communication file. The DASD device where this lock file resides must be accessible from all the sharing systems.

There must be an agreement between the sharing systems which ensures that all systems use the same lock communication file. All systems which take part in the DASD sharing must define the disk drive, where this file is located, as sharable.

How to Initialize a Shared VSE Environment

Across-system DASD sharing is generated by specifying DASDSHR=YES in the FOPT supervisor generation macro. This provides for a cross-system locking facility to ensure data integrity when a string of DASD devices is accessible from two or more VSE systems via the channel and/or string switching mechanism.

Programs can check for the DASDSHR option via the SUBSID macro. This macro is described in *VSE/Advanced Functions Macro Reference.*

To define a DASD device as sharable across systems, you must include the SHR parameter in the IPL command ADD as follows:

```
    ADD cuu,device-type,SHR
```

Example:

```
ADD 140,3330,SHR
```

All DASD devices of the shared disk pool should be defined (in all sharing systems) as sharable. Especially the disk drive where the lock file resides has to be defined as sharable.

Note 1: All DASD devices of the shared disk pool except the lock file device may be defined as switchable between channels.

Example:

```
ADD 161(S),3330,SHR
```

Note 2: The disk drive where the lock communication file resides must not be defined as switchable.

The lock communication file is created as a special system file with the dedicated file name 'DOS.LOCK.FILE' via the IPL command DLF (Define Lock File).

The DLF command has to be issued immediately after the ADD and DEL commands. When the DLF command is missing in the IPL procedure although a supervisor with DASD sharing support was IPLed and at least one device ADDed as sharable, the operator is prompted for entering the DLF command. If no DASD devices are ADDed as 'shared', the DASD Sharing support in the supervisor is reset and the system works as if the supervisor were generated with DASDSHR=NO.

Two versions of the DLF command are available:

- a long version used to create the lock file and
- a short version to refer to an already existing lock file.

The long version

```
DLF UNIT=cuu,CYL=p,DSF=Y|N  (for a CKD device)
DLF UNIT=cuu,BLK=p,DSF=Y|N  (for an FBA device)
```

is used to create the lock file.

UNIT specifies the disk unit where the lock file is to be located. You should try to place the lock file on a disk drive that is not subject to heavy I/O traffic; for example, keep it separate from files such as SYSRES, the page data set, or POWER files.

CYL/BLK define the starting cylinder/block address.

The parameter DSF defines the lock file as secured or not secured. The DASD sharing support depends heavily on the availability and integrity of the lock communication file. This file should therefore be defined as a secured file.

The lock file occupies one cylinder on a CKD device or 80 blocks on an FBA device.

The short form of the DLF command

```
DLF UNIT=cuu
```

is used by the other CPUs which join the sharing environment to reference the already existing lock file. The short form may be used also by the first IPLing CPU if you want to resume with the lock file as it existed at the end of a preceding production period. On the other hand, submitting the long form for an already existing lock file is not harmful.

Note: During the execution of the DLF command, no other sharing system can access the lock file. Therefore, lock and unlock requests cannot be serviced. A performance degradation may be encountered on the already active systems while another (new) system is in the process of IPLing.

DASD Sharing under VM/370. DASD sharing is also possible under VM/370. Disks which are defined with the multiple write feature can be used by different VM users as shared disks (minidisks or full disk packs).

Resource sharing across systems functions properly only if each sharing (virtual) CPU is discernible by a unique CPU identification. Therefore, for any virtual machine, a different CPU identification must be defined. Before IPLing a virtual machine, the VM user has to define a unique CPU identification via the CP command 'SET CPUID xxxxxx'. Without this command, catastrophic errors regarding the lock file will occur.

Definition of SYSREC in a DASD Sharing Environment

Three system files are referenced by the logical unit name SYSREC:

- the history file (file name IJSYSHF)
- the recorder file (file name IJSYSRC)
- the hard copy file (file name IJSYSCN).

The IPL DEF command 'assigns' SYSREC to a physical device. Because the DEF command allows only one SYSREC=cuu specification, those three files must reside on the same pack. For the placement of these files within a DASD Sharing environment, the following rules should be observed.

To ensure that library maintenance under control of the MSHP program is recorded in only *one* history file, the system standard label area of each sharing system has to contain identical DLBL/EXTENT information for the history file, and each DEF command must address, in the SYSREC= specification, the same physical device on which the common history file resides. This enables you to do library maintenance on the shared SYSRES file and on any of the shared or non-shared private libraries without loosing track of the change status of your libraries.

As to the hard copy file (IJSYSCN), each sharing system has to keep its own extent on the pack where SYSREC is defined. The DLBL statement must contain, for each sharing system, a unique file identifier of IJSYSCN; non-overlapping extents on the SYSREC pack must be defined in the EXTENT statement. Similar rules apply for the recorder file (IJSYSRC).

An Example of a Two-System Installation

The following example shows how two VSE systems are set up to share a string of 3340 disks. One system runs on a 4341 processor, the other one on a System/370 Model 145. Figure 4-7 presents the configuration of disk devices.

	Number of Devices	Device Type
4341 Processor:	8	3370
	6	2314
	4	3340
	4	3340 (shared)
370 Model 145:	2	3350 in native mode
	1	3350 in 3330-1 mode
	1	3350 in 3330-11 mode
	4	3330
	2	3330B
	4	3340 (shared)

Figure 4-7. Example of a DASD Sharing Configuration

The shared 3340 disks are shared via a control unit which has a 2-channel switch installed. The switch allows to address the 3340 disks through two different channels from one CPU or from two different CPUs. In the configuration presented here, the 4341 uses channel number 3, and the 145 uses channel number 2.

The following files are sharable by the two systems:

- the SYSRES file
- the history file
- the recorder file
- VSE/POWER files
- private libraries
- VSAM catalog and VSAM files
- other data files

Two supervisors are generated with DASDSHR=YES specified in the FOPT generation macro. Each supervisor is cataloged with a unique name; one for execution in ECPS:VSE mode, the other for 370 mode.

Similarly, since VSE/POWER is being used, two POWER phases are generated, each with a unique name; the POWER macro must specify the SYSID and SHARED parameters. (You can operate with only one POWER phase if SYSID is changed dynamically at autostart time.) Formatting of POWER files should be requested only by the first IPLing system. If during POWER bring-up no FORMAT statement is included in the AUTOSTART file, the operator will be prompted as to whether POWER files are to be formatted or not. If the operator replies "D,A" or the AUTOSTART file contains a FORMAT=D,A statement, the POWER program asks the operator whether another system is already IPLed and whether the shared files can be formatted.

Figure 4-8 shows two sets of IPL commands that are cataloged as ASI (Automatic System Initialization) procedures.

```
•   ASI procedure for Model 145:

    01F,$$A$SUPS,P,NOLOG,VSIZE=8800K
    ADD 148:149,3350
    ADD 14A,3330
    ADD 16A,3330
    ADD 140:143,3330
    ADD 144:145,3333B
1   ADD 2D0:2D3,3340,SHR        VIA CHANNEL 2
       .
       .
       .
    unit record devices, terminals, etc.
       .
       .
       .

2   DLF UNIT=2D1
3   DEF SYSREC=2D0,SYSCAT=2D1,SYSDMP=148
4   DLA NAME=SYST145,UNIT=148
    DPD UNIT=149,CYL=450,DSF=N
    SVA SDL=100,PSLD=20,PSIZE=100K,GETVIS=100K
```

```
•   ASI procedure for the 4341:

    01F,$$A$SUPE,P,NOLOG
    ADD 340:343,FBA
    ADD 350:353,FBA
    ADD 690:695,2314
    ADD 300:303,3340
1   ADD 300:303,3340,SHR       VIA CHANNEL 3
       .
       .
       .
     unit record devices, terminals, etc.
       .
       .


2   DLF UNIT=301
3   DEF SYSREC=300,SYSCAT=301,SYSDMP=340
4   DLA NAME=SYST4300,UNIT=340
    DPD UNIT=341,BLK=80000,DSF=N
    SVA SDL=100,PSLD=20,PSIZE=100K,GETVIS=100K
```

Figure 4-8. Example of ASI IPL Procedures for Two DASD Sharing Systems

Notice that both ADD commands for the shared disks (statement 1 in Figure 4-8) refer to the same packs although they specify different device addresses. Each CPU accesses the shared disks via different channels: 2 and 3.

The short form of the DLF command is shown here (statement 2); if ever the first IPLing system refers to a nonexisting lock file, it prompts the operator to submit the long form of the DLF command. On the 4341 processor, for example, the long form would include the specifications CYL=694 and DSF=Y. Similar considerations apply to the DLA commands.

The SYSRES specifications (statement 3), just as the ADD commands, refer to the same pack by different device addresses. Each system uses its own label information area, defined on separate packs and with unique names (statement 4).

Complete ASI JCL procedures are not shown here. These procedures would contain DLBL/EXTENT statements for the following shared resources,

- to be cataloged in the system standard label area (OPTION STDLABEL):

IJSYSRS	SYSRES file
IJSYSHF	history file

- to be cataloged in the system standard label area (OPTION STDLABEL) or in the partition standard label area (OPTION PARSTD):

IJAFILE	POWER account file
IJQFILE	POWER queue file
IJDFILE	POWER data file
IJSYSCT	VSAM catalog
VSMSPCE	VSAM data space
xxxxxxx	shared private libraries

In addition, of course, labels for the following non-shared resources must be uniquely defined for each system:

IJSYSCN	hard copy file
IJSYSRC	recorder file
DOSDMPF	dump file
DOSDMPG	dump file
xxxxxxx	dedicated files and libraries
IJSYSIN	POWER AUTOSTART file (non-shared only if the two POWER systems use different input parameters)

Error Recovery after System Break-down

When one of the sharing systems breaks down, for example, due to hardware malfunction, the other systems are set into the wait state.

Two error situations are possible:

The hardware malfunction occurred while the system was executing a LOCK or UNLOCK request. The system has reserved the disk drive containing the lock file by a 'DEVICE RESERVE' channel program. Thus the other systems are unable to execute LOCK or UNLOCK requests. The operator should press 'system reset' on the failing CPU; the device reserves will be reset.

The second error situation is as follows: prior to the system break-down, the failing VSE system has locked some vital resources (for example, a VSAM catalog). The sharing VSE systems trying to lock these resources will enter the wait state.

Use the Attention command 'UNLOCK SYSTEM=xxxxxx' to unlock all resources locked by the failing CPU. You should be extremely careful with the use of the Attention command UNLOCK. Enter this command only when you are absolutely sure that the failing system has stopped and a new IPL is required. The attention command UNLOCK when used to break the lock of a running system will cause severe errors.

Designing Programs for Virtual Mode Execution

This section describes programming techniques that may improve the efficiency of programs that execute in virtual mode. Consider these techniques for new programs to be written and old programs to be revised. The section also contains information on the use of certain macros that are provided especially for virtual storage. Programming conventions for the shared virtual area are also discussed.

Programming Hints for Reducing Page Faults

It is definitely worthwhile to spend some extra programming effort for tuning virtual-mode programs that are used frequently or that require long periods of processing time so that they will cause fewer page faults during execution. Page faults generally occur when the size of the virtual-mode program exceeds the number of page frames available to it during execution. Efforts to reduce the number of page faults occurring in a program generally involve techniques for reducing the size of the *working set* of the program. The term *working set* is one that recurs often in discussions of virtual storage systems.

The working set of a program is comprised of those program pages that contain the most frequently used sequences of instructions for a given period of time. The working set of a program is not a fixed number of pages or instructions of that program; this set changes as the execution of the program proceeds. For example, a program doing an internal sort and writing a formatted table based on the results of this sort would have two completely different basic working sets; one for the sort function and one for the write functions.

What does *execute efficiently* mean? Essentially, this means that a program will not execute appreciably slower than if the entire program were in processor storage during its entire execution.

Although the following section does not tell you how to determine the size of the working set, it does provide techniques for reducing its size.

General Hints for Reducing the Working Set

There are three general rules to keep in mind when working toward a reduction of a program's working set. The first is *locality of reference,* that is, instructions and data used together should be in storage near each other. Second is *minimum processor storage.* In other words, the amount of processor storage necessary for a program to do something should be kept as low as possible. Third is *validity of reference,* that is, references should be made only to data which will actually be used.

The chief means of achieving locality of reference is to make execution sequential whenever possible by avoiding excessive branching.

A program that executes sequentially normally requires a partition larger than the same program when it does not execute sequentially. For example, the functions of a section of code repeat themselves several times throughout the logic of your program. You are tempted to write this code once and branch to it whenever necessary, but branching violates the principle of locality of reference. Branching may cause more page faults than would coding the routine in line each time it is used. Also, it is easier for someone else to follow the logic of a program which is written to execute sequentially.

Locality of reference can be achieved only to a limited extent by programs written in a high-level language.

Elements in arrays in FORTRAN or PL/I can be referred to in the order in which they appear in storage. In FORTRAN, for example, arrays are ordered by columns. The elements of the array DIMENSION (2,2,2) are arranged as follows in contiguous virtual storage locations:

```
(1,1,1) (2,1,1)
(1,2,1) (2,2,1)
(1,1,2) (2,1,2)
(1,2,2) (2,2,2)
```

For array structures of other compilers, refer to the appropriate programming language reference manuals.

A routine which processes all the elements of such an array should refer to them in this order. If only certain elements of an array are processed, the elements should be arranged in the order in which they are to be processed. If arranging an array in a certain manner causes it to be processed advantageously one time, but disadvantageously another time, you should consider writing two arrays, even at the cost of additional virtual storage.

In an assembler language program, you should keep frequently used data and constants near each other in storage, and near the instructions which use them. This contrasts with the traditional practice of having one area at the end of the program reserved for all the data areas and constants. By the same token, seldom used data should be separated from the frequently used data and placed with the routines which use it.

Avoid, if possible, using chains which must be searched each time a data item is required. If chains are unavoidable they should be kept in a compact area of storage. This may result in some wasted (virtual) storage but will be better than searches of large areas of storage.

Another good practice to help reduce paging is to initialize variables just before they are to be used. For example in PL/I instead of the following:

```
DCL A FIXED INIT (10);
.
.
DO B=1 TO 100;
A=A+B;
END;
```

use:

```
DCL A FIXED;
.
.
A=10;
DO B=1 TO 100;
A=A+B;
END;
```

In the first method of coding, PL/I initializes the automatic variable at the beginning of execution. The second method of coding does not require the page containing A to be in processor storage until just before A is used.

An important help in reducing the amount of processor storage needed for execution is to keep coding used for errors or other unusual occurrences in a separate routine. If, for example, the main routine contains code for conditions that occur only 5% of the time, by moving this error code to a separate section of your program, you can reduce the amount of needed processor storage for 95% of the processing.

Frequently-used subroutines should be loaded near each other. Because of their frequent use, these routines tend to be in processor storage almost continuously. If they are scattered over several pages, each of these pages will need to be in processor storage most of the time, thus increasing the size of the working set. By loading these routines near each other, you reduce the number of pages required in processor storage at any one time.

Subroutines should be designed to do as much processing as possible whenever they are called. It is better to duplicate some code from the calling routine in the called routine in order to avoid switching back and forth between routines. One technique for accomplishing this is to have the calling program pass several parameters to the subroutine and make one call, rather than passing one parameter at a time and make several calls.

You should try to keep code that can be modified and code that cannot be modified in separate sections of a large program. This will reduce page traffic by reducing the number of pages that are changed. Also, try to prevent I/O buffers from crossing page boundaries unnecessarily. Check the assembler listing and the linkage editor map to determine where 2K boundaries occur in your programs.

Using Virtual Storage Macros

The macros designed for use by virtual-mode programs, which are discussed below, perform the following services:

- fix pages in processor storage (PFIX macro) and later free the same pages for normal paging (PFREE macro).
- indicate the mode of execution of a program (RUNMODE macro).
- influence the paging mechanism in order to reduce the number of page faults, to minimize the page I/O activity, and to control the page traffic within a specific partition.

In order to use these macros you must be programming in assembler language or, if your program is written in a high-level language, you must write an assembler subroutine to make use of them. Refer to *VSE/Advanced Functions Macro Reference* for a detailed description of these macros.

Fixing Pages in Processor Storage

In VSE/Advanced Functions, parts of virtual-mode programs must be in processor storage only at certain times. These parts include not only the instructions and data being processed at any one moment, but also data areas for use by channel programs. Instructions and data are always in processor storage when being used. Because of the nature of I/O operations, the data areas for these operations could be paged out during the I/O operation if something were not done to keep them in processor storage during the entire operation. The operating system therefore fixes I/O areas in processor storage for the duration of the I/O operation.

There are other parts of a program, however, which cannot tolerate paging, and these parts are not necessarily kept in storage by the operating system. For instance, programs that control time-dependent I/O operations cannot tolerate paging. A familiar example is a MICR (Magnetic Ink Character Reader) stacker select routine. If a page fault were to occur during the execution of one of these programs, the results would be unpredictable. A page fault in one of these programs can be avoided by fixing the affected pages in processor storage, using the PFIX macro.

The pages that you fix by the PFIX macro are fixed in the processor storage allocated to the partition in which the PFIX request is issued. Only as many pages may be fixed by a program at any one time as there are page frames allocated to the partition. This is done to prevent a loop in one program from fixing all the pages in the system, and to enable other programs to issue a PFIX macro concurrently.

The PFIX macro fixes the pages in processor storage, regardless of whether these pages are stored in contiguous page frames or not. The supervisor keeps a count of the number of times a page has been fixed without being freed. A page that is fixed more than once without having been freed (via the PFREE macro) is not brought in a second time and given another page frame. Instead, the counter for that page is just increased by one and the page remains in the same page frame.

The PFREE macro does not directly free a page for paging out, but each time it is issued, the counter of fixes is reduced by one. As soon as the counter for a page reaches zero, the page can be paged out. At the end of a job step, all pages that have been fixed during the job step are freed.

The PFREE macro should be used as soon as possible to make a maximum possible number of page frames available to all programs running in virtual mode.

Figure 4-9 is a skeleton example using the PFIX and PFREE macros. After the execution of a PFIX macro, a return code is given in register 15. The meanings of the return codes are:

0 - The pages were fixed successfully.
4 - You requested more page frames than the number of PFIXable page frames available to the partition.
8 - Insufficient number of free page frames were available at the time.
12 - You specified invalid addresses in your macros.

Note in the example how the return code can be used to establish a branch to parts of the program that handle these specific conditions.

```
          .
          .
FIXER     PFIX   ARTN,ARTNEND+2 FIX ARTN IN STORAGE
          B       *+4(15) BRANCH ACCORDING TO RETURN CODE
          B       HERE     CONTINUE IF OK
          B       NOPAGES GO TO CANCEL IF PART TOO SMALL
          B       WAIT     GO TO WAIT UNTIL PAGES FREED
          B       CANCL    GO TO CANCEL IF ADDR INVALID
HERE      BAL     14,ARTN GO TO ARTN
          PFREE  ARTN,ARTNEND+2 FREE ROUTINE AFTER EXECUTION
          ...
ARTN       (time dependent processing which cannot be
          paged out during execution)

ARTNEND   BR      R14      RETURN
...
NOPAGES   LA      R1,OPCCB
          EXCP   (1)      WRITE MESSAGE TO OPERATOR
          WAIT   (1)      WAIT FOR COMPLETION
CANCL     CANCEL ALL
...
WAIT       (routine to free other pages)

END       EOJ
OPCCB     CCB     SYSLOG,OPCCW
OPCCW     CCW     X'09',MSG,X'20',61
MSG       DC      CL32'AM CANCELING PLEASE ENLARGE REAL'
          DC      CL29'ADDR AREA AND RESTART THE JOB'
          .
          .
```

Figure 4-9. PFIX and PFREE Example

Indicating the Execution Mode of a Program

You may have a program that must do different processing depending upon its execution mode. It may be impractical to have two separate programs cataloged in the core image library (one program for real mode and another program for virtual mode). The RUNMODE macro can be issued during the execution of the program to inquire which mode of execution is being used. A return code is issued to the program in register 1.

Influencing the Paging Mechanism

Releasing Pages. With the RELPAG macro, you inform the page management routines that the contents of one or more pages is no longer required and need not be saved on the page data set. Thus, page frames occupied by these released pages can be claimed for use by other pages, and page I/O activity is reduced.

Forcing Page-out.

The FCEPGOUT macro is used to inform the page management routines that one or more pages will not be needed until a later stage of processing. The pages are given the highest page-out priority, with the result that other pages, which may be needed immediately, are kept in storage. Except when the RELPAG macro is in operation, the contents of any pages written out are saved.

Page-in in Advance. The PAGEIN macro allows you to request that one or more pages be read into processor storage in advance, in order to avoid page faults when the specified pages are needed in processor storage. If the specified pages are already in processor storage when the macro is issued, they are given the lowest priority for page-out.

Balancing Telecommunication Activity

The use of telecommunication and production processing at the same time may, occasionally, result in long or erratic telecommunication response times. This may be especially true if you have overcommitted processor storage, thus causing excessive paging. The telecommunication application may have to compete so strongly for page frames (because of high processing activity in the other partitions) that response time increases substantially.

Telecommunication balancing improves response time by trading off telecommunication response time against production partition throughput. TP balancing tends to reduce response times, or at least to stabilize them.

After IPL, TP balancing can be activated by the operator issuing the TPBAL command, which specifies the number of partitions that can tolerate delayed processing. These will be the lowest priority partitions. The TPBAL command is also used to change or display the current setting (for more information, see the *VSE/Advanced Functions Operating*

Procedures). Once activated, the TP balancing function can be invoked by using TPIN/TPOUT macros.

The TPIN macro signals to the operating system that an immediate demand for system resources is being made by the telecommunication application, for instance, when a message has arrived. After processing is completed, TPOUT informs the operating system that the telecommunication application has no further processing to do for the time being, and that the system resources that were exclusively used for telecommunication should be released. Failure to issue the TPOUT macro can cause serious performance degradation in production partition throughput.

The TPIN and TPOUT macros have been made available primarily for use in IBM licensed telecommunication support (for example, ACF/VTAM and CICS/VS). There is no need for these macros to be used in user-written application programs that run under control of IBM supplied telecommunication support.

Coding for the Shared Virtual Area

Besides accommodating the system directory list (SDL) and phases that are needed by the operating system (for example, end-of-job step routines), the shared virtual area (SVA) may contain user-written phases that can be used concurrently by more than one program. The SVA phases must be reenterable and relocatable; code that modifies itself will cause a protection check when executed from the SVA. This section presents some advice on coding phases to use SVA facilities and suggests some standards for base-register usage.

The basic assumptions for coding an SVA phase are:

- The reenterable code must not modify any storage within its own storage area. Therefore, the code must not contain DTFs, CCBs, or other control blocks that are modified during execution.
- The phase can modify registers only if it saves and restores them for each user.
- A user-specified work area (within the calling partition) must be provided for storing registers and for any storage modifications.

Suggested register conventions:

- Use register 12 as the base register in both the main routine and the reenterable code.
- Use register 13 as base for the working storage area. It is the responsibility of the main routine to provide addressability to the work area by loading register 13; the reenterable routine must not modify register 13. The easiest way to address the working storage area in the reenterable code is by a DSECT that defines the fields of the work area and a USING dsectname,13. In this way symbolic addressing can be used.

- Use CALL, SAVE, and RETURN macros. Since register 13 is the base register, SAVE (14,12) and RETURN (14,12) result. Use register notation for CALL, for example, CALL (15) .... Before issuing the CALL, load register 15 with the transfer address. Register 14 will always contain the return address. The standard is thus established of register 15 for calling and register 14 for returning.

- Switches, and other areas that may be modified, can be placed in the working storage area using base register 13.

Figure 4-10 illustrates the suggested conventions: MASTER is the main routine, SLAVE is the SVA phase.

```
MASTER   CSECT
         BALR     12,0
         USING    *,12
         LA       13,SAVE
         LOAD     SLAVE,WORKAREA        CANCELS IF SLAVE NOT IN CIL
*                                       LOADS SLAVE INTO WORKAREA
*                                       IF SLAVE IS NOT IN SVA
         LR       15,1
         CALL     (15),(SWITCH,TECB,FIELDA,FIELDB,WORKAREA)
         .
         .
         EOJ
SAVE     DS       9D
WORKAREA DS       200D                  SLAVE IS LOADED HERE
*                                       IF NOT IN SVA
SWITCH   DC       XL1'00'
TECB     DS       CL4
FIELDA   DS       CL15
FIELDB   DS       CL11
         END

SLAVE    CSECT                          MUST BE SEPARATE ASSEMBLY
         SAVE     (14,12)
         BALR     12,0
         USING    *,12
         USING    WORKAREA,6
         LM       2,6,0(1)
         MVC      0(15,4),DATA1
         MVC      0(11,5),DATA2
         CLI      0(2),X'FF'
         BE       EXIT
         SETIME   3,(3)                 SETIME ALTERS THE TECB
         WAIT     (3)
         .
         .
EXIT     XI       0(2),X'FF'
         RETURN   (14,12)
DATA1    DC       CL15'THIS IS FIELDA'
DATA2    DC       CL11'THIS IS FIELDB'
         LTORG
WORKAREA DSECT
FIELDC   DS       3D
FIELDD   DS       3D
         END
```

Figure 4-10. Example of Conventions for SVA Coding

Appendix A: System Layout on Disk

Figures A-1 and A-2 illustrate how the system residence (SYSRES) file is organized. The volume containing the system residence file can be any IBM DASD device supported by VSE/Advanced Functions except a 2311 disk.

IPL Records

This area contains the initial program load (IPL) bootstrap records, which cause the IPL retrieval program to be read from SYSRES and loaded into processor storage. For CKD devices the IPL retrieval program is at cylinder 0, track 1, record 5. For FBA devices it is contained within blocks 3 through 9.

System Volume Label

The volume label (VOL1 label) contains the address of the volume table of contents (VTOC) established when the pack was initialized. To initialize a pack on an FBA device, use the system utility program Initialize Disk; for a CKD device, use the initialize function of DSF (Device Support Facilities). These programs are described in *VSE/Advanced Functions System Utilities* and *Device Support Facilities,* respectively. The VTOC must be located outside of the SYSRES extent.

User Volume Label

The user volume label area is provided for any additional standard volume labels (VOL2-VOL8 labels). This area can extend from record 4 through the end of track 0 on CKD devices or from the end of the system volume label to the end of block 1 on FBA devices.

System Directory

The SYSRES file starts with the system directory. This directory contains the starting addresses of the 4 library directories and the address of the label information area.

Library Directories and Libraries

The purpose of these areas of the SYSRES file is discussed in Chapter 3 of this manual.

Label Information Area

The SYSRES file ends with the label information area. The purpose of this area is described in Chapter 2 of this manual.

Component		Starting Disk Address			Number of Tracks (Alloc.)	R = Required O = Optional
		CC	HH	R		
IPL Record	(Phase $$A$IPL1)	00	00	1	1	R
IPL Record		00	00	2		R
System Volume Label		00	00	3		R
User Volume Label		00	00	4		O
System Directory	Record 1	00	01	1	1	R
	Record 2	00	01	2		R
	Record 3	00	01	3		R
	Record 4	00	01	4		R
IPL Records (Phase $$A$PLBK)		00	01	5		R
Core Image Directory	Cataloged Phases	00	02		*	R
	Linked Phase					
Core Image Library Members		X	Y+1	1	*	R
Relocatable Directory		Z+1	00	1	*	O
Relocatable Library Members		X	Y+1	1	*	O
Source Statement Directory		Z+1	00	1	*	O
Source Statement Library Members		X	Y+1	1	*	O
Procedure Directory		Z+1	00	1	*	O
Procedure Library Members		X	Y+1	1	*	O
Label Information Area		Z+1	00	1	Device dependent	R

* Allocation Dependent on User Requirements

X = Ending CC of the Preceding Directory

Y = Ending HH of the Preceding Directory

Z = Ending CC of the Preceding Library

Note: *Track 0 of cylinder 0 is not part of the SYSRES file.*

Figure A-1. System Residence Organization on CKD Devices

Component	Starting Disk Address Block Number	Number of Blocks	R=Required
			O=Optional

IPL Records (Phase $$A$IPLO)	0	1	R
System Volume Label[1]	1	1	R
System Directory	2	1	R
IPL Retrieval Program (Phase $$A$PLBF)	3	7	R
Core Image Directory	10	*	R
Core Image Library Members	X+1	*	R
Relocatable Directory	Y+1	*	O
Relocatable Library Members	X+1	*	O
Source Statement Directory	Y+1	*	O
Source Statement Library Members	X+1	*	O
Procedure Directory	Y+1	*	O
Procedure Library Members	X+1	*	O
Label Information Area	Y+1	200 [2]	R

* =	Allocation dependent on user requirements
X =	Last block of preceding directory
Y =	Last block of preceding library

[1] Optional user volume labels if written will be in the same block following the system volume label.

[2] Using the Restore program you may allocate a label information area different than the default size of 200 blocks.

Note: *Blocks 0 and 1 are not part of the SYSRES file.*

Figure A-2. System Residence Organization on FBA devices

Glossary

This glossary defines the terms proper to this manual. If you do not find the term you are looking for, refer to the *IBM Data Processing Glossary,* GC20-1699.

This glossary includes definitions 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 Association, copies of which may be purchased from the American National Standards Institute, 1430 Broadway, New York, New York 10018. American National Standard Definitions are marked with an asterisk (*).

access method: A technique for moving data between virtual storage and input/output devices.

access method services: A multifunction service program that defines VSAM files and allocates space for them, converts indexed-sequential files to key-sequenced files with indexes, modifies file attributes in the catalog, reorganizes files, facilitates data portability between operating systems, creates backup copies of files and indexes, helps make inaccessible files accessible, and lists the records of the files and catalogs.

address: (1) An identification, as represented by a name, label, or number, for a register, location in storage, or any other data source or destination such as the location of a station in a communication network. (2) Loosely, any part of an instruction that specifies the location of an operand for the instruction.

address translation: The process of changing the address of an item of data or an instruction from its virtual address to its real storage address. See also dynamic address translation.

alternate track: One of a number of tracks set aside on a disk pack for use as alternatives to any defective tracks found elsewhere on the disk pack.

application program: A program written by a user that applies to his own work.

assembler language: A source language that includes symbolic machine language statements in which there is a one-to-one correspondence with the instruction formats and data formats of the computer.

asynchronous operator communication: A facility which allows the operator to defer the reply to a message that requires an operator's response.

attach: (1) To create a task and present it to the supervisor. (2) A macro instruction that causes the control program to create a new task and indicates the entry point in the program to be given control when the new task becomes active.

auxiliary storage: Data storage other than real storage; for example, storage on magnetic tape or disk. Synonymous with external storage, secondary storage.

blocking: Combining two or more logical records into one block.

blocking factor: The number of logical records combined into one physical record or block.

book: A group of source statements written in any of the languages supported by VSE and stored in a source statement library.

buffer: An area of storage that is temporarily reserved for use in performing an input/output operation, into which data is read or from which data is written. Synonymous with I/O area.

byte: A sequence of eight adjacent binary digits that are operated upon as a unit and that constitute the smallest addressable unit of the system.

card punch: A device to record information in cards by punching holes in the cards to represent letters, digits, and special characters.

card reader: A device which senses and translates into machine code the holes in punched cards.

cardless system: A System/370 Model 115/125 configured without a card reader or card punch, but with an IBM 3540 Diskette Input/Output Unit.

catalog: To enter a phase, module, book, or procedure into one of the system or private libraries.

* **central processing unit:** A unit of a computer that includes the circuits controlling the interpretation and execution of instructions. Abbreviated CPU.

channel: (1) * A path along which signals can be sent, for example, data channel, output channel. (2) A hardware device that connects the CPU and real storage with the I/O control units.

channel program translation: In a copy of a channel program, replacement, by software, of virtual addresses with real addresses.

compile: To prepare a machine language program from a computer program written in a high-level language by making use of the overall logic structure of the program, or generating more than one machine instruction for each symbolic statement, or both, as well as performing the function of an assembler.

compiler: A program that translates high-level language statements into machine language instructions.

configuration: The group of machines, devices, etc., which make up a data processing system.

control area: A group of control intervals used as a unit for formatting a file before adding records to it. Also, in a key-sequenced file, the set of control intervals covered by an index record; used by VSAM for distributing free space and for placing a low-level index adjacent to its data.

control interval: (1) A fixed-length area of auxiliary storage space in which VSAM stores records and distributes free space, also, in a key-sequenced file, the set of records pointed to by an entry in the index record. It is the unit of information transmitted to or from auxiliary storage by VSAM, independent of blocksize. (2) For an FBA device, the unit of data transfer between processor storage and the device. It has the same format as a VSAM control interval. In recording data, IOCS maps each control interval over an integral number of FBA blocks.

control program: A program that is designed to schedule and supervise the performance of data processing work by a computing system.

control registers: A set of registers used for operating system control of relocation, priority interruption, program event recording, error recovery, and masking operations.

control section: That part of a program specified by the programmer to be a relocatable unit.

control unit: A device that controls the reading, writing, or display of data at one or more input/output devices.

core image library: A library of phases that have been produced as output from link editing. The phases in the core image library are in a format that is executable either directly or after processing by the relocating loader in the supervisor.

count-key-data (CKD) device: A disk storage device storing data in the format: count field normally followed by a key field followed by the actual data of a record. The count field contains, among others, the address of the record in the format CCHHR (CC = cylinder number, HH = head or track number, R = record number) and the length of the data; the key area contains the record's key (search argument). See also *fixed block architecture (FBA) device.*

CPU busy time: The amount of time devoted by the central processing unit to the execution of instructions.

data file: A collection of related data records organized in a specific manner. For example, a payroll file (one record for each employee, showing his rate of pay, deductions, etc., or an inventory item, showing the cost, selling price, number in stock, etc.). See also file.

data integrity: See integrity.

data management: A major function of VSE/Advanced Functions that involves organizing, storing, locating, retrieving, and maintaining data.

deblocking: The action of making the first and each subsequent logical record of a block available for processing one record at a time.

default value: The choice among exclusive alternatives made by the system when no explicit choice is specified by the user.

deletion of an I/O Device: Removal of the I/O unit from the supervisor configuration tables.

diagnostic routine: A program that facilitates computer maintenance by detection and isolation of malfunctions or mistakes.

dial-up terminal: A terminal on a switched teleprocessing line.

direct access: (1) Retrieval or storage of data by a reference to its location on a volume, other than relative to the previously retrieved or stored data. (2) * Pertaining to the process of obtaining data from, or placing data into, storage where the time required for such access is independent of the location of the data most recently obtained or placed in storage. (3) * Pertaining to a storage device in which the access time is effectively independent of the location of the data. Synonymous with random access.

direct organization: Direct file organization implies that for purposes of storage and retrieval there is a direct relationship between the contents of the records and their addresses on disk storage.

directory: An index that is used by the system control and service programs to locate one or more sequential blocks of program information that are stored on direct access storage.

diskette: A flexible magnetic-oxide coated disk suitable for data storage and retrieval. Data may be stored and retrieved via such devices as the IBM 3740 Data Entry Unit and the IBM 3540 Diskette Input/Output Unit. Diskettes are also used to contain microprograms for some central processing units.

disk pack: A direct access storage volume containing magnetic disks on which data is stored. Disk packs are mounted on a disk storage drive, such as the IBM 3330 Disk Storage Drive.

distributed free space: Space reserved within the control intervals of a key-sequenced file for inserting new records into the file in key sequence; also, whole control intervals reserved in a control area for the same purpose.

dump: (1) To copy the contents of all or part of virtual storage. (2) The data resulting from the process as in (1).

dynamic address translation (DAT): (1) The change of a virtual storage address to an address in real storage during execution of an instruction. (2) A hardware function that performs the translation.

dynamic partition balancing: A facility of VSE/Advanced Functions wich allows the user to specify two or more or all partitions of the system to have their processing priority changed dynamically such that each of these partitions receives approximately the same amount of CPU processing time.

entry sequence: The order in which data records are physically arranged in auxiliary storage, without respect to their contents (contrast with key sequence).

entry-sequenced file: A VSAM file whose records are loaded without respect to their contents, and whose relative byte addresses cannot change. Records are retrieved and stored by addressed access, and new records are added to the end of the file.

error message: The communication that an error has been detected.

error recovery procedures: Procedures designed to help isolate, and, when possible, to recover from errors in equipment. The procedures are often used in conjunction with programs that record the statistics of machine malfunctions.

extent: A continuous space on a direct access storage device, occupied by or reserved for a particular file.

* **file:** A collection of related records treated as a unit. For example, one line of an invoice may form an item, a complete invoice may form a record, the complete set of such records may form a file, the collection of inventory control files may form a library, and the libraries used by an organization are known as its data bank.

FBA: See *fixed block architecture (FBA) device.*

FBA block: A unit of data of fixed length on which the FBA architecture is based.

fixed block architecture (FBA) device: A disk storage device storing data in blocks of fixed size; these blocks are addressed by block number relative to the beginning of the file.

fixed page: A page in processor storage that is not to be paged out.

hard copy: A printed copy of machine output in a visually readable form, for example, printed reports, listings, documents, and summaries.

hard wait state: In general, a wait state is the condition of a CPU when all operations are suspended. System recovery from a hard wait state requires that the user performs a new IPL (initial program load) procedure.

* **hardware:** Physical equipment, as opposed to the computer program or method of use, for example, mechanical, magnetic, electrical, or electronic devices. Contrast with software.

* **idle time:** That part of available time during which the hardware is not being used.

index: (1) * An ordered reference list of the contents of a file or document, together with keys or reference notations for identification or location of those contents. (2) A table used to locate the records of an indexed sequential file.

indexed-sequential organization: The records of an indexed sequential file are arranged in logical sequence by key. Indexes to these keys permit direct access to individual records. All or part of the file can be processed sequentially.

Initial Program Load (IPL): The intialization procedure that causes the VSE system to commence operation.

integrity: Preservation of data or programs for their intended purpose.

* **interface:** A shared boundary. An interface might be a hardware component to link two devices or it might be a portion of storage or registers accessed by two or more computer programs.

* **I/O:** An abbreviation for input/output.

ISAM interface program: A set of routines that allow a processing program coded to use ISAM to gain access to a VSAM key-sequenced file with an index.

job: (1) * A specified group of tasks prescribed as a unit of work for a computer. By extension, a job usually includes all necessary computer programs, linkages, files, and instructions to the operating system. (2) A collection of related problem programs, identified in the input stream by a JOB statement followed by one or more EXEC statements.

job accounting interface: A function that accumulates, for each job step, accounting information that can be used for charging usage of the system, planning new applications, and supervising system operation more efficiently.

job control: A program that is called into a partition to prepare each job or job step to be run. Some of its functions are to assign I/O devices to certain symbolic names, set switches for program use, log (or print) job control statements, and fetch the first program phase of each job step.

job (JOB) statement: The job control statement that identifies the beginning of a job. It contains the name of the job.

job step: The execution of a single processing program.

K: 1024.

* **key:** One or more characters associated within an item of data that are used to identify it or control its use.

key sequence: The collating sequence of data records, determined by the value of the key field in each of the data records. May be the same as, or different from, the entry sequence of the records.

key-sequenced file: A file whose records are loaded in key sequence and controlled by an index. Records are retrieved and stored by keyed access or by addressed access, and new records are inserted in the file in key sequence by means of distributed free space. Relative byte addresses of records can change.

label: identification record for a tape, diskette, or disk file.

label information area: Under VSE, the last portion of the system residence file that stores label information read from job control statements or commands.

language translator: A general term for any assembler, compiler, or other routine that accepts statements in one language and procedures equivalent statements in another language.

leased facility: A circuit of the public telephone network made available for the exclusive use of one subscriber.

librarian: The set of programs that maintains, services, and organizes the system and private libraries.

library: A collection of files or programs, each element of which has a unique name, that are related by some common characteristics. For example, all phases in the core image library have been processed by the linkage editor.

linkage editor: A processing program that prepares the output of language translators for execution. It combines separately produced object modules; resolves symbolic cross references among them, and generates overlay structure on request; and produces executable code (a phase) that is ready to be fetched or loaded into virtual storage.

load: (1) * In programming, to enter instructions or data into storage or working registers. (2) In VSE, to bring a program phase from a core image library into virtual storage for execution.

main page pool: The set of all page frames in processor storage not assigned to the supervisor or one of the partitions.

message: See error message, operator message.

microprogramming: A method of working of the CPU in which each complete instruction starts the execution of a sequence of instructions, called microinstructions, which are generally at a more elementary level.

multiprogramming system: A system that controls more than one program simultaneously by interleaving their execution.

multitasking: The concurrent execution of one main task and one or more subtasks in the same partition.

object code: Output from a compiler or assembler which is suitable for processing by the linkage editor to produce executable machine code.

* **object module:** A module that is the output of an assembler or compiler and is input to a linkage editor.

object program: A fully compiled or assembled program. Contrast with source program.

* **online:** (1) Pertaining to equipment or devices under control of the central processing unit. (2) Pertaining to a user's ability to interact with a computer.

operand: (1) * That which is operated upon. An operand is usually identified by an address part of an instruction. (2) Information entered with a command name to define the data on which a command processor operates and to control the execution of the command processor.

operator command: A statement to the control program, issued via a console device, which causes the control program to provide requested information, alter normal operations, initiate new operations, or terminate existing operations.

operator message: A message from the operating system or a problem program directing the operator to perform a specific function, such as mounting a tape reel, or informing him of specific conditions within the system, such as an error condition.

* **overflow:** (1) That portion of the result of an operation that exceeds the capacity of the intended unit of storage. (2) Pertaining to the generation of overflow as in (1).

overlay: n. (1) One of the segments, which consists of one or more phases, of a program that is so structured that not all of the segments need be in virtual storage at any one time. v. (2) The process of replacing a previously retrieved program segment in virtual storage by another segment.

page: (1) In VSE, a 2K block of instructions, data or both. (2) To transfer instructions, data, or both between processor storage and the page data set.

page data set: An extent in auxiliary storage, in which pages are stored.

page fault: A program check interruption that occurs when a page that is marked *not in processor storage* is referred to by an active page. Synonymous with page translation exception.

page fixing: Marking a page as nonpageable so that it remains in processor storage.

page frame: A 2K block of processor storage that can contain a page.

page in: The process of transferring a page from the page data set to processor storage.

page out: The process of transferring a page from processor storage to the page data set.

page pool: The set of all page frames that may contain pages of programs in virtual mode.

paging: The process of transferring pages between processor storage and the page data set.

* **parameter:** A variable that is given a constant value for a specific purpose or process.

partition: In VSE, a contiguous area of virtual storage available for the execution of programs.

partition balancing: See dynamic partition balancing.

peripheral equipment: A term used to refer to card devices, magnetic tape and disk devices, diskettes, printers, and other equipment bearing a similar relation to the CPU.

phase: The smallest complete unit that can be referred to in the core image library.

POWER: A unit record spooling support available as the IBM licensed program VSE/POWER.

printer: A device that expresses coded characters as hard copy.

priority: A rank assigned to a partition that determines its precedence in receiving CPU time.

private library: A user-owned library that is separate and distinct from the system library.

private second level directory: The private second level directory is a table located in the supervisor containing the highest phase names found on the corresponding directory tracks of the private core image library.

problem determination aid: A program that traces a specified event when it occurs during the operation of a program. Abbreviated PDAID.

problem program: Any program that is executed when the central 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, as well as programs written by a user.

processing program: (1) A general term for any program that is not a control program. (2) Synonymous with problem program.

processor storage: The general purpose storage of a computer. Processor storage can be accessed directly by the operating registers. Synonymous with real storage.

queue: (1) A waiting line or list formed by items in a system waiting for service; for example, tasks to be performed or messages to be transmitted in message switching system. (2) To arrange in, or form, a queue.

random processing: The treatment of data without respect to its location in auxiliary storage, and in an arbitrary sequence governed by the input against which it is to be processed.

real address: The address of a location in real storage.

real address area: In VSE, the area of virtual storage where virtual addresses are equal to real addresses.

real mode: In VSE, the mode of a program that cannot be paged.

real storage: The storage of a computing system from which the central processing unit can directly obtain instructions and data, and to which it can directly return results. Synonymous with processor storage.

reenterable: The attribute of a load module that allows the same copy of the load module to be used concurrently by two or more tasks.

relocatable: The attribute of a set of code whose address constants can be modified to compensate for a change in origin.

relocatable library: A library of relocatable object modules and IOCS modules required by various compilers. It allows the user to keep frequently used modules available for combination with other modules without recompilation.

restore: To return a data file created previously by a copy operation from cards, disk or magnetic tape to disk storage.

rotational position sensing (RPS): A standard or optional feature of most IBM disk storage devices. It permits these devices to disconnect from a block multiplexer channel (or its equivalent on Model 3115/3125 CPUs) during rotational positioning operations, thereby allowing the channel to service other devices.

* **routine:** An ordered set of instructions that may have some general or frequent use.

secondary storage: Same as auxiliary storage.

second level directory: A table located in the supervisor containing the highest phase names found on the corresponding directory tracks of the system core image library.

security: Prevention of access to or use of data or programs without authorization.

sequential organization: Records of a sequential file are arranged in the order in which they will be processed.

service program: A program that assists in the use of a computing system, without contributing directly to the control of the system or the production of results.

shared virtual area: An area located in the highest addresses of virtual storage. It can contain a system directory list of highly used phases, resident programs that can be shared between partitions, and an area for system GETVIS support.

software: A set of programs, concerned with the operation of the hardware in a data processing system.

source: The statements written by the programmer in any programming language with the exception of actual machine language.

* **source program:** A computer program written in a source language. Contrast with object program.

source statement library: A collection of books (such as macro definitions) cataloged in the system by the librarian program.

spanned records: Records of varying length that may be longer than the currently used blocksize, and which may therefore be written in one or more continuous blocks. A spanned record may occupy more than 1 track of a disk device.

stand-alone dump: A program that displays the contents of the registers and part of the real address area and that runs independently and is not controlled by VSE.

standard label: A fixed-format identification record for a tape, diskette, or disk file. Standard labels can be written and processed by the VSE system.

storage protection: An arrangement for preventing access to storage.

supervisor: A component of the control program. It consists of routines to control the functions of program loading, machine interruptions, external interruptions, operator communications and physical IOCS requests and interruptions. The supervisor alone operates in the privileged (supervisor) state. It coexists in real storage with problem programs.

switched line: A communication line in which the connection between the computer and a remote station is established by dialing. Synonymous with dial line.

system directory list: A list containing directory entries of highly used phases and of all phases resident in the shared virtual area. This list is contained in the shared virtual area.

system residence device: The direct access device on which the system residence file is located.

system residence volume: The volume on which the basic system and all related supervisor code is located.

task: A unit of work for the central processing unit from the standpoint of the control program.

teleprocessing: The processing of data that is received from or sent to remote locations by way of telecommunication lines.

terminal: (1) * A point in a system or communication network at which data can either enter or leave. (2) Any device capable of sending and receiving information over a communication channel.

throughput: The total volume of work performed by a computing system over a given period of time.

track: The portion of a moving storage medium, such as a tape, diskette, or disk, that is accessible to a given reading head position.

transient area: An area of processor storage used for temporary storage of transient routines.

UCS: Universal character set.

unit record: A card containing one complete record; a punched card.

universal character set: A printer feature that permits the use of a variety of character arrays. Abbreviated UCS.

unrecoverable error: A hardware error which cannot be recovered from by the normal retry procedures.

user label: An identification record for a tape or disk file; the format and contents are defined by the user, who must also write the necessary processing routines.

utility program: A problem program designed to perform a routine task, such as transcribing data from one storage device to another.

virtual address: An address that refers to virtual storage and must, therefore, be translated into a real storage address when it is used.

virtual address area: In VSE, the area of virtual storage whose addresses are greater than the highest address of the real address area.

virtual mode: In VSE, the mode of execution of a program which may be paged.

virtual storage: Addressable space that appears to the user as real storage, from which instructions and data are mapped into real storage locations. The size of virtual storage is limited by the addressing scheme of the computing system and by the capacity of the page data set, rather than by the actual number of real storage locations.

virtual storage access method (VSAM): An access method (available as the licensed program product (VSE/VSAM) for direct or sequential processing of fixed and variable length records on direct access devices; designated for use in a virtual storage environment.

virtual telecommunications access method (VTAM): A set of IBM programs (available as the licensed program product (ACF/VTAM) that control communications between terminals and application programs.

volume: (1) That portion of a single unit of storage media which is accessible to a single read/write mechanism, for example, a diskette, a disk pack, or part of a disk storage module. (2) A recording medium that is mounted and dismounted as a unit, for example, a reel of magnetic tape, a disk pack, or a diskette.

volume table of contents: A table on a direct access volume or diskette that describes each file on the volume. Abbreviated VTOC.

VSAM access method services: A multifunction utility program that defines VSAM files and allocates space for them, converts indexed sequential files to key-sequenced files with indexes, facilitates data portability between operating systems, creates backup copies of files and indexes, helps to make inaccessible files accessible, and lists file and catalog entries.

VSAM catalog: A key-sequenced file, with an index, containing extensive file and volume information that VSAM requires to locate files, to allocate and deallocate storage space, to verify the authorization of a program or operator to gain access to a file, and to accumulate usage statistics for files.

VTOC: See *volume table of contents.*

work file: A file on an auxiliary storage medium reserved for intermediate results during execution of the program.

working set: The set of pages of a user's virtual-mode program that must be in processor storage in order to avoid excessive paging.

Index

SC33-6094-0

VSE/Advanced Functions System Management Guide (File No. S370/4300-34) Printed in U.S.A. SC33-6094-0

IBM®

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, N.Y. 10604

IBM World Trade Americas/Far East Corporation
Town of Mount Pleasant, Route 9, North Tarrytown, N.Y., U.S.A 10591

IBM World Trade Europe/Middle East/Africa Corporation
360 Hamilton Avenue, White Plains, N.Y., U.S.A. 10601

VSE/Advanced Functions
System Management Guide
Order No. SC33-6094-0

READER'S COMMENT FORM

This manual is part of a library that serves as a reference source for system analysts, programmers, and operators of IBM systems. This form may be used to communicate your views about this publication. They will be sent to the author's department for whatever review and action, if any, is deemed appropriate. Comments may be written in your own language; use of English is not required.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation whatever. You may, of course, continue to use the information you supply.

Note: *Copies of IBM publications are not stocked at the location to which this form is addressed. Please direct any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative or to the IBM branch office serving your locality.*

Possible topics for comment are:

Clarity Accuracy Completeness Organization Coding Retrieval Legibility

If you wish a reply, give your name and mailing address:

____

____

____

Note: Staples can cause problems with automated mail sorting equipment.
Please use pressure sensitive or other gummed tape to seal this form.

What is your occupation?______________________________

Number of latest Newsletter associated with this publication:____________________

Thank you for your cooperation. No postage stamp is necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments or you may mail directly to the address in the Edition Notice on the back of the title page.)

SC33-6094-0

Reader's Comment Form

—Cut or Fold Along Line—

VSE/Advanced Functions System Management Guide (File No. S370/4300-34) Printed in U.S.A. SC33-6094-0

Fold and tape

Please Do Not Staple

Fold and tape

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 40 ARMONK, N.Y.

POSTAGE WILL BE PAID BY ADDRESSEE:

International Business Machines Corporation
Department 812 BP
1133 Westchester Avenue
White Plains, New York 10604

Fold and tape

Please Do Not Staple

Fold and tape

IBM®

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, N.Y. 10604

IBM World Trade Americas/Far East Corporation
Town of Mount Pleasant, Route 9, North Tarrytown, N.Y., U.S.A 10591

IBM World Trade Europe/Middle East/Africa Corporation
360 Hamilton Avenue, White Plains, N.Y., U.S.A. 10601

SC33-6094-0

VSE/Advanced Functions System Management Guide (File No. S370/4300-34) Printed in U.S.A. SC33-6094-0

IBM®

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, N.Y. 10604

IBM World Trade Americas/Far East Corporation
Town of Mount Pleasant, Route 9, North Tarrytown, N.Y., U.S.A 10591

IBM World Trade Europe/Middle East/Africa Corporation
360 Hamilton Avenue, White Plains, N.Y., U.S.A. 10601