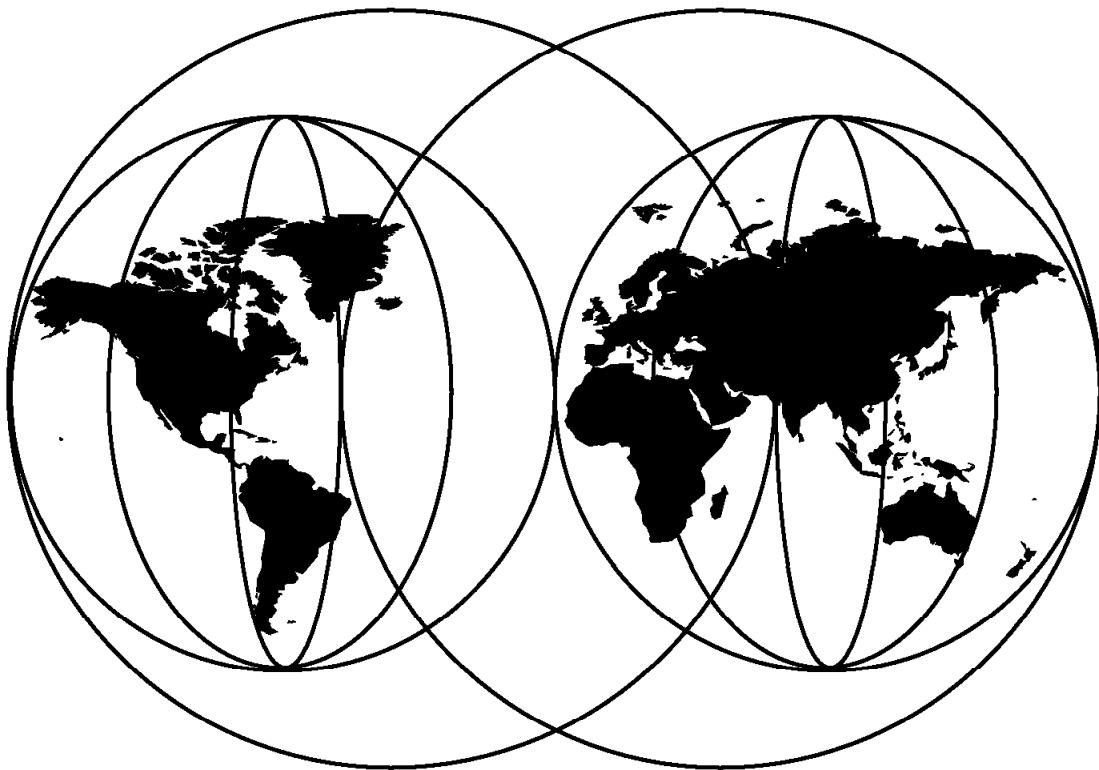# IBM Magstar Virtual Tape Server: Planning, Implementing, and Monitoring

*Jacques Bouchard, Wolfgang Kessel, Kevin Nicholls, Frans Versteeg,
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International Technical Support Organization

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International Technical Support Organization

**IBM Magstar Virtual Tape Server:
Planning, Implementing, and Monitoring**

February 2000

Take Note!

Before using this information and the product it supports, be sure to read the general information in Appendix E, "Special Notices" on page 351.

Fourth Edition (February 2000)

This edition applies to the IBM Magstar 3494 Model B18 Virtual Tape Server including the July 27th, 1999 announced features like the Extended High Performance Option, the Extended Performance Escon Channels, and the Performance Accelerator.

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Preface

This is the third update to the best selling "IBM Magstar VTS Implementation Guide" published in 1997. Since the first VTS installations in May 1997, a lot has changed in the Virtual Tape Server area. Performance, capacity and functionality of the VTS has been enhanced to a high degree. The focus of this redbook is to provide implementation and usage guidance for the IBM 3494 Model B18. A chapter on the VTS Performance Accelerator and a chapter on the migration to the IBM 3590 Enhanced Models have been added. The VTS Performance chapter is completely rewritten. Minor additions and corrections have been applied throughout the book. If you discuss, sell, order, or plan for an IBM 3494 Model B18 Virtual Tape Server, don't forget to consult this redbook first!

The Virtual Tape Server is integrated with the IBM Magstar 3494 Tape Library. The host system perceives it as an IBM 3494 Tape Library with up to 64 virtual 3490E tape drives and up to 150,000 virtual 3490E cartridges. The Virtual Tape Server fully exploits the capability of the IBM Magstar 3590 tape subsystem and capacity of its media.

The Magstar Virtual Tape Server introduces the *virtual* concept into tape subsystems, similar to *virtual storage* and *virtual disk* concepts that already have been implemented.

The Team That Wrote This Redbook

This redbook was produced by a team of specialists from around the world working at the International Technical Support Organization San Jose Center, California.

Figure 1. Almaden Research Center, San Jose

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Chapter 1. Introducing the IBM Magstar Virtual Tape Server

In June 1998, IBM announced an enhanced IBM Magstar VTS Model B18, a second generation Seascape solution. This new solution provides improved performance and capacity by replacing the original VTS processor building block with a higher performance processor and introducing an optional compression feature called EHPO, to lower the total cost of ownership for tape processing. In February 1999, new features and additional capabilities such as the Advanced Function Import/Export component and the SCSI attachment feature were announced for the IBM 3494-B18. In July 1999, IBM announced performance and capacity enhancements for the IBM 3494-B18. The Performance Accelerator Feature in combination with the Extended Performance ESCON Channels improves the IBM 3494-B18 VTS sustained performance by up to 100% and the peak performance by up to 50% over an IBM 3494-B18 VTS with the EHPO feature. IBM Magstar 3590 Model E1A tape drive support for the IBM 3494-B18 doubles the storage capacity of the physical Magstar cartridges. The IBM 3494 Library Manager allows storage of up to 300,000 logical volumes when two VTSs are included in the IBM 3494 configuration.

In this chapter we introduce the IBM 3494-B18 (shown in Figure 2) and explain how it is designed and how it works. In subsequent chapters, we explain how to implement and manage the VTS and how to make the best use of it.
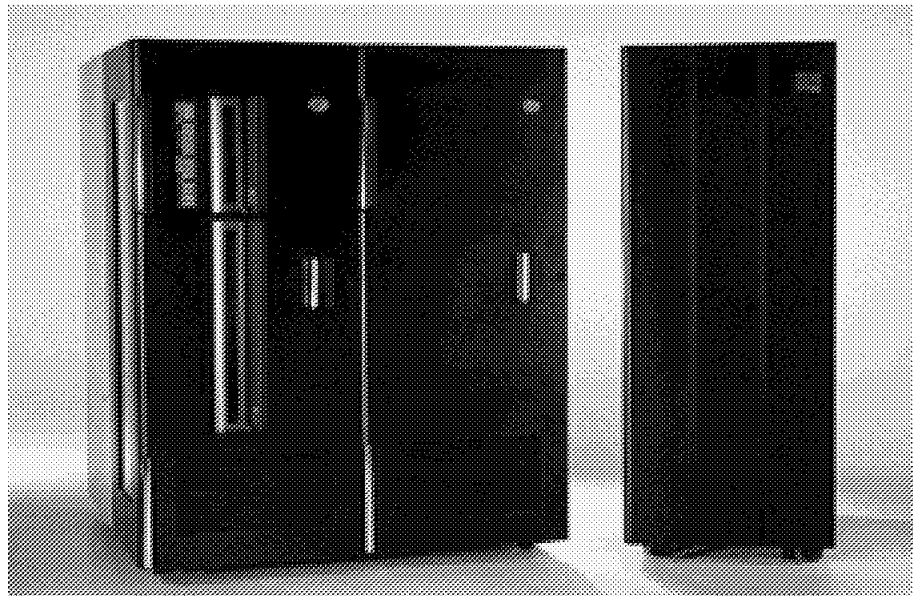
Figure 2. The Enhanced IBM Magstar 3494 Virtual Tape Server

With the implementation of new magnetic tape technology the density of data written to tape has increased by orders of magnitude in the last 10 to 15 years. The ability to record high-density tapes (for example, 60 GB of user data on one physical volume) has led to reduced costs of physical tape hardware and has simplified handling and management tasks involved. However, our traditional uses for tape (archive, backup, recovery, and even batch processing) have not changed dramatically over the last 10 years and thus have not kept pace with the technology. A survey of IBM customers shows that, on average, more than 30% of the cartridges contain fewer than 50 MB of data, and the average volume

size is less than 300 MB. The average content of extended capacity 3490E cartridges is as low as 15% of the maximum cartridge capacity.

When IBM first announced the IBM Magstar 3590 in April 1995, it was already clear that some means of using high-capacity tapes would also be required; this was expressed at that time as a statement of direction for Magstar "capacity enablement." Some applications and storage management products, such as Data Facility Storage Management Subsystem Hierarchical Storage Manager (DFSMShsm), are designed to optimize their own tape usage. However, for general tape environments, the introduction of a high capacity tape cartridge means that measured utilization will drop to less than 1% if current tape practices remain unchanged.

Over the past five years, tape data set stacking products (software solutions to increase tape utilization) have evolved in response to customer requirements for more efficient ways of managing the information stored on tape. Currently, more than 80% of S/390 sites have a tape management system and some type of hierarchical storage management product in place. However, market research companies estimate that only around 15% of these MVS installations have any type of data set stacking. To date, tape data set stacking products do not seem to have achieved mass acceptance in the marketplace, perhaps because they usually involve post-processing activity using additional host resources and increasing tape mount activity overall, or perhaps because they are perceived as too expensive, or too complex to implement.

The IBM Magstar VTS is a hardware-based solution that addresses not only tape cartridge utilization but also tape device utilization, and hence overall tape subsystem costs. Because of its transparency to the host software, the VTS is readily supported and easy to use.

1.1 Logical Components

The VTS is integrated with an IBM Magstar 3494 Tape Library. It appears to the host as an IBM Magstar 3494 Tape Library with its own library name, its own set of tape volumes (up to 300,000 standard 400 MB volumes or enhanced capacity 800 MB volumes per IBM Magstar 3494 Tape Library), and its own set of tape drives. The host sees 32 or 64 virtual 3490E drives, attached using two or four Enterprise System Connection (ESCON) paths that transfer data concurrently.

The IBM 3494-B18 can be shared between S/390 and RS/6000 systems by specifying one or two additional SCSI host attachments. Each feature provides two SCSI bus host attachments and includes data compression compatible with the EHPO. Each bus provides up to 16 virtual devices and emulates 3490E tape drives.

Currently two IBM Magstar VTS subsystems can be integrated into an IBM Magstar 3494 Tape Library sharing the maximum number of 300,000 logical volumes equally and providing up to 128 virtual drives. The VTSs can coexist effectively in the same IBM Magstar 3494 Tape Library with native IBM 3490E and native IBM 3590 Magstar tape cartridges and drives.

With access to a library with 300,000 emulated cartridges and 128 emulated drives, the host can process much more tape workload in parallel without the expense of actually installing 128 real tape drives. With so many virtual tape

drives, there is the opportunity to dedicate drives to different hosts and platforms rather than managing an often complex shared environment.

Figure 3 illustrates how the VTS appears to the ESCON-attached host. The VTS is managed by the Library Manager in the IBM 3494, so that the host sees a logical library, separate from any other drives within the IBM 3494, with its own library name (see Section 1.3, "Virtual Tape Server Configuration in the Library" on page 6).
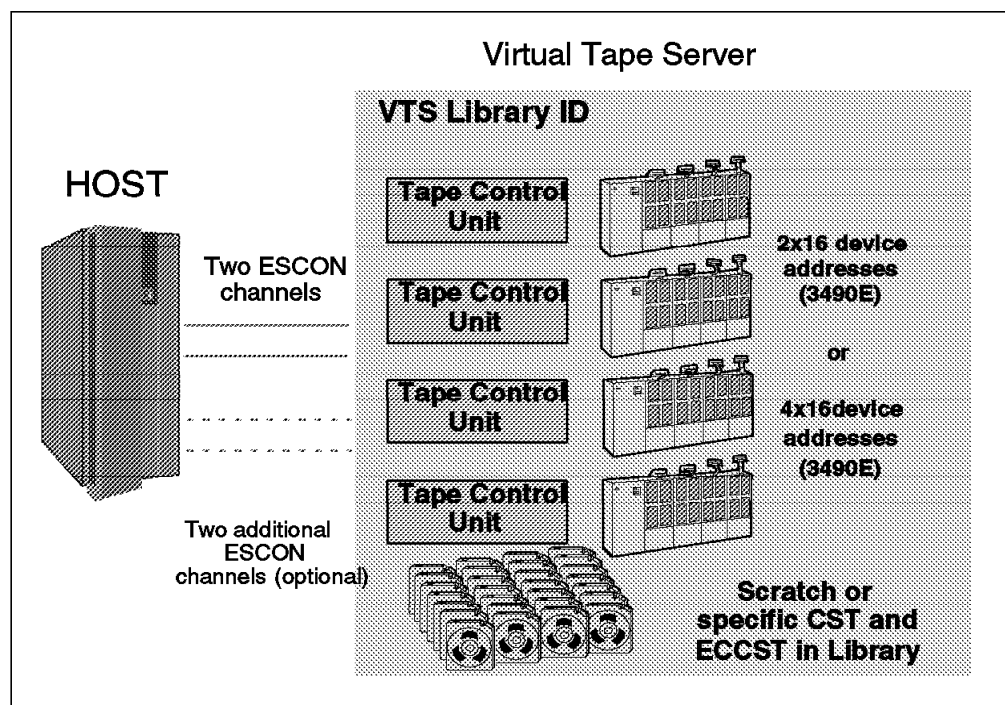
Figure 3. Logical Components of the VTS As Seen by the Host System

The internal structure of the VTS is unknown to the host; the host sees the VTS as two or four complete IBM 3490E strings inside an IBM tape library. The host is not aware of the Magstar cartridges in the VTS and does not need to provide support for the IBM 3590 drives. Therefore, you do not have to make changes to the operating system software as long as it has the standard 3494 and 3490E support.

1.2 Hardware Components

Figure 4 on page 4 shows a diagram of the physical hardware used in the VTS which is installed in two frames (an IBM 3494 D12 frame, and the stand-alone IBM Magstar VTS B18 frame), and the IBM 3494 Library Manager hardware, which is installed in the L1x frame.

The VTS is connected to the S/390 host by either two standard ESCON channel attachments or two to four Extended Performance ESCON Channels attachments in conjunction with the new Extended High Performance Option (EHPO) feature. The Extended Performance ESCON Channels provide Ziv-Lempel IBMLZ1 compaction at the channel card, resulting in a significant performance improvement in terms of data throughput and tape volume cache (TVC) use.
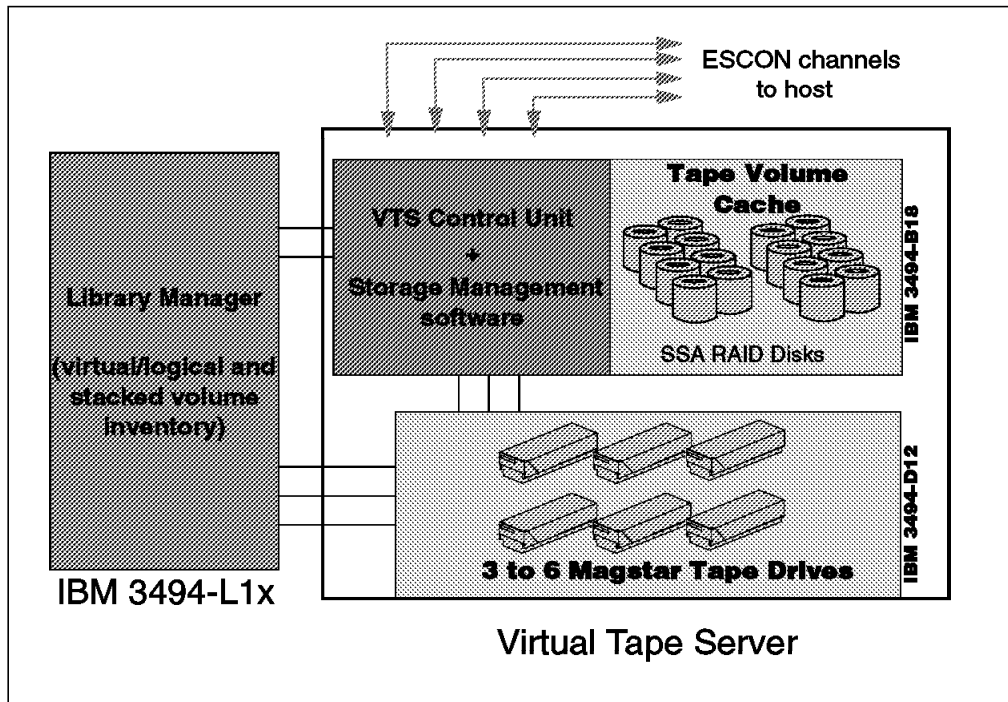
Figure 4. Hardware Components of the VTS Transparent to the Host System

Each of the major components shown is described in the subsections that follow. Section 2.1, "Hardware Configurations" on page 17 provides more detailed information about the VTS configuration.

1.2.1 VTS Controller

The VTS controller with its associated Licensed Internal Code (LIC) contains the key components of the VTS subsystem. It consists of:

- A RISC-based processor, which provides ESCON as well as SCSI attachments, 3490E emulation to the host system, and attachment to the TVC disks.

- Storage management software, which manages the TVC contents and stacked volumes, controls the movement of data between disk (the TVC) and tape (IBM Magstar 3590 cartridges), and automatically fills the Magstar tapes. The storage management techniques, built on more than 20 years of IBM experience, include many of the features and functions found in IBM's industry-leading DFSMShsm and ADSTAR Distributed Storage Manager (ADSM) software products.

  The ADSM product has been rebranded and updated and is now called Tivoli Storage Manager. The remaining references in this book do also apply to Tivoli Storage Manager.

1.2.2 Tape Volume Cache

The TVC of the VTS subsystem is the key element that enables the utilization of the IBM 3590 tape technology. Buffering host-created volumes and later stacking them on a 3590 cartridge makes it possible for the cartridge capacity of the technology to be fully utilized. The TVC is a disk buffer (up to 864GB in size, assuming a 3:1 compression ratio with EHPO) where the host 3490E emulated tape volumes are written before they are copied to the physical IBM 3590 tape cartridges. The host operating system sees IBM 3490E tape drives, but actually,

the space is represented by storage space in RAID fault-tolerant Serial Storage Architecture (SSA) disk subsystems. All host interaction is through the TVC; the host never writes directly to the Magstar tape drives inside the VTS.

While resident in the TVC, the user data is protected by RAID parity. The TVC is configured in two RAID groups. This RAID configuration gives continuous data availability to the users. If one data disk in a RAID group becomes unavailable, the user data can be re-created dynamically from the remaining disk data contents and the parity disk. In addition, the RAID group contains already mounted (hot) spare disks to replace the damaged disk, so the RAID controller can rebuild the data from the damaged disk on the hot spare. In this way, the VTS can continue working while the IBM service representative replaces the damaged hard disk assembly in the IBM 3494-B18.

With this approach, in addition to fulfilling the objective of making full use of high-capacity Magstar tape cartridges, there are these benefits:

- Fast access to the most recently written data in the tape TVC.

- Multiple, different, emulated 3490E volumes can be accessed in parallel because they physically reside in the TVC. (A virtual volume cannot be shared by different jobs or systems at the same time.)

- Emulated 3490E volumes accessed at disk speeds. Tape commands such as space, locate, rewind, and unload are mapped into disk commands that are completed in tens of milliseconds rather than the tens of seconds required for traditional tape commands.

1.2.3 Physical Magstar Tape Drives

The VTS subsystem is configured with three to six IBM Magstar 3590 tape drives (see Section 2.1, "Hardware Configurations" on page 17). Data is recalled to and copied from the TVC through these drives.

The Magstar tape drives are attached to the VTS controller and the Library Manager only and are dedicated to the function of the VTS. They are not visible to, and therefore cannot be used by, any external host system.

The IBM 3494-B18 can exploit either IBM 3590 Base Models or IBM 3590 Enhanced Models.

1.2.3.1 IBM 3590 Base Model

The IBM 3590 Base Models are characterized by a drive data rate of 9 MB/s and can store 30 Gbyte of data on a Magstar tape cartridge, assuming a 3:1 compression ratio The IBM 3590 Base Models read and write data in 128-track mode on physical Magstar tape cartridges.

1.2.3.2 IBM 3590 Enhanced Model

The IBM 3590 Enhanced Models are characterized by a drive data rate of 14 MB/s and can store 60 Gbyte of data on a Magstar tape cartridge, assuming a 3:1 compression ratio. Currently installed IBM 3590 Base Models can be upgraded to IBM 3590 Enhanced Models. The IBM 3590 Enhanced Models read and write data in 256-track mode on physical Magstar tape cartridges. The IBM 3590 Enhanced Models read 128-track mode on physical Magstar cartridges which were written by IBM 3590 Base Models.

The main reason to upgrade to IBM 3590 Enhanced Models is doubling the data storage capacity of the VTS owned tape cartridges.

1.2.4 Physical Magstar Tape Cartridges

The physical Magstar cartridges belonging to the VTS are stored anywhere in the storage cells of the library where the VTS is installed. They are not separated from any other cartridges in the library, but they are dedicated for use by the VTS subsystem. Their position and status are recorded and maintained by the Library Manager. These stacked cartridges are not visible to attached hosts.

1.3 Virtual Tape Server Configuration in the Library

So far we have discussed the logical and physical attributes of the VTS. Before moving on to look at how the VTS works, we must clarify the overall configuration of the VTS subsystem, which is a fully integrated part of the IBM Magstar 3494 Tape Library. In this section we give an overview of the configuration. Two additional sections, 2.1, "Hardware Configurations" on page 17 and 2.8, "Ordering Support" on page 36 cover configuration aspects with reference to installation planning.

As indicated in Figure 4 on page 4, the hardware components of the VTS are housed in just two frames of the IBM Magstar 3494 Tape Library:

- IBM Magstar 3494-B18

  This is a model number specific to the VTS. It contains the VTS controller and its associated storage management software, and the RAID disk arrays which make up the TVC. The IBM 3494-B18 frame is a stand-alone unit that can be located a maximum of 14 m from the associated 3494 drive unit frame.

- IBM Magstar 3494-D12

  This is the standard Model D12 frame, which can house up to six IBM 3590 Magstar tape drives. In this case, the drives it contains are dedicated to the use of the VTS subsystem. All drives attached to one VTS must either all be IBM 3590 Model B1A tape drives or all be IBM 3590 Model E1A tape drives. IBM 3590 Model B1A is the library-mountable model of the IBM 3590 Base Model IBM 3590 Model E1A is the library-mountable model of the IBM 3590 Enhanced Model.

The IBM 3494-D12 frame contributes to the cartridge storage space for the whole library; the cartridges belonging to the VTS subsystem can be stored in any of the frames that make up the total library capacity. The physical position and status of the cartridges are controlled by the Library Manager.

The IBM 3494-D12 frame belonging to a VTS can be installed anywhere along the length of the library. The stand-alone IBM 3494-B18 frame does not count toward the maximum number of 16 frames for a 3494 library.

The VTS is available in multiple configurations: 72 GB, 144 GB, 216 GB, or 288 GB of TVC in the B18 frame, (216 GB, 432 GB, 648 GB, or 864 GB if assuming a 3:1 compression ratio) of TVC in the B18 frame, with three to six IBM Magstar drives in the D12 frame. Two standard ESCON host channel attachments support 32 emulated 3490E tape drives. The new EHPO provides microcode for data

compression on the channel card for the new Extended Performance ESCON Channels. Two additional Extended Performance ESCON Channels attachments can also be specified. Up to 64 emulated tape drives are available with EHPO and a minimum cache size of 144 GB is required. The installation of the new Performance Accelerator Feature provides throughput performance for those customers where performance is a key requirement. The Performance Accelerator Feature is a package of hardware and software. It contains a new file system, processor enhancements, additional processor storage and licensed internal code (LIC) updates.

Refer to Chapter 4, "VTS Performance Accelerator" on page 99 for details of the Performance Accelerator Feature However, the logical attributes of the VTS with Performance Accelerator Feature installed remain the same; that is, 32 or 64 emulated 3490E tape drives and a maximum of 150,000 logical 3490E volumes. If two VTS subsystems are installed with any one IBM Magstar 3494 Tape Library, they share the maximum number of 300,000 volumes equally.

The VTS can be installed by adding frames to a currently installed IBM Magstar 3494 Tape Library, or it can be installed as a new library. It is designed to work as part of the IBM library infrastructure so that emulated drives and logical volumes can coexist effectively in the same library with native 3490E and native 3590 cartridges and drives (SCSI or ESCON attached); the mixed environment is fully managed by the Library Manager. In fact, the combination of native 3590 and VTS emulated drives can be particularly powerful, being able to cope with both high-throughput work that can fill cartridges, and lower-throughput work that does not fill cartridges. Table 25 on page 161 summarizes our recommendations on where to store different types of data.

In a mixed environment, the Library Manager manages the VTS and native drives within the library and presents the image of up to three logical libraries to the host systems, each with its own library name. One library contains the native 3490E or 3590 drives and cartridges and the other two libraries are VTS libraries each with 32 or 64 emulated 3490E drives and associated logical volumes. Figure 5 on page 8 shows an example of a six-frame mixed library.
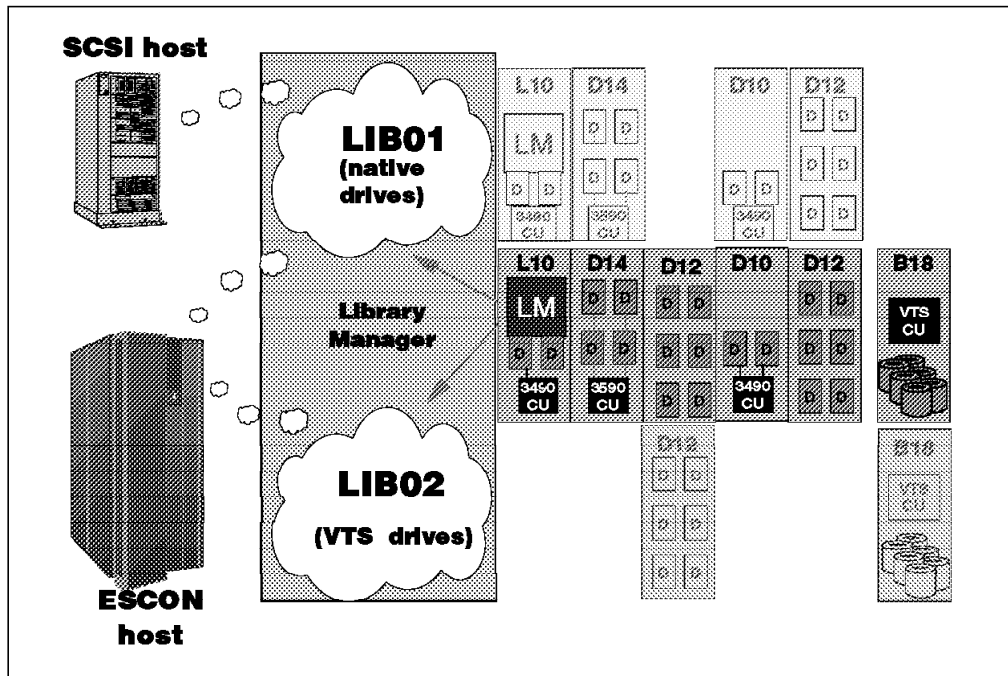
Figure 5. Virtual Tape Server Configuration in the Library

In this example, the ESCON host sees two libraries: a VTS library (LIB02) consisting of frames B18 and D12 shown as the two ″greyed″ out frames at the bottom of Figure 5 and a native library (LIB01) with four native 3590 drives in the D14 frame, two native 3490E drives in the L10 frame, and two native 3490E drives in the D10 frame. The SCSI host sees one library (LIB01) with six native 3590 drives in the second D12 frame. The native drives belonging to LIB01 are shown as the four ″greyed″ out frames in the top of Figure 5.

Note: The IBM 3494-B18 as well as the associated 3590 Magstar drives do not occupy control unit function ports (RS-422 or RS-232) because they communicate with the Library Manager through a local area network (LAN) connection.

If you just want to install a single VTS system without any other library or native drives, the minimum configuration is three frames: a Library Manager frame (Model L1x), one tape drive frame (Model D12), and the stand-alone IBM 3494-B18 frame. The Library Manager frame can be installed without any drives inside; if so, the Library Manager presents only one library image to the ESCON host system with a single library name. The host sees a single library with two or four ESCON paths and up to 64 3490E drives. Chapter 2, "Preinstallation Planning and Sizing" on page 17 provides more detail on configuring hardware, features, and upgrades when planning to install a VTS.

To summarize the rules discussed in this section:

- The IBM Magstar 3494 Tape Library unit (Model L1x) can be left without drives.
- The Model D12 can be installed anywhere along the length of the library.
- The B18 frame must reside within a distance of 14 m from the associated 3494 model D12 drive frame.
- Today, a maximum of two VTS subsystems can be installed in any one IBM Magstar 3494 Tape Library.

1.4 Architecture

From the previous sections, you can see that the VTS brings a new concept of volumes and devices because there is a difference between the host view of the system and the reality of the installed hardware. When using a VTS, the host application writes tape data to virtual drives. The volumes written by the host are physically stored in a tape volume cache (a RAID disk buffer) and are called *virtual volumes.*

The storage management software in the VTS controller copies these virtual volumes in the TVC to the physical Magstar cartridges owned by the VTS subsystem. Once a virtual volume is copied from the TVC to tape, it is called a *logical volume.*

The host cannot distinguish between physical and virtual volumes, or physical and virtual drives, and treats them as if they were "real" cartridges and drives because the host's view of the hardware is virtual. Therefore, there is no need to make changes to the host operating system software. The only change needed is the update of the SMF type 94 record, as described in Section 2.5, "Software Requirements" on page 32. The management of the physical Magstar tape drives and Magstar cartridges is completely under control of the VTS storage management software.

1.4.1 Virtual Volumes

A virtual volume is created in the TVC when the host writes data to the VTS subsystem. All host interaction with tape data in a VTS subsystem is through virtual volumes and virtual tape drives.

Each virtual volume, like a real volume, has the following characteristics :

- It has a unique volume serial (volser) number known to the host.

- It is loaded and unloaded on a virtual device.

- It supports all tape write modes, including Tape Write Immediate.

- It contains all standard tape marks and data blocks.

- It supports an IBM standard label (and nonlabeled tape as well).

- It can be appended to after it is initially written from the beginning of tape.

- The application is notified that the write operation is complete when the data has been written in the TVC.

- Each host written record has a logical block ID.

- End of volume is signaled when the total number of bytes written into the TVC (after compression by the EHPO), has reached 400 MB for an emulated cartridge system tape (CST) or 800 MB for an emulated enhanced capacity cartridge system tape (ECCST) volume.

You can define both CST and ECCST emulated cartridges to VTS, simulating MEDIA1 400 MB capacity or MEDIA2 800 MB capacity. With data compression by the EHPO and ESCON channel card in a model B18 VTS, the actual host data stored on a virtual CST or ECCST volume can be 1.2 GB or 2.4 GB, respectively (assuming a 3:1 compression ratio).

Both media types are allowed inside with the VTS, although ECCST emulation is recommended, because it does not waste space even if you write a small file

and you do not fill the 800 MB capacity, as explained in Chapter 6, "Using the IBM Magstar VTS" on page 123.

Virtual volumes can exist only in a VTS. You can direct data to a virtual tape drive by directing it to a system managed storage (SMS) tape storage group inside the VTS, using the automatic class selection (ACS) routines in a system-managed tape environment or using Basic Tape Library Support (BTLS) in any other MVS environment.

You can define up to 300,000 virtual volumes per physical 3494 library, making even a small library look very large. The volsers for the logical volumes are defined through the Library Manager Console. You can associate a "fast ready" attribute with a scratch category of VTS virtual volumes, to speed the scratch mount process, as explained in more detail in Section 3.4.5, "Define Fast Ready Categories" on page 73. Virtual volumes go through the same cartridge entry processing as native cartridges inserted in a library.

1.4.2 Logical Volumes

When a virtual volume is copied from the TVC to a physical Magstar 3590 tape cartridge, it becomes a logical volume. When a logical volume is moved from a Magstar cartridge to the TVC, the process is called *recall*, and the volume becomes a virtual volume again.

Figure 6 illustrates the relationship between virtual and logical volumes.
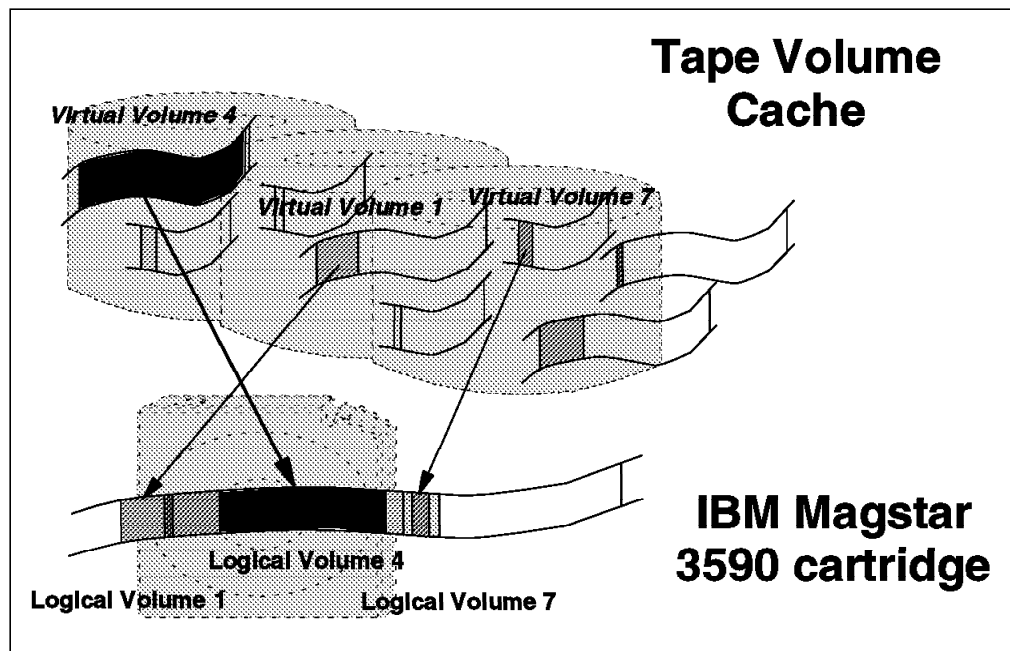
Figure 6. Data in the TVC and on Physical Tape

Although the VTS emulates a 3490E tape of a specific size, 400 MB or 800 MB, the space used in the TVC is no more than that needed for the number of bytes of data written to the virtual volume. When the virtual volume is written to the physical tape, it uses only the space occupied by the data. In other words, neither the TVC nor the physical tapes are partitioned in any way into 400 MB or 800 MB segments.

As virtual volumes are copied from the TVC to a Magstar cartridge, they are stacked on the cartridge end to end, taking up only the space written by the host application. This arrangement maximizes utilization of a cartridge's storage capacity. The storage management software manages the location of the logical volumes on the physical cartridges. The user has no control over the location of the data.

1.4.3 Stacked Volumes

The physical Magstar cartridges used by the VTS to store logical volumes are completely under the control of the VTS subsystem and are not known to the hosts. The physical volumes are called *stacked volumes*. The stacked volumes must have unique machine-readable volsers like any other cartridges in a tape library.

Through the Library Manager Console, you define which physical cartridges are to be used by the VTS subsystem. Logical volumes stored on those cartridges are mapped by the internal storage management software.

Note: Stacked Magstar cartridges containing active data cannot be removed from the VTS. Therefore, you cannot eject a stacked volume containing valid data. You can, however, eject a stacked cartridge for maintenance or operational purposes, but only from the Library Manager panels. The data is moved to another cartridge, and the empty volume is then ejected. Refer to Section 7.9, "Ejecting Stacked Volumes from the VTS" on page 180 for more information about ejecting a stacked volume.

1.4.4 Exported Stacked Volumes

The physical Magstar cartridges used by the VTS to hold exported logical volumes are called exported stacked volumes.

1.4.5 Virtual Drives

From a host perspective, the VTS subsystem looks like two or four IBM 3490E tape control units, each with 16 drives attached through ESCON channels. Virtual tape drives are defined just like physical IBM 3490 controller addresses, through hardware configuration definition (HCD), or through the I/O configuration program (IOCP) and the MVSCP or HCPRIO macro. Defining a preferred path for the virtual drives gives you no benefit because the IBM 3490 control unit functions inside the VTS are emulated to the host.

Each virtual drive has the following characteristics (just like real tape drives):

- It has a host device address.
- It is included in the I/O generation for the system.
- It is varied online or offline to the host.
- It signals ready when a virtual volume is loaded.
- It responds and processes all IBM 3490E I/O commands.
- It becomes not ready when a virtual volume is rewound and unloaded.

For software transparency reasons, the functionality of the 3490E integrated cartridge loader (ICL) is also included in the virtual drive's capability. All virtual drives indicate that they have an ICL. For scratch mounts, there is no benefit to using emulated ICL in the VTS to preload virtual cartridges in the ICL, because the virtual volume is created directly in the TVC without the need to copy the

data from a stacked volume when the fast-ready attribute is set for the scratch volume category. Therefore, no mechanical operation is required to mount a scratch volume.

1.4.6 Physical Drives

The physical IBM Magstar 3590 tape drives installed in the VTS (in the IBM 3494-D12 associated with the IBM 3494-B18 VTS controller) are invisible to any attached host system. They are completely under the control of the VTS subsystem and therefore cannot be addressed by any host system.

1.5 How the IBM Magstar VTS Works

To illustrate how the VTS subsystem works, in this section we step through what happens in response to mount requests from the host, how and when the data is moved from one part of the VTS subsystem to another, and how tape reclaiming occurs.

1.5.1 Mounting a Scratch Tape

The Library Manager uses categories to group volumes. After virtual volumes are defined through the Library Manager console, they are placed in the insert category and handled exactly as native cartridges. When the VTS subsystem is varied online, the host operating system assigns scratch volumes to a particular category. When a request for a scratch is issued to the VTS, the request specifies a mount from category. The Library Manager selects a virtual volser from the candidate list of scratch volumes in the category.

If the volume is mounted for the first time (that is, the volser has never been used before as a virtual volume), the VTS controller software generates a set of records for the volume in the TVC as if the volume had been initialized using the EDGINERS or IEHINITT program, with an IBM standard label (that is, the volume will contain a VOL1 record, an HDR1 record, and a tape mark).

Once a virtual volume has been used for the first time (initialized), information about it is maintained in the TVC. After the volume has been copied to a stacked volume and the cache data space has been made available for new volumes, data from the last use of the volume, called the *fragment*, remains in the TVC. The fragment contains the first several hundred bytes of data of the volume, including, at a minimum, the tape label information.

The MVS operating system can use two of the Library Manager categories for 3490E cartridges: either Media type 1 (standard CST), or Media type 2 (ECCST). With the introduction of the VTS, a fast-ready attribute can be assigned to a category to tell the VTS storage management software that it does not need to recall any data from tape into the TVC before signaling mount complete to the host. In other words, the operating system can use the fragment information in the TVC for volume verification and tape management system integrity checking before using a logical volume for a scratch mount, and no physical tape mount is required. You should assign the fast-ready attribute to all of your VTS scratch categories.

Having checked whether the selected volume has fragment information in the TVC, or, if not, having created the information, the VTS storage management software signals mount complete to the host, which can then start to write data to the virtual volume. Because a physical mount of a volume is not required, the

nonspecific scratch mount request is handled much faster than in a conventional tape library.

When the host closes the volume, end-of-volume (EOV) processing is performed, and the volume is rewound and unloaded, but without any physical tape movements.

1.5.2 Tape Volume Cache

The TVC is the physical disk buffer used for transferring data to and from the host. It operates as an intelligent buffer or cache. Like a cache, it is designed to operate full of data and has unused space only when the VTS is first installed. The data in the TVC is not automatically freed when the data occupying that space has been copied to a stacked volume. Once the TVC has filled with tape volumes (virtual volumes), space taken up by older volumes is freed for new allocations, using the least recently used (LRU) algorithm.

If a virtual volume is written and then accessed again within a short time, the data may still reside in the TVC even if it has been copied to a physical Magstar 3590 cartridge. The access time is less than that to mount a real tape volume because it avoids the necessity of a physical tape mount.

The time stamp is updated in this case, and the logical volume is placed back on the copy queue if it had not been copied before.

If a logical volume has not been copied to a stacked volume and it is mounted again and modified or appended to, the data in the TVC is overwritten or additional data is added to the volume. After the application closes the volume or end of volume (EOV) occurs, the logical volume becomes eligible for copy again.

Note: The length of time data remains in the TVC cache depends on how active the VTS is and how much data is being written.

Once the virtual volume has been initialized (after the first use of a logical volser), a fragment file associated is always with it in the TVC; otherwise the full virtual volume information is present in the TVC. The fragment uses space sufficient to include the VOL1, HDR1 and HDR2 records, any URL1 through URL8 records if present, and a tape mark. Even if the maximum number (150,000) of logical volumes has been initialized, the fragment files use only a fraction of the space available in the TVC.

1.5.3 Copying the Data to Tape

Once the host closes and unloads a virtual volume, the storage management software schedules the virtual volume to be copied onto a physical IBM Magstar 3590 cartridge. The VTS attempts to maintain a mounted stacked volume to which virtual volumes are copied. Thus mount activity is reduced because only one physical cartridge is mounted to service several scratch mount requests from the host.

If the virtual volume was not modified when it was mounted, the VTS does not schedule a copy operation, and the current copy of the logical volume on a stacked volume remains active.

1.5.4 Mounting a Specific Tape

The process followed within the VTS to mount a specific tape is similar to the scratch mount scenario. The storage management software first checks the TVC for the tape volser. If the virtual volume exists in the TVC (that is, the volume has not yet been overwritten), a physical tape mount is not required; the mount is signaled as complete, and the host can access the data immediately.

If only the fragment resides in the TVC, a *recall* of the logical volume to the TVC is required to create a virtual volume that the host can then access directly. Recall typically requires a physical mount unless the stacked volume is already mounted following another request. Mount completion is signaled to the host system only after the complete volume is available in the TVC. The virtual volume will remains in the TVC until it becomes the LRU volume; then its TVC space can be made available for new data.

Note: Running an IEFBR14 with a virtual volume in the DD statement will not cause the logical volume to be recalled to the TVC: IEFBR14 issues a MOUNT request to the Library Manager, immediately followed by a REWIND, UNLOAD and DEMOUNT. The Library Manager cancels the virtual volume recall and the request is dropped from the VTS recall queue.

For a JES3 environment, depending on the implementation, this may be a way to pre-load logical volumes, though.

1.5.5 Expired Volumes

When a logical volume expires, it is returned to scratch status. However, the data associated with that logical volume remains available on the stacked volume until the volser is reused as a scratch volume and new data is written on it. The space on the stacked volume used by a logical volume is not invalidated until the scratch volume has been rewritten with new data--which occurs only if unused virtual volumes are not available. Therefore it is important to specify only as many virtual volumes as needed.

Note: The best way to understand this is to consider what happens when a real physical 3490E volume expires and the physical cartridge is returned to scratch. In this case it is easy to see that the expired data remains available on the cartridge until the volume is actually reused for new data.

1.5.6 VTS Internal Space Management

The VTS automatically manages two levels of storage: the TVC (disk) and the physical stacked volumes (tape cartridges). External intervention is not required for space management, although you have the option of suppressing tape reclamation at certain times of the day, and you can add more Magstar 3590 cartridges as and when you need more tape space. In addition you have the option of changing the VTS threshold related to stacked volume occupancy.

1.5.6.1 Tape Volume Cache

The TVC is under complete and exclusive control of the VTS subsystem, with no external interfaces to influence its management. When a virtual volume in the tape volume cache is closed and demounted, it is scheduled to be copied to a stacked volume. Space for new virtual volume data or recalled existing logical

volumes is achieved by retaining in the disk space only the fragment for the LRU volumes.

1.5.6.2 Stacked Volumes

Any time a logical volume is modified, the data from the previous use of the logical volume which is on a stacked volume becomes obsolete. When you modify a logical volume, you have a new virtual volume in the TVC, and the copy on the stacked volume is invalidated. *Reclamation*, which removes obsolete data from the stacked volumes and consolidates active data, is part of the internal management functions of a VTS subsystem. Please see 3.4.6, "Reclamation and Reconciliation" on page 75 for a more detailed explanation of this process.

1.5.7 Import/Export Function

To move a set of logical volumes for vaulting, or to move volumes to another VTS subsystem, an Import/Export function is available with the IBM 3494-B18 and the Advanced Function (FC 4000) installed. The export process allows you to move logical volumes from the VTS to exported stacked volumes which are subsequently removed from the VTS. The basic steps of the export process are:

1. The host designates logical volumes to be exported from the VTS.

2. The VTS copies the logical volumes to a set of tape cartridges, *exported stacked volumes*, including information fully identifying the logical volumes exported.

3. The VTS deletes all internal references to the exported logical volumes.

4. The VTS puts the tape cartridges containing exported logical volumes in the export-hold category for later operator ejection and informs the host of the results of the export process.

The Import process allows you to copy logical volumes from exported stacked volumes back into the VTS, where the VTS can be the originating machine or another IBM 3494-B18. The basic steps in the import process are:

1. An operator inserts import cartridges (cartridges containing data to be imported) into the IBM Magstar 3494 Tape Library

2. The host designates the stacked volumes or specific logical volumes to be imported into the VTS.

3. The VTS determines the logical volumes involved and copies them from the set of import cartridges onto cartridges already in the VTS. The VTS creates internal references to each imported logical volume.

4. The VTS informs the host of the results of the import process.

Exported Stacked Volumes created on IBM 3590 Model B1A Tape Drives can be imported into IBM 3590 Model E1A configurations; however, Exported Stacked Volumes created on IBM 3590 Model E1A Tape Drives cannot be imported into IBM 3590 B1A configurations.

Chapter 2. Preinstallation Planning and Sizing

In this chapter we document the key actions that need to take place before you install an IBM Magstar VTS and provide the information you need to prepare for installation. We:

- Summarize possible hardware configurations of an IBM Magstar 3494 Tape Library including the IBM 3494-B18 VTS
- Explain which data is suitable for the VTS
- Give you guidance on sizing the VTS
- Provide information for physical planning and placement
- List the software requirements
- Provide information for operator education and training
- Describe all features to support you in ordering an IBM Magstar 3494 Tape Library including the IBM 3494-B18 VTS

We summarize the topics and tasks discussed in this chapter in Table 10 on page 52, which provides a checklist that you can use in planning the installation of an VTS.

2.1 Hardware Configurations

The IBM Magstar VTS is housed in two frames of an IBM Magstar 3494 Tape Library: an IBM 3494-B18 frame and an IBM 3494-D12 frame. The IBM 3494-D12 frame is located anywhere in the IBM Magstar 3494 Tape Library, whereas the IBM 3494-B18 frame can be located at a distance of up to 14 m from the IBM 3494-D12 frame. See Figure 7, where the IBM 3494-B18 is located outside the IBM Magstar 3494 Tape Library and its associated IBM 3494-D12 is located as frame two. The configuration shown in Figure 7 is a two-frame IBM Magstar 3494 Tape Library with a remote IBM 3494-B18 frame, which is the minimum configuration when a VTS is installed. The IBM 3494-L1x has the option of having additional non-VTS drives if required; the type and number of drives depend upon the IBM 3494-L1x model.
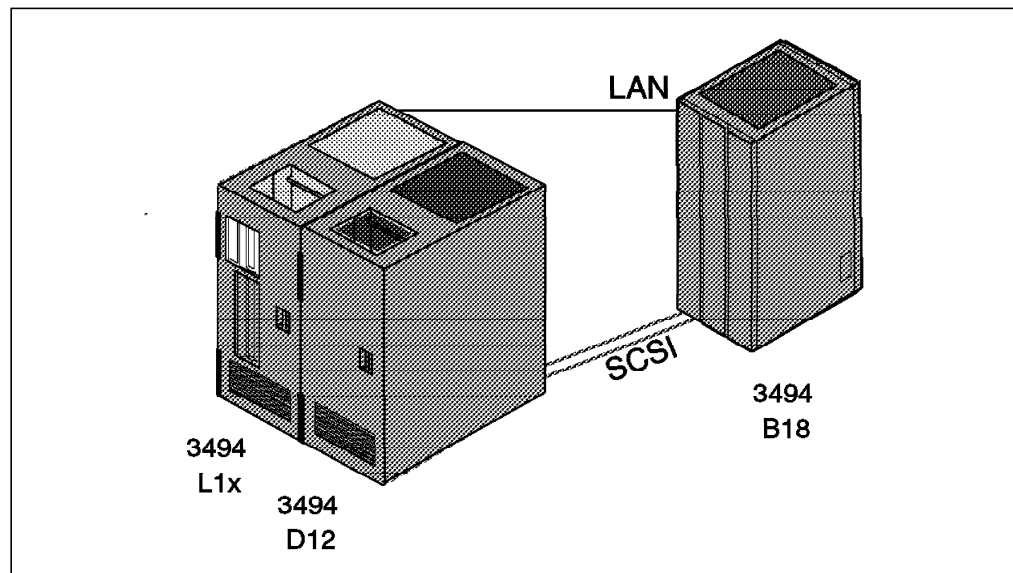
Figure 7. Minimal IBM Magstar VTS Configuration

The minimum configuration shown in Figure 7 can be enhanced to a library of up to 16 frames by adding other IBM 3494-Dxx frames, IBM 3494-S10 frames, and the IBM 3494-D12 frame for a second IBM 3494-B18 VTS subsystem in the same tape library.

Figure 8 shows an IBM Magstar 3494 Tape Library with an IBM 3494 Model L1x frame, two IBM 3494-D12 frames attached to two IBM 3494-B18 VTS subsystems, and an IBM 3494-D14 frame, which can include zero to four Magstar tape drives attached to the hosts through the IBM 3590-A60 controller and ESCON channels.
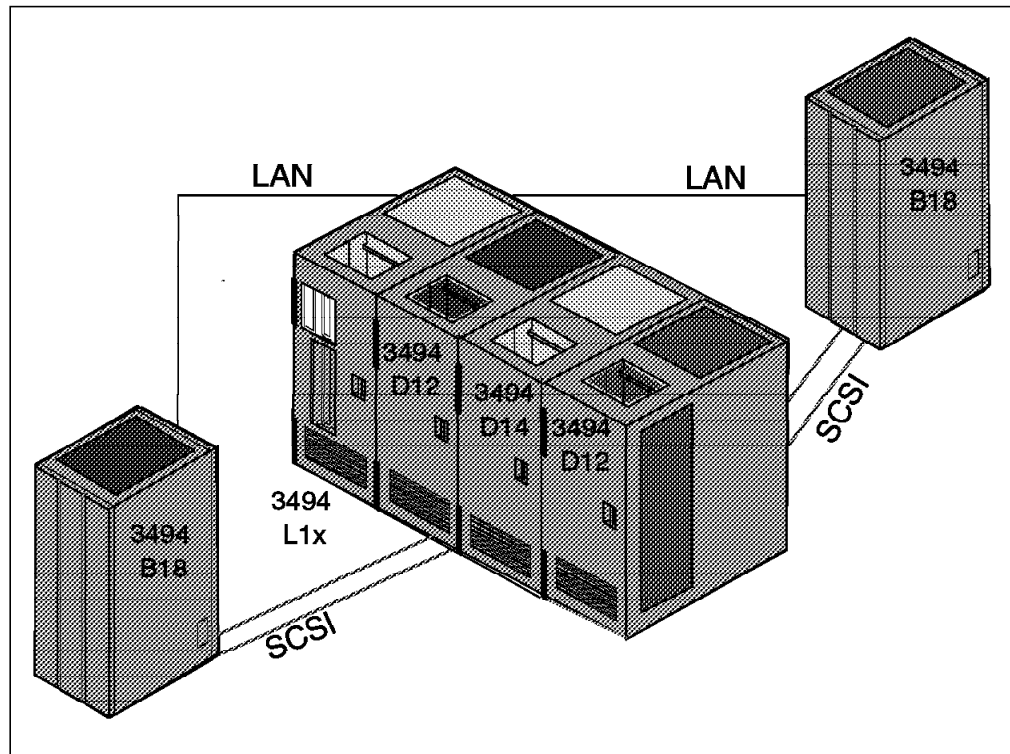
Figure 8. IBM Magstar 3494 Tape Library with VTS and Native Tape Drives

You can install a maximum of two VTS subsystems within a single IBM Magstar 3494 Tape Library either one IBM 3494-B16 and one IBM 3494-B18 subsystem, or two IBM 3494-B18 subsystems. You cannot, however, install more than one IBM 3494-B16 in a single IBM Magstar 3494 Tape Library. In addition to up to two VTS subsystems, you can extend the IBM Magstar 3494 Tape Library to up to 16 frames, which contain IBM 3490 or IBM 3590 tape drives, and cartridge storage cells.

Cartridges can be stored anywhere in the IBM Magstar 3494 Tape Library. The storage cells in the IBM 3494-D12 frame of a VTS subsystem are not dedicated to the cartridges used by that VTS subsystem. The Library Manager function is shared among all VTS and tape subsystems installed and manages all operations inside the IBM Magstar 3494 Tape Library.

Optionally, you can install the IBM 3494 Model HA1 High Availability Option, if your IBM Magstar 3494 Tape Library consists of 3, 4, 6, 8, 10, 12, or 16 frames, not counting the B18 frames. The IBM 3494-HA1 consists of two frames that are attached on the leftmost and rightmost sides of the IBM Magstar 3494 Tape Library. The frame next to the IBM 3494-L1x frame is a service bay. The frame

at the other end of the IBM Magstar 3494 Tape Library contains a second Library Manager and a second accessor in hot-standby mode.

Only one of the Library Managers can be active at any point in time. You can dynamically switch the active Library Manager to allow, for example, for concurrent Library Manager LIC update. Both Library Managers are synchronized permanently. If the active Library Manager fails, the second Library Manager will take over automatically.

The second accessor is in hot-standby mode. If the active accessor fails, the standby accessor will push it into the service bay next to the IBM 3494-L1x and will take over automatically.

For high mount performance, you can optionally activate the second accessor from standby to active mode. High availability and high reliability of an IBM 3494-HA1 are still maintained because each accessor can pick up activities of the other accessor should it require service. Figure 9 shows the configuration options for the IBM 3494-HA1 and IBM Magstar 3494 Tape Library dual active accessor (DAA).
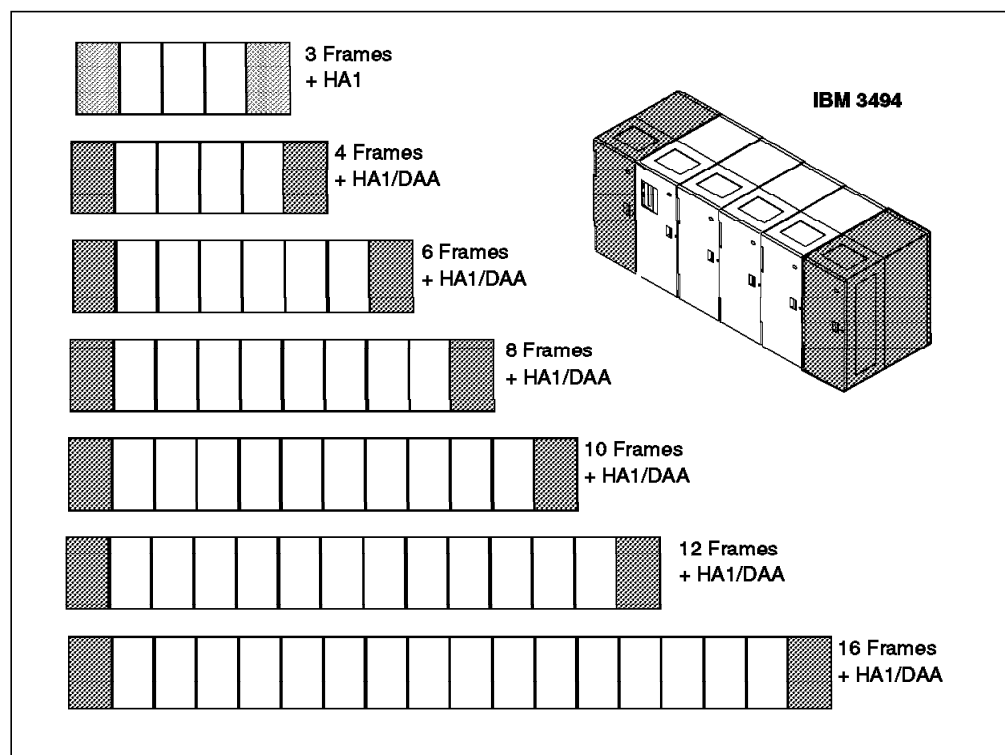
Figure 9. IBM Magstar 3494 Tape Library Configuration Options

The IBM Magstar 3494 Tape Library shown in the upper-right corner of Figure 9 is the minimum configuration for the DAA feature. The minimum configuration for installation of the IBM 3494-HA1 is three library frames, if the DAA is not installed. Attached IBM 3494-B18 frames are not considered library frames, because they do not account for the total physical length of the IBM Magstar 3494 Tape Library. The minimum configuration for the DAA feature is four library frames. For planning and operating information concerning the IBM Magstar 3494 Tape Library dual active accessor, refer to *IBM Magstar Tape Products Family: A Practical Guide,* SG24-4632.

2.1.1 IBM Magstar VTS Configurations

The Magstar VTS is available in different configurations in terms of the number and type of channels, type of host system attachments, the size of the TVC, and the number of physical Magstar tape drives that are dedicated to the VTS. Figure 10 shows the minimum and maximum configurations for the VTS with EHPO as well as the configuration options marked by dotted lines and shaded symbols.
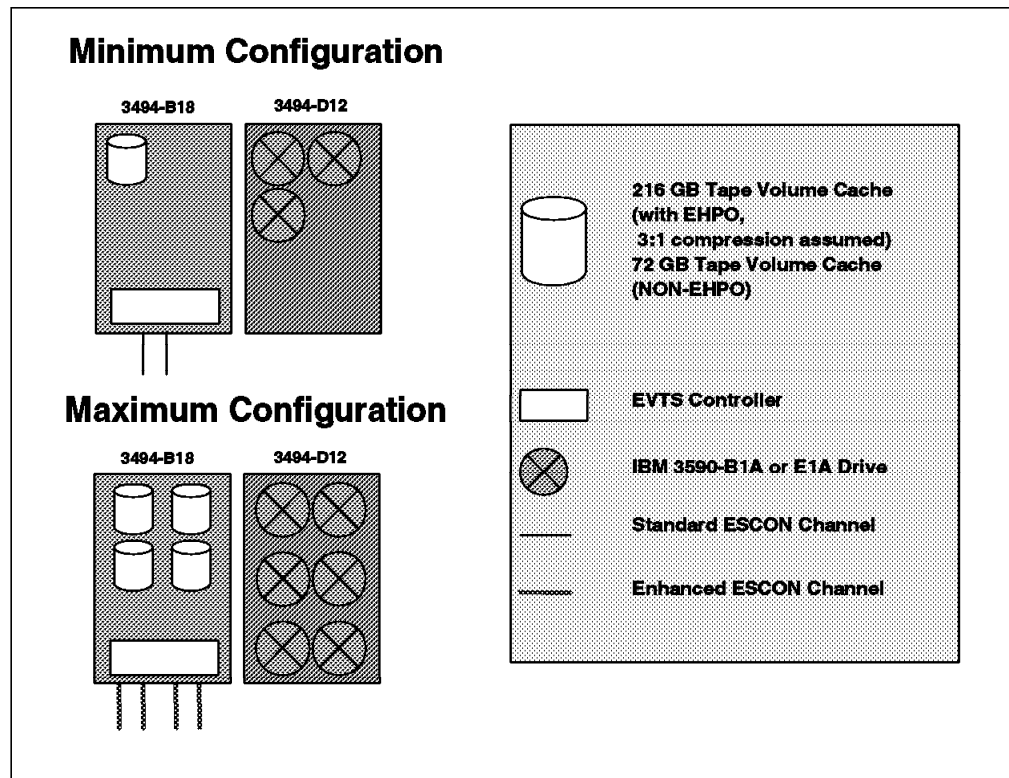
Figure 10. IBM Magstar VTS Configurations

The IBM 3494-B18 contains the VTS controller and the TVC.

In the minimum configuration, the TVC has a capacity of 72 GB for user data. The IBM 3494-B18 frame is connected to the host through two standard ESCON channels. The D12 frame contains three IBM 3590 tape drives connected to the VTS controller in the B18 frame.

In the maximum configuration, the IBM 3494-B18 frame contains the Performance Accelerator Feature and 864 GB, assuming a 3:1 compression ratio. The IBM 3494-B18 frame is connected to the host through four Extended Performance ESCON Channels. The IBM 3494-D12 frame contains six IBM 3590 tape drives connected to the VTS controller in the IBM 3494-B18 frame.

In addition to the minimum and maximum configuration, the following configuration options are available with the Magstar enhanced VTS:

- You can choose among the following attachment options:

    - Two standard ESCON channels
    - Two Extended Performance ESCON Channels
    - Four Extended Performance ESCON Channels

- Two Extended Performance ESCON Channels and one or two SCSI host attachment features, each SCSI host attachment feature provides two SCSI ports

- If you want to install the Performance Accelerator Feature additional configuration options are available:

  - Performance Accelerator Feature with four Extended Performance ESCON Channels
  - Performance Accelerator Feature with two Extended Performance ESCON Channels and two SCSI host attachment features, which provides four SCSI ports

- You can choose among the following cache configurations:

  - 72 GB
  - 144 GB
  - 216 GB
  - 288 GB

  Assuming a 3:1 compression ratio with EHPO, these figures are respectively 216 GB, 432 GB, 648 GB, and 864 GB.

- You can install three to six IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives in the IBM 3494-D12 frame for exclusive control of the VTS.

Each ESCON channel is capable of supporting 64 logical paths, for a total of 256 logical paths. Each logical path can address any of the 32 or 64 virtual devices in the VTS.

When installing an IBM 3494-B18 frame connected to selected RS/6000 SCSI hosts, the SCSI Host Attachment feature must be installed. The SCSI Host attachment feature provides two SCSI ports. The SCSI port supports the SCSI-2 (Fast, Wide, Differential) 20 MB/s standard interface, as well as the 40 MB/s Differential Wide Ultra SCSI interface. Daisy-chaining of multiple RS/6000s and multiple VTSs is permitted, however, be cautioned that sharing of the SCSI bus may affect performance. Virtual tape drive sharing between S/390 and SCSI hosts is allowed.

If you are upgrading an existing IBM 3494-B16 VTS to an IBM 3494-B18 VTS, see also Appendix D, "Migration of IBM 3494 Model B16 to Model B18" on page 325 for additional configuration information related to the migration.

2.2 Suitable Data for the IBM Magstar VTS

The IBM 3494-B18 VTS appears to the host systems as two or four 3490E strings with a total of 32 or 64 devices attached. Any data can reside on the VTS today. However, processing characteristics of workloads differ, so some data is more suited for the VTS than other data. In this section we highlight some of the considerations to bear in mind when deciding which data to place in an enhanced VTS. When you are selecting the data to migrate to the VTS subsystem, consider the following:

- **Throughput** — The VTS has a finite bandwidth as has any other device attached to a computer, and you should plan to put workloads onto the enhanced VTS that fit in its capabilities. The tools and processes described in 2.3, "Sizing the VTS" on page 24 can provide you with the information necessary to select the correct workloads for the VTS.

- **Cartridge capacity utilization** — One of the key benefits of the IBM Magstar VTS is its ability to fully utilize the huge capacity of the Magstar cartridge, and to manage that capacity effectively without host or user involvement. With enhanced ESCON host attachments that have data compression, a virtual volume may contain about the same amount of data as a native ECCST cartridge, thereby extending the capability of the VTS to store large data sets effectively. Very large data sets gain little from the VTS's ability to stack data, so you may want to leave them on native Magstar cartridges or migrate them to native Magstar cartridges.

- **Data location** — The Advanced Function feature with the Import/Export component feature of the IBM 3494-B18 allows you to export logical volumes, for example, to store them in a disaster vault, or to import them into another VTS subsystem. You should consider, however, that exporting logical volumes involves writing them onto exported stacked volumes, which then are ejected from the IBM Magstar 3494 Tape Library. If you need to export a large number of logical volumes frequently, you might consider placing them on native 3490 or Magstar cartridges or writing them to a IBM Magstar 3494 Tape Library installed at the vault location.

- **Read access after write** — Often, one step of a job writes a tape volume and a subsequent step (or job) reads it. A major benefit can be gained in an enhanced VTS environment when this occurs, as the data can be read directly from the TVC, which effectively removes the rewind time, the robotics time, and load or thread times for the mount.

Figure 11 shows the effect on a job and drive assignment that a VTS can have as compared to a native drive. The figure is a freehand drawing, and it is not to scale. It shows typical estimated elapsed times for elements that would make up the reading of data from a tape. When comparing the three time lines in Figure 11, notice that the VTS cache hit time line does not include robotics, load, or thread time at the beginning of the time line, and it does not include any rewind or unload time at the end.
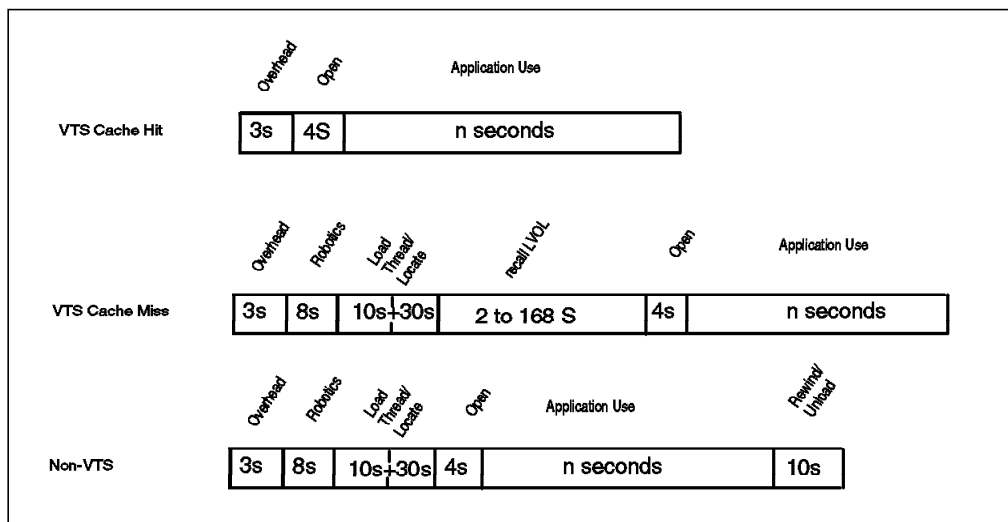
Figure 11. Tape Processing Time Comparison (freehand drawing, not to scale)

In this example, the VTS cache hit results in a savings in tape processing elapsed time of 40 sec.

The time reduction in the tape processing has two effects. First, it reduces the elapsed time of the job processing the tape. Second, it frees up a drive

earlier so the next job needing a tape drive can access it sooner as there is no rewind or unload and robotics time after closing the data set.

When a job attempts to read a volume that is not in the TVC, the logical volume is recalled to the TVC. This is shown as the cache miss and includes additional time to move the data from the tape to the TVC. In this case the processing profile is similar to that of a non-VTS environment.

- **Scratch write mount times** — When a program issues a scratch mount to write data, the VTS uses information held in the TVC to simulate the tape being mounted. We describe the scratch mount process in Section 1.5.1, "Mounting a Scratch Tape" on page 12. The effect of using the fragment data in the TVC is that the performance of scratch mounts is fast, because no physical mount is required. The performance for scratch mounts is the same as for TVC read hits, which are compared with the non-VTS equivalents in Figure 11 on page 22.

- **Drive concurrency** — The enhanced VTS appears to the host operating system as 32 or 64 3490E drives, depending on the size of the TVC and whether or not the EHPO feature is installed. If you have periods of time during the day when your tape processing jobs are limited by drive availability, the VTS may help your processing considerably. The design of the VTS allows transparent access to multiple logical volumes on the same stacked volume, because access to the logical volumes is solely through the TVC. If you need access to more than one logical volume, it is provided without requiring any user involvement, unlike some alternatives such as stacking by using JCL.

- **Volume sizes** — If your VTS subsystem does not have the EHPO feature installed, you may see an increase in the number of volsers for the host. This increase results from a logical volume size of either 400 MB or 800 MB and a compression rate for logical volumes of 1:1 (compression is performed in the IBM 3590 tape drive and thus is effective only on a stacked volume).

If you have an enhanced VTS subsystem installed that includes the EHPO feature, your logical volumes will achieve about the same compression rate as they achieve today with the (IDRC) compression of native 3490E tape drives. Because the IBMLZ1 algorithm used for compression in the TVC generally yields higher compression than IDRC used with native 3490E tape drives, you may see slight differences in the compression rates achieved.

- **Multifile volumes** — If you stack multiple files onto volumes today, by using JCL constructs or some other method, the reason you are stacking is most likely to better use cartridge capacity. Best utilization of cartridge capacity is, as already stated, a key objective of the VTS. Therefore, you should find that in many cases manual stacking of data sets onto volumes is no longer required. If you are planning a new application that would have used JCL to stack data sets onto a volume, the enhanced VTS makes the JCL step unnecessary.

Multifile volumes moved to the VTS work without changing the stacking. However, the VTS moves the complete logical volume to the TVC, rather than moving each file as you access it. Therefore, in some cases, it can be advantageous to let the VTS do the stacking automatically for you, as it can save you manual management overhead and, in some cases, host CPU cycles, host channel bandwidth, DASD space, or a combination of all of them.

For further detailed considerations on IBM Magstar VTS usage with specific types of data, see Chapter 6, "Using the IBM Magstar VTS" on page 123.

2.3 Sizing the VTS

In this section we document the process of using the Volume Mount Analyzer (VMA) to size the VTS to meet your requirements. The VMA is provided as part of the DFSMSdfp component of DFSMS/MVS.

2.3.1 Using the Volume Mount Analyzer

Figure 12, shows the steps involved in sizing a VTS. The steps will be familiar to many storage administrators as they have been used for sizing tape requirements and Tape Mount Management (TMM) requirements for a number of years.
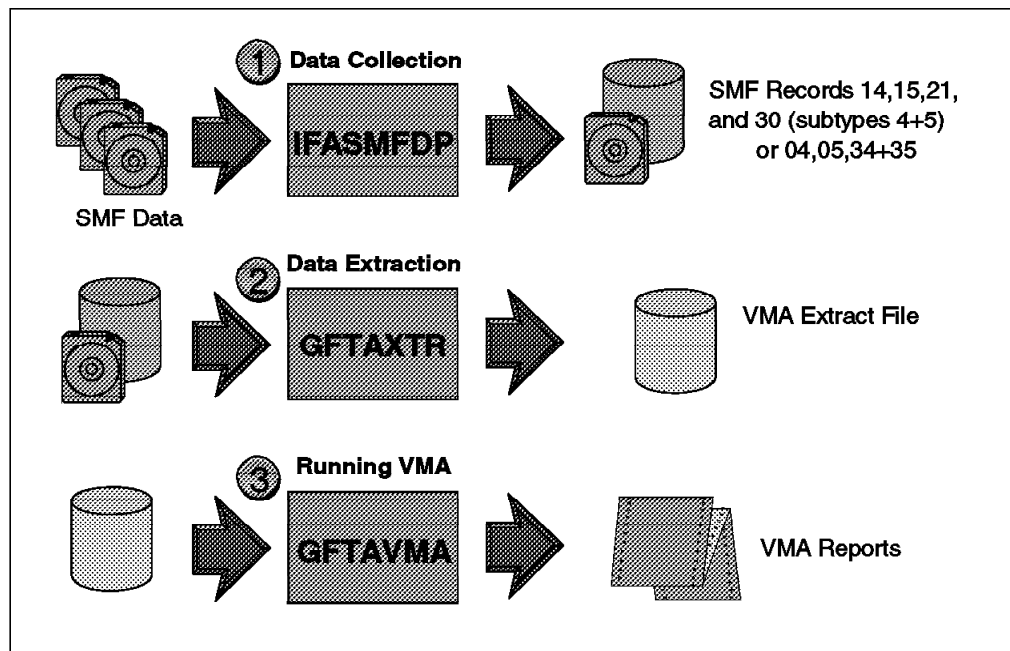
Figure 12. Steps to Sizing an IBM Magstar VTS

The steps shown in Figure 12 are:

Step 1:   The SMF data collection using the IFASMFDP program helps in selecting only the required SMF records and reduces the run time of the GFTAXTR program.

Step 2:   The data extract using the GFTAXTR program not only extracts the data you need for analysis but also reduces it in size. This reduction can be as high as 90% in most cases.

Step 3:   The VMA reporting program can be run a number of times to produce different reports from the data, allowing analysis of different parts of the workload.

2.3.1.1 Data Collection and Extraction

To correctly size the VTS, you have to analyze your current workload. The SMF records that are required to perform the analysis are record types 14, 15, and 21. In addition, record type 30, subtypes 4 and 5, or record types 04, 05, 34, and 35 are required. Be aware that VMA doesn't process record type 94. One SMF type 94 record per hour is generated by MVS per VTS and can be used to analyze an already operating VTS for capacity and performance planning. See Chapter 8, "VTS Performance" on page 203 for more information on analyzing SMF type 94. You should collect the stated SMF records for all MVS systems that share the current tape configuration and may have data migrated to the VTS. The data collected should span at least one month (to cover any month-end processing peaks). You need to check in SYS1.PARMLIB in member SMF* to see whether the required records are being collected. If they are not being collected, arrange for collection.

Use the IFASMFDP program to reduce the SMF input for GFTAXTR. You can concatenate multiple SMF input files in one GFTAXTR run to produce a single extract file. You can only process a single extract file with the VMA. This file has to be created in a single GFTAXTR run as shown in Figure 12 on page 24.

In large customer environments, GFTAXTR can run for several hours, and, if an error is encountered, the process must be started from the beginning. If you want to run the extract daily or weekly and concatenate the extract files later, you must have APAR OW21238 installed. Figure 13 shows the steps to create a single extract file from multiple runs for further analysis with the VMA.
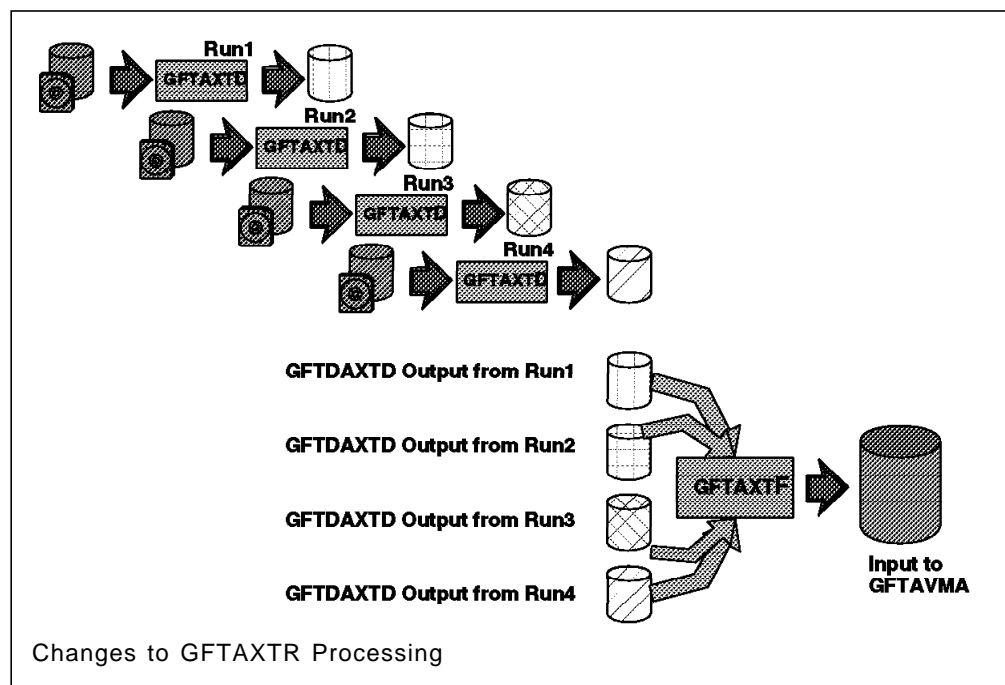
Figure 13. APAR OW21238

Instead of running the GFTAXTR program, you run GFTAXTD to create the intermediate files. These files cannot be processed by GFTAVMA you have to combine them into one extract file first by running the GFTAXTF program. When you run GFAXTD (daily or weekly), the output report only contains the internal record generation phase. When you run GFTAXTF (final), the output report contains all phases of the SMF record processing.

In addition to the extract file, the following information is useful for sizing the VTS:

- Number of volumes in your current tape library

  This should include all your tapes (those in automated libraries, on shelves, and offsite)

- Criteria for identifying volumes

  Because volumes that go offsite, that are used as backup, or that should be ignored are of particular interest, their identification is important. Identifiers such as high level qualifiers (HLQs), program names, or job names, must be documented.

- Number and type of tape control units installed

  This information and the next two items of information provide a good understanding of the current configuration and help you identify the reasons for any apparent workload bottlenecks.

- Number and type of tape devices installed

- Number and type of host channels attached to tape subsystems

2.3.1.2 Running the Volume Mount Analyzer

The VMA has been a standard part of DFSMSdfp, since DFSMS 1.1. You can use it to analyze SMF data to gain an understanding of how you use tapes today. The VMA can also model the effect of making changes to your installation such as changing from one tape technology to another or changing from one type of cartridge to another. When analyzing a tape workload for migration to a VTS, the VMA can:

- Filter out parts of data not being moved to the VTS, on the basis of program name, job name, HLQ, device address, device type, or the like
- Provide read/write ratio analysis to help you understand the effect of fast scratch mounts when you use the VTS.
- Provide analysis of hourly mount rates
- Provide analysis of hourly transfer rates (in GB) to help you determine your throughput requirements
- Provide analysis by job name, program name and HLQ to assist you in determining the effect of moving certain parts of your workload.

To find out more about running the VMA and analyzing the output, see *DFSMS/MVS Using the Volume Mount Analyzer*, SC26-4925.

For further analysis and configuration guidelines, contact your IBM representative.

2.3.2 Planning for Volume and Cartridge Storage

Before you order labels for the physical cartridges, and before you define logical volumes to the VTS subsystem, we recommend that you consider the volume serial ranges to define and the number of volumes within each range.

The volsers must be unique throughout an SMSplex and throughout all storage hierarchies such as DASD, tape, and optical storage media.

2.3.2.1 Sizing the Number of Logical Volumes

If your IBM 3494-B18 has EHPO installed, which provides compression in the TVC, you will not see many changes regarding the number of logical volumes compared to the number of physical 3480 or 3490 cartridges that you are using.

If your IBM 3494-B18 does not have EHPO installed, the size of a logical volume is limited to 400 MB for MEDIA1 volumes and to 800 MB for MEDIA2 volumes. Therefore, you might experience a large number of multivolume files. You might also need a larger number of logical volumes compared to the number of physical 3480 or 3490 cartridges that you are using.

We recommend considering the following points before defining logical volumes to the VTS subsystem:

1. First insert five virtual volumes to make sure insert and the CBRUXENT exit work with the tape management system.

2. Then put in a few hundred virtual volumes for functional testing.

3. Set a reasonable scratch limit in ISMF for each library and media type and add enough virtual volumes (less than your target amount) so that when you go into production, you will soon hit your threshold. Track the CBR3660A message, which indicates that you are low on scratch and validate your procedures for adding additional logical volumes (which eventually you may only rarely do).

   Refer to 7.8, "Inserting Stacked Volumes in the VTS" on page 177 for a description of the insert process.

A recommended formula to use to calculate the number of logical volumes needed is shown here:

Number of Virtual Volumes:

$Vv = T + (Ax + Si)N$

Where **Vv =** number of virtual volumes to be inserted

T = the value used in the ISMF Library Define panel for the scratch threshold for the media type used (normally media2)

Ax = the average expiration period in days for the volumes destined for the VTS or the length of time in days for which the VTS was designed and sized to operate, using the smaller of the two

Si = the number of days between scratch processing (return to scratch) by the tape management system

N = number of scratch volumes mounted each day by the applications using the VTS

- If you define more volumes than you need, you can delete the additional volumes. When you delete the volumes, however, you may leave gaps in the tape ranges. This will be difficult to manage because you have to keep track of which volumes you can insert later. Reinserting the volumes later has to be done on a volume-by-volume basis instead of in groups. See section 7.12, "Ejecting Logical Volumes from the VTS" on page 188 for the exact procedures to delete logical volumes.

- Tie the volser to the volume's location, rather than to the data that resides on the volume. A volser of VT0001 tells you that the logical volume is VTS resident but does not tell you whether the data on the volume is test or production. A volser of TEST02 tells you that the data that resides on the tape is test data. It does not, however, tell you that the volume is a VTS volume and cannot be physically removed.

  Make sure that you can clearly distinguish between your logical volumes and the physical cartridges.

Take the time you need to decide which volsers and which media type to define to the VTS subsystem.

2.3.2.2 Sizing the Number of Stacked Volumes

The number of stacked volumes that you need for your VTS subsystem depends on the number of logical volumes you define, the average amount of data you write on the volumes, and the average compression ratio achieved for the data. Remember that logical volumes occupy space on the stacked cartridges even after they have been returned to scratch: Only when a logical volume is rewritten, the data on the stacked volume for this logical volume is eligible to be reclaimed.

The number of stacked volumes also depends on the reclaim threshold percentage that you have specified. The default is set to 10%. If a stacked volume contains less than 10% of active data, it is eligible for space reclamation.

Note that the number of stacked volumes may not be the same for the base IBM 3494-B16 or 3494-B18 and for the IBM 3494-B18 with EHPO installed. With the base models, data is compressed by the 3590 tape drive. With the B18 with EHPO, the data is compressed as it is written to the TVC. Depending upon the nature of the data patterns, the compression achieved by the EHPO channel attachment and the 3590 tape drive will not be the same.

You can calculate the number of stacked volumes required to support a given number of logical volumes as:

```
# of stacked volumes = ( active data / stacked volume capacity ) +
# of empty stacked volumes
```

where:

- Active data = # of logical volumes * average logical volume size

  This is the amount of uncompressed user data. Note that the number of logical volumes is the number you have defined to the VTS, not merely the number of private volumes.

- Stacked volume capacity = native cartridge capacity * compression ratio * stacked volume utilization

  The native cartridge capacity of a cartridge written by an IBM 3590 Model B1A tape drives equals 10 Gbytes. The native cartridge capacity of a cartridge written by an IBM 3590 Model E1A tape drives equals 20 Gbytes.

  This is the amount of active data a stacked volume will hold, on average. **Compression ratio** is the average compression ratio for data you are moving into the VTS.

If you do not know the compression ratio assume a conservative 2:1, unless the data is already in compressed format, in which case you assume 1:1. Please see 8.4, "Monitoring and Evaluating VTS Performance" on page 210 for information on obtaining your compression ratio.

Stacked volume utilization is calculated as:
((100% + reclaim threshold percentage)/100)/2

We assume that the utilization of non-empty stacked volumes varies evenly between 100% and the reclaim threshold percentage specified for the VTS.

- # of empty stacked volumes = active data * (buffer percentage/100) / stacked volume capacity

The VTS needs empty stacked volumes to store new copies of logical volumes. It also needs empty stacked volumes to do reclamation and import/export of stacked volumes if the Advanced Function feature has been installed. Reclamation will eventually return low utilized stacked volumes back to scratch but you need to make sure the VTS has enough free storage to operate with. In addition, you should have additional free storage as a buffer against an overall increase in the amount of data in the VTS which may be due to an increase in the average logical volume size, or a decrease in the average compression ratio. We express the size of the free storage buffer as a percentage of active data and calculate the required number of empty stacked volumes based on it. The buffer should be at least 10% of your active data, preferably in the range of 15% to 25%.

You should consider having a minimum of 50 empty stacked volumes in the VTS at all times. Remember that the way reclamation works depends on whether there are more than or less than 50 scratch stacked volumes available to the VTS subsystem. You should never let the number of empty stacked volumes fall below 10, as that will have an impact on VTS performance. For more details refer to section 1.5.6.2, "Stacked Volumes" on page 15.

Each time you add new logical volumes you must check that you have enough stacked volumes to support them. Do not simply add stacked volumes in the same ratio as you add logical volumes. Take into account the characteristics (volume size and compression ratio) of the new workload you are moving into the VTS.

Table 1 on page 30 gives you some guidelines for sizing the number of stacked volumes that you will need according to the compression ratio that you achieve. The values listed in the table are based on the following assumptions:

- Low compression is a factor of 2:1, high compression is a factor of 3:1.
- The reclaim threshold is 10% (the default), yielding a stacked volume utilization of 0.55
- The free storage buffer is 25%; however, a minimum of 50 empty stacked volumes are included.
- The logical volumes are defined as ECCST or MEDIA2 in the VTS
- 1 GB = 1000 MB

Table 1. Minimum Physical Cartridges Required for 10,000 Logical Volumes				
Avg Volume Size (uncompressed)	**Average Compression Ratio**			
	2 : 1		**3 : 1**	
	3590-B1A	**3590-E1A**	**3590-B1A**	**3590-E1A**
150 MB	187	119	141	96
200 MB	232	141	172	111
250 MB	285	164	202	126
300 MB	341	187	232	141
350 MB	398	210	266	157
400 MB	455	232	304	172
500 MB	569	285	379	202
600 MB	682	341	455	232
700 MB	796	398	531	266
800 MB	910	455	607	304
1000 MB	1137	569	758	379
1200 MB	1364	682	910	455
1600 MB	1819	910	1213	607
2000 MB	(1)	(1)	1516	758
2400 MB	(1)	(1)	1819	910
Note: (1) Not possible with the given compression ratio				

At an average volume size of 700 MB, you can see in Table 1 that, depending on the compression ratio, you will need at least 266 to 398 physical cartridges assuming 10,000 logical volumes using IBM 3590 Enhanced Models or 531 to 796 physical cartridges using IBM 3590 Base Models.

2.4 Physical Planning and Placement

In this section we present information that your planning department needs to ensure that the site planned for the VTS is suitable. Refer to the *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279, for additional information.

2.4.1 Operational Requirements

The physical dimensions of the IBM 3494-B18 frame, which is located outside the IBM Magstar 3494 Tape Library, differ from the dimensions of the other IBM 3494 frames. Table 2 lists the dimensions without service clearance.

Table 2. IBM Magstar 3494 Tape Library Frame Dimensions in Millimeters			
Frame	**Height**	**Front**	**Side**
3494-B18	1800	724	1036
3494-L1x/D1x	1800	725	1520
3494-S10	1800	725	715
3494-HA1	1800	725	1520

In addition to the dimensions listed in Table 2, a service clearance of 1016 mm is required in front of and behind the IBM Magstar 3494 Tape Library. On both

the left- and the right-hand side of the IBM Magstar 3494 Tape Library, a service clearance of 762 mm is recommended.

Table 3 provides the VTS specifications for weight, heat output, airflow, power requirements, and cartridge slots.

Table 3. IBM Magstar VTS Specifications					
Frame	Weight (kg)•	Heat Output (kW)	Airflow (qm/min)	Max. Power (KVA)	Cartridge Slots•
L1x w/o drives	444	0.3	0	0.3	240•
D12 + 3xB1A/E1A	405.8	1.00	3.9	1.20	290
D12 + 4xB1A/E1A	434.4	1.30	5.2	1.50	290
D12 + 5xB1A/E1A	463.0	1.60	6.5	1.80	250
D12 + 6xB1A/E1A	491.6	1.90	7.8	2.10	250
B18 (216GB) •	485	1.08	0	1.2	0
B18 (432 GB) •	540	1.53	0	1.7	0
B18 (648 GB) •	595	1.98	0	2.2	0
B18 (864 GB) •	650	2.43	0	2.7	0
HA1 (left)	444	0.1	0	0.1	0
HA1 (right)	444	0.3	1.5	0.3	0
Note:					
1. All weights exclude any cartridges installed in frames.					
2. Cartridge slot capacities are based on the installation of a single gripper. If a dual gripper is installed, reduce slot numbers by 10%.					
3. If the L1x frame does not have the optional Convenience Input/Output station. The optional Convenience Input/Output Station feature reduces the cartridge capacity by 30 cartridges (10-cartridge Convenience Input/Output Station) or 80 cartridges (30-cartridge Convenience Input/Output Station)					
4. Assuming a 3:1 compression ratio with EHPO. Without EHPO respectively 72 GB, 144 GB, 216 GB, and 288 GB.					

For further information about the physical installation of VTS subsystems, please refer to the *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279.

2.4.2 Physical Planning Considerations

While physical planning is a customer responsibility, we recommend that you consider the following factors when you decide where to put your new VTS subsystem:

- Do you plan to add additional frames to the IBM 3494 in the near future? Do you, for example, plan to install the High Availability option some time later? If so, allow enough space for the new frames when the VTS subsystem is installed. A few extra hours spent planning up front can save you days relocating equipment later.

- Do you plan to relocate the computer room to another room, building, or site in the near future? If so, how much time does it take to relocate a VTS subsystem and its IBM 3494? If the VTS subsystem is in production use before the relocation, how will the relocation affect your production schedule?

- Have you allowed for service clearances when determining where you will put the VTS subsystem? Consult the *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279, *Magstar 3494 Tape Library Operator Guide*, GA32-0280, and the IBM Magstar 3494 Tape Library Systems Assurance Product Review (SAPR) Guide (available from your IBM representative) for additional information about physical specifications and service clearances.

- Will your IBM Magstar 3494 Tape Library be located in a remote area without operating staff, for example, in a disaster recovery vault? If it will be, you might consider installing the Remote Library Manager Console feature, which allows you to see intervention required messages or perform such actions as defining additional logical volumes without having to be at the site where the IBM Magstar 3494 Tape Library is installed. For additional information about the Remote Library Manager Console, see 2.8, "Ordering Support" on page 36.

  In addition to the Remote Library Manager Console, you might consider implementing Simple Network Management Protocol (SNMP) traps for monitoring IBM 3494 events.

  For more information about SNMP, see 8.4, "Monitoring and Evaluating VTS Performance" on page 210.

The considerations listed above are intended to help you think about your physical environment, and the placement of the VTS subsystem in that environment. It is easier to move equipment on paper than in real life when the equipment is fully loaded.

2.5 Software Requirements

The IBM Magstar VTS appears to the host operating system as two or four fully configured IBM 3490E tape subsystems. The software levels required to support the VTS are the same as those for IBM 3490E tape subsystems, because the VTS appears to the host as an IBM 3490E tape subsystem in an IBM Magstar 3494 Tape Library. The MVS software levels are documented in Table 4 on page 33, along with appropriate levels of DFP or DFSMS. For DFP 3.3.0 or DFP 3.3.2 support, BTLS must be installed.

Table 4. IBM Magstar VTS MVS Host Software Support						
MVS Level•	DFP 3.3.0•	DFP 3.3.2•	DFSMS 1.1	DFSMS 1.2	DFSMS 1.3	DFSMS 1.4 and higher
MVS 4.2.2	Yes	Yes				
MVS 4.3.0	Yes	Yes	Yes	Yes	Yes	
MVS 5.1.0	Yes	Yes	Yes	Yes	Yes	Yes
MVS 5.2.0			Yes	Yes	Yes	Yes
MVS 5.2.2			Yes	Yes	Yes	Yes
OS/390 R1 or higher					Yes	Yes
Note:						
•For JES3 support of BTLS, refer to Washington Systems Center						
• DFP 3.3.0 or DFP 3.3.2 support requires BTLS. Flash 9421.						

Installation of APAR OW27369 is recommended, but not necessary, for correct operation of the VTS. APAR OW27369 provides VTS statistics in SMF record type 94. The SMF data is an extension of library hourly statistics data, added in bytes 128 through 209. The following PTFs provide APAR OW27369 for each DFSMS/MVS and BTLS release:

- UW39020 for DFSMS/MVS 1.2.0
- UW39021 for BTLS on DFSMS/MVS 1.2.0
- UW39022 for DFSMS/MVS 1.3.0
- UW39023 for BTLS on DFSMS/MVS 1.3.0
- UW39024 for DFSMS/MVS 1.4.0

With the Installation of APAR OW28687, the VTS subsystem can provide service information messages (SIMs) and maintenance information manual (MIM) messages to MVS. These messages are sent to MVS and displayed on the console when certain hardware events occur. The following PTFs provide APAR OW28687 for each DFSMS/MVS release:

- UW45782 for DFSMS/MVS 1.2.0
- UW49119 for BTLS on DFSMS/MVS 1.2.0
- UW45784 for DFSMS/MVS 1.3.0
- UW49121 for BTLS on DFSMS/MVS 1.3.0
- UW45786 for DFSMS/MVS 1.4.0
- UW49123 for BTLS on DFSMS/MVS 1.4.0

If you have Performance Reporter for MVS (5695-101), some maintenance is required to support the SMF type 94 fields for the VTS. If you have Performance Reporter for MVS (5695-101) Release 2, you need APAR PQ11003, which is provided in PTF UQ12562. If you have Performance Reporter for MVS (5695-101) Release 3, you need APAR PQ15261, which is provided in PTF UQ17979.

Table 5 on page 34, shows the host software support levels other than MVS, DFP, and DFSMS. The levels of software required are the same as those for IBM 3490E devices. In the case of VSE, there is no native support for tape libraries.

Table 5. IBM Magstar VTS Host Software Support	
Environment	**Minimum Levels**
Native VM	VM/ESA 1.2 DFSMS/VM 221
Native VSE	No support for the VTS
VSE guests	VM/ESA 1.2 DFSMS/VM 221 VSE/ESA 1.3.5 + PTFs
EREP	3.5 + PTFs

No specific software level or PTF is required for DFSMSrmm to support VTS. We recommend that you check DFSMSrmm information APARs II08155 and II10888 for new functions related to the VTS and library environment. In general a check of the PSP bucket for the VTS is recommended.

2.5.1 Software Requirements for Advanced Functions

Functional exploitation of the VTS Advanced Function feature, including the Import/Export component, is provided as an SPE on DFSMS/MVS 1.4, and on DFSMS/MVS 1.5. There is no associated changes required for MVS/SP or OS/390. Independent software vendors for tape management systems should be contacted regarding their support plans for exploitation of the Import/Export capability. Refer to Chapter 9, "IBM Magstar VTS Advanced Function" on page 245 for APAR numbers.

In order to allow Import/Export enhanced hosts to share an Advanced Function feature capable VTS with other S/390 host systems that do not have Import/Export capability, toleration PTFs are provided for DFSMS/MVS V1.1 and later.

Note: Support for the Advanced Function feature is currently not available for VM/ESA. Support for the Advanced Function feature is not available and not planned for BTLS.

2.6 Education and Training on the IBM 3494-B18 VTS

The amount of education and training your staff requires on the IBM 3494-B18 VTS depends on a number of factors, including these:

- Are you installing the IBM 3494-B18 VTS in an existing IBM Magstar 3494 Tape Library?
- Are both the IBM 3494-B18 VTS and the IBM Magstar 3494 Tape Library new to your site?
- Are you using BTLS or SMS tape to manage your IBM Magstar 3494 Tape Library?
- Is the tape library and the VTS shared among multiple systems?
- Do you have existing 3590 tape drives at your site?

2.6.1 IBM 3494-B18 VTS in an Existing IBM Magstar 3494 Tape Library

If you are adding an IBM 3494 Model B18 to an existing IBM Magstar 3494 Tape Library containing an IBM 3494 Model B16 training for your operators, systems programmers, and storage administrators is minimal. Although the Library Manager posts operator interventions that are specific to the IBM 3494-B18 VTS, the messages posted to the host are not new. The operator intervention and help pull-downs in the Library Manager have been updated to contain these VTS-specific interventions and the actions necessary to resolve the conditions.

We recommend that training for your operations staff include the following:

- VTS subsystem as a closed store for VTS subsystem without the Advanced Function feature
- Operator intervention conditions and their resolution
- Proper procedures for opening and closing frames
- VTS-specific Library Manager functions
- Advanced Function (Export/Import)

We recommend that your storage administrators and systems programmers receive the same training as the operations staff plus :

- Software choices and how they affect the VTS subsystem
- Disaster recovery considerations

2.6.2   New VTS and New IBM Magstar 3494 Tape Library

If you are putting in a new IBM Magstar 3494 Tape Library with an IBM 3494-B18 VTS, the education and training for your staff should include the IBM 3494-B18 VTS training items listed in 2.6.1, "IBM 3494-B18 VTS in an Existing IBM Magstar 3494 Tape Library," as well as the following IBM Magstar 3494 topics:

- Role of the Library Manager and how the operator interacts with it
- Proper procedures for changing modes
- Proper procedures for changing states
- Entering and exiting manual mode
- Proper procedures for entering tape cartridges in the IBM 3494
- Operator intervention conditions and how to resolve them
- How data is allocated to a tape cartridge in the IBM 3494
- Proper procedures for ejecting tapes from the IBM 3494

We recommend that you review the *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279, *Magstar 3494 Tape Library Operator Guide*, GA32-0280, and the *IBM Magstar 3494 Tape Library SAPR Guide* for additional information about education and training.

You may also contact your IBM marketing representative for further information about education and training for the IBM Magstar 3494 and VTS.

2.6.3 Migrating of an Existing IBM 3494-B16 to a Model B18

If you are migrating an existing IBM 3494-B16 VTS to a Model B18 VTS, the education of your staff should include the changes that have been introduced with the IBM 3494-B18. For details on these changes, refer to Appendix D, "Migration of IBM 3494 Model B16 to Model B18" on page 325. We recommend that you also review Chapter 7, "Operating the VTS" on page 165 and 8.4, "Monitoring and Evaluating VTS Performance" on page 210 for additional information about operational changes.

2.6.4 Sharing the IBM 3494-B18 VTS with Other Systems

In addition to the material in 6.3.4, "Sharing a VTS Subsystem" on page 130, refer to the *Guide to Sharing and Partitioning Tape Libraries*, SG24-4409.

2.6.5 Experience with IBM 3590 Technology

If IBM 3590 technology is new for your staff, their education and training should include:

- Differences between IBM 3490 and IBM 3590 technology
- Cleaning recommendations and procedures for IBM 3590 drives
- Care, handling, and storage of 3590 tape cartridges
- Message display pods on IBM 3590 drives and how to use them

2.7 Implementation Services

IBM Global Services provides two different levels of service to help customers implement the VTS and IBM Magstar 3494 Tape Library.

IBM Planning Services

IBM provides:

- Consultation on the implementation options for the IBM Magstar 3494 Tape Library
- Consultation on your VTS
- Basic skills instruction for your operators and storage administrators on VTS server implementation uses
- Skills instruction for advanced implementation of your IBM Magstar 3494 Tape Library.

Refer to announcement letter ZS98-0128.

IBM Design Services

IBM provides:

- Migration reviews that include analysis of your tape subsystem and tape mounts
- Verification that data migration conditions do not exist that could adversely affect your tape subsystem and tape mounts
- A three-phase design that includes tape environment analysis, virtual tape server environment design, and a presentation of the results.

Refer to announcement letter ZS98-0129.

For availability in your country, check with your IBM service representative.

2.8 Ordering Support

In this section we describe all feature codes that are related to the installation of an IBM 3494-B18 VTS. We group the feature codes according to the frame models to which they belong. If you install additional frames other than IBM 3494 Model B18 and its attached Model D12, or Models L1x, S10, or HA1, refer to the *IBM 3494 Tape Library: Introduction and Planning Guide*, GA32-0279 and to the *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632.

2.8.1 IBM 3494 Model B18 Feature Codes

These feature codes can be installed on the IBM 3494-B18 frame and determine the configuration of the enhanced VTS. The feature codes are used to specify the Remote Support Facility configuration, the size of the TVC, the type and number of channel attachments to be shipped with the IBM 3494-B18, and other options. Table 6 summarizes the feature codes required on the IBM 3494 Model B18 VTS.

Table 6. IBM 3494-B18 Special and Specify Feature Codes				
Feature Code	Min. Qty.	Max. Qty.	Field / Factory Install	Description
2710	0 •	1	yes / yes	Remote Support Facility
2711	0 •	1	yes / yes	Remote Support Switch
2712	0 •	1	yes / yes	Remote Support Attachment
3200 •	0	1	yes / yes	ESCON High Performance Option (Withdrawn)
3302	0	1	yes / yes	Additional Enhanced ESCON Host Channel Attachments (Withdrawn)
3400	0	1	yes / yes	Extended High Performance Option
3412	0	2	yes / yes	Extended Performance ESCON Channels
3422	0	2	yes / yes	SCSI Host Attachments
3702	1 •	4	yes / yes	Disk Storage Capacity for Model B18
4000	0	1	yes / yes	Advanced Function (Import/Export)
5001	0	4	yes / yes	4.5 m SCSI Cable
5002	0	4	yes / yes	10 m SCSI Cable
5003	0	4	yes / yes	20 m SCSI Cable
5004	0	4	yes / yes	10 m SCSI VHDCI Cable
5234	1	1	yes / yes	18 m SCSI Cables
5236	1	1	yes / yes	Performance Accelerator
9106	0 •	1	yes / yes	RS/6000 Attached Processor
9109	0 •	1	yes / yes	S/390 Attached Processor
9201	0	1	yes / yes	VTS Open Systems Device Drivers
9702	0	4	yes / yes	Interposer for RS/6000
9986	0	1	yes / yes	6 ft Chicago Power Cord

Note:

1. One feature code 2710, 2711, or 2712 must be installed.

2. Feature code 3400 replaces FC 3200 on any new order; it is required to support 64 virtual drives and for the Import/Export function.

3. A minimum of two feature codes 3702 are required to support 64 virtual drives.

4. One feature code 9106 or 9109 must be installed.

For details on the feature codes listed in Table 6, review the descriptions below.

2.8.1.1 Remote Support Facility (FC 2710)

The remote support feature codes (FC 2710, 2711, 2712) provide rapid diagnostic and remote support facilities. The same modem and switch can be shared among the following units: 3494 Model B18, HA1, L10, L12, or L14 and 3590 Model A00, A50 or A60. One of these three feature codes should be selected on the basis of the number of units in the installation. Each 3494 Model B18, L10, L12, and L14 must specify either FC 2710, 2711, or 2712. Model HA1 must specify either FC 2711 or 2712.

For a configuration example, see 2.8.1.4, "Remote Support Configuration Example."

Feature code 2710 supplies a cable and connectors for connection to an IBM supplied modem to enable remote diagnostic support. This feature code should be specified only on the first unit of each set of 14 units in an installation.

2.8.1.2 Remote Support Switch (FC 2711)

Feature code 2711 provides cable, connectors, and a switch for the attachment of multiple units through the switch to a modem. It should be ordered on the second unit attached to the modem in an installation. One switch should be specified for each set of 14 units in an installation.

2.8.1.3 Remote Support Attachment (FC 2712)

Feature code 2712 provides an additional cable and connector to attach to the remote support switch (FC 2711). It should be ordered on the third through the fourteenth unit attached to the switch in an installation.

2.8.1.4 Remote Support Configuration Example

This example shows how to configure feature codes 2710, 2711, and 2712. For instance, an IBM 3494 configuration with one Model L14, one Model HA1, one Model D14, one Model B18, and two 3590 Model A60 tape controllers represents 18 units in total to be connected to the remote support facility. The following feature codes must be configured:

- One feature code 2710: for example, on Model L14. One modem is supplied with feature code 2710.
- One feature code 2711: for example, on Model HA1
- Two feature code 2712s: for example, one for each 3590 Model A60 tape controller
- One feature code 2712: for example, on Model B18

2.8.1.5 ESCON High Performance Option (FC 3200)

Withdrawn from marketing.

Feature code 3200 contained the micro code for compression and two enhanced ESCON host channel attachments that provided larger effective cache and the definition of up to 64 virtual devices.

Installations with this feature installed will keep it, but the Enhanced ESCON Channel card will be replaced during the upgrade with the Performance Accelerator Feature. Feature code ESCON High Performance Option F/C 3200 is replaced by Extended High Performance Option F/C 3400 with any new order.

2.8.1.6 Additional Enhanced ESCON Channel Attachments (FC 3302)

Withdrawn from marketing.
Feature code 3302 provided two additional Enhanced ESCON Channel attachments for attaching the IBM 3494-B18 to host system ESCON channels is replaced by Extended Performance ESCON Channels F/C 3412 now.

Feature code 3200 had to be installed or ordered as a prerequisite for this feature code.

2.8.1.7 Extended High Performance Option (FC 3400)

FC 3400 for the VTS Model B18 enables data compression capability, which provides larger effective cache capacities and improved performance. This feature also enables virtual addressing of 64 tape drives. Furthermore it is prerequisite for the Advanced Function FC 4000, the Extended Performance ESCON Channels FC 3412 and the Performance Accelerator Feature FC 5236. This feature can be specified for factory or field installation. It replaces the old EHPO feature code 3200 but contains no changes.

2.8.1.8 Extended Performance ESCON Channels (FC 3412)

FC 3412 provides two independently operating Extended Performance ESCON Channels adapters for the Model B18. Either FC 3200 ESCON High Performance Option or FC 3400 with FC 3412 Extended Performance ESCON Channels is a prerequisite to FC 3412. One FC 3412 may be ordered if FC 3200 is installed already. A maximum of two FC 3412 may be ordered with FC 3400, if you order a new VTS Model B18 or upgrade a B18 standard model. FC 3412 includes two 30.5 meter (100 foot) ESCON cables. This feature can be specified for factory or field installation.

2.8.1.9 SCSI Host Attachments (FC 3422)

Each feature code 3422 provides two SCSI ports for attachment to the SCSI-2 (Fast, Wide, Differential) 20 MB/s standard interface or the 40 MB/s Differential Wide Ultra SCSI interface on open system hosts. A maximum of two FC 3422 may be ordered (factory or field). Either FC 3200 ESCON High Performance Option or FC 3400 with FC 3412 Extended Performance ESCON Channels is a prerequisite to FC 3422. An operational ESCON host must be attached. Each bus provides up to 16 virtual devices and emulates 3490E tape drives. Each feature supports a maximum of 16 virtual devices. Today, this feature is supported on selected RS/6000 systems with appropriate software support.

FC 3422 requires feature 9201 (VTS open systems device driver), and feature code 9106 (RS/6000 attachment) and is mutually exclusive with feature 3302. Attachment requires the use of a Double Byte Wide Interposer (9702) with the appropriate SCSI cable (such as feature code 5001).

FC 5220 (Ethernet adapter) is required if the RS/6000 is attached to the IBM 3494 using a LAN. LAN connection enables control command processing from the host. Instead of FC 5220, FC 5217 (RS-232 cable) can be used, if host communication is to be done using the serial connection.

2.8.1.10 Disk Capacity for the Tape Volume Cache (FC 3702)

Feature code 3702 provides the DASD arrays and instructions for installing 216 GB, assuming a 3:1 compression ratio with EHPO, of usable storage capacity for the TVC. Without EHPO feature, 72 GB of user data capacity is supplied.

A minimum of one feature code 3702 must be ordered together with the IBM 3494-B18. Up to three additional feature codes can be specified for factory or field installation. A minimum of two feature codes 3702 is required if you want to configure 64 virtual drives.

To allow for a model upgrade of an IBM 3494-B16 to an IBM 3494-B18 VTS subsystem, feature code 3702 can be ordered as field installable concurrent with the model upgrade MES. For details see Appendix D, "Migration of IBM 3494 Model B16 to Model B18" on page 325.

2.8.1.11 Advanced Function (FC 4000)

Feature code 4000 provides host controlled functions such as the import or export of logical volumes. The Advanced Function feature is supported on S/390 systems with the appropriate software support as described in 2.5, "Software Requirements" on page 32.

FC 4000 requires EHPO to be installed and a minimum of four Magstar 3590 tape drives in the associated 3494 Model D12 drive frame. In addition, the IBM 3494 must have a convenience I/O station.

2.8.1.12 SCSI Cable (FC 5001, FC 5002, FC 5003)

Feature codes 5001, 5002, and 5003 provide one cable with HD68 (high-density 68-pin) connectors on both ends of 4.5 m, 10 m, or 20 m length. It can attach one bus attachment on the SCSI Host Attachment feature (3422) directly to a SCSI-2 adapter such as the RS/6000 PCI SCSI-2 Fast/Wide Differential Adapter or the PCI Differential Ultra SCSI Adapter. With the addition of an interposer (9702) it can attach to other RS/6000 adapters.

2.8.1.13 SCSI Cable (FC 5004)

Feature code 5004 provides one cable with VHDCI 0.8 mm connectors on both ends of 10 m length. It attaches a Model B18 to another Model B18.

2.8.1.14 18 Meter SCSI Cables (FC 5234)

Feature code 5234 provides two 18 m SCSI cables for the attachment of the IBM 3494-B18 to the IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives installed in the IBM 3494-D12 frame. This feature code can be ordered for field and factory installation. You must specify one feature code 5234 when ordering the IBM 3494-B18 or the MES for model upgrade of the IBM 3494-B16 to an IBM 3494-B18.

2.8.1.15 Performance Accelerator (FC 5236)

Feature code 5236 provides a high performance streaming file system, additional processing power, and memory increase. It enables new levels of performance for the Model B18. This feature requires one of these channel feature combinations:

- Feature code 3200 plus one feature code 3412
- Feature code 3200 plus two feature codes 3422
- Feature code 3400 plus two feature codes 3412
- Feature code 3400 plus one feature code 3412 plus two feature codes 3422

In addition to:

- Two or four FC 3702
- At least four 3590 tape drives in the associated 3494 Model D12

This feature code can be ordered for field and factory installation.

2.8.1.16 RS/6000 Attachment (FC 9106)

Feature code 9106 Notifies the manufacturing plant that an IBM 3494 frame is to be attached to a RS/6000 host processor. It is used for documentation. One feature code 9109 or 9106 must be specified for field or factory installation.

2.8.1.17 S/390 Attachment (FC 9109)

Feature code 9109 Notifies the manufacturing plant that an IBM 3494 frame is to be attached to a S/390 host processor. It is used for documentation. One feature code 9109 or 9106 must be specified for field or factory installation.

2.8.1.18   Open System Device Drivers (FC 9201)

This feature on the Model B18 provides the device drivers for the attachment of the VTS to open systems. The device driver function for RS/6000 in this feature is the same as in FC 9200 which is available for open systems attachment of native tape drives.

Features 3422 (SCSI Host Attachment) and feature 9106 (RS/6000 attachment) must also be specified.

2.8.1.19   Interposer, Double Byte Wide for RS/6000 (FC 9702)

This interposer makes it possible to connect an industry standard high-density 68-pin (HD68) cable connector, typically used on fast/wide devices, to a 68-pin ribbon connector host system adapter such as the RS/6000 enhanced SCSI-2 differential fast/wide adapter.

2.8.1.20 Six Feet Chicago Power Cord (FC 9986)

Feature code 9986 is a specify feature that can be ordered for field and factory installation. If you do not order this feature, which is required only in Chicago, the appropriate power cord is attached at the factory on the basis of the country to which the IBM 3494-B18 is designated.

Note that if a Chicago power cord is required, you must specify one for every library frame except the IBM 3494-HA1, which requires two.

2.8.2 IBM 3494 Model D12 Feature Codes

Table 7 on page 42 lists the feature codes on the IBM 3494-D12 frame that are relevant when installing the IBM 3494-D12 frame connected to the IBM 3494-B18 enhanced VTS. For a complete list of all feature codes available for the IBM 3494-D12, refer to the *IBM 3494 Tape Library Introduction and Planning Guide*, SG24-4632.

Table 7. IBM 3494-D12 Special and Specify Feature Codes				
Feature Code	Min. Qty.	Max. Qty.	Field / Factory Install	Description
4630	0	6	yes / no	Field Install Drive
4663	0	6	yes / no	Replace Model B1A Tape Drive with a Model E1A
5233	1	1	yes / yes	SCSI Extender
9010	1	1	yes / yes	VTS Attached Model D12
9630	0	6	no / yes	Field Merge Drive (order FC 4630 to get drive)
9631	0	6	no / yes	Factory Install B1A
9663	0	6	no / yes	Factory Install E1A

2.8.2.1 Field Install Drive (FC 4630)

Feature code 4630 provides the necessary hardware to field install an IBM 3590 Model B1A tape drive or IBM 3590 Model E1A tape drive in an already installed IBM 3494-D12 frame. It should be used when the plant has not installed drive-mounting hardware or feature code 9630, or when an odd number of drives is installed in an IBM 3494-D12.

Feature code 4630 is required when the IBM 3590 Model B1A and E1A tape drives are not installed in the factory. One feature code 4630 must be specified for each IBM 3590 Model B1A tape drive or IBM 3590 Model E1A tape drive to be added.

2.8.2.2 Replace Model B1A Tape Drive with a Model E1A (FC 4663)

Feature code 4663 provides the necessary hardware to replace an IBM 3590 Model B1A tape drive with an IBM 3590 Model E1A tape drive in an already installed IBM 3494-D12 frame. For every ordered feature code 4663 one feature code 4630 or 9630 or 9631 should be removed from the already installed IBM 3494-D12.

Feature code 4663 is required for every to be upgraded IBM 3590 Model B1A tape drive so the plant can send the right installation instructions and required microcode for the VTS and Library Manager.

2.8.2.3 SCSI Extender (FC 5233)

Feature code 5233 is required to connect the IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives installed in the IBM 3494-D12 frame to the IBM 3494-B18 VTS. It provides the hardware to extend the SCSI interfaces between the IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives and the VTS controller. It supports two extended SCSI attachments.

This feature code is required when a VTS is installed in an IBM Magstar 3494 Tape Library. One feature code 5233 must be specified for field or factory installation. Feature code 5233 is not intended for extending SCSI interfaces to other SCSI hosts. Feature code 9010 is a corequisite that assigns the IBM 3494-D12 as an VTS attached IBM 3494-D12.

2.8.2.4 VTS Attached Model D12 (FC 9010)

Feature code 9010 allows the appropriate internal cables to be provided for the installation of the IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives. The individual SCSI cables do not have to be ordered separately for each tape drive.

This feature code is required when the IBM 3494-D12 attaches to the IBM 3494-B18. One feature code 9010 must be specified for field or factory installation.

2.8.2.5 Field Merge Drive (FC 9630)

Feature code 9630 indicates to the manufacturing plant to provide the mounting hardware required to install an IBM 3590 Model B1A tape drive or IBM 3590 Model E1A tape drive in the field. Up to six feature code 9630s can be specified for field installation, depending on the number of tape drives.

2.8.2.6 Factory Install B1A (FC 9631)

Feature code 9631 indicates to the manufacturing plant to install one IBM 3590 Model B1A tape drive in the IBM 3494-D12 frame. Up to six feature codes 9631 can be specified for factory installation in one IBM 3494-D12 frame.

When the to be ordered IBM 3494-D12 is attached to an IBM 3494-B18, a minimum of three feature code 9631s must be specified. If specified, this feature code must appear on both the IBM 3494 Model D12 order and on the IBM 3590 Model B1A tape drive.

2.8.2.7 Factory Install E1A (FC 9663)

Feature code 9663 indicates to the manufacturing plant to install one IBM 3590 Model E1A tape drive in the IBM 3494-D12 frame. Up to six feature codes 9663 can be specified for factory installation in one IBM 3494-D12 frame.

When the to be ordered IBM 3494-D12 is attached to an IBM 3494-B18, a minimum of three feature code 9663s must be specified. If specified, this feature code must appear on both the IBM 3494 Model D12 order and on the IBM 3590 Model E1A tape drive.

2.8.3 IBM 3590 Model B1A Feature Codes

The following feature codes can be specified for IBM 3590 Model B1A tape drives that are installed for use with the VTS.

2.8.3.1 ES/9000, S/3090, S/390 Attachment (FC 9000)

One feature code 9000 must be specified per IBM 3590 Model B1A tape drive for field or factory installation.

2.8.3.2 3590 Model B1A Drive Installation (FC 9631)

One feature code 9631 must be specified to indicate to the manufacturing plant that this IBM 3590 Model B1A tape drive is to be factory installed. Feature code 9631 is not required if you order new IBM 3590 Model B1A tape drives to be included in an existing IBM 3494-D12 frame. If specified, this feature code must appear on both the IBM 3494 Model D12 order and on the IBM 3590 Model B1A tape drive.

2.8.4 IBM 3590 Model E1A Feature Codes

The following feature codes can be specified for IBM 3590 Model E1A tape drives that are installed for use with the VTS.

2.8.4.1 ES/9000, S/3090, S/390 Attachment (FC 9000)

One feature code 9000 must be specified per IBM 3590 Model E1A tape drive for field or factory installation.

2.8.4.2 Plant Install Drive in 3494 (FC 9663)

One feature code 9663 must be specified to indicate to the manufacturing plant that this IBM 3590 Model E1A tape drive is to be factory installed. Feature code 9663 is not required if you order new IBM 3590 Model E1A tape drives to be included in an existing IBM 3494-D12 frame. If specified, this feature code must appear on both the IBM 3494 Model D12 order and on the IBM 3590 Model E1A tape drive.

2.8.5 IBM 3494 Model L1x Feature Codes

Table 8 on page 45 lists the feature codes that are required or can be specified on the IBM 3494-L1x frame when an IBM 3494-B18 VTS is installed if there are no tape drives in the IBM 3494-L1x.

Table 8. IBM 3494 Model L1x Special and Specify Feature Codes

Feature Code	Min. Qty.	Max. Qty.	Field / Factory Install	Description
2710 •	0	1	yes / yes	Remote Support Facility
2711 •	0	1	yes / yes	Remote Support Switch
2712 •	0	1	yes / yes	Remote Support Attachment
5050	0	1	yes / yes	Dual Active Accessors
5210	0	1	yes / yes	Ten Cartridge Convenience I/O Station
5214	1	1	yes / no	Second Library Manager Hard Disk Drive
5215	0	1	yes / yes	Dual Gripper
5219 •	0	1	yes / yes	Token Ring Adapter
5220 •	0	1	yes / yes	Ethernet Adapter
5226	0	1	yes / yes	Remote Library Manager Console
5230	0	1	yes / yes	30 Cartridge Convenience I/O Station
5232	1	1	yes / yes	Attachment Concentrator
5500	0	1	yes / no	Additional Storage Unit Frame
5502	0	1	yes / no	VTS Drive Unit Frame
5503	0	1	yes / no	SCSI Drive Unit
5504	0	1	yes / no	ESCON Drive Unit
9002	1	1	yes / yes	Storage Unit Attach Frames 2 to 8
9003	1	1	yes / yes	Drive Unit Attach Frames 2 to 8
9004	1	1	yes / yes	Storage Unit Attach Frames 9 to 16
9005	1	1	yes / yes	Drive Unit Attach Frames 9 to 16
9020	1	1	yes / yes	3494-B18 VTS Attachment
9040	1	1	yes / yes	High Availability Attachment
9986	1	1	yes / yes	6 ft Chicago Power Cord

Note:

1. See Table 6 on page 37

2. Either feature code 5219 or feature code 5220 is required in order to implement SNMP.

2.8.5.1 Dual Active Accessors (FC 5050)

Feature code 5050 allows both accessors in an IBM 3494-HA1 to be active at the same time. The 3494-HA1 is required in the IBM Magstar 3494 Tape Library. This feature code is available only for IBM Magstar 3494 Tape Librarys with 4, 6, 8, 10, 12, or 16 frames, not including HA1 service bays and B18 frames. One feature code 5050 can be ordered for field or factory installation.

2.8.5.2 Ten Cartridge Convenience I/O Station (FC 5210)

Feature code 5210 allows you to add and remove up to 10 cartridges from the IBM Magstar 3494 Tape Library without interrupting normal operations. If the convenience I/O station is installed, it reduces the cartridge storage capacity in the IBM 3494-L1x frame by 30 cartridges. One feature code 5210 can be ordered for field or factory installation.

Note: The Import/Export function requires a convenience I/O station to be installed. If you plan to use the Import/Export function, you must order either feature code 5210 or 5230.

2.8.5.3 Second Library Manager Hard Disk Drive (FC 5214)

Feature code 5214 is applicable to all 3494 Model L1xs. It enables a second copy of the Library Manager database to be kept. It reduces the time required to recover from a primary Library Manager disk failure. One feature code 5214 can be ordered for field installation.

All IBM 3494 Model L1x manufactured after November 1st, 1999 will have Mirrored Dual Disk standard and FC 5214 should not be ordered anymore for new IBM 3494 Model L1x. With Mirrored Dual Disk there are two hard disks that mirror each other and contain identical information. In the event of a loss of one disk there can be a non disruptive switch over to the secondary disk. The IBM 3494 will continue to operate using the secondary disk allowing the customer to schedule service at their convenience.

Before the availability of the Mirrored Dual Disk the Magstar 3494 Library Manager could be ordered with FC 5214. This feature did not supply a second copy of the Library Manager control program that resides on the primary disk. In a non HA1 configuration, the loss of the primary Library Manager disk would result in a immediate Magstar 3494 outage. the outage would require a service representative to replace the defective disk and reconstruct the data on that disk.

Customers with installed Magstar 3494s (and HA1s) can purchase the Mirrored Dual Disk feature by ordering FC 5045, Enhanced Library Manager.

Feature code 5214 or Mirrored Dual Disk is required on the 3494 Model L1x when a Model B18 or a Model HA1 is installed.

2.8.5.4 Dual Gripper (FC 5215)

Feature code 5215 provides a second gripper, which is mounted below the first gripper on the cartridge accessor. When the dual gripper feature is installed, library cartridge capacity is reduced by approximately 10% because you cannot store cartridges in the two uppermost and two lowermost rows of storage cells.

One feature code 5215 can be ordered for field and factory installation. Feature code 5215 is required on the 3494 Model HA1 when it is installed on the IBM Magstar 3494 Tape Library.

2.8.5.5 Token-Ring Adapter (FC 5219)

Feature code 5219 allows you to connect the Library Manager to a token ring network. Either this feature code or Ethernet Adapter (FC 5220) can be ordered for field or factory installation, but not both. If you plan to implement SNMP monitoring, you need to order either feature code 5219 or 5220.

2.8.5.6 Ethernet Adapter (FC 5220)

Feature code 5220 allows you to connect the Library Manager to an Ethernet network. Either this feature code or Token Ring Adapter (FC 5219) can be ordered for field or factory installation, but not both. If you plan to implement SNMP monitoring, you need to order either feature code 5219 or 5220.

2.8.5.7 Remote Library Manager Console (FC 5226)

Feature code 5226 allows for the remote operation of up to eight IBM tape libraries. The Remote Library Manager Console is attached to the Library Manager through a Token Ring Adapter (5219) or Ethernet Adapter (5220) local area network (LAN). Advanced Program-to-Program Communication (APPC) is used as the communication protocol. The Remote Library Manager Console uses the Distributed Console Access Facility (DCAF) to capture the Library Manager screens. The remote library manager console feature supplies the DCAF and Library Manager code only; the Remote Library Manager Console PC hardware, OS/2, and communications software are not supplied as part of the feature code. One feature code 5226 is required for each IBM Magstar 3494 using the Remote Library Manager Console.

We recommend that you load the Remote Library Manager console software of feature code 5226 on the second Library Manager provided by the High Availability unit when it is installed to ensure that this functionality is still available after a Library Manager switchover has taken place.

2.8.5.8 30 Cartridge Convenience I/O Station (FC 5230)

Feature code 5230 allows you to add and remove up to 30 cartridges from the IBM Magstar 3494 Tape Library without interrupting normal operations. If the convenience I/O station is installed, it reduces the cartridge storage capacity in the IBM 3494-L1x frame by 80 cartridges. One feature code 5230 can be ordered for field or factory installation.

Note: The Import/Export function requires that a convenience I/O station be installed. If you plan to use the Import/Export function, you must order either feature code 5210 or 5230.

2.8.5.9 Attachment Concentrator (FC 5232)

Feature code 5232 provides the hardware for the attachment interface between the Library Manager of the IBM Magstar 3494 Tape Libraryand the IBM 3494-B18 that uses the internal LAN connection interface. All cables required for the attachment are included in this feature code. One feature code 5232 must be specified for field or factory installation of the first IBM 3494-B18 VTS to be installed in an IBM Magstar 3494 Tape Library.

2.8.5.10 Additional Storage Unit Frame (FC 5500)

Feature code 5500 is required on an MES for the 3494 Model L1x control unit frame when an IBM 3494-B16 VTS is upgraded to an IBM 3494-B18 VTS and the B16 frame is to be converted to a storage frame. The 3494-B16 no longer carries a model number but is converted instead to feature code 5500. The resulting storage unit is a frame containing additional cartridge storage cells for up to 400 cartridges that is attached to the IBM Magstar 3494 Tape Library.

Feature code 9006, (Virtual Tape Server Attachment) or feature code 9007, (Virtual Tape Server Attachment Greater than eight Frames) must be removed from the IBM 3494-L1x frame. This feature can be converted to feature (5502, 5503 or 5504).

2.8.5.11 VTS Drive Unit Frame (FC 5502)

Feature code 5502 is required on an MES for the 3494 Model L1x control unit frame when an IBM 3494-B16 VTS is upgraded to an IBM 3494-B18 VTS and the B16 frame is to be converted to a drive unit frame for the Model B18. The 3494-B16 no longer carries a model number but is converted instead to feature code 5502.

The drive unit for B18 frame contains additional cartridge storage for up to 290 cartridges and provides the necessary hardware for installation of three or four IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives which will be attachable to a IBM 3494-B18 VTS. The SCSI Extender hardware is also provided. To install five or six IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives, you need RPQ 8B3167, which provides the necessary hardware and instructions for installation. Feature codes 5500 (Additional Storage Unit), 9006 (Virtual Tape Server Attach Frames 2 to 8) or feature 9007 (Virtual Tape Server Attach Frames 9 to 16) must be removed from the IBM 3494-L1x frame.

This feature can be converted to feature 5503 or 5504. When feature code 5502 is ordered on an IBM 3494-L1x that already has feature code 5500 installed, the material and installation instructions are provided for upgrading.

2.8.5.12 SCSI Drive Unit Frame (FC 5503)

Feature code 5503 is required on an MES for the 3494 Model L1x control unit frame when an IBM 3494-B16 VTS is upgraded to an IBM 3494-B18 VTS and the B16 frame is to be converted to a SCSI drive unit frame. The converted frame no longer carries a model number but is converted instead to feature code 5503 on the L1x Library Control Unit frame.

The SCSI drive unit frame contains additional cartridge storage for up to 290 cartridges and provides the necessary hardware for installation of three or four IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives. Order RPQ 8B3167 for the mounting hardware for the installation of the fifth and sixth tape drives.

Feature 5500, 5502, 9006 or 9007 must be removed from the Model L1x with installation of this feature.

You can upgrade feature code 5500 or 5502 to feature code 5503. When feature code 5503 is ordered on an IBM 3494-L1x that already has feature code 5500 or 5502 installed, the material and installation instructions are be provided for upgrading. This feature is for field installation only.

2.8.5.13 ESCON Drive Unit Frame (FC 5504)

Feature code 5504 is required on an MES for the 3494 Model L1x control unit frame when an IBM 3494-B16 VTS is upgraded to an IBM 3494-B18 VTS, if the B16 frame is to be converted to an ESCON drive unit frame. The converted frame no longer carries a model number but is converted instead to feature code 5504 on the L1x Library Control Unit frame.

The ESCON drive unit frame contains additional cartridge storage for up to 345 cartridges and provides the necessary hardware for installation of one or two IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives and one 3590 Model A50 that can be attached to host system ESCON channels. Order

RPQ 8B3168 for the mounting hardware for the installation of the third and forth tape drives.

Feature 5500, 5502, 9006 or 9007 must be removed from the Model L1x with installation of this feature.

You can upgrade feature code 5500 or 5502 to feature code 5504. When feature code 5504 is ordered on an IBM 3494-L1x that already has feature code 5500 or 5502 installed, the material and installation instructions are be provided for upgrading. This feature is for field installation only.

2.8.5.14 Storage Unit Attach Frames Number 2 to 8 (FC 9002)

Feature code 9002 is used by the manufacturing plant to determine the total length of an IBM Magstar 3494 Tape Library and to provide the correct length accessor and control cables. One feature code 9002 must be ordered for each IBM 3494-S10 frame included in the first eight frames of the IBM Magstar 3494 Tape Library.

2.8.5.15 Drive Unit Attach Frames Number 2 to 8 (FC 9003)

Feature code 9003 is used by the manufacturing plant to determine the total length of an IBM Magstar 3494 Tape Library and to provide the correct length accessor and control cables. One feature code 9003 must be ordered for each IBM 3494-D12 frame included in the first eight frames of the IBM Magstar 3494 Tape Library.

2.8.5.16 Storage Unit Attach Frames Number 9 to 16 (FC 9004)

Feature code 9004 is used by the manufacturing plant to determine the total length of an IBM 3494 and to provide the correct length accessor and control cables. One feature code 9004 must be ordered for each IBM 3494-S10 frame included in the second eight frames of the IBM Magstar 3494 Tape Library.

2.8.5.17 Drive Unit Attach Frames Number 9 to 16 (FC 9005)

Feature code 9005 is used by the manufacturing plant to determine the total length of an IBM Magstar 3494 Tape Library and to provide the correct length accessor and control cables. One feature code 9005 must be ordered for each IBM 3494-D12 frame included in the second eight frames of the IBM Magstar 3494 Tape Library.

2.8.5.18 3494-B18 VTS Attachment (FC 9020)

Feature code 9020 indicates that an IBM 3494-B18 is included in the IBM Magstar 3494 Tape Library. One feature code 9090 must be specified for each IBM 3494-B18 for field and factory installation.

2.8.5.19 High Availability Attachment (FC 9040)

Feature code 9040 provides the connection between the Library Manager in the IBM Magstar 3494 Tape Library and the second Library Manager provided by the High Availability unit. One feature code 9040 must be specified for field or factory installation when an IBM 3494-HA1 is installed in the IBM Magstar 3494 Tape Library.

2.8.6 IBM 3494-HA1 Feature Codes

If the IBM Magstar 3494 Tape Library includes only IBM 3494-D12 frames attached to IBM 3494-B18 frames, the following feature codes are relevant for the IBM 3494-HA1:

2710, 2711, 2712 Remote Support Facility, Switch and Attachment

5215   Dual Gripper

9109   S/390 Attachment

2.8.7 Media Feature Codes

Table 9 lists the feature codes that you can specify to order magnetic tapes along with the IBM 3494 frames.

Table 9. IBM 3494 Magnetic Media Feature Codes		
Feature Code	**Description**	**Maximum Quantity Per Frame**
8002	One 3590 cleaning cartridge	10
8005	One 3490 cleaning cartridge	10
8410	210 3490E data cartridges	1 •
8420	420 3490E data cartridges	1 •
8510	210 3590 data cartridges	1 •
8520	420 3590 data cartridges	1 •
9540	No data cartridge	1 •
Note:		
1. Only one of feature codes 8410, 8420, 8510, 8520,and 9540 must be ordered per IBM 3494 frame.		

Note: Cartridges ordered with this feature code will not be labeled or initialized. Initialized and labeled Magstar 3590 data cartridges can be ordered through the Magstar 3599 machine/types. See your IBM representative for further information about ordering Magstar 3590 data cartridges independent of a frame or library order.

2.8.8 Sample Configuration of the IBM 3494-B18

The sample configuration of an IBM Magstar 3494 Tape Library as shown in Figure 14 on page 51 consists of the following components:

- One IBM 3494-L14 including a 10-cartridge convenience I/O station, and the dual gripper. No drives are installed.
- Two IBM 3494-S10 storage unit frames
- One VTS subsystem including
  - One IBM 3494-D12 frame including six IBM 3590 Model E1A tape drives
  - One IBM 3494-B18 frame including 864 GB of TVC and four enhanced ESCON 864 GB of TVC, assuming a 3:1 compression ratio, and four enhanced ESCON channels
- The IBM 3494-HA1 option including the Dual Active Accessors feature
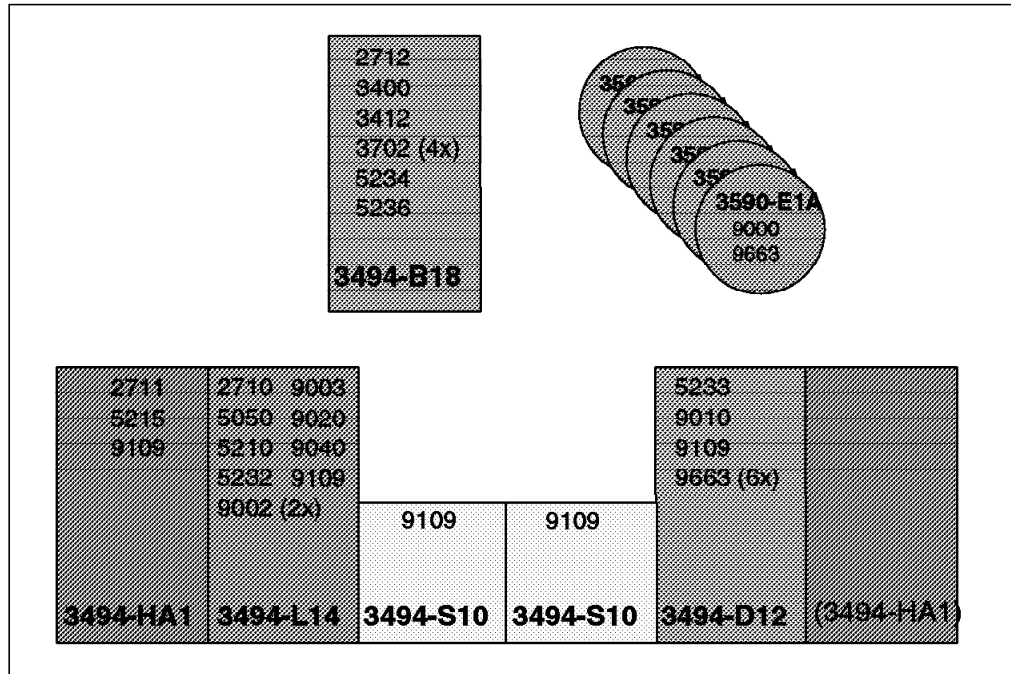
Figure 14. IBM Magstar VTS Sample Configuration Including Feature Codes

As indicated in Figure 14, you need these feature codes for the sample configuration.

Note: For FC 9109, see comment in 2.8.1.17, "S/390 Attachment (FC 9109)" on page 41.

3494-HA1

- FC 2711: Remote Support Switch
- FC 5215: Dual Gripper

3494-L14

- FC 2710: Remote Support Facility
- FC 5050: Dual Active Accessors
- FC 5210: Ten Cartridge Convenience I/O Station
- FC 5232: Attachment Concentrator
- FC 9002: Storage Unit Attach Frames Number 2 to 8, required twice
- FC 9003: Drive Unit Attach Frames Number 2 to 8
- FC 9020: 3494-B18 VTS Attachment
- FC 9040: High Availability Attachment

3494-S10

- None

3494-D12

- FC 5233: SCSI Extender
- FC 9010: VTS Attached Model D12
- FC 9663: 3590 Model E1A Drive Installation, required six times

3494-B18

- FC 2712: Remote Support Attachment
- FC 3400: Extended High Performance Option
- FC 3412: Extended Performance ESCON Channel

- FC 3702: Disk Capacity for the Tape Volume Cache, required four times
- FC 5234: 18 Meter SCSI Cables
- FC 5236: Performance Accelerator

3590-E1A

- FC 9000: ES/9000, S/3090, S/390 Attachment
- FC 9663: Plant Install in 3494

2.9 Hardware Planning Checklist

For the latest version of the IBM Magstar VTS preinstallation checklist, arrange for your IBM storage specialist to review the *IBM Magstar 3494 Tape Library SAPR Guide* with you. Table 10 lists tasks that should be assigned and completed before installation of your VTS.

Table 10. IBM Magstar VTS Hardware Planning Checklist
Task
Analyze your tape environment.
Determine the workload for the VTS.
Size the IBM Magstar VTS
Size the IBM Magstar 3494 Tape Library.
Size the number of stacked volumes and logical volumes for your environment.
Decide on volser range for stacked volumes.
Decide on volser range for logical volumes.
Order the IBM Magstar 3494 Tape Library including the VTS. and the cartridges.
Order cartridges and labels (if you acquire them separately) for stacked volumes.
Complete physical installation planning.
Check out cable requirements. The IBM 3494-B18 comes with two 31 m ESCON jumpers. If these are not long enough, alternatives must be ordered.
Prepare for implementation of the Remote Library Manager Console (if required).
Prepare for implementation of SNMP (if required).
Arrange telephone line for Remote Support Facility (RSF) connection.

Chapter 3. Installing the Virtual Tape Server

In this chapter we describe how to install the VTS. Because the VTS works with the IBM Magstar 3494 Tape Library's Library Manager, it must be installed together with an IBM Magstar 3494 Tape Library. You can install a VTS together with your existing IBM Magstar 3494 Tape Library, or you can install a new IBM Magstar 3494 Tape Library and a VTS at the same time. Either way, you must have an IBM Magstar 3494 Tape Library if you want to take advantage of the unique performance and functions that a VTS offers.

VTS Software Implementation

We only discuss the specific issues for the VTS in this chapter.

If you are new to the IBM 3494 tape library, we strongly recommend to consult the *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632 for the tape library implementation guidelines that apply to VTS and non-VTS libraries and are not included here.

The VTS installation procedure is divided into three phases:

The first phase, system generation, consists of such processes as ESCON channel attachment to a host, HCD and IOCP definition, and power preparation. Because the host operating system sees the VTS as an IBM Magstar 3494 Tape Library, the HCD and IOCP definition for VTS virtual drives are essentially the same as the HCD and IOCP definition for drives resident in an IBM Magstar 3494 Tape Library without VTS.

During the second phase, you define stacked volumes, using Library Manager operations. These Library Manager operations are performed by using the operator panels for the VTS definitions. If you already have an existing IBM Magstar 3494 Tape Library, you benefit from the transparent operational capability of the Library Manager console.

During the third phase, you define the new tape library. The definition process is the same for VTS virtual drives as it is for IBM Magstar 3494 Tape Library resident drives. If you are using DFSMS/MVS and SMS tape, you update DFSMS, Object Access Method (OAM), and your tape management system during this phase.

3.1 Overview

The tasks we outline in this section are meant to give you an overall concept of the tasks required for VTS installation. The task lists we provide are not all-inclusive, and they are not intended to replace any current documentation for the VTS.

3.1.1 Preinstallation Tasks

Whether you are installing a VTS in an existing IBM Magstar 3494 Tape Library or in a new IBM Magstar 3494 Tape Library, review the following items:

- IBM Magstar 3494 Tape Library specific hardware items

  - Review the *IBM Magstar 3494 Tape Library SAPR Guide*, including checklists

  - Review the *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279

    The latest versions of this document can be found on: *http://www.storage.ibm.com/hardsoft/tape/pubs/prodpubs.html*

  - Complete systems assurance for the IBM Magstar 3494 Tape Library

- IBM Magstar 3494 Tape Library specific software items

  - Review software support based on platform and installed features

    - OS/390 (Table 4 on page 33 and 2.5.1, "Software Requirements for Advanced Functions" on page 34)
    - VM/ESA (Table 5 on page 34)
    - VSE/ESA (Table 5 on page 34)

  - Review software support based on storage management products

    - DFSMS/MVS and OAM (see the *DFSMS/MVS OAM Planning Guide for Tape Libraries*, SC26-3051, and *Implementing System Managed Storage*, SC26-3123)
    - BTLS (see the *Basic Tape Library Support User's Guide and Reference*, SC26-7016, and Section 6.3.6, "Basic Tape Library Support Considerations" on page 132)
    - DFSMS/VM RMS (see the *VM/ESA DFSMS/VM Removable Media Services User's Guide and Reference* and Section 6.8, "VM/VSE Considerations" on page 157)

  - Review software support based on the tape management system and based on the VTS functions you are planning to use, like the Advanced Function feature Import/Export component. For DFSMSrmm see 6.4.2, "DFSMSrmm and Tape Management Systems" on page 135. For other tape management systems, contact the independent software vendor for your product.

  - Review IBM Magstar 3494 Tape Library and 3490E PSP bucket for applicable maintenance. (Your IBM representative can assist you in obtaining PSP buckets.)

    - Include PSP buckets for 3490E.

- VTS-specific hardware items

  - Review the *IBM Magstar 3494 Tape Library SAPR Guide*
  - Review the *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279
  - Review the *Magstar 3494 Tape Library Operator Guide*, GA32-0280
  - Review the VTS and EVTS QBUCKET (available on IBMLINK or you can contact your IBM representative to obtain them)
  - Complete systems assurance for the VTS

- IBM 3490E items specific to the native drive:

- Review the IBM 3490E PSP bucket 3490E *Installation Planning and Operator's Guide*
- Review the *3490E Installation Planning and Operator's Guide*

- IBM 3590 items specific to the native drive:

  - Review the IBM Magstar 3590 PSP bucket
  - Review the *IBM Magstar 3590 Introduction and Planning Guide*, GA32-0329
  - Review the *IBM Magstar 3590 Operator's Guide*, GA32-0330

3.1.2 Installation Tasks

The tasks outlined in this section are specific to the simultaneous installation of an IBM Magstar 3494 Tape Library and a VTS. If you are installing a VTS in an existing IBM Magstar 3494 Tape Library, some of these tasks may not apply to you.

- Hardware items (completed by your IBM service representative):

  - Install the IBM Magstar 3494 Tape Library and Library Manager.
  - Install any native drives that will not be VTS controlled:
    - IBM Magstar 3590
    - IBM 3490E
  - Install the IBM 3494-B18 and IBM 3494-D12 VTS frames.

- Host-specific activities (define drives to the host):

  - OS/390
  - VM/ESA
  - VSE/ESA

- Software-specific items:

  - Apply maintenance for the IBM Magstar 3494 Tape Library
  - Verify or update exits for the tape management system (if applicable) and define logical volumes to it.
  - Update the storage management system software:
    - DFSMS/MVS
      - SYS1.PARMLIB members
      - OAM parameters
      - Define or update SMS classes and groups
      - Define or update ACS routines
      - Install applicable OAM exits
    - BTLS
      - Follow tasks in the BTLS user's guide
      - Install and update exits
      - Apply maintenance
      - Update JCL with new unit parameter
    - DFSMS/VM RMS
      - Consult the *DFSMS/VM RMS User's Guide and Reference*, SC35-0141, and Section 6.8, "VM/VSE Considerations" on page 157

- VTS-specific installation items:

  - Decide on the volser ranges for VTS-owned physical cartridges and logical volumes (see Section 7.5, "Defining Volser Ranges for Stacked Volumes" on page 173).
  - Define VTS environment, using the Library Manager.

- Define the volser ranges for VTS-owned physical and logical volumes to the Library Manager (see Section 7.11, "Inserting Logical Volumes in the VTS" on page 185).
- Insert VTS-owned physical volumes in the IBM Magstar 3494 Tape Library (see Section 7.8, "Inserting Stacked Volumes in the VTS" on page 177).

3.1.3 Post Installation Tasks

Once your VTS is installed in the IBM Magstar 3494 Tape Library, carry out these post installation tasks:

1. Schedule and complete operator training

2. Schedule and complete storage administrator training

3. Route data to the VTS (see Section 6.6, "Moving Data into and out of VTS" on page 146) through:

   - SMS tape, using ACS routines
   - BTLS, using the unit parameter
   - DFSMS/VM RMS

4. Send more data to the VTS

3.2 Hints and Tips

In this section we present some hints and tips for installing the VTS.

3.2.1 Host Software Transparency

The VTS built-in storage management functions and the ability of the VTS to automatically fill Magstar 3590 cartridges enables it to perform transparent cartridge tape capacity exploitation and management.

The operating system knows only about tape drives and volumes and does not need to manage the storage of virtual and stacked volumes as long as they are kept within the library. However, if you plan to use the Advanced Function feature, you need to make sure that adequate controls are installed and available to manage your exported stacked volumes and the functions to control import and export tasks.

3.2.2 Add-on Installation Capability

The hardware add-on installation to the existing tape library control unit frame (IBM 3494-Lxx) involves the hardware component connection of the VTS and the subsystem setup procedures. The tape library will be either unavailable to the host or degraded at some times. If you want to continue to use the IBM Magstar 3494 Tape Library during VTS installation, some manual operation is required to satisfy host requests.

During field installation, the following activities affect host access to the IBM Magstar 3494 Tape Library containing the VTS:

- VTS box attachment

- Power and ESCON cable attachment

- The teach operation when the new tape library configuration is brought into the Library Manager

- Definition of VTS environment

- Software definition of the VTS to tape management systems, and other software products including DFSMS/MVS

- Whenever the customer introduces any other customer-originated tape management environment modifications.

The actual degree of impact on host access depends on the IBM Magstar 3494 Tape Library configuration and other hardware and software configurations. Therefore we recommend that you give careful consideration to the scheduling of the installation and migration activities during your VTS implementation.

3.2.3 Coexistent Real and Virtual 3490E Drives

The IBM Magstar 3494 Tape Library supports the coexistence of both real and virtual 3490E type drives in one physical tape library (See Figure 15). If you already have the IBM Magstar 3494 Tape Library, you do not have to install a dedicated tape library control unit frame solely for the VTS.

In this case, two or three logical libraries are defined by the Library Manager function, according to the number of VTS subsystems installed in the IBM Magstar 3494 Tape Library. One or two libraries will consist of the VTS 3490E tape drives, and one will consist of real IBM 3490E or IBM 3590 tape drives.
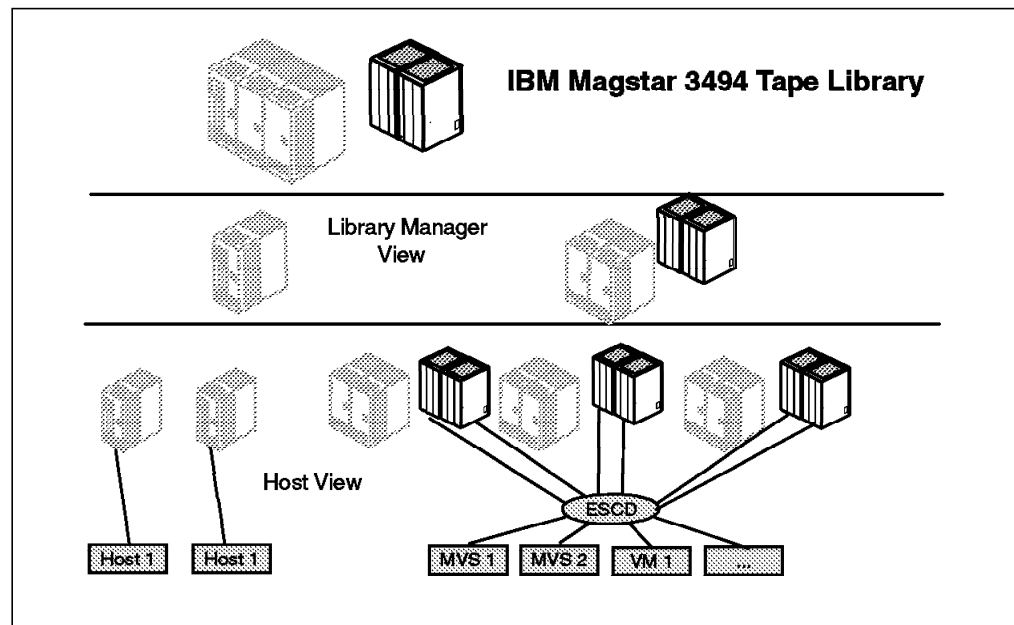
Figure 15. Coexistent Real and Virtual 3490E Drive

From the host's perspective, each VTS and its associated media constitute one logical library that resides in one physical tape library under the control of the Library Manager. The VTS and its media, both stacked volumes (physical 3590 cartridge) and logical volumes, will be contained in one tape library. Each logical tape library has a unique tape library ID number, which is used in all communications with the host to identify which tape library is being requested and accessed.

Because there is one physical tape library with two or three logical libraries, there is one Library Manager, and its database in one IBM 3494 Tape Library, the volsers for both physical and logical volumes must be unique. Therefore that

the same volser cannot exist in the logical libraries at the same time. The Library Manager enforces the uniqueness of a volser across a single physical tape library. Checks for volser uniqueness of the tape volumes are performed by the Library Manager during cartridge insert processing and during definition of the volser ranges for both, real cartridges and logical volumes.

Refer to 3.5.2.2, "The Insert Process" on page 84 for volser uniqueness requirements from a host software perspective.

3.2.4 Defining VTS to Tape Management System

Because the VTS emulates an IBM Magstar 3494 Tape Library with logical 3490E, the procedures for defining the VTS to your tape management system, and other software products such as DFSMS/MVS, is the same as that for the IBM Magstar 3494 Tape Library with real IBM 3490E tape drives.

Additional considerations apply if you plan to use the Advanced Function feature with the Import/Export function. We discuss this topic in Chapter 9, "IBM Magstar VTS Advanced Function" on page 245. For general tape library implementation guidelines, refer to *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632.

3.2.5 Sharing VTS from Multiple Hosts

Each logical library has its own library sequence number, which is used to define the logical library to the host. Each logical library looks like a separate library to the host. A VTS can be shared by multiple MVS, VM, and VSE guest systems in the same way that a physical tape library can be shared.

Note: If sharing a VTS with the Advanced Function feature installed between multiple hosts, you have to make sure that the proper toleration maintenance is installed in all attaching systems. See 2.5.1, "Software Requirements for Advanced Functions" on page 34.

Sharing can be achieved in two different ways: by logically dividing it into different partitions (partitioning) or by allowing all attached systems to sequentially access physical as well as logical volumes (sharing).

Sharing of an IBM Automated Tape Library means that all attached hosts have the same access to all volumes in the tape library. To achieve this true sharing you need to share the host control data set, tape management system inventory and the catalog information, that is the tape configuration database (TCDB), among the attached hosts. In a non-SMS environment, all systems must share the ICF catalog that contains the BTLS inventory.

In general, these requirements can be met only in a single-platform environment. In this configuration only one global tape volume scratch pool is available.

Partitioning is the solution if you need to dedicate the use of volume ranges to certain systems or complexes or different host platforms. Dividing one or more libraries into logical libraries is the easiest way to allow different hosts to access them. Each host or complex owns its own set of drives and volumes, which another system or complex cannot access without manual intervention. Each system knows only about its part of the library.

Partitioning is also appropriate for the attachment to a OS/390 logical partition (LPAR) for testing. If there is a need for running test with a date different from the actual date, as it used to be during Y2K tests, you should have a separate

TCDB and tape management system inventory for the test complex. For details on sharing and partitioning a library, refer to Chapter 5, "Implementation in a DFSMS/MVS Environment" in the *Guide to Sharing and Partitioning IBM Automated Tape Library Dataservers*, SG24-4409.

3.2.6 VTS Installation Time

The expected installation time for the B18 VTS is approximately 3.8 hours. The expected installation time for the D12 is approximately 5 hours per frame. The estimated times for frame removal and reinstall for the D1x or S10 are approximately 1.0 hour each.

Field installation largely depends on the current configuration of the tape library. Contact your IBM service representative about the actual installation time estimate so that you can create a detailed schedule for your VTS installation.

3.2.7 VTS Teach Operation

The teach operation is performed by an IBM service representative as part of the installation process for the IBM Magstar 3494 Tape Library with a VTS. Therefore, you need not be concerned with teach operations. A teach must be performed as a part of the IBM 3494-B18 VTS control unit installation.

3.2.8 Initial Library Inventory

The IBM service representative typically performs an inventory of the IBM Magstar 3494 Tape Library as part of the VTS installation. Either a reinventory complete system, or an inventory new storage is performed, depending on whether the VTS is part of a whole new 3494 library, or is installed in an existing 3494 library.

Before the inventory is performed, you can insert your stacked volumes in empty cartridge cells in the library frames to be inventoried. If you have many cartridges to insert, this is a good time to do so. Note that with inventory new storage, you should only insert cartridges in the newly installed library frames as those are the only ones to be inventoried. During the inventory, the IBM service representative is presented with the option of defining stacked volser ranges. You should inform the service representative of the ranges which need to be specified. Later, you can add and modify the range definitions, and insert more stacked volumes.

During the inventory, the IBM service representative is also presented with the option of defining the cleaner volume masks. At least one cleaner mask must be defined. Inform the service representative of your cleaner cartridge volsers.

See Section 7.15, "Inventory New Storage or Re-inventory Complete System" on page 195 for more details on the inventory process.

3.2.9 Physical and Power Considerations

The stand-alone IBM 3494-B18 frame needs its own power connection. IBM 3494-B18s shipped with two primary control compartments and two power cards allow connection to two independent power sources. Other than that, the VTS imposes no additional environmental requirements over those of the IBM Magstar 3494 Tape Library and IBM 3590 products.

A VTS relies on the power controls that are part of the IBM Magstar 3494 Tape Library. Therefore a power sequence cable connects the last primary control compartment of frames in an IBM Magstar 3494 Tape Library to the stand-alone B18 frame. During a normal power-off sequence, the VTS:

- Is told to start a power-off sequence by the Library Manager
- Synchronizes any buffered data to the TVC
- Signals the ESCON hosts that the subsystem is offline
- Unloads all virtual drives
- Shuts down copy, recall, or reclamation operations
- Unloads the physical tape drives
- Notifies the Library Manager when the sequence has completed.

3.3 Hardware I/O Configuration Definition

From a host perspective, the VTS subsystem looks like two or four IBM 3490E tape control units, each with 16 devices attached through ESCON channels. Virtual 3490E tape drives are defined just like a physical IBM 3490-A10 controller with 16 addresses through the HCD, or through the IOCP and the MVSCP or HCPRIO macro. However, you should not define a preferred path for the VTS virtual devices.

Because the virtual tape drives of the VTS are library resident, you must define them through the HCD dialog, specifying LIBRARY=YES. As for the VTS drives resident in the physical library, there is no definition in IOCP, MVSCP, and HCPRIO. For BTLS-managed libraries, HCD is not required, because BTLS does not require the LIBRARY=YES definition.

Before you can use the VTS, you need to define it to the MVS system and processor through HCD. If you are using BTLS to control the library functions of the VTS, you can use either HCD or IOCP/MVSCP. You may need to update missing interrupt handler (MIH) values as well.

In this section we discuss the steps required to configure (Figure 16 on page 63), a VTS attached through two IBM 9032-3 ESCON directors. If you are installing ESCON directors for the first time, the ESCON directors themselves also have to be defined in the IOCP or HCD input/output definition file (IODF). Refer to the *IOCP User's Guide*, GC38-0401, and/or the *HCD User's Guide*, SC28-1848 for information about defining the ESCON directors themselves. A CNTLUNIT and an IODEVICE macro must be coded for each ESCON director.

3.3.1 Logical Paths Considerations

The VTS can be attached to S/390 hosts and logical partitions through 2 or 4 ESCON channels:

- Two standard ESCON channels
- Two or four Enhanced ESCON channels
- Two or four Extended ESCON channels

Each channel attachment provides 64 logical paths, which makes up a total of 128 logical paths in a two-channel configuration and a total of 256 logical paths in a four-channel configuration.

Depending on the configuration of the VTS, you will have:

- 32 virtual devices with only one F/C 3702 (tape volume cache) and
- 64 virtual devices with two to four F/C 3702 and EHPO

You need to define one control unit (CU) macro in the HCD dialog for every 16 virtual devices. You can define up to four channel paths to each control unit. You can think of a logical path as a three element entity: you need a host port, connect to a VTS port, and a logical control unit in the VTS.

Use this formula to calculate the number of logical paths required:

`# of hosts * # of CUs * # of ESCON channels  =  # of logical paths`

If you plan to attach more than 16 hosts to a single VTS, several options may help to extend the current limitation of 256 logical paths by adjusting the attachment definitions to the throughput requirements of individual hosts.

Note: The reduction of paths will reduce the throughput of the VTS; the reduction of control units will reduce the number of virtual devices for that individual host.

- Define two channels per host and CU

  This definition extends the attachment of the VTS to 32 hosts. All hosts still have access to 64 virtual devices. With two channels to each control unit only, the throughput is limited to one half of the total possible throughput bandwidth.

- Define two control units per host

  This definition extends the attachment of the VTS to 32 hosts. All hosts have access to 32 virtual devices only, but the throughput is not affected.

- Define two control units and two channels per host

  This definition extends the attachment of the VTS to 64 hosts. All hosts have access to 32 virtual devices only, and the throughput is limited to one half of the total possible throughput bandwidth.

- Adjust the attachment to individual hosts

  In an environment where more than 16 hosts have to be attached, it may be assumed, that not all of the hosts have the same throughput requirements. Therefore the best solution is to adjust the attachment definitions to the throughput requirements of individual hosts. Define four channels and four control units at hosts with high throughput requirements, and define less channels or less control units at those hosts, that have less throughput requirements or require less virtual devices.

3.3.2 Defining Devices through IOCP

In the IOCP examples below the virtual drives have been configured by using the CUADD parameter in the CNTLUNIT macro statements. Although this method is not used in most installations, the definitions can be used to get an idea on how the logical control unit and device addresses have to be defined in HCD.

3.3.2.1 IOCP Statements for VTS and ESCON Director

This sample input deck and Figure 16 on page 63 show a two-channel-path and four-control-unit configuration with a single ESCON director:

```
                Virtual Tape Server IOCP
CHPID PATH = 40,TYPE=CNC,SWITCH=01
CHPID PATH = 50,TYPE=CNC,SWITCH=01
CHPID PATH = 60,TYPE=CNC,SWITCH=01
CHPID PATH = 70,TYPE=CNC,SWITCH=01
    :
CNTLUNIT  CUNUMBR=440,PATH=(40,50,60,70),UNIT=3490,         X
      UNITADD=((00,16)),LINK=(D6,D7,D8,D9),CUADD=0
IODEVICE ADDRESS=(A40,16),UNIT=3490,CUNUMBR=(440),          X
      UNITADD=00
CNTLUNIT  CUNUMBR=441 PATH=(40,50,60,70),UNIT=3490,         X
      UNITADD=((00,16)),LINK=(D6,D7,D8,D9),CUADD=1
IODEVICE ADDRESS=(A50,16),UNIT=3490,CUNUMBR=(441),          X
      UNITADD=00
CNTLUNIT  CUNUMBR=442,PATH=(40,50,60,70),UNIT=3490,         X
      UNITADD=((00,16)),LINK=(D6,D7,D8,D9),CUADD=2
IODEVICE ADDRESS=(A60,16),UNIT=3490,CUNUMBR=(442),          X
      UNITADD=00
CNTLUNIT  CUNUMBR=443 PATH=(40,50,60,70),UNIT=3490,         X
      UNITADD=((00,16)),LINK=(D6,D7,D8,D9),CUADD=3
IODEVICE ADDRESS=(A70,16),UNIT=3490,CUNUMBR=(443),          X
      UNITADD=00
```
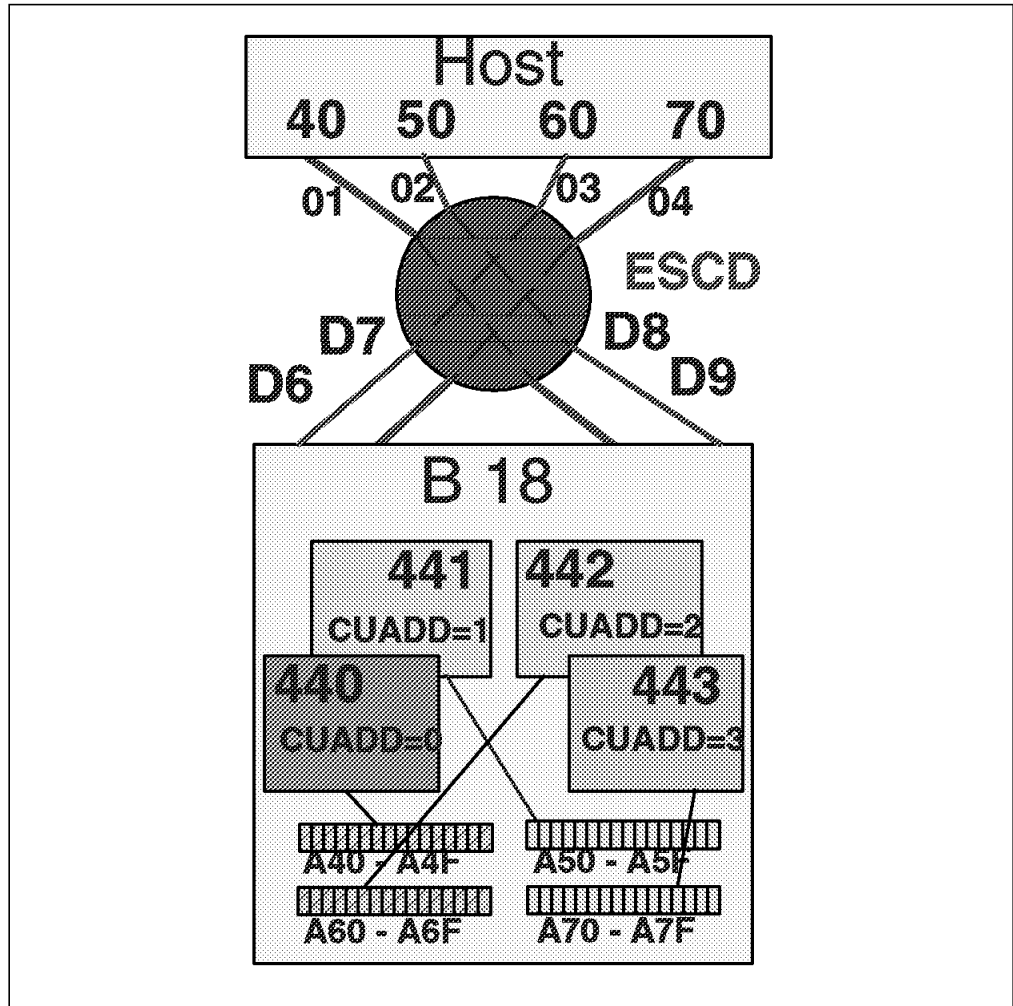
Figure 16. VTS Definition with ESCON Director

3.3.2.2 IOCP Statements for VTS without ESCON Director

This sample input deck and Figure 17 on page 64 show a four-control- unit configuration without ESCON directors:

```
                   Virtual Tape Server IOCP
           CHPID PATH = 40,TYPE=CNC
           CHPID PATH = 50,TYPE=CNC
           CHPID PATH = 60,TYPE=CNC
           CHPID PATH = 70,TYPE=CNC
              :
           CNTLUNIT  CUNUMBR=440,PATH=(40,50,60,70),UNIT=3490,          X
                 UNITADD=((00,16)),CUADD=0
           IODEVICE ADDRESS=(A40,16),UNIT=3490,CUNUMBR=(440),          X
                 UNITADD=00
           CNTLUNIT  CUNUMBR=441 PATH=(40,50,60,70),UNIT=3490,          X
                 UNITADD=((00,16)),CUADD=1
           IODEVICE ADDRESS=(A50,16),UNIT=3490,CUNUMBR=(441),          X
                 UNITADD=00
           CNTLUNIT  CUNUMBR=442,PATH=(40,50,60,70),UNIT=3490,          X
                 UNITADD=((00,16)),CUADD=2
           IODEVICE ADDRESS=(A60,16),UNIT=3490,CUNUMBR=(442),          X
                 UNITADD=00
           CNTLUNIT  CUNUMBR=443 PATH=(40,50,60,70),UNIT=3490,          X
                 UNITADD=((00,16)),CUADD=3
           IODEVICE ADDRESS=(A70,16),UNIT=3490,CUNUMBR=(443),          X
                 UNITADD=00
```
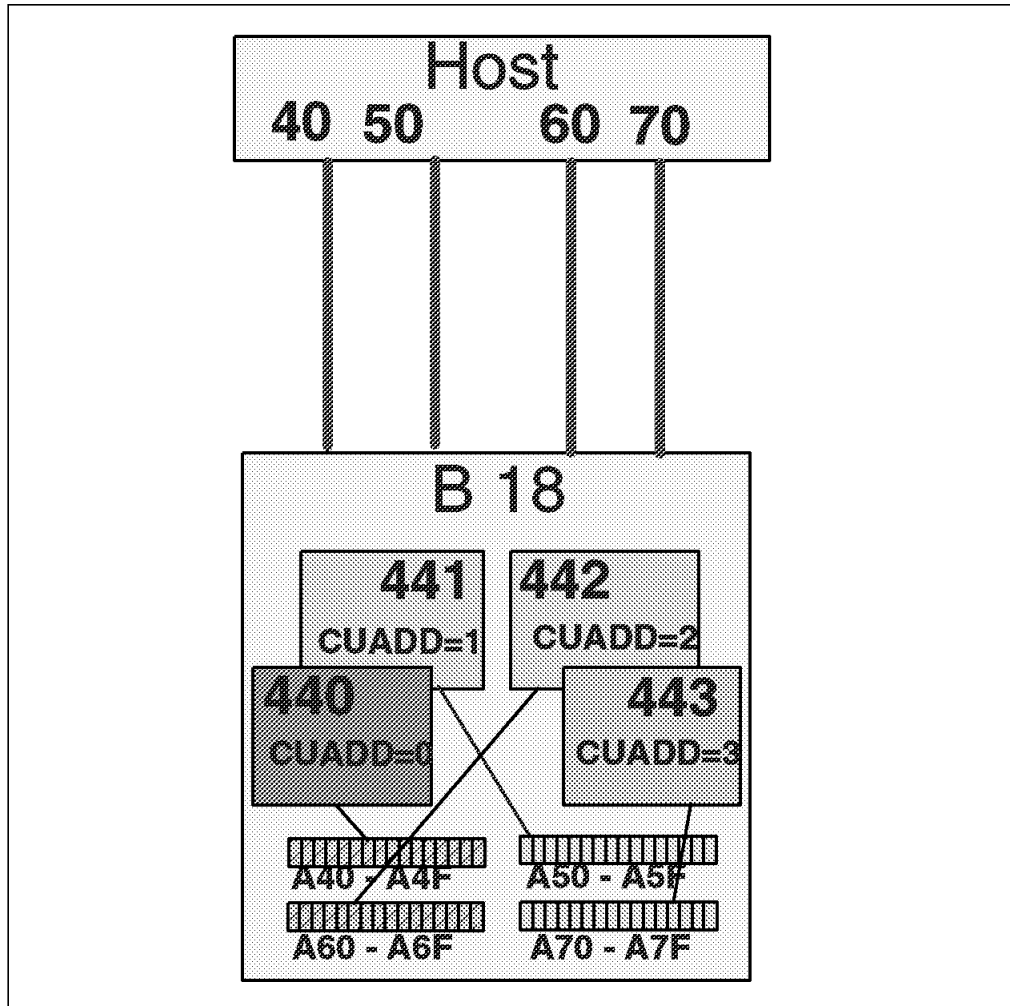

Figure 17. VTS Definition without ESCON Director

3.3.3 Defining Devices through HCD

In this section we describe the process of defining the VTS through HCD panels. The most important points to observe are:

- HCD definitions are required for SMS tape.

- Two or four 3490 tape control units have to be defined, with 16 3490E drives each.

- Keep the link address blank when no ESCON director is used.

- Specify LIBRARY=YES when using system-managed tape.

To properly define a single VTS subsystem, it is necessary to define two or four tape control units using logical unit address (CUADD) = 0 to 3, and two or four strings, 16 drives each.

Figure 18, and Figure 19 on page 66 show the two important panels for specifying one tape control unit.

```
 ---------------------- Add Control Unit --------------------
CBDPCU10

Specify or revise the following values.
Control unit number  . . . . 0440  +

Control unit type  . . . . . 3490           +

Serial number  . . . . . . . _____
Description  . . . . . . . . _____

Connected to switches  . . . 01  01  01  01  __  __  __  __  +
Ports  . . . . . . . . . . . D6  D7  D8  D9  __  __  __  __  +

If connected to a switch, select whether to have CHPIDs/link
addresses, and unit address range proposed.

Auto-assign  . . . . . . . . 2  1.  Yes
                               2.  No


 F1=Help    F2=Split   F3=Exit    F4=Prompt  F5=Reset   F9=Swap
 F12=Cancel
```

Figure 18. Adding the First VTS Control Unit through HCD, Part 1

After you have specified the control unit number and the type (here, 3490) as shown in Figure 18, and after you have chosen the processor to which the control unit is connected, the panel shown in Figure 19 on page 66 is displayed.

```
  ┌─────────────────────────────────────────────────────────────────────────
  │
  │   ------------------------ Add Control Unit ------------------------
  │  CBDPCU12
  │
  │  Specify or revise the following values.
  │  Control unit number  . : 0440       Type . . . . . . : 3490
  │  Processor ID . . . . . : PROC1       This is the main processor
  │
  │  Channel path IDs . . . . 40   50   60   70   __  __  __  __   +
  │  Link address . . . . . . D6   D7   D8   D9   __  __  __  __   +
  │
  │  Unit address . . . . . . 00   __   __   __   __   __   __   __   +
  │  Number of units  . . . . 16   ___  __   __   __   __   __   __
  │
  │  Logical address  . . . . 0  + (same as CUADD)
  │
  │  Protocol . . . . . . . . __   + (D,S or S4)
  │  I/O concurrency level  . 2  + (1, 2 or 3)
  │
  │
  │   F1=Help     F2=Split    F4=Prompt   F5=Reset    F9=Swap    F12=Cancel
  │
  └─────────────────────────────────────────────────────────────────────────
```

Figure 19. Adding the First VTS Control Unit through HCD, Part 2

Note that if the VTS is not being attached through ESCON directors, the link
address fields would be blank. You should define the second to fourth VTS tape
control units, specifying the logical unit address (CUADD) = 1 to 3 in the
CBDPCU12 panel. The number of drives to be specified for an IBM Magstar VTS
control unit is always 32 or 64, but you must specify these in two or four strings,
with each string associated with one of the previously defined control units.

To define the IBM 3490E virtual drives, you need to go to the Device List Panel
either from the Main Panel by entering 1 and then 5, or by means of the Control
Unit List Panel by using action *s*. To add the VTS virtual drives, press PF11. The
screen shown in Figure 20 is displayed.

```
  ┌─────────────────────────────────────────────────────────────────────────
  │
  │   ------------------------------ Add Device --------------------------
  │  CBDPDV10
  │
  │  Specify or revise the following values.
  │  Device number  . . . . . . . . 0A40   (0000 - FFFF)
  │  Number of devices  . . . . . . 16__
  │  Device type  . . . . . . . . . 3490_____   +
  │
  │  Serial number  . . . . . . . . _____
  │  Description  . . . . . . . . . _____
  │
  │  Connected to CUs . . 0440   ____  ____  ____  ____  ____  ____  ____   +
  │
  │
  │   F1=Help     F2=Split    F3=Exit     F4=Prompt   F5=Reset    F9=Swap
  │  F12=Cancel
  │
  └─────────────────────────────────────────────────────────────────────────
```

Figure 20. Adding the First 16 Drives through HCD, Part 1

After entering the required information and specifying to which processors and
operating systems the devices are connected, the screen in Figure 21 on
page 67 is displayed, where you can update the device parameters.

```
  CBDPDV13              Define Device Parameters / Features          Row 1 of 6
  Command ===> _____ Scroll ===> PAGE

 Specify or revise the values below.
 Configuration ID . : AB          MVS operating system
 Device number  . . : 0A40        Number of devices  :16
 Device type  . . . : 3490


 Parameter/  Value    P Req.  Description
 Feature
 OFFLINE     yes              Device considered online or offline at IPL
 DYNAMIC     yes              Device supports dynamic configuration
 LOCANY      no               UCB can reside in 31 bit storage
 LIBRARY     yes·             Device supports auto tape library
 AUTOSWITCH  No               Device is automatically switchable
 LIBRARY-ID  12345            5 digit library serial number
 LIBPORT-ID  02               2 digit library string ID (port number)
 ALTCTRL     No               Separate physical control unit path
 SHARABLE    yes·             Device is Sharable between systems
 COMPACT     yes              Compaction
 **************************** Bottom of data ****************************



  F1=Help        F2=Split       F4=Prompt      F5=Reset       F7=Backward
  F8=Forward     F9=Swap        F12=Cancel     F22=Command
```

Figure 21. Adding the First 16 VTS Drives through HCD, Part 2

Notes:

1. If you are defining drives that are installed in a system-managed IBM 3494
   VTS Library, you must specify LIBRARY=YES. For BTLS-managed library
   drives, specify LIBRARY=NO.

2. If more than one MVS system will be sharing the virtual drives in the VTS,
   specify SHARABLE=YES. This will force OFFLINE to YES. It is up to the
   installation to ensure proper serialization from all attached hosts.

To define the next 16 VTS 3490E virtual drives, you need to go back to the Device
List Panel from the Main Panel by entering 1 and then 5. To add the VTS virtual
drives, press PF11. The CBDPDV10 screen is displayed again.

3.3.4 HCD Support for Library and Port IDs

LIBRARY-ID and LIBPORT-ID are optional parameters provided by the following
APARs:

- OW25291 CL97/03/19 R110 UR1 TAPE LIBRARY HCD SUPPORT
- OW25292 CL97/03/19 R110 UR1 TAPE LIBRARY HCD SUPPORT
- OW25293 CL97/03/19 R110 UR1 TAPE LIBRARY HCD SUPPORT
- OW27801 CL97/07/22 R521 UR1 TAPE LIBRARY HCD SUPPORT
- OW29692 CL97/10/13 R1C0 PER GET MESSAGE MSGIGD306I RC12 RSN56

These fields allow HCD to provide the library configuration information that is
normally obtained from the device at IPL time. For devices that are available
during IPL, the HCD information is redundant. However, if the library is
unavailable during IPL or in OFFLINE status, the HCD information allows the
library device to be brought online (when it subsequently becomes available to
the system) without reactivating the IODF.

If you provide the LIBRARY-ID and LIBPORT-ID, they must match the IDs provided by the hardware:
The LIBPORT=ID reflects the order in which the tape control units are connected to the Library Manager and provides the tape drive pool ID, which is transparent and only used by allocation, and JES3. For example, in a five frame plus two IBM 3494-B18 configuration, as shown in Figure 22, you have the frames in the following order:

- L10 frame with two 3490E tape drives
- D12 frame providing VTS physical drives
- D12 frame providing VTS physical drives
- D14 frame providing four native 3590 drives
- D14 frame providing four native 3590 drives
- B18 frame providing first VTS
- B18 frame providing second VTS
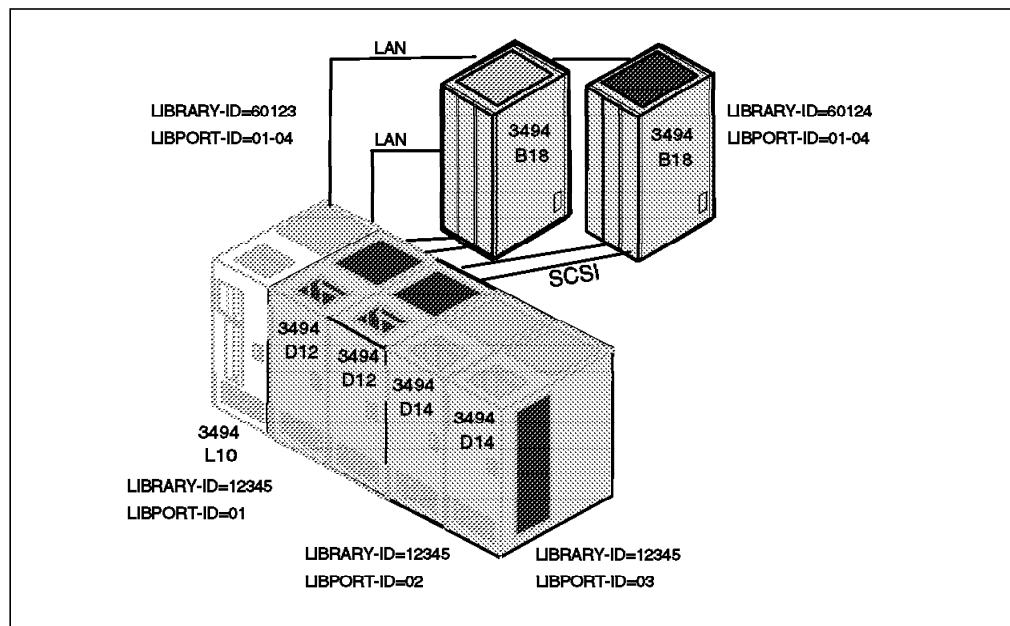
Figure 22. Sample Configuration Showing LIBRARY-ID and LIBPORT-ID

You need to specify the following LIBRARY-IDs and LIBPORT-IDs:

- L10 LIBRARY-ID = 12345, LIBPORT-ID = 01
- D12 none
- D12 none
- D14 LIBRARY-ID = 12345, LIBPORT-ID = 02
- D14 LIBRARY-ID = 12345, LIBPORT-ID = 03
- B18 LIBRARY-ID = 60123, LIBPORT-ID = 01 to 04, CUADD = 0 to 3
- B18 LIBRARY-ID = 60124, LIBPORT-ID = 01 to 04, CUADD = 0 to 3

Note: If 32 virtual drives are defined:
LIBPORT-ID = 01 to 02 and CUADD = 0 to 1 are used.

In an existing installation you can use the new DEVSERV QTAPE system command to find out what to specify. All tape drives connected to a control unit have the same LIBPORT-ID. Therefore you have to issue the DS QT command only once per control unit. The command syntax is:

DS QT,*devnum***,1,RDC**

DS	device service
QT	query tape
devnum	device address
1	number of devices to be displayed
RDC	read device characteristics

Here is the output of a DS QT system command:

```
DS QT,0300,1,RDC
IEE459I 06.54.14 DEVSERV QTAPE 422
UNIT DTYPE DSTATUS CUTYPE  DEVTYPE  CU-SERIAL  DEV-SERIAL ACL LIBID
0300 3490   ON-RDY  3494C2A 3590B1A* 0113-00000 0113-00000 I   60107
  READ DEVICE CHARACTERISTIC
34905434905400E0 1FD8808004000000 0000000000000000 3494183590100002
0601070100000000 4281000000000000 0000000000000000 0000000000000000
------
     │ --
     │ │------->              4. Byte = LIBPORT-ID
     │
     │---------------->  1.-3. Byte = LIBRARY-ID (omit first half byte)

LIBRARY-ID=60107
LIBPORT-ID=01
DEVTYPE * indicates underlying physical device type
```
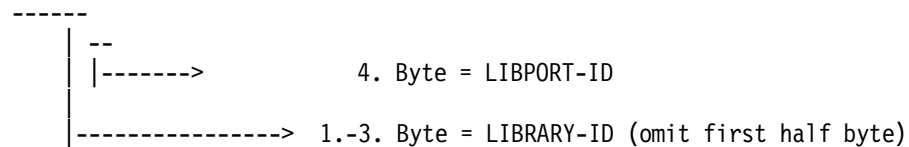
3.3.5 Set Values for Missing Interrupt Handler

An MIH time of 45 min is recommended for the all VTS drives. The VTS emulates 3490E devices and does not automatically communicate the MIH timeout values to the host operating system in the Read Configuration Data Channel Control Word (CCW). You must specify the MIH timeout values for IBM 3490E devices. The value applies only to the virtual 3490E drives and not to the IBM 3590 Model B1A tape drives or IBM 3590 Model E1A tape drives that the VTS manages.

The IBM 3590-Ax0 tape control unit returns recommended MIH timeout values to the host operating system in Read Configuration Data. You do not have to specify MIH timeout values for IBM 3590 devices; the device-supplied values handle all MIH timeouts.

If you currently specify your own MIH timeout values for non-3590 tape devices, we recommend that you review your procedures to see whether a timeout value other than the IBM-supplied default of 3 min must be used. If so, specify the timeout for each individual device. MIH timeout values can be specified only by class (for example, all tapes) or on an individual device basis. Specification of an MIH timeout value for the entire tape class would negate the IBM 3590 device's recommended values and adversely affect MIH recovery processing on IBM 3590 devices. You can specify the MIH values either in PARMLIB member IECIOSxx or through the MVS operator command, SETIOS.

Figure 23 on page 70 shows how to specify MIH values for IBM 3480 devices (addresses 800 to 807), IBM 3490E drives using CST cartridges (addresses 900 to 907), IBM 3490E drives with ECCST cartridges (addresses 9E0 to 9EF), and the VTS virtual drives.

```
        MIH=(0800-0807),TIME=03:00
        MIH=(0900-0907),TIME=10:00
        MIH=(09E0-09EF),TIME=20:00
        MIH=(0A40-0A5F),TIME=45:00
```

Figure 23. Sample MIH Specification in PARMLIB Member IECIOSxx

Figure 24 shows an example of the operator commands to specify the MIH values on a device basis.

```
        SETIOS MIH=(0800-0807),TIME=03:00
        SETIOS MIH=(0900-0907),TIME=10:00
        SETIOS MIH=(09E0-09EF),TIME=20:00
        SETIOS MIH=(0A40-0A5F),TIME=45:00
```

Figure 24. Sample Operator Commands to Set MIH Value

3.4 VTS Definition from the Library Manager

After your IBM service representative installs the IBM Magstar VTS, you must define the environment so that you can use high-performance VTS functions. All VTS definition procedures are performed from the Library Manager console. For details on operating an IBM Magstar 3494 Tape Library, refer to Chapter 6, "Advanced Operating Procedures," in the *Magstar 3494 Tape Library Operator Guide*.

The procedure of defining the VTS from the Library Manager includes defining initial volser ranges and management policies for the VTS operation and the 3590 cartridge insertion for VTS stacked volume preparation. The following tasks have to be performed at the library manager:

1. Define stacked volume ranges

2. Define (insert) logical volumes

3. Define fast ready categories

4. Define VTS management policies

   • Inhibit reclaim schedule

   • Reclaim threshold percentage

   • Free storage threshold

3.4.1 Check the VTS Library Sequence Number

You need to know the library sequence number when you later define the library through the Interactive Storage Management Facility (ISMF). These numbers are set during the teach operation by the IBM service representative. Check the library sequence number on the Operational Status pop-up window (Figure 25 on page 71).

```
┌──────────────────────────────────────────────────────────────────┐
│ ▌ Operational Status                                    ☑ ◻ □     │
│ Refresh   Help                                                     │
│ ┌─────────────────────────────────────────────────────────────┐▲  │
│ │               Pending Operations                            │   │
│ │                                                             │   │
│ │   Mounts.....:  0           Inserts....:  0                 │   │
│ │   Demounts...:  0           Audits.....:  0                 │▓  │
│ │   Ejects.....:  0           Cleans.....:  0                 │   │
│ │   Exports....:  0           Imports....:  0                 │   │
│ │ ─────────────────────────────────────────────────────────── │   │
│ │             Library sequence numbers                        │   │
│ │                                                             │   │
│ │          Non-VTS     VTS 1      VTS 2                        │   │
│ │           12345      54321      98765                       │   │
│ │ ─────────────────────────────────────────────────────────── │   │
│ │ Subsys IDs:  1-6,C,7-B                                       │   │
│ │ ─────────────────────────────────────────────────────────── │   │
│ │                     Capacity                                │   │
│ │             Storage         High-Capacity                   │   │
│ │ Total cells...:  2148            100                        │   │
│ │ Empty cells...:  2086            100                        │   │
│ │ ─────────────────────────────────────────────────────────── │   │
│ │                  Home Cell Mode                             │   │
│ │                                                             │   │
│ │ Current mode...:  Fixed                                     │▼  │
│ │◄                                                           ►│   │
│ └─────────────────────────────────────────────────────────────┘   │
└──────────────────────────────────────────────────────────────────┘
```
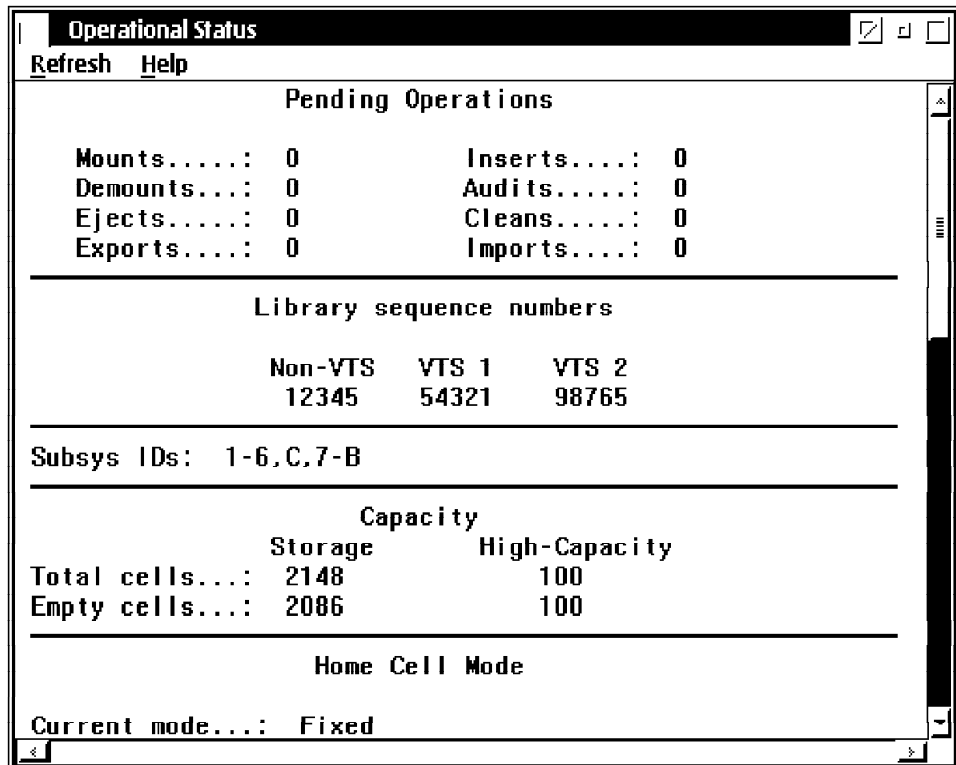
Figure 25. Operational Status Pop-Up Menu

In the Operational Status pop-up window, library sequence numbers show the
unique identification numbers for each non-VTS and VTS logical tape library
within the physical IBM Magstar Tape Library. These numbers are assigned at
the plant of manufacture and set during the teach operation by the IBM service
representative. Refer to Chapter 6 "Advanced Operating Procedures" in the
Magstar 3494 Tape Library Operator Guide for details.

3.4.2 Navigating the Library Manager

Although a physical tape library logically defined as described in Figure 22 on
page 68 looks like two separate libraries to the host, the libraries share the
same Library Manager and its database. Therefore, the volsers of both the
virtual and physical volumes in the same physical tape library must be unique.
Before you can insert physical 3590 cartridges for VTS use into a library, you
must define them through the Library Manager console. You must also define a
beginning set of volsers ranges for your virtual volumes.

Use the **Commands** pull-down menu (see Figure 26 on page 72) to work with the
tape library command invocation to define the VTS in a tape library. When you
define a VTS in a tape library soon after the physical installation, you must use
the System management pop-up window for VTS definition work.

```
┌─────────────────────────────────────────────────────────────────────────┐
│ 3494 Tape Library Dataserver              01-27-1999 (27)  09:55:23       │
│ Mode  Status  Queues  Database  │Commands│ Options  Help                  │
│                                  ┌──────────────────────────────────────┐ │
│                                  │ Cleaning                           ► │ │
│                                  ├──────────────────────────────────────┤ │
│                                  │ Send message to host consoles...     │ │
│                                  ├──────────────────────────────────────┤ │
│                                  │ Promote a command in the queue...    │ │
│      ┌──────────────────────────┐├──────────────────────────────────────┤ │
│      │ Volser range for media types...│ System management            ► │ │
│      │ Insert VTS logical volumes...   ├──────────────────────────────────┤ │
│      │ Eject a VTS stacked volume...   │ Inventory                    ► │ │
│      │ Set VTS category attributes...  ├──────────────────────────────────┤ │
│      │ Set VTS management policies...  │ Stand-alone device...        ► │ │
│      ├──────────────────────────┤├──────────────────────────────────────┤ │
│      │ Manage unassigned volumes...    │ Insert Unlabeled Cartridges...   │ │
│      │ Manage import volumes...        ├──────────────────────────────────┤ │
│      │ Manage insert volumes...        │ LAN options                  ► │ │
│      │ Manage export-hold volumes...   ├──────────────────────────────────┤ │
│      │ Cancel VTS export/Import...     │ Operator intervention...         │ │
│      └──────────────────────────┘├──────────────────────────────────────┤ │
│                                  │ Change system administrator password │ │
│                                  ├──────────────────────────────────────┤ │
│                                  │ Service access                   ► │ │
│                                  ├──────────────────────────────────────┤ │
│                                  │ SNMP options                     ► │ │
│                                  └──────────────────────────────────────┘ │
└─────────────────────────────────────────────────────────────────────────┘
```

Figure 26. Commands Pull-Down Menu

Click on System management. The System management pop-up window has the following selections:

- **Volser range for media types** — Use this panel to define the volser range of VTS 3590 cartridges to use for the VTS. The 3590 cartridges are used for stacked volumes in the VTS.

  On this panel you can enter up to 50 volser ranges and associated media types. The volser ranges are used to help determine a volser's media type when it is inserted into the library. Volser ranges are used only for physical volumes.

- **Insert VTS logical volumes** — Use this panel to insert logical volumes into a VTS library.

- **Eject a VTS stacked volume** — Use this panel to eject a VTS stacked volume from the library.

- **Set VTS category attributes** — Use this panel to assign the Fast Ready attribute to categories.

- **Set VTS management policies** — Use this panel to enter the *Inhibit reclaim schedule* policies and the *Reclaim threshold percentage* and *Free storage threshold* values.

A detailed review of the System management pop-up window begins with Section 3.4.3, "Define Stacked Volume Ranges."

The functions on the bottom half of the window are related to the Import/Export operations. Refer to Chapter 9, "IBM Magstar VTS Advanced Function" on page 245.

3.4.3 Define Stacked Volume Ranges

You have to tell the Library Manager which 3590 cartridges are to be used as VTS stacked volumes before you actually insert the cartridges in the IBM Magstar 3494 Tape Library. Define a volser range that associates a range of volsers with the VTS.

At this point, define the volser ranges for the stacked volumes you will initially insert in the library during the installation. Later, you can define new volser

ranges to add new stacked volumes. See Section 7.5, "Defining Volser Ranges for Stacked Volumes" on page 173.

3.4.4 Insert Logical Volumes

You insert logical volumes in the VTS through the Library Manager console by defining a range of volsers for the logical/virtual volumes and their media type. You can insert up to 150,000 logical volumes per VTS. The maximum number of logical volumes in one IBM 3494 configuration is 300,000 when two VTSs are included.

Be aware that you can only delete or change the media type of logical volumes from a VTS subsystem as long as they are in an insert or scratch (fast ready) category. That means if a volume was in use once, it can only be deleted if it is expired and returned to the scratch category. You should therefore carefully plan what volsers and media types to insert. For more detailed information how to eject logical volumes please refer to 7.12, "Ejecting Logical Volumes from the VTS" on page 188

At this point, insert your initial set of logical volumes in the VTS. We recommend that you insert only the number of logical volumes that your application needs in the near future. You can insert new logical volumes whenever more scratch volumes are needed.

See Section 7.11, "Inserting Logical Volumes in the VTS" on page 185 for details on how to determine the amount of logical volumes and on how to perform the action.

3.4.5 Define Fast Ready Categories

To take advantage of the scratch mount performance in the VTS and to prevent recalls for scratch mounts, you need to assign the Fast Ready attribute to the categories used by the host for scratch volumes. The MOUNT FROM CATEGORY command, as used for scratch mounts, is not exclusively used for scratch mounts, though the VTS cannot assume that any mount from category is for a scratch volume. The fast ready attribute provides a definition of a category to supply scratch mounts. The Fast Ready definition is done through the Library Manager console. Figure 27 on page 74 shows the Define Fast Ready Categories window.
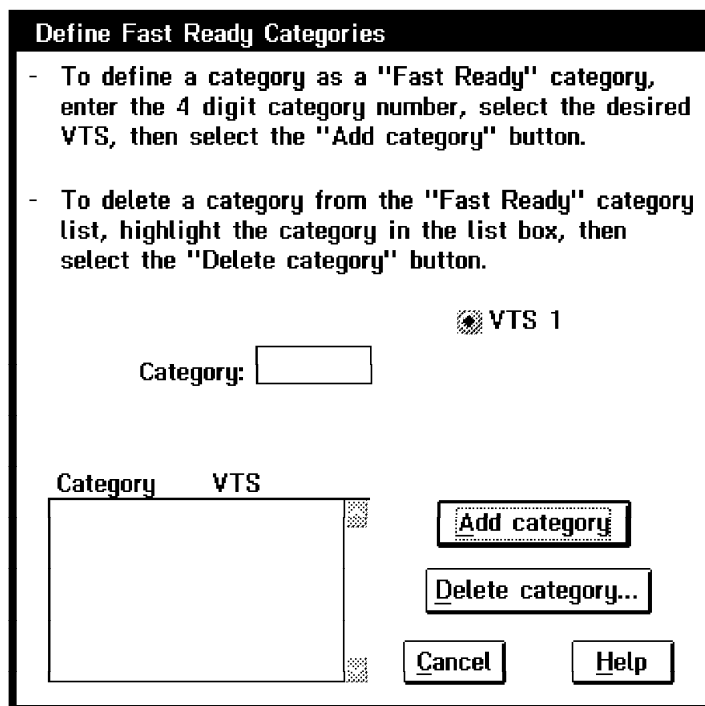
Figure 27. Set VTS Category Attributes Pop-up Window

This will add the category to the list of categories in the tape library that have the Fast Ready attribute set. To reset a category's Fast Ready attribute, on the Library Manager panel you highlight one of the categories in the list with the Fast Ready attribute set and then request that it be reset.

On the Set VTS Category Attributes pop-up window you can define categories as Fast Ready categories, so that any mounts from this category can be accomplished without recalling data from a stacked volume. Because a recall is not required to satisfy the mount request, the mount time is reduced.

To define a category as Fast Ready, on the Define Fast Ready Categories window, enter the 4-digit hexadecimal category number, select the desired VTS, and select the **Add category** button. You must specify the scratch mount categories of MEDIA1 and MEDIA2 as VTS Fast Ready when you use DFSMS/MVS. These scratch mount categories are 0001 and 0002, respectively if you use the DFSMS/MVS default values. The actual category hexadecimal number depends on the software environment and on the definitions done in the SYS1.PARMLIB member DEVSUPnn for library partitioning.

Note: We recommend to add a comment to DEVSUPnn to make sure that the library manager Fast Ready categories are updated whenever the category values in DEVSUPnn are changed. They need to be in synch at all times.

Refer to Appendix A, "Library Manager Volume Categories" on page 301 for the scratch mount category for each software platform. In addition to the DFSMS/MVS default value for the scratch mount category, you can define your own scratch category to the IBM Magstar 3494 Tape Library. In this case, you should also add your own scratch mount category to the VTS Fast Ready category list.

To delete a category from the Fast Ready list, highlight the category in the list box and select the **Delete category** button. You are prompted to confirm the delete operation. Select **Yes** to continue the deletion operation. Select **No** to cancel the delete operation. You can click on the **Help** button to display the Set VTS Category Attributes help panel.

3.4.6 Reclamation and Reconciliation

To minimize the effect of VTS internal processes like space reclamation on your tape operation, you can inhibit space reclamation for certain periods of time and adjust reclamation thresholds through the Library Manager console.

However, before we discuss the definitions that have to be made, we introduce the concepts of reclamation and reconciliation.

Any time a logical volume is modified, the data from the previous use of the logical volume which is on a stacked volume becomes obsolete. When you modify a logical volume, you have a new virtual volume in the TVC, and the copy on the stacked volume is invalidated.

The reconciliation process, when run, checks for invalidated volumes. A reconciliation is that period of activity by the VTS when the most recent instance of a logical volume is determined as the active one, and all other instances of that volume are deleted from the active volume list. This process automatically adjusts the active data threshold for any stacked volumes which hold invalidated logical volumes.

A reconciliation normally occurs sometime during a 24 hour period. It can occur more often if it is forced by a reclamation process. A reconciliation would occur before every reclamation process. This would make the reclamation process more effective as it will delete more invalidated logical volumes from the active volume list and, thus, reduce the threshold percentage of active data on more stacked cartridges.

Reclamation, which consolidates active data and frees stacked volumes for return to VTS scratch use, is part of the internal management functions of a VTS subsystem.

Over time, more and more logical volume copies on a stacked volume become obsolete, and the stacked volume contains less and less active data. The storage management software monitors the amount of active data on stacked volumes and marks the cartridge eligible for reclamation when the percentage set by the Library Manager Reclaim Threshold Percentage value is met. During reclamation, the active data is copied to another stacked volume, leaving the source volume to be used as a scratch stacked volume by the storage management software in the VTS. The reclamation process always uses two tape devices, a source and a target, and the movement of active data is a tape to tape copy function which does not use TVC.

All volumes with active data less than the Reclaim Threshold Percentage are eligible to go through the space reclamation process. The default Reclaim Threshold Percentage is 10%; however, you may change this percentage at the Library Manager console.

3.4.6.1 Reclamation Enablement

To minimize any impact on VTS activity, the storage management software monitors resource utilization in the VTS and schedules the reclamation when the Reclaim Threshold Percentage is reached. You can optionally prevent reclamation activity at specific times of day by specifying an Inhibit Reclaim Schedule on the Library Manager Console. However, the VTS subsystem determines whether reclamation is to be enabled or disabled once an hour.

Reclamation is currently enabled or disabled according to the following rules:

- If more than 50 empty stacked volumes are available (category FF03), space reclamation is enabled according to the Inhibit Reclaim Schedule and whether the reclamation will be non-invasive of VTS activity.

- If more than 10 but not more than 50 empty stacked volumes are available, space reclamation is enabled according to the Inhibit Reclaim Schedule and whether at least two Magstar 3590 drives are available.

- If 10 or fewer empty stacked volumes are available to the VTS, reclamation becomes a top priority. In this case reclamation is enabled regardless of the drive availability and the Inhibit Reclaim Schedule. In addition, the VTS increases the reclaim threshold percentage to yield at least 15 scratch cartridges after space reclamation is run. The threshold is raised and overrides the customer-specified value until 15 or more scratch stacked cartridges are available.

The information in Table 11 shows the reclaim settings that are available. The default value is 10%.

Table 11. VTS Space Reclamation Algorithm		
Number of Magstar Scratch Cartridges	**Reclaim Enabled If**	**Reclaim Threshold Percentage**
> 50	Non-invasive of VTS activity, and time is outside Inhibit Reclaim Schedule.	10% or customer setting
10 to 50	Two or more drives available and time is outside Inhibit Reclaim Schedule.	10% or customer setting
< 10	Always	As required for at least 15 free cartridges

You can also monitor the utilization level of stacked cartridges through the Library Manager panels. This new panel on the Library Manager allows you to monitor the amount of active data on stacked volumes and helps you plan for a reasonable and effective Reclamation Threshold Percentage.

Even though reclamation is enabled, there may not always be stacked volumes going through the process all the time. Other conditions must be met, such as stacked volumes that are below the threshold and drives available to mount the stacked volumes.

Reclaim is stopped by the internal management functions if a tape drive is needed for a recall or copy (as these are of a higher priority) or a logical volume

is needed for recall off a source or target tape being used in the reclaim. If this happens reclaim is stopped after the current logical volume move is complete.

3.4.7 Define Management Policies

On the Set VTS Management Policies window you can get the inhibit reclaim schedule, the reclaim threshold percentage, and free storage threshold policies.

3.4.7.1 Inhibit Reclaim Schedule

The *Inhibit Reclaim Schedule* defines when the VTS should refrain from reclaim operations. Reclaim operations require physical drives. Therefore drives are used for reclaim operations at the same time others are used to recall data to satisfy mount requests. During times of heavy mount activity, it may be desirable to make all of the physical drives available for recall operations. If these periods of heavy mount activity are predictable, you can use the inhibit reclaim schedule to inhibit reclaim operations for the heavy mount activity periods. You can add up to 14 entries to the schedule.

If the VTS must perform space reclamation in order to continue operating, the inhibit reclaim schedule is ignored.

Figure 28 on page 78 shows the Set VTS Management Policies window. Five drop-down lists are used to set up an inhibit reclaim entry. The drop-down lists contain the following items:

- **Day of week**

  The choices are **Sunday** through **Saturday** or **Every day**. If Every day is selected, the Start time and Duration entered will apply to every day of the week.

- **Start Hour** and **Minute**

  These are the start hour and minute for the inhibition. A 24-hour clock is used where 00 in the hour field indicates midnight.

- **Duration Hours** and **Minutes**

  These are the number of hours and minutes during which the inhibit reclaim should remain in effect. Up to 167 hours and 59 minutes (7 days minus 1 minute) can be specified. By specifying the maximum it will essentially always inhibit reclaim.

- Checkboxes to indicate to which VTS to apply the schedule.

Add an entry to the inhibit reclaim schedule by selecting a day of week, a start time, and the duration, and select the **Add** button.

Delete an entry by highlighting it in the list box and selecting the **Delete** button.

```
 VTS Management Policies
┌Inhibit Reclaim Schedule──────────────────────────────────────────────┐
│ - Add an entry to the schedule by selecting a day of week, start time, duration, which │
│   VTSs then select the "Add" pushbutton. Up to 14 entries can be made. │
│ - Delete an entry by highlighting it in the list box then selecting the "Delete" │
│   pushbutton. │
│                    Start Time              Duration │
│ Day of week     Hour    Minute        Hours    Minutes    ☐ VTS 1 │
│ [        ][⩒]  [    ][⩒] [    ][⩒]    [    ][⩒] [    ][⩒]        │
│ ┌──────────────────────────────────────────────────┐      [ Add ] │
│ │                                                  │                │
│ │                                                  │      [ Delete ]│
│ └──────────────────────────────────────────────────┘                │
└───────────────────────────────────────────────────────────────────────┘
┌Reclaim Threshold Percentage───────────────────────────────────────────┐
│ VTS 1:[10%  ][⩒] │
└───────────────────────────────────────────────────────────────────────┘
┌Free Storage Threshold (GB)────────────────────────────────────────────┐
│ VTS 1:[100  ] │
└───────────────────────────────────────────────────────────────────────┘
  [ Save ]   [ Cancel ]   [ Help ]
```

Figure 28. Set VTS Management Policies Pop-up Window

The following are the push buttons:

Add   Adds an entry to the inhibit reclaim schedule.

Delete   Deletes an entry from the inhibit reclaim schedule.

Save   Closes the panel and saves all the changes made to the inhibit
             reclaim schedule and the free-storage threshold.

Cancel   Closes the panel without saving any of the changes.

Help   Displays the Set VTS Management Policies help panel.

3.4.7.2 Reclaim and Free Storage Thresholds

The *Reclaim Threshold Percentage* is used to identify when a Magstar cartridge
is to be made available for reclamation. Each stacked volume has some amount
of active data and some amount of invalidated data which has been deleted from
the active volume list. If the percentage of active data is less than the
percentage specified in this panel, the stacked volume is available to go through
reclamation. During the reclamation process all of the active data from the
original stacked volume is moved to another stacked volume. After all active
data is moved from the original stacked volume, its category is set to scratch.
This makes it available for reuse.

The Reclaim Threshold Percentage is initially set at 10%. We recommend that
you start with this value and slowly raise it by 5% increments, if you need to. As
a general rule try not to go above 30% to 40%. It is better to add additional
stacked volumes rather than raise this value. The higher this number is, the
longer it takes the VTS subsystem to reclaim a stacked volume, because more
data must be copied from one Magstar cartridge to the other Magstar cartridge.
Be aware that two drives are involved in the reclamation process and because
of this resource usage, one should not specify too high percentages. The Active
Data Distribution bar graph will assist you in setting this number. See Section

8.5.7, "Active Data Distribution" on page 229 for information about displaying the panel.

The *Free Storage Threshold* is used to provide a warning when the VTS is running low on free storage, the capacity of all the empty stacked volumes in the VTS. A threshold is provided for each VTS installed in the library and is entered in GB. The default value is 600 GB. The VTS Active Data window displays the Free Storage Threshold as the Free Storage Alarm Level. If the free storage drops below the threshold (alarm level), the Library Manager signals an intervention-required condition to notify the operator to add more stacked volumes.

The number of stacked volumes required to store the Free Storage Threshold GB specified on the Set VTS Management Policies window is dependent on the compression of data when writing from the TVC to the stacked volume. The 3494-B18 VTS with enhanced ESCON host attachments provides compression into the TVC; therefore, further compression when writing to the stacked volume is unlikely, and the capacity of a stacked volume will be approximately 10 GB of TVC data for IBM 3590 Base Models based VTSs and 20 GB for IBM 3590 Enhanced Models based VTSs. The earlier VTS, 3494-B16, relied on the compression capability of the IBM 3590 Base Models to store approximately 20 GB of TVC data, assuming a compression ratio of 2:1.

Table 12 provides examples for the Free Storage Threshold which will result in an Intervention Required alarm when the number of scratch stacked volumes is less than required to contain the threshold free storage GB specified.

Table 12. Minimum Physical Cartridges Required for 10,000 Logical Volumes					
Free Storage Threshold (GB)					
VTS Model	**IBM 3590 Tape Drive Model**	**ESCON or Extended High Performance Option installed**	**Scratch Stacked Volumes**		
			10	**30**	**50**
B16	B1A	not applicable	200 GB	600 GB	1000GB
B18	B1A	no	200 GB	600 GB	1000GB
B18	E1A	no	400 GB	1200 GB	2000GB
B18	B1A	yes	100 GB	300 GB	500GB
B18	E1A	yes	200 GB	600 GB	1000GB
Note: We recommend that you double the Free Storage Threshold value in the Library Manager if you upgrade from IBM 3590 Base Models to IBM 3590 Enhanced Models in order to maintain the correct number of scratch Stacked Volumes.					

When only ten scratch stacked volumes are available, the VTS performance may be impacted by reclamation since the Inhibit Reclaim Schedule is ignored. This is necessary to provide stacked volumes for copying data from the tape volume cache. However, when more than 50 scratch stacked volumes are available, reclamation will be non-invasive.

> **Amount of Scratch Stacked Volumes**
>
> Refer to 7.8, "Inserting Stacked Volumes in the VTS" on page 177 for details on how to determine the number of scratch stacked volumes directly from the host console.

Note: You can see the effect reconciliation or reclamation has when they run by looking at the VTSSTATS report. Please see Figure 78 on page 214 for an example report. The field labeled SMF94VLA in the SMF record type 94 indicates the number of logical volumes managed by VTS. This actually includes all the logical volumes that have ever been used by the VTS, plus every instance of every volume that has been used by the VTS since the VTS has last done what is called a reconciliation. Therefore, once all the volumes have been used at least once, SMF94VLA value should be at least as large as the total number of logical volumes defined. The difference between SMF94VLA and the total number of defined logical volumes is the number of instances that logical volumes have been used since the last reconciliation. Thus, the number would show an increase as logical volumes are being used until the next reconciliation.

3.4.8 Cleaning Schedule Pop-Up Window

As part of the VTS installation process, you should ensure that the Library Manager cleaning schedule for the VTS-managed IBM 3590 tape drives is set correctly. See 7.13, "Cleaning" on page 189 on how to set the cleaning schedule.

3.4.9 Simple Network Management Protocol Traps

The Magstar 3494 Tape Library can be attached to a variety of host systems over various connections. When errors or events occur that the host operations personnel should know about, the Magstar 3494 Tape Library can notify them. This notification occurs using Transmission Control Protocol/Internet Protocol (TCP/IP) over a LAN. Connectivity to the LAN can be provided by Token Ring (FC 5219) or Ethernet (FC 5220).

SNMP is the message protocol used to transmit this information. The messages that the Magstar 3494 Tape Library sends are called *traps.* They are sent to one or more (up to five) SNMP monitoring stations. From there the monitor programs can take a specific action depending on the contents of the trap. See 7.4.3, "Simple Network Management Protocol Traps" on page 170 for information about setting up SNMP on the VTS.

3.4.10 Initial Physical Cartridge Insertion

Physical cartridges can be loaded into the tape library after the hardware installation is complete. The loading of cartridges can take place before the IBM service representative teach operation and the inventory operation.

Note: You must define the physical volser range to the VTS before initial physical cartridge insertion. See 7.5, "Defining Volser Ranges for Stacked Volumes" on page 173 for proper procedures on performing this function.

The initial cartridge insertion phase of IBM Magstar VTS consists of:

1. Define stacked volume range

2. Insert stacked volumes to be managed by VTS

3. Insert (define) logical volumes

4. Insert volumes to be used for native drives, if any

5. Insert cleaner volumes

The following types of cartridges can be loaded:

- **Stacked volumes** — If an IBM Magstar VTS is installed, the 3590 High Performance Cartridge Tapes that it will use to store and manage logical volumes cannot be loaded into the tape library without first:

  - Having the IBM service representative perform an initial teaching of the tape library.

  - Setting up one or more volser ranges that identify the physical volumes that the VTS will manage. See Section 3.4.3, "Define Stacked Volume Ranges" on page 72 for a description of how to enter the volser ranges.

- **Logical volumes** — If a VTS is installed, logical volumes are inserted into the tape library through the Insert Logical Volumes panel.

- **Customer volumes** — Customer volumes are the initial set of data and scratch volumes to be automated. Any number of cartridges can be added to the tape library up to its maximum available cartridge storage cells.

  Note: These customer volumes are not VTS-owned volumes.

- **Cleaner volumes** — One or two cleaner volumes should be installed in the tape library for each type of (3490E/3590) tape subsystem that is resident in the tape library. Two cleaner cartridges are considered ideal. The cleaner cartridges can be placed in any available cell.

  Note: If the cleaner cartridge is ejected, the mount count of a tape cartridge is reset to zero.

  The external volser must match the mask value that is provided; otherwise the inventory operation will treat the cleaner cartridge as a normal customer volume. A cleaner cartridge should have a unique volser.

- **Service volume** — The IBM service representative installs one or two service volumes in the tape library, depending on its configuration.

3.4.11 Magstar 3590 Cartridge Insertion

At this point, insert your Magstar 3590 cartridges in the IBM 3494 Tape Library. As this is the first time you insert stacked volumes for your VTS, you may have a large number of cartridges to insert. The easiest way to insert larger numbers of cartridges is to open the frame doors and insert them in empty cells in the library. Once you have inserted all of the cartridges and closed the frame doors, you have to perform inventory update, if it is not done automatically. See Section 7.8, "Inserting Stacked Volumes in the VTS" on page 177 for information about inserting cartridges in the library.

3.5 VTS Software Definition for S/390

In this section, we describe the software definition considerations for implementing the VTS in OS/390, VM/ESA, and VSE/ESA environments. From a software point of view, the VTS is same as the IBM Magstar 3494 Tape Library with IBM 3490E tape drives.

The VTS must be defined as a new tape library with emulated IBM 3490E tape drives from the host system. Refer to *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632, for more information.

Section 2.5, "Software Requirements" on page 32 explains the software support levels required to support the IBM Magstar 3494 Tape Library configuration with VTS.

3.5.1 DFSMS System-Managed Tape

To use the VTS in an OS/390 or MVS/ESA environment, you can use either DFSMS/MVS or BTLS. During hardware installation of the VTS, the customer engineer assigns a five-character tape library sequence number to the VTS library. You use this sequence number to define a new tape library to SMS through the ISMF Library application. See Section 3.4.1, "Check the VTS Library Sequence Number" on page 70.

3.5.1.1 DFSMS Definition Overview

In this section we describe the IBM Magstar VTS in the DFSMS environment.

When you install the VTS in a DFSMS environment, you must use the ISMF panel to create a new definition of the VTS logical tape library to be recognized from the host. This definition is done in the same way as the new installation of a real IBM Magstar 3494 Tape Library because the host recognizes the VTS as an IBM Magstar 3494 Tape Library. To use the VTS, a storage group should be created and dedicated to the VTS logical library, to allow the VTS logical tape library virtual drives to be allocated by the ACS routine.

To direct the host allocations to the VTS, you must define new storage groups that contain only VTS libraries. You should not intermix VTS and non-VTS libraries in the same storage group.

Here is the overall definition procedure for a first tape library installation:

1. Modify SYS1.PARMLIB member (IEFSSNxx, SCHEDxx, IGDSMSxx, LOADxx, DEVSUPxx, COMMANDxx, and all related members for daily tape library operation).

2. Create VOLCAT.

   IDCAMS IMPORT CONNECT to the other system is required when tape library sharing capability is used.

3. Create cataloged procedure of OAM address space.

4. Define the tape library as a DFSMS resource.

5. Create or update the data class (DC), storage class (SC), management class (MC), and storage group (SG) for the VTS.

6. Create ACS to assign VTS storage class.

   Translate, test, and validate ACS routines.

7. Activate new SCDS.

8. Bring the tape library online.

9. Bring the VTS virtual drives online.

Be sure to correct the size of the TCDB when you use the VTS tape library.

If you have a system-managed tape environment with more than one IBM Magstar 3494 Tape Library, the TCDB size will increase considerably defining all the 150,000 virtual volumes of one VTS to the Library Manager. A good solution is to split the TCDB, using a general VOLCAT for the real volumes and a user VOLCAT pointing to a unique first character identifier for the volsers of the virtual volumes. In this way, you easily separate the volume catalog information of the VTS from the other IBM Magstar 3494 Tape Library, achieving better performance in addition. Refer to *DFSMS/MVS OAM Planning Guide for Tape Libraries*, SC26-3051, for more information.

The use and modification of OAM exits is applicable under the following conditions:

- You already have a DFSMS OAM environment.
- You have already installed the OAM installation exits and are using them.
- You are adding a VTS adding to an existing IBM Magstar 3494 Tape Library.
- You are installing a VTS together with a new IBM Magstar 3494 Tape Library.

The OAM installation exits are described in *DFSMS/MVS Object Access Method Planning, Installation, and Administration Guide for Tape Libraries*, SC26-3051.

If you use the VTS in a single SMS environment, define a new storage group for each VTS. If you plan to use storage groups that include more than one VTS, refer to 6.3.5, "System-Managed Tape Considerations" on page 131 for a discussion of implications and possible drawbacks.

You must change your ACS routines to assign the newly defined storage groups in order to write data to the VTS. The modified ACS routine allocates data to a VTS-owned virtual volume on a VTS-owned virtual drive. You decide how to assign volumes for data that is written to the VTS, based on data set name, job name, or any of the other acceptable variables that DFSMS allows.

DFSMSrmm is an optional tape management software component of DFSMS/MVS. DFSMSrmm provides all installation-wide exits, CBRUXENT, CBRUXCUA, CBRUEXJC, and CBRUXVNL, used by the OAM library control system (LCS) to perform management of the IBM tape libraries. You can define and use DFSMSrmm for a VTS in the IBM Magstar 3494 Tape Library the same way as for the IBM Magstar 3494 Tape Library without VTS.

Please refer to Chapter 9, "IBM Magstar VTS Advanced Function" on page 245 for additional tape management system considerations when using the Advanced Function feature with the Import/Export function.

For details about DFSMSrmm, refer to *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632.

For other tape management systems, you need to ask the vendor of your tape management system (TMS) for its version of the exits to communicate with OAM.

3.5.2 Inserting Virtual Volumes

In this section we describe the process which takes place when you insert virtual volumes into the VTS.

3.5.2.1 Initial Volume Inventory Upload

After the IBM 3494 completes all initialization operations (including the teach operation by the IBM service representative and the inventory operation) and enters the online state for the first time, the host software requests an upload of the volume inventory. The information from the Library Manager database is uploaded to the attached hosts before host applications can access the tape cartridges inside the IBM Magstar 3494 Tape Library.

Uploading this volume inventory information requires no operator action and, depending on the customer environment, may require some planning to avoid uploading to the wrong host or swamping the host consoles with 'rejected' messages. We are going to explain this considerations in more detail here.

3.5.2.2 The Insert Process

This process is managed by Object Access Method (OAM). OAM provides the management facilities for the physical movement and tracking of the tape volumes used within the tape library. OAM provides many services for the support of tape libraries, and in particular cartridge entry, eject, audit, mount and demount processing.

When you define a logical or number of logical volumes to the VTS via the Library Manager the following processes take place:

The Library Manager notifies all hosts that there are logical volumes to process in the insert category. For each logical volume, OAM invokes the cartridge entry installation exit (CBRUXENT) to approve or disapprove entry of a cartridge into a library and to determine TCDB volume record contents and to ensure volume serial uniqueness for each entered volume: A volume serial has to be unique within all host systems that are connected to the same TCDB.

Note: CBRUXENT is supplied by DFSMSrmm. If your installation is not using DFSMSrmm then your tape management vendor will supply the equivalent Exit.

Without a GRS ring, all hosts get notified and start to process the same list of entered volumes. You cannot influence which host will process the insert processing. The first host to move the volume from scratch to private status will get the volume added to its TCDB. If the volumes in the library are to be partitioned across multiple hosts, the RC=12 (ignore) option from the cartridge entry installation exit can be used to make sure an appropriate host and TCDB process the volume for entry. When this option is used, the following messages are issued:

- CBR3602I Enter request rejected by the cartridge entry installation exit

- CBR3621I Enter request ignored by the cartridge entry installation exit CBRUXENT

With the usage of a GRS ring, the same processing occurs, however each host within the GRS ring would wait until its turn to process the list of entered volumes. For those volumes that had already been processed and moved out of the insert category, the remaining hosts would have nothing to do.

For those volumes that had been previously ignored (RC=12 from the entry exit) the remaining hosts would have the opportunity to process those volumes and get them added to its TCDB.

Note: If all LPARs reject the volume, then the volume will remain in the insert category and OAM will retry the insert process with all attached LPARs every time it is reloaded or the CBRUXENT exit is refreshed or additional volumes are inserted into the same VTS.

Though entry processing will work without the usage of a GRS ring, it is recommended that a GRS ring be used connecting the systems. This then enables OAM to send a systems level ENQUEUE around the ring limiting the processing of the insert category to a host at a time.

If you are defining large ranges of logical volumes at a time and are partitioning your volumes across multiple hosts with the usage of RC=12 (Ignore) from the entry exit, the messages above may appear multiple times until an owning host processes the volumes for entry.

Note: When you are inserting many logical volumes into the VTS via the library manager console, it is advised that you only add volumes to one LPAR at a time to prevent the operator console from being flooded with the ignore-type messages.

Following are the options to assist in this effort:

- Suppress the messages via an automation package.

- Only have OAM up on the LPAR that you are adding logical volumes during the insert process. This should only be done if you are sure that no tape processing will take place when you are inserting logical volumes.

- Issue the command *Library Disable,CBRUXENT* on the attached LPARs where you do not want to process the logical volumes. This will turn off the entry process for the LPAR in question. Once you have finished your logical volume insert processing, then issue the command *Library Reset,CBRUXENT* for each of the LPARs. This will reset the Exit and make it enabled.

3.5.3 JES3 Environments

Because the VTS emulates IBM 3490E tape drives, VTS virtual 3490E drives can be used in a JES3 environment. The IBM Magstar VTS has the same limitations related to the JES3 Dynamic Support Programs (DSP) as native tape drives in a IBM Magstar 3494 Tape Library. The VTS is not supported by DSPs.

A customer might want a JES3-managed tape library if it:

- Already has or plans to install a JES3 environment

- Wants to share the tape library among multiple hosts

- Does not have or define switchable tape-drive support in a Parallel Sysplex environment

- Does not have or define a DFSMSplex environment

Here are the considerations to take into account in a JES3 environment:

- **UNITNAME** — Because one tape library has only 3490E drives, and the other tape library has only virtual 3490E drives, you must never specify a virtual tape drive as an alternate name for another tape library specific unit name. From an operational point of view, separate the tape allocations to the VTS from other real tape drives in the same IBM Magstar 3494 Tape Library.

- **DFSMS** — If you want to define the DFSMS-managed VTS drive, you define the JES3-managed drive as usual. To define the VTS as a JES3-managed drive, the following setups are required in the JES3 initialization deck:

  1. Define JES3-managed drives in the IBM Magstar VTS through DEVICE statements.

  2. Set JES3 device names through the SETNAME statement.

  3. Define which device names are subsets of other device names through the HWSNAME statement.

  Refer to *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632, for detailed information about the DEVICE, SETNAME, and HWSNAME statements to define in the JES3 initialization deck.

  For a working example of how to define the JES3 initialization deck and esoteric names for a mixed configuration, native 3490E drives, native 3590 drives, and virtual 3490E drives, refer to 3.5.3.1, "JES3 Sample Initialization Deck Definition."

  JES3 can continue to manage tape devices outside the IBM Magstar 3494 Tape Library as long as those drives do not belong to the same generic or esoteric unit types as tape drives inside the IBM Magstar 3494 Tape Library. For example, you must not have JES3-managed 3490E drives outside the IBM Magstar 3494 Tape Library while there are IBM 3490E drives inside the IBM Magstar 3494 Tape Library. However, you can have JES3-managed IBM 3480 or IBM 3490 base drives (non 3490E) outside the IBM Magstar 3494 Tape Library while the drives inside the IBM Magstar 3494 Tape Library are all IBM 3490E.

  The IBM 3490 base drives (non-3490E) are identical to IBM 3480 drives as far as MVS and JES3 are concerned. Therefore you cannot have IBM 3490 base drives (not 3490E) inside the IBM Magstar 3494 Tape Library and JES3-managed IBM 3480 or 3490 base (not 3490E) drives outside it at the same time.

3.5.3.1 JES3 Sample Initialization Deck Definition

In this section we present a working example of a JES3 initialization deck and of an esoteric names definition in the HCD for a four frame plus one IBM 3494-B18 configuration.

Note: You must not specify any other esoteric names for either physical or virtual devices inside an IBM Magstar 3494 Tape Library or VTS. Therefore do not specify esoterics such as 3480, 3480X, SYS3480R, or 3490. Also, never use esoterics such as Tape or Cart.

Assuming the frames are in the following order:

- L10 frame with two 3490E tape drives. Library ID = 12853 device numbers 520 to 521

- D14 frame providing four native 3590 drives. device numbers 510 to 513

- S10 frame cartridge storage only

- D12 frame providing VTS physical drives

- B18 frame providing VTS with 32 virtual drives. Library ID = 60286 device numbers 5A0 to 5AF and 5B0 to 5BF

SETNAME rules that apply to defining a VTS for JES3:

- The complex-wide library name must be included in all statements.
- A library-specific name must be included for XTYPEs within the referenced library.
- The complex-wide device type name must be included for all XTYPEs of the corresponding device type in the complex.
- A library-specific device type name must be included for the XTYPE associated with the devices within the library.
- Do not specify generic (e.g. 3480, 3480X, 3490) or esoteric (e.g. TAPE, CART) unit names for library devices.

General HWSNAME Rules:

- Alternates must be a subset of or equal to the primary
- List all names as the primary once, even if no alternates are possible
- Do not list names as alternates which span multiple libraries unless the primary does

For the implementation of a VTS this means that:

- The complex-wide library name LDGW3495 must include all other LDGxxxxx names as alternates.
- The library-specific name LDGxxxxx must include all LDG names for the corresponding library as alternates.
- The complex-wide device type name LDG3490/LDG3490E must include all library-specific device type names.

Figure 29 shows the dependencies explained above:

510-513	520-521	5A0-5BF
LDB12853	LDE12853	LDE60286
LDG3591	LDG3490E	
LDG12853		LDG60286
LDGW3495		

Figure 29. JES3 Library SETNAMES

For the given configuration, the JES3 definition should be:

```
/* Devices (native 3590) 510 to 513
DEVICE,XTYPE=(ROBI,CA),XUNIT=(510,SY1,,ON)
DEVICE,XTYPE=(ROBI,CA),XUNIT=(511,SY1,,ON)
DEVICE,XTYPE=(ROBI,CA),XUNIT=(512,SY1,,ON)
DEVICE,XTYPE=(ROBI,CA),XUNIT=(513,SY1,,ON)
/*
/* Devices (native 3490E) 520 and 521
```

```
DEVICE,XTYPE=(ROB3490,CA),XUNIT=(520,SY1,,ON)
DEVICE,XTYPE=(ROB3490,CA),XUNIT=(521,SY1,,ON)
/*
/* Devices (virtual 3490E) 5A0 to 5AF and 5B0 to 5BF
DEVICE,XTYPE=(ATLVTS,CA),XUNIT=(5A0,SY1,,ON)
DEVICE,XTYPE=(ATLVTS,CA),XUNIT=(5A1,SY1,,ON)
        ⇕           ⇕
DEVICE,XTYPE=(ATLVTS,CA),XUNIT=(5BE,SY1,,ON)
DEVICE,XTYPE=(ATLVTS,CA),XUNIT=(5BF,SY1,,ON)
/*
/* This SETNAME is for native 3590 drives
SETNAME,XTYPE=ROBI,NAMES=(LDGW3495,LDG12853,LDG3591,LDG12583)
/*
/* This SETNAME is for native 3490E drives
SETNAME,XTYPE=ROB3490,NAMES=(LDGW3495,LDG12853,LDG3490E,LDE12853)
/*
/* This SETNAME is for virtual 3490E drives
SETNAME,XTYPE=ATLVTS,NAMES=(LDGW3495,LDG60286,LDG3490E,LDE60286)
/*
/* Sysplex Wide Library Name
HWSNAME,TYPE=(LDGW3495,LDG12853,LDG60286,
               LDG3591,LDG3490E,LDB12853,LDE12853,LDE60286)
/* Library Specific Library Name
HWSNAME,TYPE=(LDG12853,LDB12853,LDE12853,LDG3591)
HWSNAME,TYPE=(LDG60286,LDE60286)
/* Sysplex Wide Device Name
HWSNAME,TYPE=(LDG3591,LDB12853)
HWSNAME,TYPE=(LDG3490E,LDE12853,LDG60286,LDE60286)
/* Library Specific Device Name
HWSNAME,TYPE=(LDB12853,LDG3591)
HWSNAME,TYPE=(LDE12853)
HWSNAME,TYPE=(LDE60286,LDG60286)
/*
```

The esoteric names definition in the HCD should be:

```
/ Esoteric   VIO    Token   State
_ LDGW3495   No     ____            510-513, 520-521 5A0-5BF
_ LDG12853   No     ____            510-513, 520-521
_ LDG60286   No     ____            5A0-5BF
_ LDG3591    No     ____            510-513
_ LDG3490E   No     ____            520-521, 5A0-5BF
_ LDB12853   No     ____            510-513
_ LDE12853   No     ____            520-521
_ LDE60286   No     ____            5A0-5BF
```

HCD Library ID and Port ID:

```
520-521 Library ID = 12853,  Port ID = 01
510-513 Library ID = 12853,  Port ID = 02
5A0-5AF Library ID = 60286,  Port ID = 01
5B0-5BF Library-ID = 60286,  Port-ID = 02
```

3.5.3.2 Basic Tape Library Support

If you implement the VTS under BTLS, you can define the tape drives through the hardware HCD dialog, or you can use IOCP and MVSCP. You also have to define a new logical tape library to BTLS that contains all virtual drives associated with this VTS logical library. If only BTLS is using the VTS, you define all 32 or 64 drives. To direct tape allocations to the VTS, define a new

esoteric unit name and use it in the DD statement for the newly allocated tape data set. For BTLS-managed libraries, HCD is not required because BTLS does not require the LIBRARY=YES definition.

Because of the tape library definitions, BTLS knows that the drive allocated resides in a VTS tape library. For BTLS implementation details, refer to the *Basic Tape Library Support User's Guide and Reference*, SC26-7016. For additional practical information, refer to *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632.

Note: There is no support available in BTLS for the Advanced Function feature with the Import/Export operations.

JES3 provides BTLS support as follows:

• Because the tape subsystems in the IBM Magstar 3494 Tape Library must not be defined in the JES3 initialization deck, they are not managed by JES3.

• MVS performs all IBM Magstar 3494 Tape Library tape drive allocations with the allocation assist function of BTLS. BTLS is responsible for communication with the Library Manager in the IBM Magstar 3494 Tape Library.

• BTLS functions in the JES3 environment are identical to the BTLS functions in the JES2 environment.

• JES3 tape DSPs or JES3 tape commands for tape drives inside an IBM Tape Library are not supported.

3.5.4 VM/ESA

After you have defined the new VTS tape library through HCD, you must define VTS to DFSMS/VM if the VM system is to use the VTS directly. You define the VTS tape library through the DFSMS/VM DGTVCNTL DATA control file. Also, you define the available tape drives though the RMCONFIG DATA configuration file.

You have the removable media services (RMS) as a component of DFSMS/VM. To allow the RMS to perform automatic insert bulk processing, you must create the RMBnnnnn DATA file in the VMSYS:DFSMS CONTROL directory, where *nnnnn* is the five-character tape library sequence number that is assigned to the VTS during hardware installation.

Note:

The Advanced Function feature is currently not supported with VM/ESA.

For details on implementing of DFSMS/VM and RMS, refer to the *VM/ESA DFSMS/VM Removable Media Services User's Guide and Reference*, SC35-0141. If the VTS is shared by your VM system and other systems, additional considerations apply. Refer to the *Guide to Sharing and Partitioning IBM Automated Tape Library Dataservers* SG24-4409, for further information.

3.5.4.1 MVS/ESA Guests

It is possible for the environments described in the Section 3.5.1, "DFSMS System-Managed Tape" on page 82 to operate when MVS/ESA is running as a guest of VM/ESA Release 2 or higher. The considerations are the same as when MVS/ESA runs natively without VM/ESA.

In this environment additional software products are not required.

3.5.4.2 VSE/ESA Guests

VSE/ESA must run as a guest system under VM/ESA to use a VTS library. Some VSE tape management systems require VSE Guest Server (VGS) support as well as DFSMS/VM RMS for communication with the Library Manager of the VTS library.

If the VGS is required, define the LIBCONFIG file on the VGS service machine's A disk. This file simply cross-references the VSE/ESA guest's tape library names with the names that DFSMS/VM uses. To enable VSE/ESA guest exploitation of inventory support functions through the LIBSERV-VGS interface, the LIBRCMS part must be installed on the VM system. If VGS is to service inventory requests for multiple VSE/ESA guests, you must edit the LIBRCMS SRVNAMES cross-reference file. This file enables the inventory support server to access Librarian files on the correct VSE guest machine. See Section 6.8.2, "VSE/ESA As a VM/ESA Guest Using a VSE Guest Server" on page 158. For further information, please refer to Section 7.6 "VSE Guest Server Considerations" in the *Guide to Sharing and Partitioning IBM Automated Tape Library Dataservers*, SG24-4409.

The CA DYNAM/TM-VSE does not use the VGS machine.

3.5.5 Native VSE/ESA

Native VSE/ESA does not support the VTS because a separate LAN connection between the host and the Library Manager is required to communicate with the Library Manager. The VTS subsystem has only ESCON connection to S/390 hosts.

3.5.6 Host Operation Control

Host operation control of the IBM 3494 is operating-system dependent. Because the IBM Magstar 3494 Tape Library operates under a variety of host operating systems, you must be familiar with each operating system for your tape library and the required protocol.

For more information about host operating systems, refer to *IBM 3494 Tape Library Introduction and Planning Guide.*

3.6 IBM Magstar VTS SCSI Attachment

In this section, we provide the information that you need to plan a VTS which connects to its hosts through SCSI attachments.

The SCSI host attachment for the IBM 3494 Model B18 VTS is offered to share the VTS between S/390 and Open Systems hosts. This may eliminate redundant tape drive attachments, reduce operational costs and allow increased data automation. The SCSI host attachment also reduces the complexity of sharing data between S/390 and the distributed environment by using common tape drive technology. From a customer viewpoint, or from an operating system perspective, the Virtual Tape Server appears as an IBM 3494 Automated Tape Library with 32 or 64 3490E tape drives and 150,000 cartridges. There can be one or two SCSI host adapters on a B18 with each adapter supporting two SCSI busses. The feature provides data compression that is compatible with the ESCON High Performance option (EHPO).

The SCSI Host Attachment is a feature (FC 3422) for an IBM 3494 Model B18 VTS which permits open-systems host attachment through industry-standard SCSI busses. FC 3422 provides two SCSI interfaces on a single card for the IBM 3494 Model B18 VTS. Either Feature 3200 (ESCON High Performance Option) or Feature 3400 (Extended High Performance Option) with Feature 3412 (two extended Performance ESCON Channels) is a prerequisite to FC 3422. Feature 3302 (Additional Enhanced ESCON Channel Attachment) or an additional Feature 3412 may not be installed, because there would be no place to install the SCSI attachment. One or two SCSI Host Attachment features can be installed in a VTS providing two or four SCSI interfaces in addition to the two ESCON Channels.

Note: Currently, there needs to be one active S/390 host attached to the VTS for management and error recovery scenarios.

Initial SCSI host support is for selected RS/6000 and RS/6000 SP systems running AIX 4.2.1 and above. VTS Open Systems Device Driver (FC 9201) provides the tape drive and library device driver support for the RS/6000 host adapters listed in Table 13:

Table 13. Supported SCSI Host Adapters for RS/6000	
Adapter Type	**RS/6000 Feature Code**
Enhanced SCSI-2 Differential Fast/Wide	2412
PCI SCSI-2 Fast/Wide Differential	6209
PCI Differential Ultra SCSI	6207

3.6.1 IBM Magstar VTS Open Systems Design

The 3490E drive commands, status, and data are passed on the SCSI bus, and communications between the host and Library Manager are performed over a separate LAN or serial connection, bypassing the VTS. The conceptual drawing in Figure 30 on page 92 shows the components and connections used by this feature.
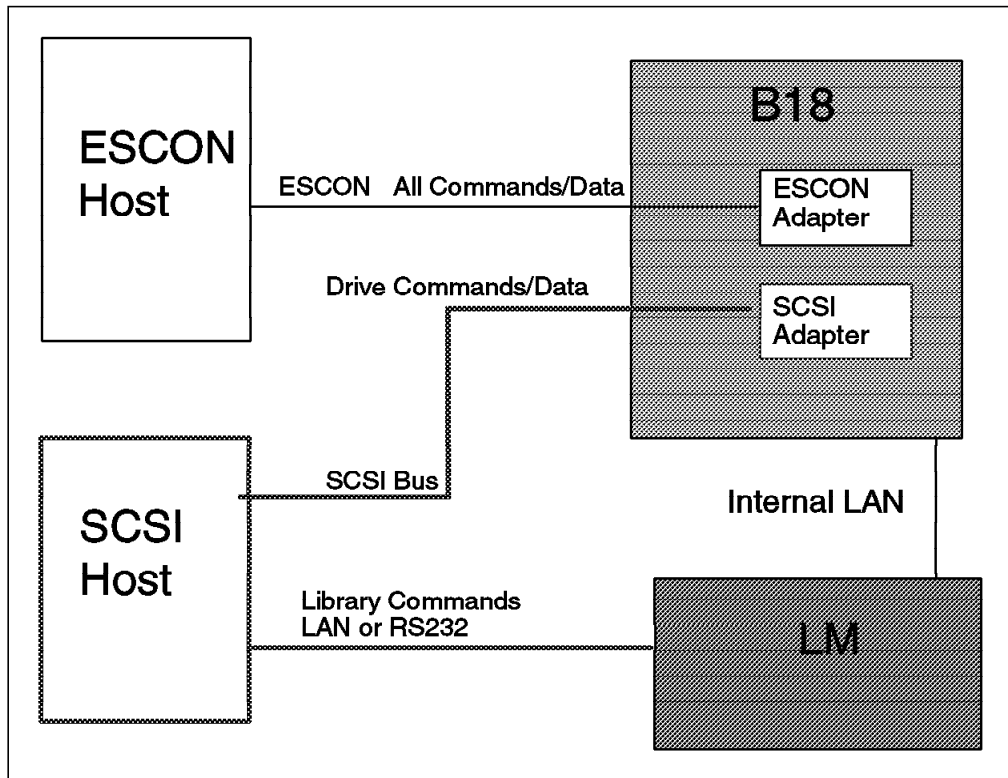
Figure 30. VTS with Mixed ESCON and SCSI Host Attachments

The VTS virtual drives are emulated 3490E tape drives. This emulation is used for both ESCON and SCSI attachments. Behavior on the ESCON interface is not changed by this feature. Application programs supporting library attached 3490E tape drives should operate without change with a VTS.

The maximum number of virtual drives available with a single IBM 3494 Model B18 VTS remains unchanged with the installation of the SCSI Host Attachment feature: Up to 64 virtual drives can be defined and used. Any virtual drive can be assigned to either host or may be switched between hosts based on usage requirements. A maximum of 32 virtual drives is available to the SCSI hosts of a single IBM 3494 Model B18 VTS with two SCSI Host Attachment features. One SCSI Host Attachment feature supplies a maximum of 16 virtual drives. This maximum of 16 virtual drives per SCSI Host Attachment feature can be accessed over one or over both SCSI interfaces of that SCSI Host Attachment feature.

Open systems device drivers are described in *IBM SCSI Tape Drive, Medium Changer, and Library Device Drivers: Installation and User's Guide* GC35-0154 Any changes for VTS support will be documented in a revision of this publication.

3.6.2 SCSI Bus

The SCSI Host Attachment feature supports the SCSI-2 (Fast/Wide Differential) 20 MB/s standard interface, as well as the 40 MB/s Differential Wide/Ultra SCSI interface. The total cable length for a SCSI bus having a VTS SCSI connection is 20 meters.

The SCSI Host Attachment feature on the VTS controller must be terminated externally by using the provided terminators. Adapter cards are fitted with connection blocks to permit daisy-chain connections or external terminators.

Daisy-chain connections of multiple VTS SCSI adapters requires reconfiguration of adapter nodes to provide unique starting target IDs. This is because all busses have a default configuration with starting target ID of 8. For recommended definitions to avoid conflicts, see 3.6.3, "SCSI Target Addressing" on page 93.

A new cable type is required when connecting a RS/6000 or RS/6000 SP to a VTS. The cable connects the host to the VTS using a 0.8mm SCSI connector. The supported cable lengths are 4.5m, 10m, and 20m. The SCSI interface on the VTS controller uses external termination and must be properly terminated. Adapter cards are fitted with connection blocks to permit daisy-chaining to a second VTS or external terminators.

3.6.3 SCSI Target Addressing

The SCSI target addresses to be used on each bus are configurable through a service panel by an IBM service representative upon installation of the VTS with a SCSI Host Attachment feature or installation of the SCSI Host Attachment feature in the field. Each adapter (= SCSI Host Attachment feature) provides two SCSI interfaces. One or two adapter cards may be installed in the VTS controller. The criteria for the installation of one or two adapters are:

- Number of SCSI tape drives required:
  Two SCSI Host Attachment features (adapters) are required if more than 16 virtual tape drives are needed.
- Required data transfer rate:
  Two adapters are required if data transfer rate exceeds single adapter capability.
- Not enough cable length to daisy-chain to all attached SCSI hosts from one adapter.

Each SCSI Host Attachment feature (adapter) is restricted to accessing no more than 16 virtual drives. Each bus may be configured to address any even number of up to 16 contiguous virtual tape drives, starting with an even device number. Note that, internally, virtual tape drives are numbered from 0 to 63. The target addresses for each bus of a SCSI Host Attachment feature must be contiguous (see Figure 31 on page 94).
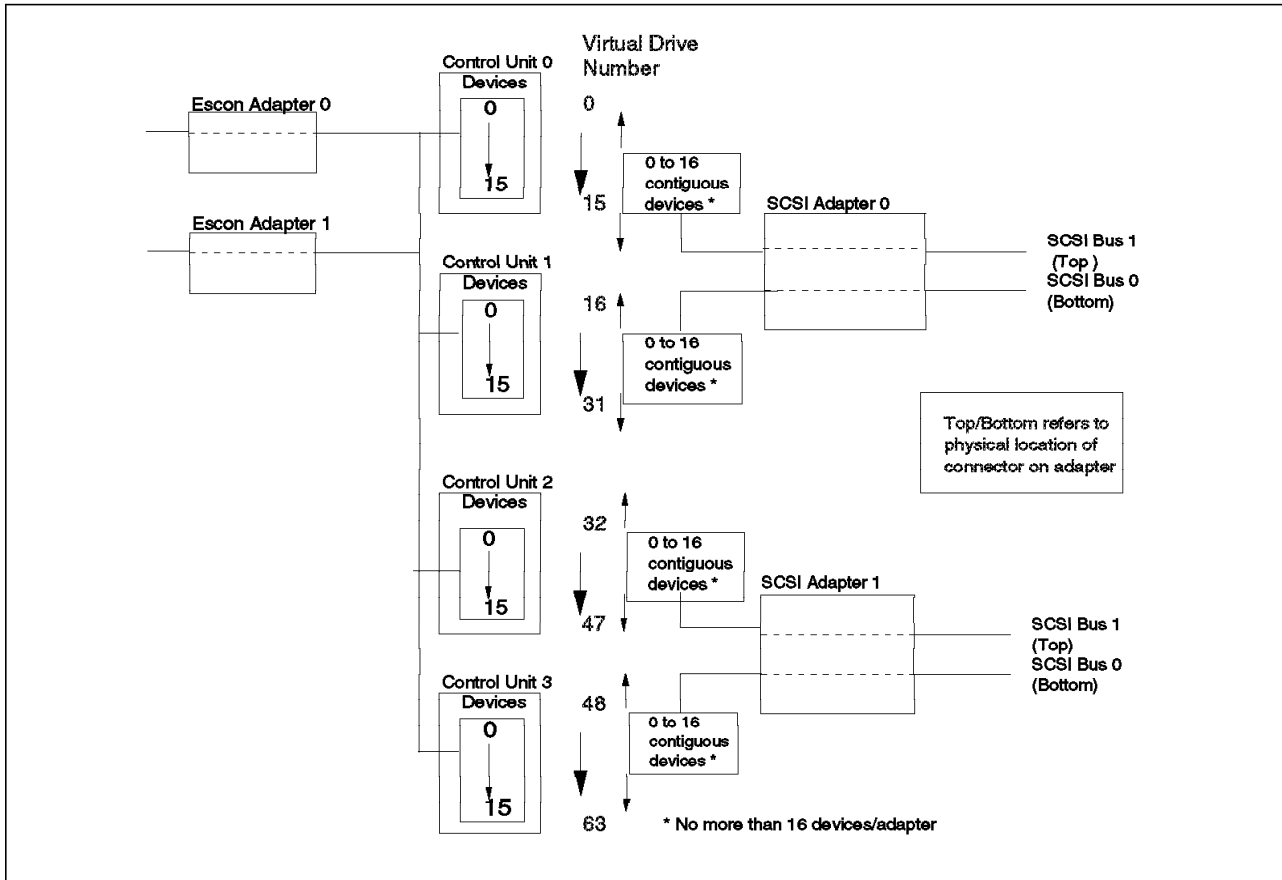
Figure 31. SCSI Target Addressing

The division of the virtual tape drives between virtual control units is done for ESCON addressing purposes. Therefore, device 0 for one virtual control unit is contiguous to device 15 of the previous (lower-numbered) virtual control unit. There may be an overlap between the virtual drives accessed on each SCSI bus and/or SCSI adapter. Hosts are expected to use the SCSI *Reserve Unit* and *Release Unit* commands to prevent use of a single virtual tape drive by multiple initiators or contention with ESCON-attached hosts. To keep it simple we recommend to dedicate virtual drives to SCSI hosts if possible.

The adapter cards use one SCSI target address for every two virtual drives configured, starting with the specified base address for the bus. LUN (logical unit number) 0 and 1 are used for virtual drives at each target address. The base target address for each bus may be set to 0 through 16 minus the number of virtual tape drives addressed on the bus divided by two (16-(devices/2)). That is, no target address on the adapter may exceed 15. Each bus is independently configurable.

The initial SCSI device addressing for each bus of a SCSI Host Attachment feature is set for eight virtual tape drives, beginning at target address 8. Table 14 on page 95 shows the initial assignments of target addresses for the SCSI Host Attachment feature. The default setting, for all SCSI virtual tape drives, is non-shared. If you would like to share the same virtual drives between SCSI interface 0 and 1 or share between a SCSI host and a S/390, they must be configured by the IBM service representative.

Multiple SCSI attached VTS subsystems on the same SCSI bus (daisy chaining) will require reassignment of the initial target address of one or more subsystems to avoid conflicts. These initial assignments may be changed from a service panel by an IBM service representative.

Table 14. SCSI Target Addresses Initial Setting						
SCSI Adapter	**Bus on Adapter**	**CU ID**	**Device Number Range**	**Virtual Drive Number Range**	**SCSI Target Address Range**	**LUN Range**
0	0	0	0-7	0-7	8-11	0-1
0	1	0	8-15	8-15	8-11	0-1
1	0	1	0-7	16-23	8-11	0-1
1	1	1	8-15	24-31	8-11	0-1

The VTS virtual drives can be shared between ESCON and SCSI hosts if the ESCON *assign/unassign* and SCSI *reserve/release* functions are properly implemented.

In an environment where the first 48 virtual devices are assigned to an ESCON host, a possible definition for 16 SCSI devices could be done as shown in Table 15. Refer to 3.3.3, "Defining Devices through HCD" on page 65 for HCD definition samples.

Table 15. SCSI Target Addresses Sample				
CU ID	**Device Number**	**Virtual Drive Number**	**SCSI Target Address**	**LUN**
3	0	48	8	0
3	1	49	8	1
3	2	50	9	0
3	3	51	9	1
3	4	52	10	0
3	5	53	10	1
3	6	54	11	0
3	7	55	11	1
3	8	56	12	0
3	9	57	12	1
3	10	58	13	0
3	11	59	13	1
3	12	60	14	0
3	13	61	14	1
3	14	62	15	0
3	15	63	15	1

For a detailed discussion on tape library sharing between S/390 and SCSI hosts, including considerations about drive sharing, volume sharing and related software implementation steps, refer to *Guide to Sharing and Partitioning IBM Tape Library Dataservers,* SG24-4409.

3.6.4 SCSI Drive Emulation

The IBM 3494 Model B18 VTS appears to the SCSI host as up to 32 IBM 3490E drives. In fact one or more IBM 3490 Model C2A Tape Subsystems with each two SCSI adapters are emulated. The IBM 3490 Model C2A Tape Subsystem contains a single control unit that can access two IBM 3490E tape drives. Before a host application can access a tape drive it must first address the tape drive. Figure 32 illustrates the components used to address IBM 3490E tape drives in an IBM 3490 Model C2A Tape Subsystem.
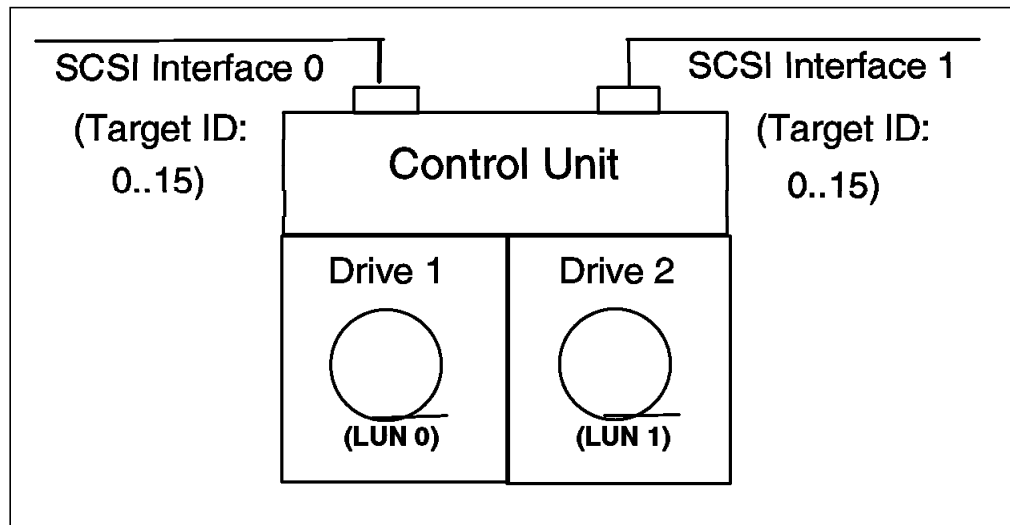
Figure 32. IBM 3490 Model C2A Tape Subsystem with Two IBM 3490E Tape Drives

The IBM 3494 Model B18 VTS SCSI host attachment feature provides two SCSI interfaces per adapter. The default for the virtual drive is non shared. This means that one virtual drive can only be accessed by one SCSI interface. If the customer chooses to have the virtual drives defined as shared then either one or both of the interfaces can be used to access a drive. There are three components used to access a drive. They are the SCSI bus interface that the control unit resides on, the target address of the control unit on the bus, and the address of the drive on the control unit. The format for addressing a SCSI drive is:

```
┌─── SCSI Address Format ─────────────────────────────────────────┐
│                                                                  │
│  SCSI Interface address / Target ID address / LUN address        │
│                                                                  │
└──────────────────────────────────────────────────────────────────┘
```

SCSI refers to either VTS SCSI bus interface 0 or 1. Target ID refers to the target address of the control unit of the emulated IBM 3490-C2A on the SCSI bus. The valid Ids are 0 - 15. LUN refers to the drive you are addressing, address 0 is the first emulated 3490E tape drive, address 1 represents the second emulated 3490E tape drive. Figure 33 on page 97 illustrates an RS/6000 host accessing 8 virtual tape drives in an IBM 3494 Model B18 VTS.
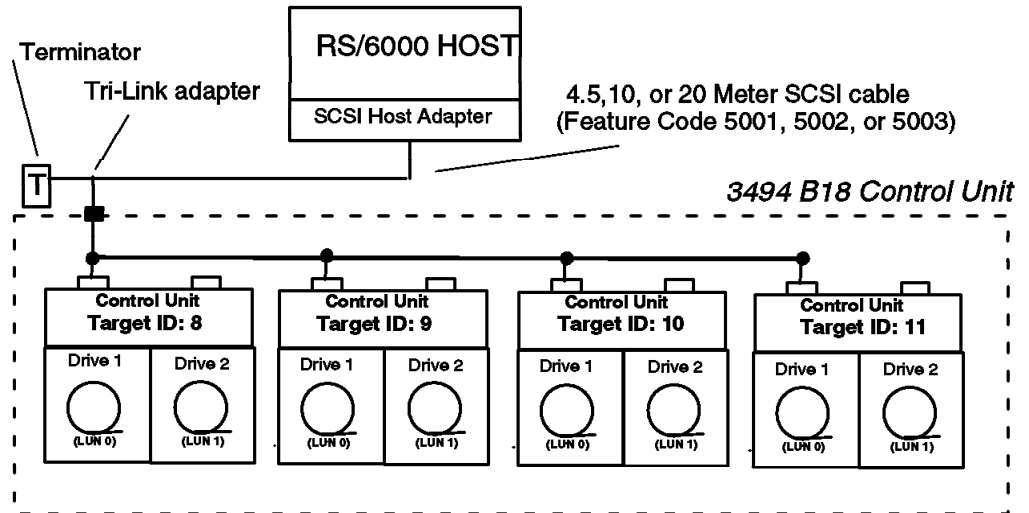
Figure 33. Sample RS/6000 Addressing 8 Virtual 3409E Tape Drives

Figure 34 illustrates an RS/6000 host accessing two IBM 3494 Model B18 VTS with 8 defined virtual drives for SCSI each.
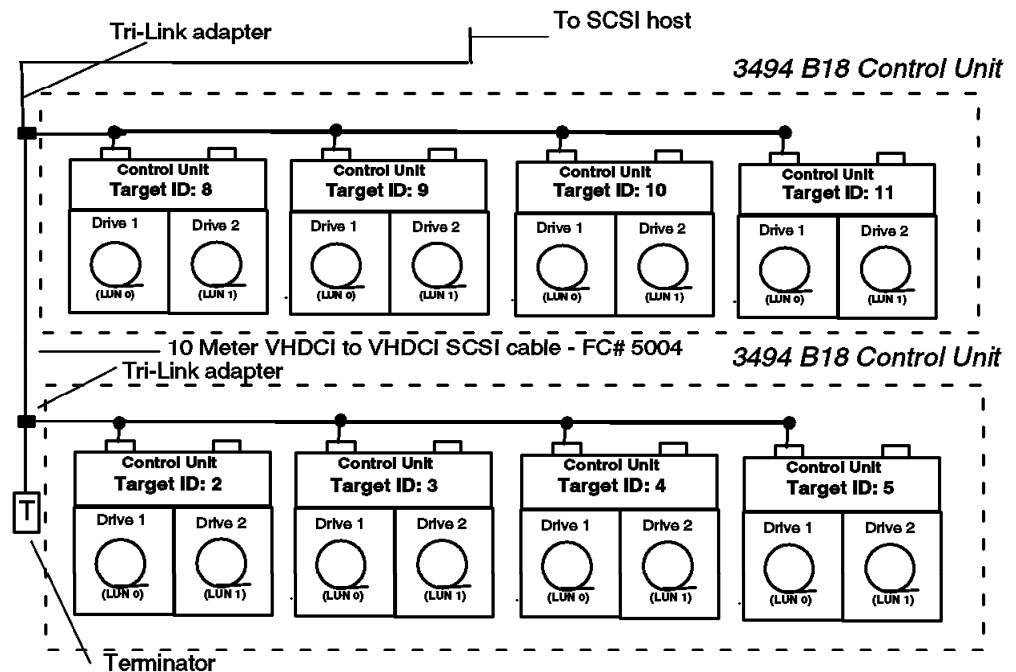
Figure 34. Sample RS/6000 with Daisy-chained IBM 3494 Model B18 VTSs

3.6.5 AIX Implementation

The AIX implementation is similar to implementing real IBM 3490-C2A Tape Subsystems with SCSI interfaces into an IBM 3494 Tape Library. Detailed information is provided in the AIX section of *IBM Magstar Tape Products Family: A Practical Guide.* For recommendations on the using Tivoli Storage Manager see 6.4.3, "Tivoli Storage Manager" on page 137 and the *Tivoli Storage Manager Version 3.7: Technical Guide,* SG24-5477.

Chapter 4. VTS Performance Accelerator

In this chapter, we describe the VTS enhancements which are available since September 1999. We describe different installation and upgrade options based on the current installation with the focus on Model B18 and the options for ordering a VTS with the new enhancements. The enhancements are based on three new features: the Performance Accelerator Feature, the EHPO, and the Extended Performance ESCON Channels. These enhancements expand the performance and capability of the industry leading Magstar 3494 VTS.

The availability of a high performance streaming file system and an enhanced controller processor, which are contained in the Performance Accelerator Feature, in conjunction with new Extended Performance ESCON Channels, dramatically improve performance characteristics over the current Model B18 which is the base for these enhancements.

The IBM Magstar 3494 VTS B18 exploits the unique performance and capacity of the Magstar 3590 tape drives to reduce the total cost of ownership of tape solutions for MVS, TPF, VM, VM/VSE and AIX environments. Both, 3590 model B1A and the new 3590 model E1A are supported.

The enhancements available now further demonstrate IBM′s commitment to the Seascape Architecture and the power of this architecture to bring products to the marketplace and react to customer requirements as fast as possible.

These new features once again increase the performance, connectivity and scalability of the Virtual Tape Server. These enhancements will allow existing customers to incorporate additional workloads and protect their investment in the IBM solution. For new customers, where performance is a key requirement, these enhancements allow the installation of a significantly smaller configuration to support their business, improve performance, and reduce cost.

The upgrade path from VTS Model B16 to Model B18 with standard ESCON channels or the new Extended Performance ESCON Channels and the different model conversion options for the B16 frame is described in Appendix D, "Migration of IBM 3494 Model B16 to Model B18" on page 325.

4.1 The VTS Enhancements at a Glance

This list of enhancements, new features, extended connectivity and improved functionality has been available since September 1999.

- Extended High Performance Option
- Extended Performance ESCON Channels
- Performance Accelerator Feature
- Support of 3590 E1A tape drives
- Increased number of logical volumes
- Additional drive frame features
- Exported volume read utility
- Support of Transaction Processing Facility (TPF)

The announcement also contained a product preview for:

- Storage Area Network attachment
- ″Call Home″ service support

Previewed product features and functions will further enhance the Magstar 3494 Model B18 VTS.

- Hardware Withdrawal from IBM Marketing
    - ESCON High Performance Option (FC 3200)
    - Additional Enhanced ESCON Channels (FC 3302)

4.1.1 Extended High Performance Option

The Extended High Performance Option (EHPO FC 3400) enables data compression for host channel attachments, which provides larger effective tape volume cache capacities, improved performance, and up to 64 virtual devices. The principal benefits of compression are to increase the throughput performance of the VTS and increase the number of virtual volumes in the tape volume cache available for cache hits. The compression algorithm is similar to the algorithm used by the Magstar 3590 tape drive. With the EHPO, compression takes place regardless of the channel connection, ESCON and SCSI.

The first generation of the compression feature code 3200 called ESCON High Performance Option, was introduced with the Model B18 in 1998. This required a new microcode level along with two Enhanced ESCON Channels cards. It provided together with the Enhanced ESCON Channels the data compression for the first generation of VTS Model B18.

The new EHPO feature code 3400 with FC 3412 (Extended Performance ESCON channels) replaces ESCON High Performance Option feature code 3200.

Refer to 4.2.7, "Upgrade Scenarios" on page 106 for an outline on the upgrade possibilities and recommendations for the channel features.

4.1.2 Extended Performance ESCON Channels

The Extended Performance ESCON Channels feature code 3412 provides two independently operating extended performance ESCON channel adapters to maximize VTS performance. The Extended High Performance Option feature code 3400 or ESCON High Performance Option feature code 3200 is a prerequisite. Up to two of FC 3412 can be ordered with FC 3400 providing a total of four Extended Performance ESCON Channels. This feature replaces the Additional ESCON Channel feature code 3302.

FC 3412 is mutually exclusive with FC 3302. Feature code 3302 must be converted to feature code 3412 Extended Performance ESCON Channels to enable adding the Performance Accelerator Feature.

4.1.3 Performance Accelerator Feature

The Performance Accelerator Feature is a combination of hardware and software improvements, which provide in conjunction with the new Extended Performance ESCON Channels a balanced subsystem. The essential elements of the Performance Accelerator Feature are:

- A new File System

- Additional processing hardware and storage

- Improved Licensed Internal Code

One principal element of the Performance Accelerator Feature is the increase of RS/6000 processing power from two to four processors. Another is the buffering of the incoming data to the RS/6000, either from an host or tape, in logically contiguous blocks of 256KB, that are written in parallel across the disks of the tape volume cache (Full Stride Write). These enhancements are accomplished by the new file system GPFS (General Parallel File System) and result in an increase of the MB/s throughput of the TVC. The Performance Accelerator Feature and the Extended Performance ESCON Channels provide additional performance options for customers to either allow additional storage access during a period of peak activity or reduce the duration of peak activity for jobs requiring higher transfer rates. It can also decrease the time it takes to respond to virtual volume recalls and allow more host data transfer. Furthermore, it is possible to make a further step towards storage consolidation as one part of the total SAN strategy within your DP organization. Either you may consolidate more workload of the S/390 platform or use the extended connectivity to migrate the workload from a TPF system or RS/6000 servers onto one and the same VTS environment.

In configurations with either the EHPO FC 3400 or the ESCON High Performance Option FC 3200 and four Extended Performance ESCON Channels, the Virtual Tape Server performance will be maximized and can provide up to a 100% increase in sustained performance and up to a 50% increase in Peak performance. These improvements apply to both configurations of cache, 432 GBytes and 864 GBytes, assuming a 3:1 compression ratio. A comparison of bandwidth numbers of various VTS models, based on initial modeling and measurements and assuming a 3:1 compression ratio, is shown in Figure 35.
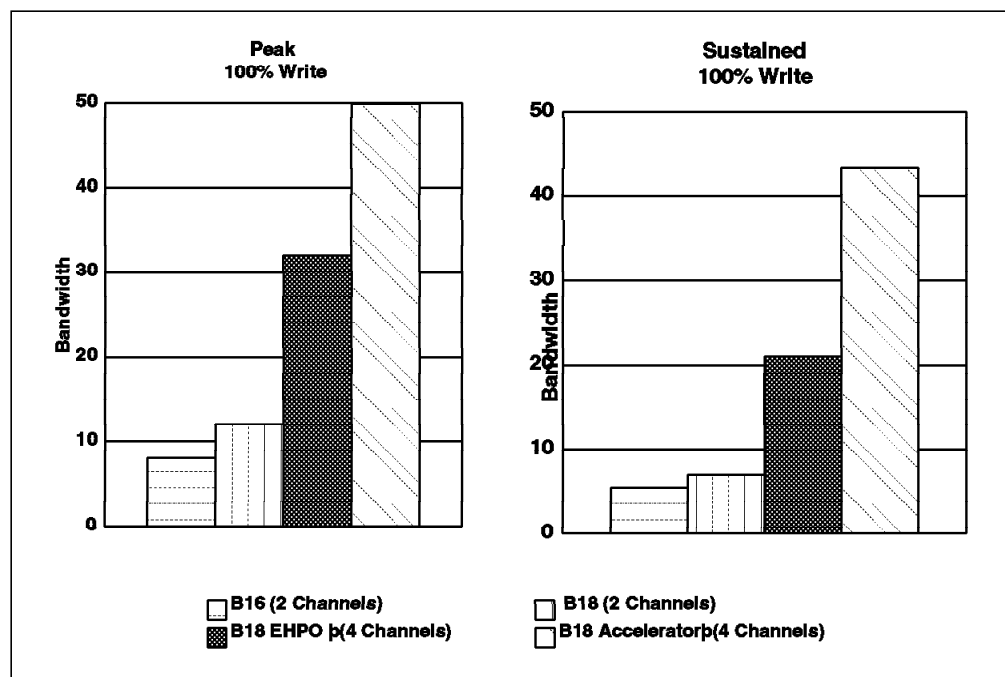
Figure 35. Performance Comparison

In general, performance depends on such factors as total system configuration, VTS tape volume cache capacity, the number of tape drives available to the VTS, the number of channels, read/write ratio, data characteristics like blocksize and mount pattern.

Chapter 8.4, "Monitoring and Evaluating VTS Performance" on page 210 discusses all these performance factors in depth and contains performance numbers of different configurations.

4.1.4 Support of 3590 E1A Tape Drives

Magstar 3590 B1A tape drives are supported by the VTS for the stacking of virtual volumes. Current 3590 B1A installations may be upgraded to include the Magstar 3590 E1A models. Exported stacked volumes created on 3590 B1A drives can be imported into 3590 model E1A configurations. The 3590 E1A is able to read 128-track format as well as 256-track format. However, exported stacked volumes created on 3590 E1A drives cannot be imported into 3590 model B1A configurations.

A VTS configuration must consist of either all 3590 model B1A tape drives or all model E1A tape drives.

A detailed discussion of all aspects using 3590 B or 3590 E models is in chapter Chapter 5, "Migration to the IBM 3590 Enhanced Models" on page 117.

4.1.5 Increased Number of Logical Volumes

The 3494 Library Manager is extended to allow up to 300,000 logical volumes within a configuration of two B18 frames connected to and controlled by one 3494-L1x Library Manager. Each VTS installed in a library may have a maximum of 150,000 logical volumes defined.

4.1.6 Additional Drive Frame Features

Installation flexibility for the 3494 Tape Library is increased with two additional frame features available on the 3494 Models L10, L12, and L14. These features provide additional options for model conversions of a 3494 Model B16 to a Model B18.

4.1.6.1 The Basic Feature Codes

The features available since the introduction of the Model B18 are FC 5500 for an additional Storage Unit Frame and FC 5502 for the conversion of Model B16 frame to an Additional VTS Drive Unit Frame. Feature code 5500 is required on an MES to upgrade Model B16 to Model B18 and if the B16 frame is converted to an additional storage frame. Feature code 5502 is required on such a MES, if the B16 frame is to be converted to a drive unit for B18 frame.

4.1.6.2 The New Feature Codes

In addition to the two current options the 3494 Model B16 VTS frame can now be converted into a SCSI Drive Frame (similar to a 3494 D12 frame) with FC 5503 or into an ESCON Drive Frame (similar to a 3494 D14) with FC 5504.

4.1.6.3 Feature Code Conversion Based on FC 5500

Feature Conversions can also be accomplished to convert a current Storage Frame FC 5500 to an Additional VTS Drive Frame with FC 5502, to a SCSI Drive Frame with FC 5503, or to an ESCON Drive Frame with FC 5504.

4.1.6.4 Feature Code Conversion Based on FC 5502

Current VTS B18 Drive Frame FC 5502 can be converted to a SCSI Drive Frame with FC 5503, or to an ESCON Drive Frame with FC 5504.

Table 16 lists all feature conversions for FC 5500 and FC 5502

Table 16. Feature Code Conversion Table		
from	**to**	**Description**
5500	5502	Storage Unit to Drive Unit for B18
5500	5503	Storage Unit to SCSI Drive Unit
5500	5504	Storage Unit to ESCON Drive Unit
5502	5503	Drive Unit for B18 to SCSI Drive Unit
5502	5504	Drive Unit for B18 to ESCON Drive Unit

For more details on the different feature codes, see the section starting with 2.8.5.10, "Additional Storage Unit Frame (FC 5500)" on page 47.

4.1.7 Exported Volume Read Utility

DITTO/ESA for MVS Version 1 Release 3 provides a VTS Exported Volume Read Utility to:

- Create a list of logical volumes contained on an exported stacked volume.

- Copy a logical volume from an exported stacked volume and create a physical volume containing only the single logical volume.

The output device has to be a tape drive of any type; it is not possible to copy the logical volume to a DASD device.

This support is available through APAR PQ26582.

The creation of copies of exported logical volumes outside the normal export/import procedure is not transparent in terms of catalog management, Tape Management System, or other control datasets like the OCDS of DFHSM. It is the responsibility of the administrator of such an operation to update the control datasets for further processing. See 9.12, "DITTO VTS Functions" on page 285 for further information.

4.1.8 Support of TPF

Transaction Processing Facility TPF is a high performance transaction processing system software solution. TPF Version 4.1 plus PTFs supports 3490E virtual devices and can share the drives within a VTS as well as logical volumes.

By this support the VTS connectivity is extended to an additional operating system environment which helps to consolidate storage and reduce the total cost of ownership.

4.1.9 Hardware Withdrawal from IBM Marketing

Effective September 1999, IBM has withdrawn these features from marketing:

- ESCON High Performance Option FC 3200

- Additional Enhanced ESCON Channels FC 3302

ESCON High Performance Option FC 3200 is replaced by EHPO FC 3400 in conjunction with the Extended Performance ESCON Channels feature code 3412, and the feature Additional Enhanced ESCON Channels FC 3302 is replaced by Extended Performance ESCON Channels FC 3412.

4.2 Installation of the Performance Accelerator Feature

We describe the different upgrade paths, which are available to enhance the installed VTS base with the new features. The different installed VTS configurations have to be taken under consideration when you plan to install the Performance Accelerator Feature with Extended Performance ESCON Channels.

4.2.1 Upgradeability

The Model B18 with standard ESCON channels provides an entry configuration for customers with limited bandwidth requirements. The ESCON High Performance Option for the B18 provides data compression and the addressability of up to 64 virtual devices. The overall throughput depending on the achievable compression-rate provides a solution for customers with higher performance requirements.

The second enhancement of the VTS provided by the Extended Performance ESCON Channels and the Performance Accelerator Feature is an incremental change based on a 3494 model B18 with ESCON High Performance Option. The combination of these new features provides the high level of performance for those customers with stringent performance requirements.

Entry configurations can easily be upgraded to increasingly higher performance solutions by adding the EHPO, Extended Performance ESCON Channels, and the Performance Accelerator Feature.

Customer investment in the VTS is protected with feature upgrades and conversions.

4.2.2 Hardware Requirements and Prerequisites

The Performance Accelerator Feature which provides the high performance file system, more processor power, more processor storage and micro code enhancements requires the following prerequisites:

- Extended Performance ESCON Channels Each Extended Performance ESCON Channels feature provides two extended performance ESCON channel adapters to maximize VTS performance. A maximum of two FC 3412 features for a total of four Extended Performance ESCON Channels can be installed. In order to install Extended Performance ESCON Channels one of the features is required:

- FC 3200 (ESCON High Performance Option)

- FC 3400 (Extended High Performance Option)

With each FC 3412 two 30.5 meter (100 foot) ESCON cables are included to attach to host ESCON channels. Different ESCON cable length have to be ordered separately.

- One of these channel feature combinations is required for the Performance Accelerator Feature:

  − Feature code 3200 plus one feature code 3412
  − Feature code 3200 plus two feature codes 3422
  − Feature code 3400 plus two feature codes 3412
  − Feature code 3400 plus one feature code 3412 plus two feature codes 3422

- 432GB or 864GB of TVC, assuming a 3:1 compression ratio (that is, two or four FC 3702).

- A minimum of four 3590 tape drives

On any new order including the Performance Accelerator Feature, you have to order the EHPO FC 3400 plus four Extended Performance ESCON Channels (two FC 3412), or two Extended Performance ESCON Channels (one FC 3412) plus two SCSI attachments (that is, four SCSI busses, two FC 3422).

4.2.3 Software Requirements and Prerequisites

For the implementation of the VTS enhancements, there is no special software level required beyond the software levels listed in the 2.5, "Software Requirements" on page 32.

4.2.4 Library Manager and VTS LIC Prerequisites

The IBM Library Manager Microcode must be at EC level F23225 (that is, microcode level 523.01) or higher. This level includes support for the Import/Export feature.

The IBM Virtual Tape Server must be at EC level F23233 (that is, microcode level 2.17.8.0 and the AIX level 4.3.2) or higher.

Both EC levels should be installed on you current installation during your normal maintenance window. The upgrade of your VTS with the Extended Performance ESCON Channels and Performance Accelerator Feature may be planned later.

4.2.5 ESCON Channel Attachment

In general, there is no benefit to update from old channels (the Enhanced ESCON Channels, FC 3200 and 3302) to new channels (the Extended Performance ESCON Channels, FC 3400 and 3412). The VTS Model B18 with EHPO, the 2-way processor, and the Journaled File System (JFS) is balanced between the channel capability and the file system capability. The Extended Performance ESCON Channels will not improve the overall bandwidth of this VTS configuration. Having installed four channels without the Performance Accelerator Feature, the old and new channels will provide the same sustained and peak performance.

If you have a configuration with two enhanced ESCON channels connected to System_A and two Extended Performance ESCON Channels connected to System_B, System_B will get a better bandwidth than System_A. The enhanced throughput capability of the new Extended Performance ESCON Channels will improve the performance of System_B, but the overall bandwidth of the VTS, which is limited by the JFS, cannot be exceeded.

If you decide to install the Performance Accelerator Feature, four channel attachments are required, four Extended Performance ESCON Channels or two SCSI attachments FC 3422 plus two Extended Performance ESCON Channels. Adding ESCON Channels to your host requires an update to the OS/390 Hardware Configuration Definitions (HCD). This can be done in advance of the VTS upgrade.

4.2.6 Ordering Support

As mentioned before there are two hardware requirements beside the new Extended Performance ESCON Channels and Performance Accelerator Feature:

- 432GB or 864GB of TVC, assuming a 3:1 compression ratio (that is, two or four FC 3702).

- A minimum of four 3590 tape drives.

This implies the upgrade to two FC 3702, if you have only FC 3702 installed, and the upgrade to four FC 3702, if you currently work with three FC 3702 of TVC.

A minimum of four 3590 tape drive requires the ordering of an additional drive explicitly if you are currently running with three tape drives only. Furthermore there are two prerequisites in terms of features. The EHPO FC 3400 is one prerequisite for the Performance Accelerator Feature and has to be configured explicitly. The new Extended Performance ESCON Channels which come along with FC 3412 are the second prerequisite. If you plan to connect the upgraded VTS to S/390 systems only, you have to order two Extended Performance ESCON Channels FC 3412, which effectively means four Extended Performance ESCON Channels attachments. If you plan to connect the upgraded VTS to other platforms via SCSI attachments, you need to configure two SCSI attachment feature codes 3422 in conjunction with one Extended Performance ESCON Channels feature.

4.2.7 Upgrade Scenarios

This chapter describes the different scenarios and upgrade paths when migrating to a VTS with the Extended Performance ESCON Channels and Performance Accelerator Feature.

If you have currently installed the basic VTS B18 Model and are planning to upgrade it, you may have four different target systems:

- VTS B18 with EHPO and Extended Performance ESCON Channels

- VTS B18 with EHPO and Extended Performance ESCON Channels plus SCSI Attachment

- VTS B18 with EHPO, Extended Performance ESCON Channels, and Performance Accelerator Feature

- VTS B18 with EHPO, Extended Performance ESCON Channels, SCSI, and Performance Accelerator Feature

4.2.7.1 Upgrade Model B18

The Upgrade options of Model B18 are described in Table 17 on page 107.

Table 17. Feature Code Conversion and Additions		
current	**target**	**Features required**
B18 standard	B18 EHPO, 2 ESCON	Order FC 3400, FC 3412
B18 standard	B18 EHPO, 4 ESCON	Order FC 3400, 2 x FC 3412
B18 standard	B18 EHPO, 2 ESCON, 2 SCSI	Order FC 3400, FC 3412, FC 3422
B18 standard	B18 EHPO, 2 ESCON, 4 SCSI	Order FC 3400, FC 3412, 2 x FC 3422
B18 standard	B18 EHPO, 4 ESCON, PA	Order FC 3400, 2 x FC 3412, FC 5236
B18 standard	B18 EHPO, 2 ESCON, 4 SCSI, PA	Order FC 3400, FC 3412, 2 x FC 3422, FC 5236
B18 FC 3200	B18 EHPO, 4 ESCON	Order FC 3412
B18 FC 3200	B18 EHPO, 4 ESCON, PA	Order FC 3412, FC 5236
B18 FC 3200, FC 3302	B18 EHPO, 4 ESCON, PA	Order FC 3302 --> FC 3412, FC 5236
B18 FC 3200, FC 3422	B18 EHPO, 2 ESCON, 4 SCSI, PA	Order FC 3422, FC 5236
B18 FC 3200, 2 x FC 3422	B18 EHPO, 2 ESCON, 4 SCSI, PA	Order FC 5236

The scenarios below describe upgrade paths to a Performance Accelerator Feature VTS.

4.2.7.2 Upgrade B18 Standard

The Target System is B18 with Performance Accelerator Feature and Extended Performance ESCON Channels. When you want to upgrade the B18 to work with the standard ESCON channels without the ESCON High Performance Option you have to configure the Performance Accelerator Feature FC 5236 and two of the Extended Performance ESCON Channels FC 3412 and the EHPO FC 3400. You must have four channel attachments together with the Performance Accelerator Feature this configuration results in four Extended Performance ESCON Channels which have to be defined within your HCD configuration.

4.2.7.3 Upgrade B18 EHPO, 2 ESCON

The Target System is B18 with Performance Accelerator Feature and Extended Performance ESCON Channels. When you want to upgrade the B18 to work with the ESCON High Performance Option and enhanced ESCON channels, you have to configure the Performance Accelerator Feature FC 5236 and one Extended Performance ESCON Channels FC 3412. The ESCON High Performance Option FC 3200 will be kept and not converted to the EHPO FC 3400. The present two enhanced ESCON channels are replaced by Performance Accelerator Feature FC 5236. The Feature FC 3412 you have to configure finally builds a target configuration with four Extended Performance ESCON Channels.

4.2.7.4 Upgrade B18 EHPO, 4 ESCON

The Target System is B18 with Performance Accelerator Feature and Extended Performance ESCON Channels. When you want to upgrade the B18 to work with the ESCON High Performance Option and enhanced ESCON channels, you have to configure the Performance Accelerator Feature FC 5236 and one Extended Performance ESCON Channels FC 3412. The ESCON High Performance Option FC 3200 will be kept and not converted to the EHPO FC 3400. The present Feature FC 3302 Additional Enhanced ESCON Channels will be converted and removed. This migration builds a target configuration with four Extended Performance ESCON Channels.

4.2.7.5 Upgrade B18 EHPO, 2 ESCON, 2 SCSI

The Target System is B18 with Performance Accelerator Feature and one Extended Performance ESCON Channels and SCSI attachment. When you want to upgrade the B18 to work with the ESCON High Performance Option, Enhanced ESCON Channels and one SCSI attachment, you have to configure the Performance Accelerator Feature FC 5236 and one additional SCSI attachment FC 3422. The ESCON High Performance Option FC 3200 will be kept and not converted to the EHPO FC 3400. The present enhanced ESCON Channel is replaced implicitly by the installation of the Performance Accelerator Feature. In addition to the present SCSI Attachment feature FC 3422 a second feature FC 3422 is added. This migration builds a target configuration with two Extended Performance ESCON Channels and four SCSI busses.

4.2.8 Migrating to the Performance Accelerator Feature

In this section, we describe in detail all of the migration steps for a conversion to the Performance Accelerator Feature. The steps are listed according to the sequence in which the upgrade has to be performed.

- Upgrade of the Library Manager

- Installation of Extended High Performance Option (FC 3400)

- Installation of Extended Performance ESCON Channels (FC 3412)

- Installation of Performance Accelerator Feature (FC 5236)

Other Installation tasks like additional Cache, SCSI attachments, or additional 3590 drives may occur in parallel.

4.2.8.1 Upgrade of the Library Manager

If the Library Manager and the VTS are not at the appropriate EC level, you have to plan to upgrade them both. The following steps are required:

- **Vary the VTS and the library offline**

  The IBM Magstar 3494 Tape Library and the VTS subsystem have to be shut down before the Library Manager or the Library Manager LIC can be replaced. Therefore, you should first terminate all processing on library drives and thereafter vary offline all logical libraries inside this IBM Magstar 3494 Tape Library. After completion, the IBM service representative can shut down the VTS subsystem and the Library Manager.

- **Upgrade the Library Manager LIC**

  The appropriate Library Manager LIC level has to be installed on the Library Manager. This task is performed by the CE.

- **Vary the IBM Magstar VTS and the library online**

After completion of the Library Manager upgrade, you can vary the libraries online again.

Plan for a two hour outage for this part of the migration if you decide to have it done upfront. However, we recommend doing the library manager upgrade during the model upgrade to minimize overall effort.

4.2.8.2 Installation of Extended High Performance Option (FC 3400)

This feature enables data compression for host channel attachments, ESCON and SCSI. It provides larger effective cache, improved performance, and up to 64 virtual device addressing. Included within this feature are:

- One Feature diskette

Prerequisites for this installation are:

- Library Manager must be at level 523.01 or higher
- VTS microcode must be at level 2.17.8.0 or higher

The installation time is estimated to be 1.5 hours. The 3494 VTS subsystem must be set to microcode maintenance during the update. Thus, all operations have to be completed on the VTS and all tape drives for the VTS have to be varied offline.

4.2.8.3 Installation of Extended Performance ESCON Channels (FC 3412)

This feature provides two Extended Performance ESCON Channels adapters to maximize VTS performance in conjunction with the Performance Accelerator Feature. Included within this feature are:

- Two ESCON cards
- Two 30.5 m ESCON Cables
- One Feature diskette
- LM and VTS microcode updates

Prerequisites for this installation are:

- Library Manager must be at level 523.01 or higher
- VTS microcode must be at level 2.17.8.0 or higher
- FC 3200 (ESCON High Performance Option) or
- FC 3400 (EHPO) must be installed prior to installing this MES

The installation time has to be calculated with 1.5 hours. The 3494 VTS subsystem must be powered off during the upgrade. Operations have to be completed on the VTS and all library devices for the VTS have to be varied offline.

The 3494 tape library will not be powered down. Other 3494 functions like all activities with native drives may continue.

4.2.8.4 Installation of Performance Accelerator Feature (FC 5236)

This is the main part of the upgrade during which

- The new file system will be installed
- The processor will be upgraded
- Additional disks may be installed

Included within this feature are:

- An additional CPU card
- Additional memory card and module
- Two Extended Performance ESCON Channels cards
- Storage Migration/Backup diskette
- Array configuration/Restore diskette
- FC 5236 diskette

These Prerequisites must be installed prior to installing this MES

- Library Manager must be at level 523.01 or higher
- VTS microcode must be at level 2.17.8.0 or higher
- FC 3200 (ESCON High Performance Option) or
- FC 3400 (EHPO)
- Minimum of four 3590 drives
- Minimum of two DASD drawers (FC 3702)

If the current installation has one or three DASD drawers (FC 3702) installed, the additional FC 3702 can be installed concurrently.

The installation time is calculated to be 6.0 hours. This does not include the total time for force migrate and backup processing.

The VTS Database and the file fragments have to be saved prior to the installation of this MES.

- **Complete all host jobs and vary the VTS logical library offline**

  To accelerate the subsequent Force Migrate operation, the IBM service representative has the possibility to activate a background job which finds resident virtual volumes and copies them to stacked volumes.

  When the library is offline to all attached hosts, the IBM service representative places it in PAUSE mode and checks for any cartridges left in the VTS owned IBM 3590 physical tape drives.

- **Force migrate to copy all logical volumes to tape**

  After setting the library back to AUTO-Online, the IBM service representative initiates a force migrate operation of the VTS subsystem. Force migrate causes all virtual volumes that have not yet been copied to tape to be copied and all virtual volumes that are still residing in the TVC to be migrated. When force migrate is active, you do not have access to your data in the VTS subsystem. If native tape drives are available in the IBM Magstar 3494 Tape Library, they can be used.

Note that the force migrate operation can require from 1.5 to 7.5 hrs. depending on the size of the TVC and the number of virtual volumes that have to be migrated. To shorten the time required, consider starting the upgrade after some period of low activity in the VTS.

- **Copy VTS database and cache resident file fragments to tape**

  After the Force Migrate operation has completed, the IBM service representative initiates the backup of the VTS database and of all file fragments in the TVC.

  During this step, you have access to native drives in the IBM Magstar 3494 Tape Library but not to the VTS subsystem.

4.2.8.5 Installation of SCSI Adapter Cards (FC 3422)

This feature provides SCSI channel adapter to connect RS/6000 or RS/6000 SP servers to a VTS. Included within this feature is:

- One SCSI card with two tri-link connectors and two terminators

Prerequisites for this installation are:

- Library Manager must be at level 523.01 or higher

- VTS microcode must be at level 2.17.8.0 or higher

- FC 3200 (ESCON High Performance Option) or

- FC 3400 (EHPO) must be installed prior to installing this MES

The installation time has to be calculated with 1.5 hours. The 3494 VTS subsystem must be powered off during the upgrade. The operation has to complete or cancel jobs which request virtual volumes, and all library devices for the VTS have to be varied offline.

The 3494 tape library will not be powered down. Other 3494 functions like all activities with native drives may continue (see Table 18).

4.2.8.6 3494 and VTS Accessibility

Table 18 (Page 1 of 2). Migration Tasks		
Task	**VTS Accessibility**	**3494 Accessibility**
Update HCD	Yes	Yes
Update JES3 definitions	Yes	Yes
IPL / activate IODF	n/a	n/a
Vary virtual drives offline	No	Yes
Force migrate TVC	No	Yes
Copy VTS DB and file fragments	No	Yes
Vary the VTS and LM offline	No	No
Update LIC of the 3494 L1x	No	No
Update LIC of the VTS	No	No
Install Accelerator Feature	No	Yes
Install EHPO FC 3400	No	Yes
Install new Channels FC 3412	No	Yes
Install additional TVC FC 3702	No	Yes

Table 18 (Page 2 of 2). Migration Tasks		
Task	**VTS Accessibility**	**3494 Accessibility**
Install SCSI attachment FC 3422	No	Yes
Restore VTS DB and file fragments	No	Yes
Attach host ESCON cables to B18	No	Yes
Vary VTS online	No	Yes
Note:		
Accessibility indicators are a guideline only. The current individual customer environment and the configuration of the target system may require different downtimes.		

4.2.8.7 Installation Times

The total upgrade time for the installation of new microcode, the EHPO, new Extended Performance ESCON Channels, and the Performance Accelerator Feature is 9 to 11 hours.

During the installation, the IBM Magstar 3494 Tape Library is unavailable for 2 hours, and the VTS subsystem is unavailable for 6 hours, not including the time needed for force migrate and backup processing.

If you are installing additional 3590 tape drives, upgrade to new models of tape drives, add SCSI attachments, or install additional cache during the upgrade with the Performance Accelerator Feature, and check with your IBM representative on additional installation considerations and outage times. Refer to Table 19 for installation time estimates.

Table 19. Installation Times		
Task	**VTS Outage**	**3494 Outage**
Upgrade LIC	1 - 2 hr	1 - 2 hr
Install EHPO	1 - 2 hr	n/a
Install Extended Performance ESCON Channels	1 - 2 hr	n/a
Install Performance Accelerator Feature	6 - 7 hr	n/a
Install FC 3422	1 - 2 hr	n/a
Install FC 3702	6 - 7 hr	n/a

4.3 Performance Accelerator Technical Overview

The Performance Accelerator Feature is a package of hardware and software enhancements which are expected to remove the tape cache bandwidth as a limiting factor in the throughput of the VTS. The Performance Accelerator Feature contains:

- A new File System (GPFS)
- Additional Processor Power and Memory
- Improved Licensed Internal Code

This chapter describes the content of the Performance Accelerator Feature feature in a more detailed way. It will provide you some insight into the used file system, the processor improvements, and licensed internal code.

4.3.1 General Parallel File System (GPFS) Introduction

IBM′s General Parallel File System (GPFS) is a UNIX operating system style file system designed for the RS/6000 SP server. It allows applications on multiple nodes to share file data. GPFS supports very large file systems and stripes data across multiple disks for higher performance. GPFS is based on a shared disk model which provides lower overhead access to disks not directly attached to application nodes and uses a distributed locking protocol to provide full data coherence for access from any node. It offers many of the standard AIX file system interfaces by allowing most applications to execute without modification or recompilation. These capabilities are available while allowing high speed access to the same data from all nodes of the SP system.

Note: This description is targeted towards GPFS Release 1.2

4.3.2 When Is GPFS Appropriate

There are four major indicators that GPFS might be appropriate for use:

- You have large amounts of file data
- The data rates required exceed what can be delivered with other file systems available
- The access patterns for your data are large sequential reads and writes
- Your requirements include access to the data across a number of types of failures

GPFS is capable of storing any file type. It is derived from a video server file system, which was tuned for sequential reads and writes within regions of a file. The most optimal performance will be obtained from applications exhibiting these access characteristics.

4.3.3 Why is GPFS Used for the VTS

One of the critical performance factors for the VTS is the file system. The performance of the file system has a strong effect on the major activities of the VTS, that is, writing data to the tape volume cache and reading data from the cache.

The General Parallel File System (GPFS) was chosen as the high performance file system for the VTS tape volume cache, because it provides a dramatic improvement in both peak and sustained performance. Performance is improved mainly by the large blocksizes of GPFS. Large blocksizes are critical for achieving write performance with striped SSA raid arrays - the full stride write. GPFS is a new file system that co-exists with the native Journaled File System (JFS) on a RS/6000 running AIX. JFS continues to run the AIX operating system. GPFS may span many clustered processors and disks, or a single processor and a set of physical disks. The VTS implementation of GPFS uses a single RS/6000 and a set of SSA disks. The central location of the File System within the data flow inside the VTS is shown in Figure 36 on page 114.
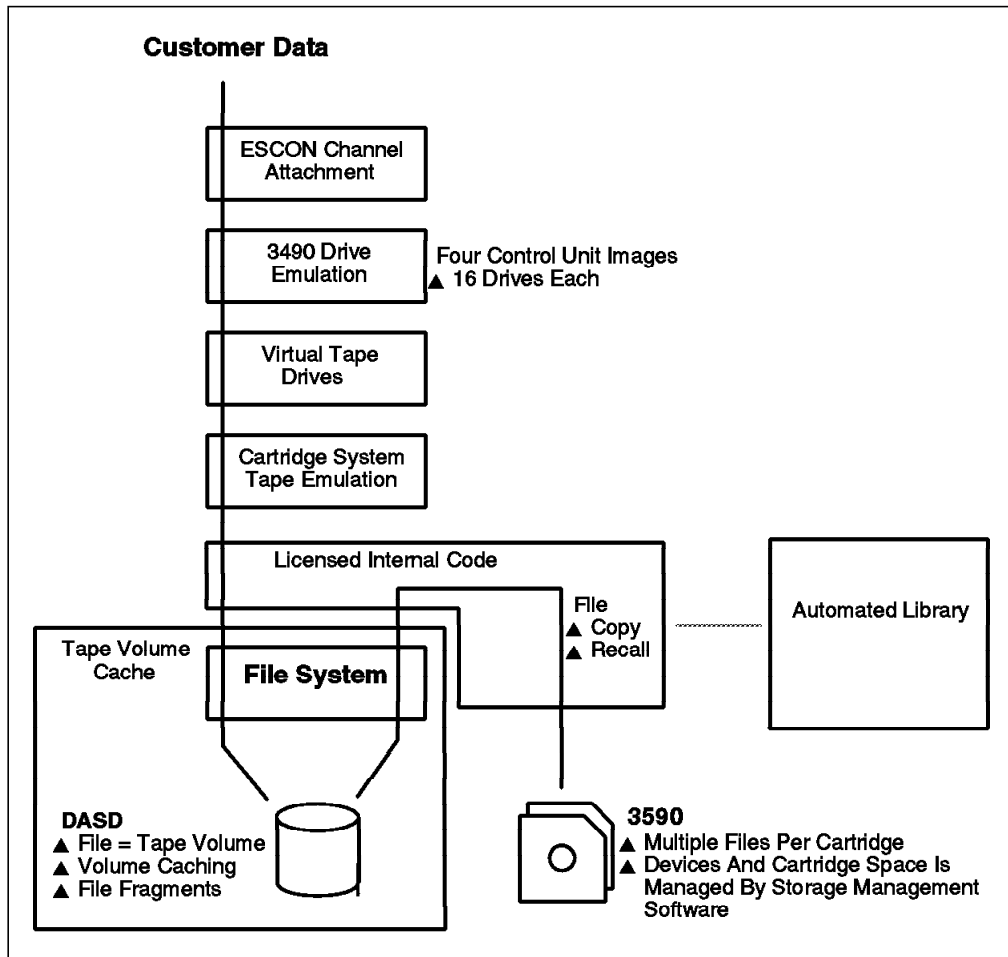
Figure 36. Central Role of the File System

Actually, it is the same as the code shipped to SP customers. However, VTS uses special configuration file options to allow the GPFS code to work in the VTS environment.

4.3.3.1 GPFS AIX Interface

AIX accesses files through GPFS, which accesses the disks through the LVM (Logical Volume Manager) interface. With the VTS, an additional layer is introduced by Tivoli Storage Manager (formerly ADSM Hierarchical Storage Manager) in the form of an FSM (File System Manager). Standard AIX file system commands are used to write and read data. The Virtual File System (VFS) interface of AIX is not used for the VTS implementation.

4.3.3.2 GPFS Blocksize

The GPFS implementation for the VTS uses 256KB blocksizes. This blocksize allows efficient use of disk bandwidth. AIX JFS uses a blocksize of 4KB to optimize space. The larger GPFS blocksize provides speed. Space is not sacrificed: the last piece of a GPFS file needs not be a full block of 256KB, but might be a fraction of it. A fraction can be a multiple of a subblock, which is 1/32 of a full block. With 256KB full blocks, a subblock is 8KB in size. The amount of space needed to store the last piece of a GPFS file is the size rounded up to the next multiple of 8 KB.

4.3.3.3 GPFS Sequential Throughput

GPFS stripes data across data disks to balance load and maximize parallelism. Successive blocks of each file are striped across successive disks. Disk I/O for sequential reads and writes is done in parallel (prefetch, write behind). Disk throughput is measured to automatically determine optimal parallelism.

4.3.3.4 Full Stride Write

Each GPFS write command sends enough data to the SSA adapter for a ″Full Stride Write″. The Raid controller will break up the 256KB block into 64KB chunks for each disk; for the 2 + P raid implementation of the VTS, a 256KB block will be two full-stride writes of 128KB each.

4.3.3.5 GPFS Stripe Groups

GPFS stores files using wide striping. The disks are defined into striping groups and data from each GPFS file is striped across all disks in the stripe group. This means that data is striped across multiple disks within an SSA Raid Array and also across multiple arrays within the VTS cache. Each read or write is done in parallel across many physical disks. The JFS striped across disks within the SSA array only. For the VTS cache, there are two stripe groups defined, smfs0 and smfs1. The names of the stripe groups have nothing in common with SMF Systems Management Facility of OS/390.

4.3.3.6 GPFS Failure Groups

Failure groups are defined to provide the maximum data protection. On VTS, disks on each RAID adapter are assigned to a different failure group.

4.3.3.7 GPFS Logging

All updates that may leave inconsistencies, if not completed for some reason, are logged. The write ahead policy forces log records to disk before dirty metadata is written. The Redo log function replays all log records at recovery time, thereby, restoring file system consistency.

4.3.4 VTS Controller Processor

When you install the Performance Accelerator Feature, you get an additional processor card which provides 4-way processing and additional processor RAM. The increase of the Processing power is necessary to fully exploit the power of GPFS. Like all file systems, GPFS caches data in memory. By using larger blocksizes, it utilizes the larger processor storage. The 2-way processor with JFS had limited throughput capability, which is explained in Figure 37 on page 116.
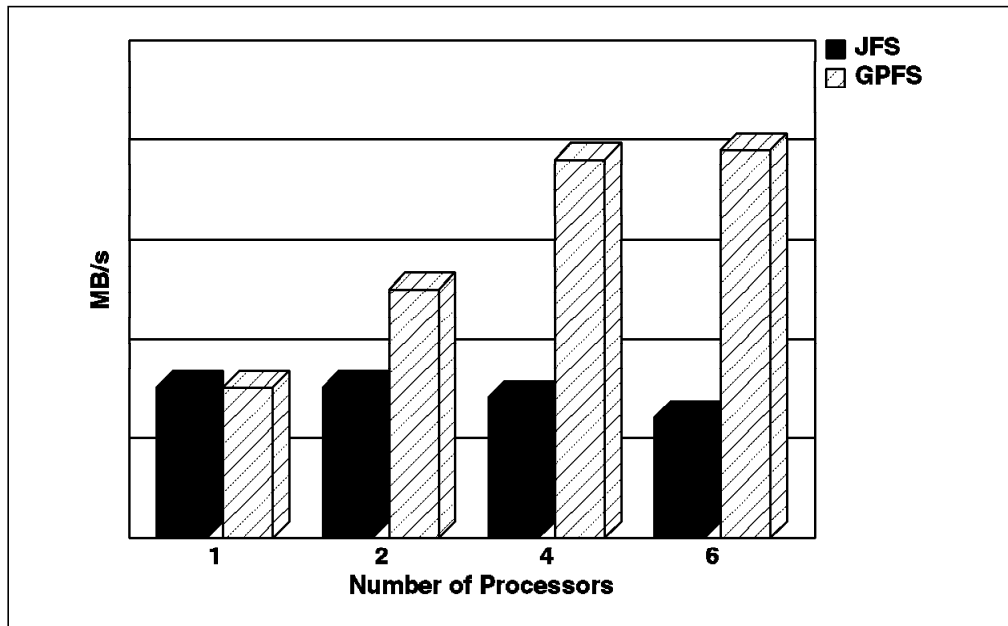
Figure 37. GPFS Performance Exploitation

As you can see, the performance of JFS cannot be increased even with more processing power. The best performance of GPFS, related to the number of used processors, is achieved with four processors. Only minor improvements could be achieved by additional processors.

4.3.5 Improved Licensed Internal Code

With the Performance Accelerator Feature installed, the management of tape volume cache content is modified to take full advantage of all available processing resources. This has been achieved by the improved efficiency of the High Performance Streaming File System and the configuration of the cache. The primary changes of the VTS Licensed Internal Code apply to the throttling function which controls the VTS throughput in a different way when the Performance Accelerator Feature is installed.

A further explanation of Throttling is contained within 8.4, "Monitoring and Evaluating VTS Performance" on page 210.

Chapter 5. Migration to the IBM 3590 Enhanced Models

In this chapter, we describe the IBM 3590 Enhanced Models and how to migrate from an IBM 3590 Base Model based VTS configuration to an IBM 3590 Enhanced Model based VTS configuration.

5.1 Introduction to the IBM 3590 Enhanced Models

The IBM 3590 Enhanced Models offer improvements in tape performance, capacity, and connectivity:

- Native data transfer rate improvement of over 50% to 14 MB/s

- Up to 34 Mb/s sustained data rate with maximum data compression

- A doubling of the current native cartridge capacity to 20 GB that uses a new 256-track format.

- A new digital channel technology and predictive failure analysis to further enhance reliability

- Investment protection with upgrades from the current IBM 3590 Base Models and backward read compatibility of current cartridges created by IBM 3590 Base Models

The IBM 3590 Enhanced Models use the same cartridges as the IBM 3590 Base Models. The IBM 3590 Enhanced Models read and write the new 256-track format and read the 128-track format created by IBM 3590 Base Models.

The IBM 3494 Model B18 VTS supports the IBM 3590-E1A tape drive. Owners of IBM 3494 Model B16 VTS who like to migrate to IBM 3590 Enhanced Models must upgrade their VTS to an IBM 3494 Model B18 VTS.

Table 20 on page 118 summarizes the IBM 3590 tape drive characteristics.

Table 20. IBM 3590 Tape Drive Characteristics		
Characteristics	**Specifications**	
	IBM 3590-B1A	**IBM 3590-E1A**
Data Capacity (Native)	10 GB	20 GB
Device Data Rate (Native)	9 MB/s	14 MB/s
Data Transfer Rate (Max. for ESCON)	17 MB/s	17 MB/s
Data Transfer Rate (Max. for SCSI-2 F/W)	20 MB/s	n/a
Data Transfer Rate (Max. for Ultra SCSI)	40 MB/s	40 MB/s
Max. device Data Rate (assuming a 3:1 compression ratio)	27 MB/s (Ultra SCSI), 16 MB/S (SCSI-2 F/W)	34 MB/s (Ultra SCSI)
Tape Read/Write Access Speed	2 m/s	3.14 m/s
Tape Length of Magstar Tape	300 m	300 m
Search/Rewind Speed	5 m/s	5 m/s
Average Cartridge Load Time	23.5 s	23.5 s
Full Cartridge Rewind Time	2 s	2 s
Maximum Cartridge Rewind Time	60 s	60 s
Search/Rewind Speed	5 m/s	5 m/s

5.2 Why Migrate to IBM 3590 Enhanced Models

The main reason to upgrade to IBM 3590 Enhanced Models is to double the data
storage capacity of the Magstar data cartridges. IBM 3590 Enhanced Models
generate 256-track format cartridges which stores twice as much data as
128-track format cartridges written by IBM 3590 Base Models. 100% customer
data growth can easily be accommodated without needing extra Magstar
cartridges or extra cartridge slots.

5.3 Planning Considerations

A VTS must consist of either all IBM 3590 Model B1A tape drives or all IBM 3590
Model E1A tape drives. Mixed tape drive configurations are not supported.
However, if two VTS subsystems are installed in an IBM 3494, one VTS could use
IBM 3590 B1A tape drives and the second one could use IBM 3590 E1A drives.

5.3.1 Export/Import Dependencies

Exported Stacked Volumes created on IBM 3590 Model B1A tape drives can be imported into IBM 3590 Model E1A tape drive based configurations. Exported Stacked Volumes created on IBM 3590 Model E1A tape drives **cannot** be imported into IBM 3590 Model B1A tape drive based configurations.

5.3.2 The IBM 3590 Model B1A to IBM 3590 Model E1A Migration

There are two procedures to upgrade a VTS to IBM 3590 Enhanced Models. Both will be described.

The IBM 3494 which houses the VTS drives can stay online during the upgrade if the Library Manager code is at the right level. So non-VTS services continue to be available during the upgrade of the VTS Magstar Tape drives to IBM 3590 Enhanced Models.

If an IBM 3494 library contains two VTSs, they can be upgraded independently, thus one VTS can be configured with 3590-B1A drives and the second can be configured with 3590-E1A drives.

The first procedure enables the capability of initially upgrading two, for a four Magstar tape drive configuration, or three IBM 3590 tape drives, for a five or six Magstar tape drive configuration, while the VTS is still available for the attached hosts. After the conversion of these first two or three tape drives, the VTS will be set offline for a code update and be brought online with only two or three IBM 3590 Model E1A tape drives. The remaining two or three IBM 3590 Model B1A tape drives will be upgraded directly after that. This procedure can be used for a VTS with more than three Magstar tape drives, without the Performance Accelerator Feature and without the Advanced Function Feature.

The second procedure will be used for all other cases and will upgrade all Magstar tape drives while the VTS is offline.

5.3.3 IBM 3590 Enhanced Model Upgrade Times

The total upgrade time for the installation of the IBM 3590 Enhanced Model upgrade depends on the current LM level, the VTS code level, number of installed IBM 3590 Base Models, and the installed VTS features.

Sample timings for the activities that have to be carried out are presented in Table 21.

Table 21. Sample IBM 3590 Enhanced Model Upgrade Times		
Task	**VTS Outage**	**3494 Outage**
Upgrade LIC to 523.00 or higher	1 - 2 hours	1 - 2 hours
Install VTS 2.17.10.0 or higher and AIX 4.3.2 or higher	2 - 5 hours	n/a
Conversion of one IBM 3590 Model B1A tape drive	1.5 - 2 hours	n/a
Tape drive removal/install	First drive 1 hour, 0.5 hour per remaining drive	n/a

As described in 5.3.2, "The IBM 3590 Model B1A to IBM 3590 Model E1A Migration" there are two procedures IBM uses to upgrade to IBM 3590 Enhanced Models in an IBM 3494 Model B18 VTS. Customers that cannot afford long outage times are advised to discuss the split of the IBM 3590 Enhanced Model upgrade into two smaller upgrades: one for the microcode updates, and one for the physical tape drive upgrade. Depending upon the IBM service representative resources available some tasks can be executed simultaneously.

5.3.4 Hardware/Software Prerequisites

To upgrade the VTS to IBM 3590 Enhanced Models, it has to be an IBM 3494 Model B18. The IBM 3494 Model B16 does not support the IBM 3590 Enhanced Models. IBM 3494 Model B16 users who would like to upgrade to IBM 3590 Enhanced Models must upgrade to an IBM 3494 Model B18 first.

There are no host software requirements for implementation of IBM 3590 Enhanced Models. This is one of the clear advantages of the IBM VTS: the attached hosts only see virtual IBM 3490E drives and virtual IBM 3490E cartridges, which makes this upgrade completely transparent to the host.

5.4 Operational Considerations

After the IBM 3590 Enhanced Model upgrade, the VTS will start to write only in 256-track mode onto scratch stacked volumes and will not append to partially filled 128-track formatted stacked volumes.

The VTS will write double the amount of data on each Magstar tape cartridge. Rewriting of the VCR region in 256-track format takes 42 seconds and occurs only once per stacked volume. This effect is negligible. Currently there are no performance implications. Read and write characteristics from a host point of view are similar. Read misses from the TVC are handled at the same speed, because the mechanical characteristics like load, search, and rewind didn't change.

Immediately after the IBM 3590 Enhanced Model upgrade, the LM panels and SMF94 statistics will report twice the amount of *Free Storage*. After reclamation, more and more 128-track format cartridges will return to scratch and are eligible to be written in 256-track mode. Gradually the amount of reported free storage capacity will increase, as can be seen, on the LM panels and SMF record 94 reports.

There is no external indication on the amount or percentage of stacked volumes that are in 256-track format.

Note: To force stacked volumes to be reclaimed and be re-written in 256-track format, you may consider to temporarily increase the ″Reclaim Threshold Percentage″ (refer to 3.4.6, "Reclamation and Reconciliation" on page 75).

After the IBM 3590 Enhanced Models upgrade, the LM panels and SMF94 statistics will show twice the amount of *Maximum Active Data*.

Immediately after the IBM 3590 Enhanced Models upgrade the LM panels and SMF94 statistics will show the same amount of *Free Storage Threshold*. As a consequence, the alarm now goes off at half the number of scratch cartridges. We recommend that you double the Free Storage Threshold after the IBM 3590

Enhanced Model upgrade to be sure the alarm goes off at the same amount of scratch cartridges as with the IBM 3590 Model B1A tape drives. See 3.4.6, "Reclamation and Reconciliation" on page 75 for a detailed discussion on the Free Storage Threshold mechanism.

Chapter 6. Using the IBM Magstar VTS

The VTS can eliminate a series of bottlenecks that you might have in your tape environment. If you need more drives, the VTS enables you to address up to 64 virtual drives. If you are wasting space on tape cartridges, the VTS can help by stacking the logical volumes and filling the real cartridge completely. The VTS subsystem can reduce the number of operations staff needed because of the reduction or elimination of physical tape mounts.

The VTS subsystem can also help you in scratch management, a task that must be performed daily to keep production going.

By defining up to 150,000 virtual volumes in a VTS or 300,000 in an IBM 3494 Tape Library with two VTSs, you can use many more scratch volumes than you ever used before, so that the scratch recycle operation can be performed far less often.

Whether your tape environment has only a VTS subsystem, or has other non-VTS tape drives as well, you should pay attention to some general hints and product-specific considerations that can help you exploit the potential of the VTS.

As you can see in Figure 38, you must select the right data to put under VTS control.
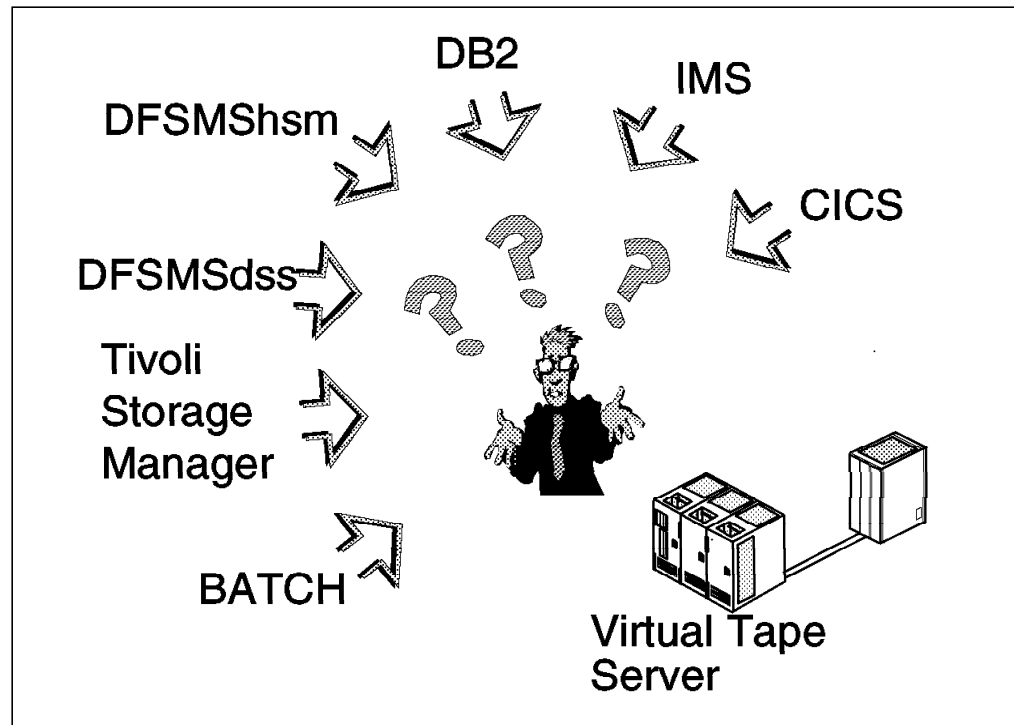
Figure 38. What Data Should Be Put in the VTS?

6.1 VTS Compared to other Tape Stacking Methods

In this section we compare the tape stacking methods actually available and the VTS. The comparison is made only for the most common techniques used in an IBM environment, as you can see from Figure 39.

	VTS	TMM	User JCL stacking	pre-alloc stacking sw	post-alloc stacking sw
Cartridge 100% used	✓	✓	✓	✓	✓
No JCL changes	✓	✓	✗	✓	✓
Media awareness	✓	✓	✗	✓	✓
No extra management.	✓	✗	✗	✗	✗
No additional sw	✓	✓	✓	✗	✗
No additional DASD	✓	✗	✓	✓	✓
No additional mounts	✓	✓	✓	✓	✗

Figure 39. Benefits of VTS Compared with Other Stacking Methods.

- **Tape Mount Management** has the following characteristics:

  - Fills the tape cartridge completely because TMM tape data is DFSMShsm managed.

  - Is not dependent on media type. DFSMShsm is aware of MEDIA type used.

    In most cases, TMM methodology does not require JCL modifications.

  - Needs SMS installed and active. TMM uses SMS to redirect selected allocations from tape to DASD.

  - Needs DFSMShsm installed and active

    TMM then uses DFSMShsm to move DASD data back to tape.

  - Needs DASD buffer

    TMM uses a DASD buffer to store data that later will be stacked on tape.

  - TMM is not appropriate for all data. Some data cannot use TMM, and some data does not benefit from using TMM. Refer to *DFSMS/MVS Implementing System Managed Storage*, SC26-3123, for more information.

- **User JCL stacking** has these characteristics:

  - Requires many JCL modifications

    To stack data onto tape, you have to modify the JCL considerably to use multiple labels on the same volume.

  - Depends on media type. Every time the capacity of the media you are using changes, more JCL modifications are required.

  - Depends on the size of the data set

    If the size of the data set being written changes, you the user must modify the JCL to fill the output tape correctly.

  - High management overhead

With the previous considerations, the management of tape stacking imposes a very high overhead.

- **Stacking software** (pre-allocation or post-allocation) has these characteristics:

  - Needs a specific tape management system installed and active

    Some tape management systems have stacking functions. You have to install, activate, and tailor the product and probably migrate from another tape management system to use these stacking functions.

  - JCL modifications are required to read uncataloged data

    Stacking is performed either before data is written on tape or tape data is consolidated after the job completes. The file number and the volser specified in the JCL are probably not the same as specified in the JCL. When you need to read from tape and the data set is not cataloged, you have to find the volume and label number that holds your data.

  - Management overhead.

    Human resources are required to tailor and manage the stacking process and the tape management system.

Compared with the previous stacking methods, VTS gives you the following benefits:

- **Fills tape cartridge up to 100%**. Putting multiple virtual volumes into a stacked volume, VTS uses all of the available space on the cartridge. VTS uses IBM 3590 cartridges when stacking volumes.

- **DFSMShsm, TMM, or Tape Management System (TMS) not required**. VTS is a hardware stacking function; no software prerequisites are required.

- **JCL modifications not required**. The JCL references a virtual volume and does not need modification.

- **More tape drives are available**. Data stacking is not the only benefit; VTS emulates 32 or 64 virtual drives, allowing more tape volumes to be used concurrently.

- **Little management overhead**. The stacking of data is performed by the VTS management software, without host knowledge.

- **No new software support is required**. VTS works with all current releases of MVS and SMS. See Section 2.5, "Software Requirements" on page 32 for more information.

6.2 Software based Virtual Tape Solutions versus IBMs VTS

In this section we compare the IBM VTS solution with a S/390 software based virtual tape solution. We describe what a S/390 software based virtual tape solution is, what the advantages are, and how it compares to IBMs VTS.

The S/390 software based virtual tape solution concept

S/390 software based virtual tape solution claims to be a highly scalable, flexible and cost effective storage solution that allows customers to take advantage of virtual tape concepts while protecting their investment in existing S/390 hardware technology. S/390 software based virtual tape solution redirects s/390 tape I/O to OS/390 memory buffers. Virtual volume data is then staged from

memory to standard S/390 Disk devices for virtual volume creation, interim storage and possible reuse. Following virtual tape EOV processing S/390 software based virtual tape solution stacks the virtual tape onto a physical tape. This physical tape can be mounted on either stand alone or automated tape drives. Once stacked on a tape cartridge the virtual tape volumes on the S/390 DASD 'buffer' remain available for recalls and the space is then released according to the disk management LRU management. After this space release takes place subsequent recalls for the virtual volume will require that the volume be staged from the tape to the buffer prior to system access.

Perceived advantages of a S/390 software based virtual tape solution in general are:

- Minimizing new S/390 hardware investments and optimizing existing S/390 resources

- Works with any S/390 disk subsystem

- Works with any S/390 tape subsystem (no automation needed)

- Highly scalable

- Unlimited cache

- Can emulate IBM 3480 or IBM 3490 Base models

- Easy to evaluate - no hardware to install

Comparing **S/390 software based virtual tape solutions** with IBMs VTS:

- S/390 software based virtual tape solution is another TMM like method with similar characteristics (it is S/390 processor intensive and requires substantial management resources). IBMs VTS is an outboard tape management solution that doesn't require extra S/390 processor power and needs minimal resources to manage because it is a self managed system.

- No sharing of virtual volumes with other systems. IBMs VTS can share virtual volumes across multiple S/390 with VM/VSE, VM, OS/390, TPF S/390 hosts and with AIX hosts.

- Tape data flows three times over the S/390 channel infrastructure, with IBMs VTS tape data flows only once over the S/390 channel infrastructure.

- Incremental S/390 DASD is needed for the interim buffer, the tape data isn't software compressed normally because it costs too much S/390 processing cycles, IBMs VTS EHPO feature compresses Tape Volume Cache with a typical 3:1 compression ratio on the ESCON channel adapter cards.

- Incremental processor memory needed. These resources IBMs VTS are inherent in IBMs VTS outboard design.

- Incremental S/390 processor cycles are needed for a S/390 software based virtual tape solution. IBMs VTS doesn't require extra S/390 processor cycles at all.

- Extra S/390 software costs with S/390 software based virtual tape solution. IBMs VTS doesn't need extra S/390 software and therefore, no extra S/390 software costs.

- For S/390 software based virtual tape solution solution extra software needs to be installed and maintained by the customer on the S/390 host running OS/390. IBMs VTS doesn't require changes in the OS/390 software and therefore, doesn't need customer resources to be maintained.

- Tape hardware changes needs involvement of the S/390 hardware and software. Changes in the S/390 software based virtual tape solution and OS/390 system software are a natural consequence. Skilled S/390 manpower is needed. Tape hardware changes in the IBM VTS are transparent to OS/390. OS/390 is only aware of virtual 3490E cartridges and tape drives and changes of the physical tape drive are transparent to the attached hosts.

Questions one should ask considering a S/390 software based virtual tape solution:

- How much memory is needed to support 32 or 64 virtual tape drives?

- How many MIPS are required to support the desired workload?

- How much S/390 Disk cache is required to provide the buffer for the virtual volumes?

- Can the extra channel load be accommodated without effecting the other batch processes?

- What will be the effect on resource contention and DASD subsystem throughput?

- What total throughput will be derived? Which software product will migrate the data to tape? What are the limitations of that software migration product? Can that software product fill the tapes fully and exploit the tape drive fully?

- How much of the operating budget will be spent on systems personnel to plan, implement and manage the installation?

- What are the future functions of the S/390 software based virtual tape solution?

Conclusion

S/390 software based virtual tape solution requires significant S/390 processor cycles and channel resources. The S/390 software based virtual tape solution supplies no savings with regard to disk or tape resources at all and will require extra manpower to manage.

6.3 General Considerations

The VTS characteristics discussed below are independent of the type of data you are putting in the VTS.

6.3.1 Data Compression

The IBMLZ1 compaction ratio for virtual volumes created on a VTS *without EHPO* is assumed to be at a 1:1 ratio because the ***real*** compression is performed by the IBM 3590 drive when the data is copied to the stacked cartridge. Although there is no compaction in this type of emulated control unit, the VTS still reports to the host that it is compaction capable. If your VTS installation uses system-managed tape, we recommend that you code compaction in the data class construct.

If you have a virtual volumes created on a VTS *with EHPO*, the ratio is whatever is performed at time of compaction. Because the IBMLZ1 algorithm used for compression in the TVC generally yields higher compression than IDRC used with native 3490E tape drives, you may see slight differences in the compaction ratios achieved.

When writing data to a virtual volume, the host compression definition is honored. Compression is turned on or off by JCL parameter DCB=TRTCH=COMP|NOCOMP, data class parameter COMPACTION=YES|NO, or the COMPACT=YES|NO definition in the DEVSUPxx parmlib member. The TRTCH parameter overrides the data class definition, and both override the parmlib definition. We strongly recommend that you check your definitions to make sure that you specify compression when writing data to the IBM 3494-B18 VTS with the EHPO (EHPO) feature installed in order to achieve the optimum throughput. It should be noted that the backward reads executed on a VTS, whether it is equipped with or without EHPO, does not degrade like it did on real IBM 3480 (if IDRC enabled) and IBM 3490 tape drives.

For data migration considerations for stacked cartridges created on a VTS B16 or B18 without EHPO, refer to D.2.3, "Volume and Data Migration" on page 333.

6.3.2 Size of Virtual Volumes

The effective size of virtual volumes can be either 400 MB with CST emulated cartridges or 800 MB with (ECCST) emulated cartridges. This is the size of the virtual volumes after compression if you have the Enhanced High Performance Option or the Extended High Performance Option feature installed. If you do not have the EHPO feature installed, you may see the number of multivolume cartridges (logical volumes) grow. This will depend on the media size from which you are converting. The choice between CST or ECCST emulated cartridges depends mostly on the data you put in the VTS subsystem.

Important:

In most applications, if you do not have a special need for using CST emulation, use the ECCST.

It is possible to mix both CST and ECCST emulated cartridges inside the VTS subsystem; the choice really depends on the application need. The amount of data copied to the stacked cartridge is only the data that has been written. The choice between CST or ECCST emulated cartridges does not affect the real space used in either the VTS TVC or the stacked volume, as you can see from Figure 40 on page 129.
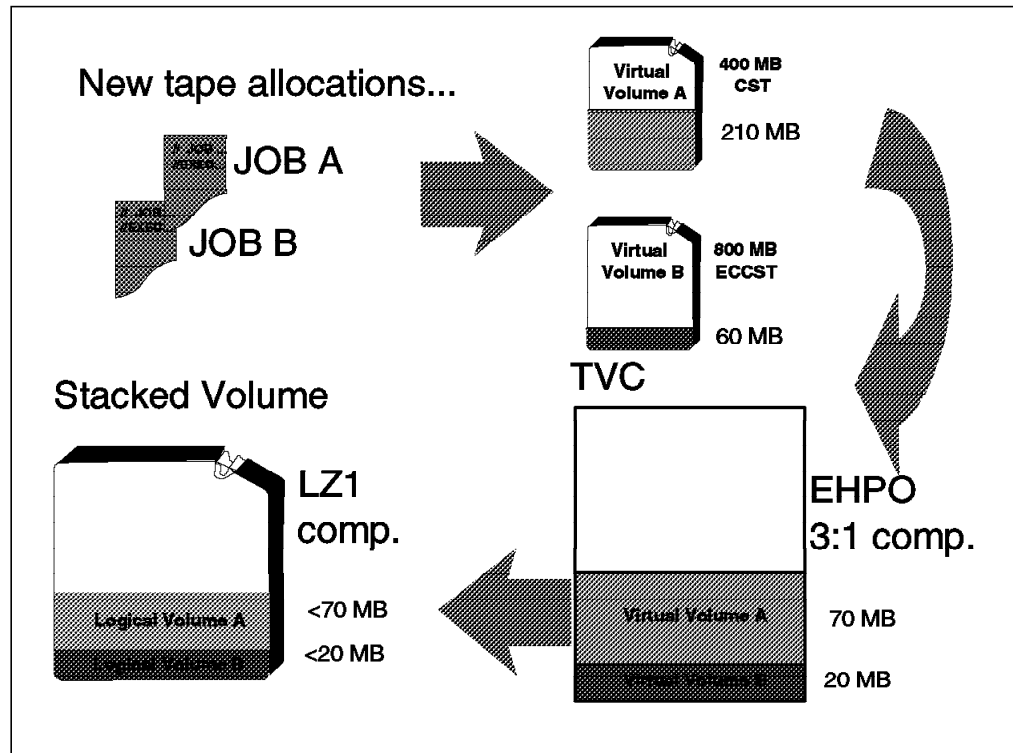
Figure 40. VTS space for CST and ECCST Emulated Cartridges.

6.3.3 The VTS as Logical Library

When an IBM Magstar 3494 Tape Library contains both a VTS subsystem and native drives, the Library Manager splits the physical library into two logical libraries, one for the VTS drives and one for all other drives. Each logical library looks to the host like a separate physical library. Therefore each logical library has its own full set of Library Manager categories that can overlap. The Library Manager maintains two sets of category tables and keeps the VTS and physical volumes separate.

A host can use category X′0001′ for Media Type 1 for real and virtual volumes (based on DFSMS). Issuing a mount for category X′0001′ to a VTS drive results in selecting a logical volume from the volumes owned by the VTS library. Issuing a mount from that category to a real IBM 3490 drive results in selecting a volume from the volumes owned by the real side of the IBM 3494 Tape Library.

6.3.3.1 Partitioning the VTS into Multiple Logical Libraries

The virtual drives and virtual volumes of VTS can be partitioned just like physical drives and real volumes in any other IBM Magstar 3494 Tape Library. Any virtual volume can go to any physical stacked volume. The VTS places no restrictions on the use and management of those resources. However, the physical stacked volumes managed by the VTS subsystem cannot be partitioned.

Figure 41 on page 130 shows how the process of copying to stacked volumes mixes the logical volumes regardless of the VTS logical library to which they belong.
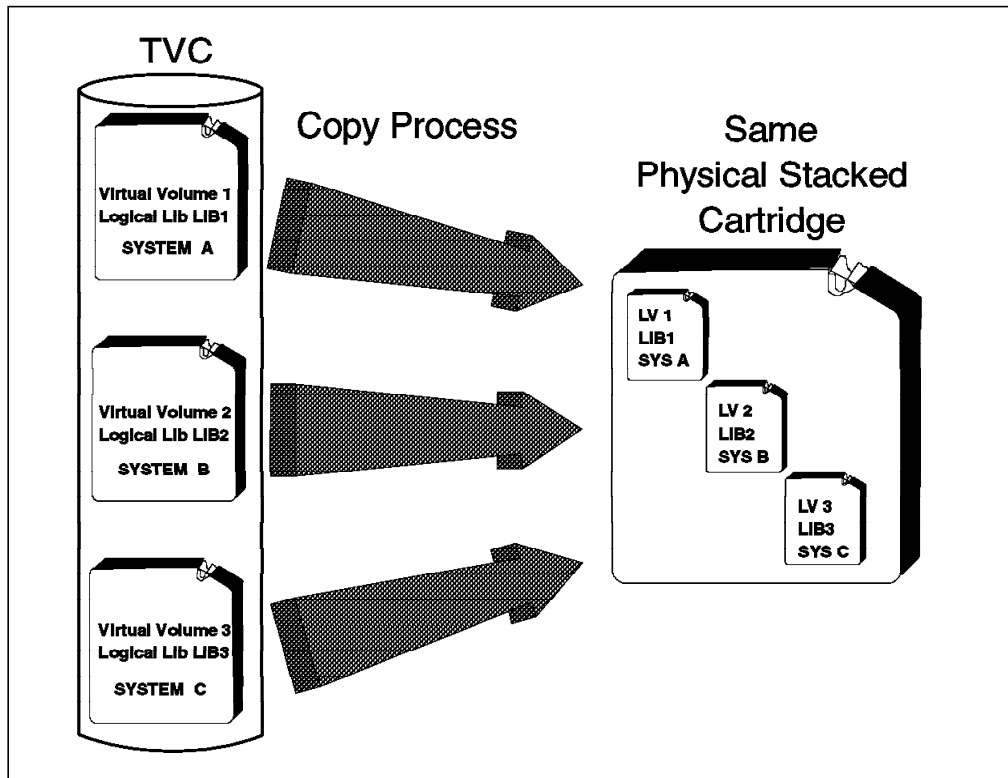
Figure 41. Copying Process with Multiple Logical Libraries inside the VTS.

When the VTS itself is partitioned into two or more libraries, the categories used by each accessing system must be unique. For DFSMS/MVS, the default category numbers for all systems in SYS1.PARMLIB(DEVSUPxx) must be changed. Each accessing system should use different category numbers for the cartridges, and each partition will have its own range of logical volumes.

6.3.4 Sharing a VTS Subsystem

A VTS supports two or four physical ESCON channels, each of which is capable of supporting 64 logical paths, for a total of 256 logical paths. Each logical path can address any of the 32 or 64 virtual devices in the VTS. We recommend that you use an ESCON Director when connecting the VTS to more than one system.

The VTS places no limitations on the number of hosts that can use those channel paths, or the types of hosts, or their operating system environments. This is the same as for any tape technologies that are supported in IBM tape libraries.

An operating environment, through its implementation, however, does impose limits. BTLS has a limit of eight because of its eight scratch pools. DFSMS/MVS—starting with Version 1.3— can support up to 32 systems or groups of systems.

A host running BTLS can be attached to a VTS at the same time as a host running system-managed tape.

Basically, anything that can be done with standard drives in an IBM 3494 can be done with the virtual drives in a VTS. Refer to the *Guide to Sharing and Partitioning IBM Automated Tape Library Dataservers, SG24-4409* for more information about sharing a Magstar 3494 Tape Library.

6.3.5 System-Managed Tape Considerations

These are the most important factors to consider using a VTS subsystem in a system managed tape environment:

- **Integrated Cartridge Loader simulation**

  The VTS subsystem appears to the host to be an IBM 3490E subsystem with the ICL installed but inactive. A cartridge loader's status is reported as ACTIVE in a 3494 library if a media type has been assigned to the device and there are scratch volumes of that media type available in the library. You can use the MVS **LIBRARY SETCL** command to load the emulated ICL with scratch cartridges of a specified media type. There is no scratch mount performance advantage to assigning a media type to a virtual drive, so the normal recommendation is to assign the drives to NONE. This is because, when you use the fast-ready attribute for that scratch category, the new scratch volume is created directly in the TVC without staging the data from tape.

- **Define more than one VTS per storage group**

  When selecting a virtual tape drive for non-specific mounts, the host operating system doesn't have information about the following critical VTS resources and configurations:

  - Number of available drives (virtual drives as well as physical drives)
  - Number of available scratch cartridges
  - Busy condition of VTS control unit or tape library accessor (e.g. reclamation going on)
  - Size and degree of occupation of the TVC
  - Level of LIC
  - Availability of features (e.g. EHPO, Performance Accelerator Feature)

  Your chances to get "balanced" allocation in this scenario are limited. Our recommendation is to define one storage group per VTS and try to make good decisions on how to balance the main workloads between the VTSes, based on the knowledge of the applications and criteria developed during the analysis phase. A second advantage of having each VTS in it's own storage group is the operational flexibility: You can ensure that two copies of a data set are sent to different VTS. If the VTS are in one storage group there is no way to guarantee that the allocation will hit different VTS.

- **Support for cartridges with no external label**

  Although cartridges without an external label are allowed in a real Magstar 3494 Tape Library, their use is not recommended, as stated in Chapter 6, under "Insert Unlabeled Cartridges," in the *Magstar 3494 Operator Guide*, GA32-0280.

- **Standard label**

  The VTS subsystem always creates an IBM standard label for every new virtual volume regardless of the JCL specification. It works the same as for a real Magstar 3494 Tape Library.

- **TCDB size considerations**

  The TCDB size must be checked and possibly increased to fit the 150,000 virtual volumes the VTS is capable of holding. Refer to 3.5.1, "DFSMS System-Managed Tape" on page 82 for more information related to allocating the TCDB.

6.3.6 Basic Tape Library Support Considerations

The considerations applied to system-managed tape can also be valid when using a VTS subsystem in a BTLS environment.

The emulated integrated cartridge loaders can be used, but they do not give any performance benefit—the same as in an system-managed tape environment. BTLS deals with NL and NSL tapes as system-managed tape does.

The size of the BTLS catalog should be increased to fit the additional 150,000 volumes that VTS can manage. To calculate the correct size of the BTLS catalog, refer to *Basic Tape Library Support User's Guide and Reference*, SC26-7016.

6.3.7 Tape Mount Management Considerations

TMM uses DFSMS to redirect selected data sets onto DASD as they are allocated, and DFSMShsm to move those data sets back onto tape.

TMM enables installations to stack multiple compacted tape data sets automatically onto a tape, in most cases without having to identify and modify any JCL procedures. If you are already using TMM, you will have to decide which data will go to VTS and which data will stay with TMM.

After introducing the VTS subsystem to your environment, you must review your actual TMM environment and make changes as required, to better fit VTS into your tape shop.

6.4 Product-Specific Considerations

In this section we analyze the strengths and benefits of specific products in a VTS environment.

6.4.1 DFSMShsm

DFSMShsm, the DFSMS/MVS hierarchical storage manager, has its own functions that allow full utilization of the tape cartridge.

Using the VTS subsystem in an DFSMShsm environment does not bring any special advantage from a capacity point of view, because you create virtual volumes, which, once copied, fill a stacked volume completely. You can have the same results from direct use of a physical tape drive, leaving VTS storage for other applications that are better candidates for VTS management.

From another perspective, there might be reasons to use VTS with DFSMShsm. The limited amount of native drives often found at small customers limits the number of DFSMShsm tasks that can be run concurrently. The unique VTS capability of having 32 or 64 drives available can help to circumvent drive-peak bottlenecks for those environments.

DFSMShsm data can be put into a VTS, given suitable tailoring of some parameters that can affect DFSMShsm performance.

Consider tailoring the following ARCCMDxx SETSYS parameters:

SETSYS TAPEUTILIZATION(LIBRARYBACKUP(PERCENTFULL(97)))
SETSYS TAPEUTILIZATION(LIBRARYMIGRATION(PERCENTFULL(40)))

Using a high value for backup tapes helps you minimize the number of virtual volumes. Using a lower value for migration tapes speeds up recall processing, because having smaller logical volumes reduces the delay for the recall operation, while still allowing the use of MEDIA2 logical volumes.

- **SETSYS SELECTVOLUME(SCRATCH)**
  SETSYS PARTIALTAPE(MARKFULL)
  SETSYS TAPEDELETION(SCRATCHTAPE)

  Using a global scratch pool, you benefit from a fast mount time by using the fast-ready attribute for the scratch category (see Chapter 3, "Installing the Virtual Tape Server" on page 53). The MARKFULL parameter does not mean a waste of space using VTS, because the stacked volume contains only the written data of each logical volume copied and the same applies to the TVC.

- **SETSYS TAPESPANSIZE(800)**

  Using a high value reduces tape spanning. This will reduce the number of virtual volumes that need to be recalled to satisfy DFSMShsm recall/recover requests. With VTS, you can be very generous with the value, as no space is wasted. For example, TAPESPANSIZE of 800 would mean that any data set less than 800 MB will not fit on the remaining space of a virtual volume will be started on a fresh new virtual volume.

Note: The maximum value was recently increased to 4000 MB and the default value has been changed to 500 MB.

To better understand the use of the DFSMShsm with VTS, we summarize the different DFSMShsm functions that use tapes and we analyze the benefit that VTS gives:

- **Backups of DFSMShsm Control Data Sets**—The backup of DFSMShsm control data sets (CDSs) can easily be done in a VTS subsystem, exploiting the benefit of using virtual volumes instead of physical volumes, which might otherwise be under utilized.

- **ABARS**—The purpose of the DFSMShsm ABARS function is disaster recovery. Therefore, ABARS should not be directed in a VTS subsystem.

  However, if the VTS subsystem is installed offsite, the virtual volumes created reside in the VTS, with no strong need to eject them. The ABARS **SETSYS ABARSTAPES(STACK)** parameter is not recommended in a VTS environment. It would cause ABARS to write all output files to a single output volume.
  SETSYS ABARSTAPES(NOSTACK) should be specified instead.

  ABARS function can be used to export data from the VTS subsystem, as detailed in Section 6.6.6, "Moving Data out of VTS" on page 153.

- **Volume Dumps**—Using VTS as output for the DFSMShsm AUTODUMP function, do not specify the **DEFINE DUMPCLASS(dclass STACK(nn))** or **BACKVOL SG(sgname)|VOLUMES(volser) DUMP(dclass STACK(10))** parameters. This parameters were introduced to force DFSMShsm to use the capacity of native Magstar cartridges. If used with VTS, they cause unnecessary multivolume files. We recommend using the default value, which is **NOSTACK**.

- **Migrate/Recall (DFSMShsm Level 2)**—The only problem that should be considered when using a VTS as DFSMShsm level 2 is the recall process throughput of the VTS subsystem. Consider how many recall tasks are

started at the same time and compare that number with the number of physical drives of your VTS subsystem. For example, if your installation often has more than 10 tape recall tasks at one time, you probably need two VTS subsystems to satisfy this throughput request, because all migrated data sets may already have been copied into stacked volumes and may not be in the TVC.

- **Backup and Recovery**—Unlike the DFSMShsm RECALL operation, RECOVERY usually has lower frequency in an DFSMShsm environment. Therefore, using VTS for DFSMShsm backup and recovery functions benefits you without impacting DFSMShsm performance. However, be careful to review your DFSMShsm performance requirements before migrating DFSMShsm RECOVERY to the VTS subsystem.

- **TAPECOPY**—The DFSMShsm TAPECOPY function requires that original and target tape volumes are of the same media type and use the same recording technology. Using a VTS without the EHPO feature as target for the TAPECOPY operation can cause problems because VTS virtual volumes are specified with an IDRC compaction ratio of 1:1 and can have a capacity smaller than native input volumes.

  Use Table 22 to tailor your TAPECOPY environment.

Table 22. TAPECOPY Utilization		
ORIGINAL Volume Unit Name	**ALTERNATE Volume Unit Name**	**Percent Full That Should Be Defined (Assuming IDRC 2:1)**
VTS w/o EHPO (CST)	3490E (CST), VTS (CST)	97%
VTS w/o EHPO (ECCST)	3490E (ECCST), VTS (ECCST)	97%
3490E (CST)	VTS w/o EHPO (CST)	45%
3490E (ECCST)	VTS w/o EHPO (ECCST)	45%
VTS w EHPO (CST)	3490E (CST)	85%
VTS w EHPO (ECCST)	3490E w EHPO (ECCST)	85%

For example, if you are planning to put DFSMShsm alternate copies into a VTS subsystem, a tape capacity of 45% may not be enough for the input non-VTS ECCST cartridges. TAPECOPY will fail if the (virtual) output cartridge encounters EOV before the input volume has been copied completely.

On the other hand, using VTS logical volumes as original and 3490E native as TAPECOPY target may cause EOV at the alternate volume because of the higher IBMLZ1 compression seen on the virtual drive compared to the IDRC compression on the native drive.

The **DUPLEX TAPE** function, available with DFSMShsm 1.4 and later uses the same logic and has the same restrictions: Both output tapes have to be of the exact same size and unit type.

- **RECYCLE**—The DFSMShsm RECYCLE function reduces the number of logical volumes inside the VTS but when started can cause bottlenecks in the VTS subsystem recall process. If you have a VTS subsystem with three physical drives, use a maximum of two concurrent DFSMShsm RECYCLE tasks. If you have a VTS subsystem with six physical drives, use no more than five concurrent DFSMShsm RECYCLE tasks.

Select the RECYCLEPERCENT carefully, bearing in mind that:

– What you will free up is logical volumes residing on a stacked volume with hundreds of other logical volumes.

– The space occupied by the logical volume will be freed up only if and when the logical volume is used (overwritten) again.

– To RECYCLE, the VTS has to load the input volumes into the TVC.

Using RECYCLE SELECT (INCLUDE(RANGE(nnnnn:mmmmm))) or RECYCLE SELECT (EXCLUDE(RANGE(nnnnn:mmmmm))) for RECYCLE input can be helpful while selecting and migrating data to and from a VTS. Its immediate purpose is to enable you to set up volume ranges for different media types and different emulation types, like VTS logical volumes and 3490-emulated Magstar cartridges.
There are no special data set names for RECYCLEOUTPUT, although you must code your ACS routines, or BTLS options if using BTLS, to route RECYCLEOUTPUT to the library, using the &UNIT variable.

Refer to *DFSMShsm Primer*, SG24-5272, for more information on implementing DFSMShsm.

6.4.2 DFSMSrmm and Tape Management Systems

No changes are required to any tape management system to support basic VTS, but you need to review the retention and movement criteria for the data in the VTS. However, if you plan to use the Advanced Function feature with the Import/Export component, you must have the appropriate tape management system software levels installed and implemented to control and manage vaulting and expiration of logical volumes residing on exported stacked volumes outside of the VTS. DFSMSrmm keeps track of logical volumes outside of the VTS in a *CONTAINER* field of the specific volume record. Refer to Chapter 9, "IBM Magstar VTS Advanced Function" on page 245 for detailed information about Advanced Function feature.

When you direct allocations inside the VTS, the Vital Record Specifications (VRSs) or vault rules should tell the tape management system that the data set will never be moved outside the library if you do not want to use the export function.

Stacked volumes cannot be used by the host; they are managed exclusively by VTS.

Exported stacked volumes cannot be used by the host either, but they reside outside the VTS and the tape management system needs to know about them in order to track the location and movement.

To indicate that the stacked volser range is reserved and cannot be used by any host system, define the volsers of the stacked volumes to RMM (see Figure 42 on page 136).

A good method is to add racks and volsers of stacked cartridges to RMM and put them in a *loan location*. When exporting logical volumes, you can manually assign vault locations to the exported stacked volumes to keep track of their location. This can be done using the command:

```
RMM CHANGEVOLUME LOCATION(newloc)
```

Use the PARMLIB parameter:

```
REJECT ANYUSE(VTS*)
```

assuming that VTS is the prefix of your stacked VTS cartridges. RMM will deny any attempt to read or write those volumes on native drives.

Using

```
REJECT OUTPUT(VTS*)
```

will cause RMM to deny any attempt to write on those volumes on native drives, but will not prevent reading operations. This option is recommended if you plan to read exported stacked volumes outside the VTS to recover logical volumes using a special utility function.
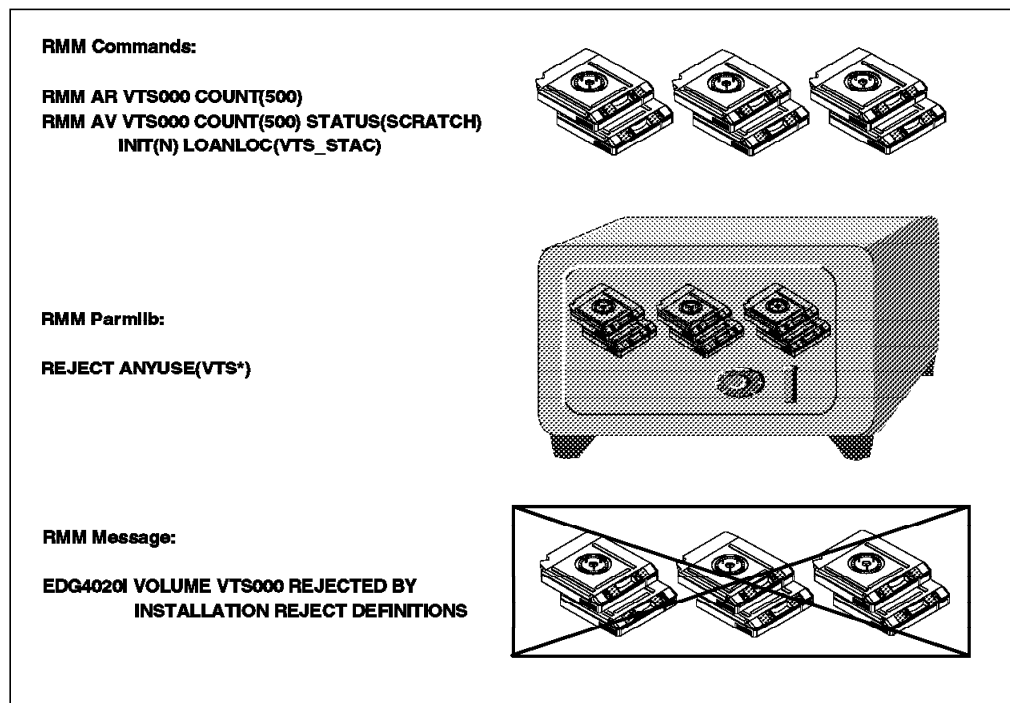
Figure 42. Defining Stacked Volumes to RMM

You do not need to explicitly define the virtual volumes to RMM. During entry processing, the active RMM automatically records information about each volume in its control data set. RMM uses the defaults you specified in ISMF for the library entry values if there is no RMM entry for an inserted volume; set the default entry status to SCRATCH.

When adding 150,000 virtual volumes the size of the RMM CDS and the amount of secondary space available must be checked. RMM uses 1 MB for every 1000 volumes defined in its CDS; an additional 150,000 volumes would need 150 MB of space.

To increase the size of the RMM CDS, you have to stop RMM activities, back up the CDS, then reallocate a new CDS with a larger size, and restore the CDS from the backup copy. To calculate the correct size of the RMM CDS, refer to the *DFSMS/MVS DFSMSrmm Implementation and Customization Guide*, SC26-4932.

Other tape management systems, such as CA/DYNAM-TLMS or TMS/CA-1, need to reformat their database to add more volumes.

Additionally, some tape management systems do not allow the specification of tape volumes with alphanumeric characters or require user modifications to do so. Refer to the proper product documentation for this operation.

In both RMM and the other tape management systems, the virtual volumes do not have to be initialized. The first time a volser is used, VTS marks the virtual volume with VOL1, HDR1, and a tape mark, as if it had been done by EDGINERS or IEHINITT.

The virtual volumes, once used, appear to the tape management system as normal CST or ECCST cartridges with IDRC compaction used. The information on media errors (temporary and permanent) for virtual volumes is always null, because the errors for the real media (Magstar stacked volumes) are registered and managed by the VTS subsystem without host knowledge.

6.4.3 Tivoli Storage Manager

With Tivoli Storage Manager there are significant new features and performance improvements over previous versions of ADSM. With support for SANs, Tivoli Storage Manager protects over 35 operating platforms from a single management console, making it the best choice for customer's heterogeneous server environments. Tivoli Storage Manager provides data availability, records retention, and enterprise management for data on multiple vendor platforms in a networked environment.

The VTS provides ESCON as well as SCSI systems a new approach to storage management. If you plan to use Tivoli Storage Manager with VTS is important to understand how these products work together. Customers who use Tivoli Storage Manager with 3490s or tape solutions that have slower overall performance than VTS might be very satisfied with the performance of Tivoli Storage Manager with VTS. Other customers who use 3590 today and go to VTS to solve drive availability, drive sharing problem or to eliminate dedicate libraries for Tivoli Storage Manager, might be less satisfied with performance of Tivoli Storage Manager and VTS compared to the connection to native drives. In general, Tivoli Storage Manager operations will perform better with native 3590 drives than with VTS and the trade off between the performance and the VTS functionality should be understood.

6.4.3.1 Recommendations for VTS Usage

Tivoli Storage Manager, like DFSMShsm, can automatically fill a native Magstar cartridge. It can use the tape up to the EOV, independent of the media type. If you plan to store Tivoli Storage Manager data into the VTS, consider the following for placing your data on VTS.

- **Use VTS for Tivoli Storage Manager archiving** —Use VTS for archiving and back up of large files or data bases for which you don't have a high performance requirement during back up and restore. VTS is ideal for Tivoli Storage Manager archive or long term storage because archive data is not frequently retrieved. Archives and restores for large files should see less impact from the staging overhead. Small files, such as individual files on file servers, can see performance impacts from the VTS staging. (If a volume is not in cache the entire volume must be staged before any restore can be done).

- **Set Reclamation off** —by setting the reclamation threshold to 100 percent. Tivoli Storage Managerlike DFSMShsm has a reclamation function to

consolidate valid data from tapes with a low valid data percentage onto scratch tapes so that tapes can be freed up for reuse. Reclamation with VTS can be slower because all volumes have to be staged to the cache. Periodically set reclamation on, by setting the threshold to a lower value to regain the use of VTS volumes with small amount of valid data that will not expire for a longer period of time. The reclamation should be scheduled for non peak hours.

- **Use collocation** —to reduce he number of VTS volumes required for a full restore. Tivoli Storage Manager has a collocation function to group Tivoli Storage Manager client data onto a minimum set of tapes to provide a faster restore, and to provide separation of client data onto different physical tapes. Collocation with VTS will not minimize the physical tapes used but will minimize the number of logical volumes used. Collocation with VTS can improve restore time for large amounts of data. VTS will not ensure physical tape separation when collocation is used because different logical volumes can reside on the same physical tape.

- **Use VTS for Tivoli Storage Manager database back-ups** —that are to be used for recovery from local media and use VTS at a recovery site or native drives for back-ups that are to be used for recovery from offsite media. Tivoli Storage Manager requires a different tape for every back-up of the Tivoli Storage Manager database, thus a large number of logical volumes with less data is created. Using the VTS you don't have to care about the unused capacity of logical volumes.

- **Use VTS for back-ups of primary pool** —similar considerations to database back-ups apply to copy storage pools. If only one copy pool is used for local back-ups, then that storage pool should not be in the VTS, because it cannot be ensured that data in the copy storage pools are on different physical volumes. If storage pools for local and offsite back-ups are used, the copy storage pools for local back-ups can be in the VTS. The copy storage pools for offsite back-ups should use native drives or a VTS at the recovery site.

- **Use VTS in server-to-server configurations** —in a multiple Tivoli Storage Manager server implementation where some servers are remote from the VTS, a so called server-to-server configuration. The data from the remote server is stored as virtual volumes, which appear as sequential media volumes on the source server and which are actually stored as archive files on a target server.

6.4.3.2 Recommendations for native drives

Use native drives for data that will be used for frequent individual file restores or that has a requirement for high performance for backup and restores without any delays because of staging activity. Tivoli Storage Manager uses EXPORT to move data from one Tivoli Storage Manager server to another. This requires that both servers have compatible devices for the EXPORT media. Native drives should be used for Tivoli Storage Manager EXPORT unless you have the advanced function IMPORT/EXPORT at both VTSes.

6.4.3.3 Tivoli Storage Manager Parameter Settings

The setting for the following parameters can affect the performance of Tivoli Storage Manager with VTS.

- **MAXSCRATCH** (defining a storage pool)—As for DFSMShsm, Tivoli Storage Manager should use a scratch pool for tapes, because you do not have to

predefine tapes to Tivoli Storage Manager, and you could benefit from the faster VTS scratch mounts.

- **MOUNTLIMIT** (defining device class)—With VTS, you have up to 64 virtual drives available. The number of drives available for Tivoli Storage Manager use can probably be increased, taking into account VTS performance. Set Mountlimit high enough so that the number of available drives does not limit the performance of Tivoli Storage Manager tape operations.

- **MOUNTRETENTION** (defining device class)—When storing data in the VTS, you can set this parameter to zero, because you have a greater chance of finding the virtual volume still in the TVC when Tivoli Storage Manager must use it. This avoids the need to keep the virtual volume mounted and frees a virtual drive for other users.

- **MAXCAPACITY** (defining device class)— Using this parameter, you can tailor the size of the data written in a virtual volume. Having smaller virtual volumes can speed up recall processing. Using the full capacity of the virtual volume can limit the number of volumes used by Tivoli Storage Manager.

- **BACKUP DB** (Tivoli Storage Manager command)—Use SCRATCH=YES to use tapes from the TMS scratch pool and benefit from the faster VTS scratch mounts.

For details on setting up Tivoli Storage Manager refer to the Tivoli Storage Manager Administrators Guide that can be found on *http://www.tivoli.com/support/storage_mgr/pubs/admanual.htm*

6.4.4 Network Storage Manager (NSM) Alternative

The VTS architecture is based on a modified ADSM-Server/Space Management implementation which uses the migrate/recall functionality of ADSM/HSM to map 3490 virtual volumes on filesystem disk space. Using ADSM algorithms the data gets written on a few tapes. The staged approach of writing data to physical tape can result in reduced throughput depending on the overall load on the VTS. You cannot expect Tivoli Storage Manager exploiting 3590 drive speed. Another concern for some customers might be that the VTS must be attached to S/390 to ensure operation in general because of messaging and error recovery.

An alternative is to connect the IBM 3494 tape library directly to the Network Storage Manager (NSM C00-model) or any Tivoli Storage Manager-Server (NT, AIX, SUN, OS/400, HP, etc.) and attach dedicated native 3590 tape drives via SCSI to the open system host.

6.4.5 DFSMSdss

DFSMSdss can be a good user of the VTS subsystem. You have to plan carefully, however, and make sure you can achieve the required throughput: A DFSMSdss full volume physical dump can easily provide a data transfer rate of 10 MB/sec and higher for a single job. In the past, the data rate was often limited by the bandwidth of the DASD subsystem as the weakest part in the chain.

With VTS, you fill the stacked cartridge completely without changing JCL, using multiple virtual volumes. VTS then moves the virtual volumes created into a stacked volume.

The only problem you might experience when using VTS for the DSS volume dumps is related to the size of the virtual volumes. This can occur on a VTS without the EHPO feature. With sizes of 400 or 800 MB on this type of VTS, you could require greater than five cartridges to dump a DASD volume. If so, you must use an SMS DATACLAS specification, **Volume Count nn**, to enable more than five volumes.

Using the *COMPRESS* keyword of the *DUMP* command, you obtain a software compression of the data at the host level.

When the IDRC feature is installed and is active on a native tape drive, the software compression loses its meaning. It uses CPU cycles without providing benefit, because the data compaction occurs at the control-unit level.

In a VTS *without the EHPO feature* environment, you can use the *COMPRESS* keyword to save space in the VTS TVC and increase the data throughput capability of the VTS. However, doing so gives you no further compaction when copying the data to a stacked volume because the data is already compressed.

In a VTS *with the EHPO feature* we do not recommend specification of the *COMPRESS* keyword. It does not save space in the TVC, it does not save logical or physical cartridges, it does not increase the VTSs data throughput capabilities but it does increase HOST processor utilization.

6.4.6 Stand-Alone Services

Stand-Alone Services of DFDSS V2.5 and DFSMS/MVS V1 provide a stand-alone restore function that enables you to restore vital system packs without needing to rely on an MVS environment.

Stand-Alone Services supports the Magstar 3494 Tape Library and the Virtual Tape Server. It enables you to restore from native as well as virtual tape volumes in a Magstar 3494 Tape Library. Stand-Alone Services lets you specify the input volumes on the RESTORE command and sends the necessary mount requests to the Library Manager.

You can initial program load (IPL) the stand-alone services core image from a virtual tape device and use it to restore dump data sets from virtual tape volumes.

Stand-Alone Services is provided as a replacement to the previous DFDSS V2.5 and DFSMS/MVS V1 stand-alone functions. The installation procedure for Stand-Alone Services retains, rather than replaces, the existing stand-alone restore program so you do not have to immediately change your recovery procedures. We recommend that you implement the procedures as soon as you can and start using the enhanced Stand-Alone Services.

To use Stand-Alone Services, create a stand-alone core image suitable for IPL, using the new BUILDSA command of DFSMSdss.

The following APARs provide the Stand-Alone Services of DFDSS V2.5 and DFSMS/MVS V1:

- DFDSS Version 2.5

    APARs PN77830 and PN74583

- DFSMS/MVS Version 1

Use the steps listed below to IPL the Stand-Alone Services program from a virtual device and to restore a dump data set from virtual volumes. Refer to Section 7.19, "Stand-Alone Support" on page 200 on how to use Library Manager menus to set a device in stand-alone mode.

1. Ensure that the virtual devices you will be using are offline to other host systems. Tape drives to be used for stand-alone operations must remain offline to other systems.

2. Set in stand-alone mode the virtual device from which you will load the Stand-Alone Services program by using the 'Setup Stand-alone Device' window on the Library Manager console. Select 'Mount a single volume' and specify the virtual volume that contains the core image for IPL.

3. Load the Stand-Alone Services program from the device you just set in stand-alone mode. As part of this process, select the operator console and specify the input device for entering Stand-Alone Services commands.

4. When the IPL is complete enter Stand-Alone Services RESTORE command from the specified input device. For example:

   ```
   RESTORE FROMDEV(TAPE) FROMADDR(0A40) TOADDR(0900) -
   NOVERIFY TAPEVOL((L00001),(L00002))
   ```

   L00001 and L00002 are virtual volumes that contain the dump data set to be restored, 0A40 is the virtual device used for reading source volumes L00001 and L00002, and 0900 is the device address of the DASD target volume to be restored.

   Stand-Alone Services requests the Library Manager to mount the source volumes in the order in which they are specified on the TAPEVOL parameter. It automatically unloads each volume, then requests the Library Manager to demount it and to mount the next volume.

5. When the restore is complete, unload and demount the IPL volume from the virtual device by using the Library Manager's 'Setup Stand-alone Device' window.

6. Take the IPL device out of stand-alone mode by using the Library Manager's 'Reset Stand-alone Device' window.

Note that we did not set source device 0A40 in stand-alone mode. Stand-Alone Services issued the necessary mount and demount orders to the library. If you are using another stand-alone restore program which does not support the mounting of library resident volumes, you would have to set the source device in stand-alone mode and manually instruct the Library Manager to mount the volumes using the 'Setup Stand-alone Device' window.

For details on how to use Stand-Alone Services, refer to *Data Facility Data Set Services Version 2 Release 5 and DFSMS/MVS Version 1 Stand-Alone Services Overview*, SC26-0185.

6.4.7 Object Access Method

Tape cartridges provide a low-cost storage medium for storing primary and or backup copies of OAM objects.

Allowing objects to be stored on tape volumes in conjunction with DASD and optical media provides flexibility and more efficiency within the storage management facility.

OAM stores objects on a VTS subsystem as in a normal IBM 3494 or 3495 Tape Library, with up to 64 virtual drives and many virtual volumes available.

Consider using the TAPEPERCENTFULL parameter with object tape data, because the retrieve time of an OAM object is important. The recall time for smaller logical volumes can be reduced considerably.

Virtual volumes in a VTS subsystem can contain primary or backup copies of OAM objects, addressing either OBJECT or OBJECT BACKUP storage groups.

An advisable solution is to address VTS with the OBJECT storage group and other non-VTS tape devices with the OBJECT BACKUP storage group, or use VTS Import/Export because usually the volumes in the object backup storage group are moved offsite for disaster recovery purposes.

A virtual volume can contain multiple OAM objects, separated by a buffer space. To optimize the use of VTS storing OAM object data, consider the following:

- Review the MOUNTWAITTIME parameter when using VTS to store OAM object tape data. The default (5 minutes) should probably be increased if you have to recall a logical volume to read object data, and are other recall requests are queued, because the operation could take longer.

- Review the MAXTAPERETRIEVETASKS and MAXTAPESTORETASKS parameters when using VTS, because you have more virtual tape drives available.

- There are also other parameters, such as DEMOUNTWAITTIME, TAPEPERCENTFULL and TAPEFULLTHRESHOLD, that may need to be reviewed when using VTS to store OAM data.

For more information about OAM object tape support, refer to the *DFSMS/MVS OAM Planning Guide for Object Support*, SC26-4918.

6.5 Database Backups

Using a VTS subsystem as output confers several advantages on database backups. A detailed description of these benefits for every product follows.

6.5.1 DB2 Data

DB2 uses tapes for two purposes: for storing archive logs, and for storing image copies. Either one may be created in multiple copies, to be stored both onsite for local recovery, and offsite for disaster recovery purposes.

To use DB2 tape data with VTS, we recommend the following:

- **Archive logs**

  DB2 keeps track of database changes in its active log. The active log uses up to 31 DASD data sets (up to 62 with dual logging) in this way: When a data set becomes full, DB2 switches to the next one and automatically offloads the full active log to an archive log.

Archive logs are sequential data sets that are allocated on either DASD or tape. When archiving to tape, a scratch tape volume is requested each time.

Archive logs contain unique information necessary for DB2 data recovery. Therefore, to ensure DB2 recovery, customers usually make backups of archive logs. You can use general backup facilities or DB2′s dual archive logging function.

When creating a dual copy of the archive log, usually one is local and the other is for disaster recovery. The local copy can be written to DASD, then moved to tape, using the TMM. The other copy can be written directly to tape and then moved to an offsite location.

With VTS, you can write the local archive log directly inside the VTS subsystem. Avoiding the use of TMM saves DASD space, saves DFSMShsm CPU cycles, and simplifies the process. The disaster-recovery copy must be created on non-VTS tape drives, so that it can be moved offsite.

The size of an archive log data set varies from 150 MB to 1 GB. The size of a virtual volume **on a VTS without EHPO** can be up to 800 MB,[1] so be sure that your archive log can fit in only one virtual volume. This is because it is suggested to use a single volume when unloading an archive log to tape. The size of a virtual volume **on a VTS with EHPO** can be up to 2,400 MB, assuming a 3:1 compression ratio.

Tailoring the size and the number of active log DASD data sets allows you to obtain an archive log on tape whose size does not exceed the virtual volume size.

Limiting data set size may increase the frequency of offload operations and reduce the amount of active log data on DASD. However, this should not be a problem because VTS does not require manual operation, and archive logs will stay in the TVC for some time and be available for fast recovery.

One form of DB2 recovery is backward recovery, typically done after a processing failure, where DB2 backs out uncommitted changes to resources. When doing so, DB2 processes log records in reverse order, from the latest back toward the oldest.

If the application being recovered has a large data set and makes only a few commits, you probably need to read the old archive logs that are on tape. When archive logs are on tape, DB2 uses read-backward channel commands to read the log records. Read-backward is a slow operation on tape cartridges processed on real IBM 3480 (if IDRC enabled) and IBM 3490 tape drives. On a VTS it is only about 20% slower than a normal I/O because data is retrieved from the TVC, so the tape drive characteristics are replaced by the random access disk characteristics.

Another benefit VTS can provide to DB2 operations is the availability of up to 64 virtual drives, because DB2 often needs a large number of drives concurrently to perform recovery or backup functions.

Having two VTSs, one onsite and one offsite, makes dual logging very easy, exploiting the benefit of the VTS subsystem.

Figure 43 on page 144 shows an example of where to put tape data.

---

[1] Use ECCST cartridge emulation whenever possible, it does not incur any waste of space in the VTS.
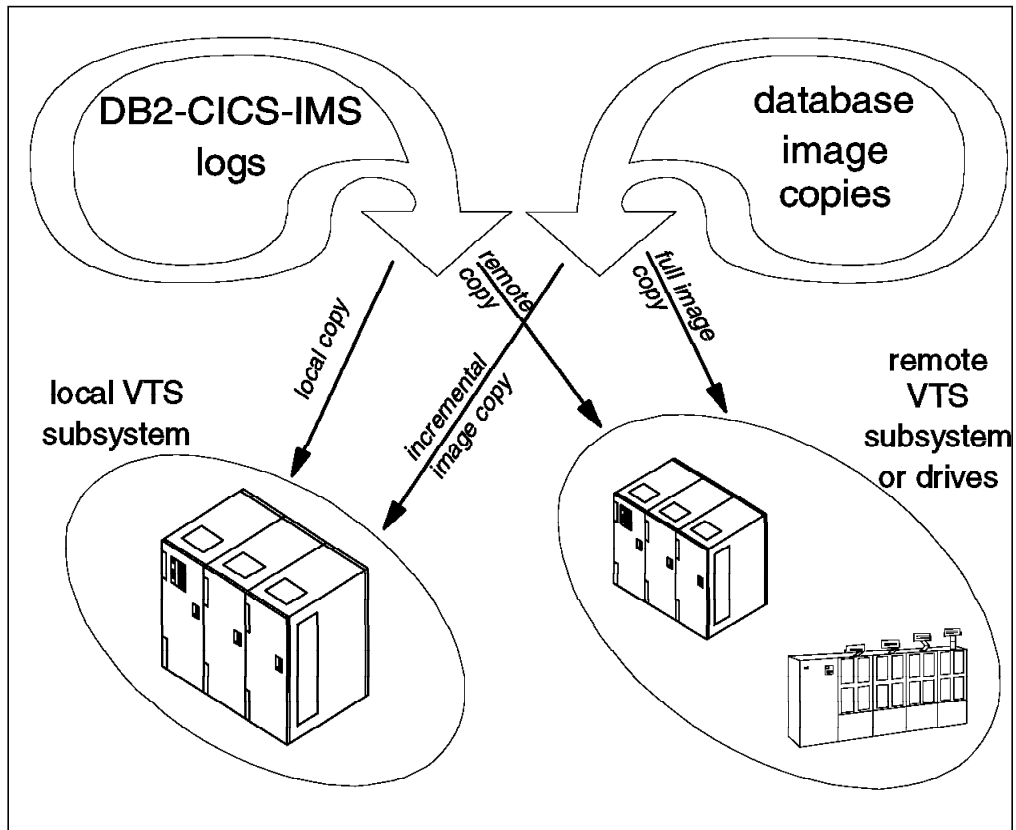
Figure 43. How to Distribute Database Tape Data among Local and Remote Sites.

- **Image copies**

  Image copies are backup copies of table spaces in a DB2 database. DB2 can create both full and incremental image copies. A full image copy contains an image of the whole table space at the time the copy was taken. An incremental image copy contains only those pages of a table space that have changed since the last full image copy was taken. Incremental image copies are typically taken daily, whereas full image copies are typically taken weekly.

  DB2 provides the option for multiple image copies. You can create up to four identical image copies of a table space, one pair for local recovery use, and one pair for offsite storage.

  The size of the table spaces to be copied varies from a few megabytes to several gigabytes. The VTS solution is the best for small and medium sized table spaces, because you need a higher bandwidth for large table spaces.

  When a database is recovered from image copies, a full image copy and the subsequent incremental image copies need to be allocated at the same time. This can potentially tie up many tape drives and, in smaller installations, can prevent other work from being run. With VTS, with its 64 virtual drives, this is not an issue.

  The large number of tape drives is important also for creating DB2 image copies. Having more drives available allows you to run multiple copies concurrently and use the MERGECOPY DB2 utility without impact. An advisable solution is to run a full image copy of the DB2 databases once a week outside the VTS and run the incremental image copies daily using VTS. (The smaller incremental copy fits better with the VTS volume sizes.)

6.5.2 CICS and IMS

Like DB2, both CICS and IMS use tapes to store logs and image copies of databases.

CICS is only a data communication product, whereas IMS has both the data communication and the database function (IMS-DL/1). CICS uses the same DL/1 database function to store its data.

- **CICS journals and IMS logs**

  CICS keeps track of database changes in its journal data sets. IMS keeps track of database changes in its online log data sets. Once these data sets become full, both CICS and IMS offload the logs to tape.

  CICS and IMS logs are sequential data sets. When offloading these logs to tape, you must request a scratch volume every time.

  The logs contain information necessary to recover databases, and usually those logs are offloaded, as with DB2, in two copies, one local and one remote. You can write one local copy and then create the second for disaster recovery purposes later, or you can create the two copies in the same job stream.

  With VTS, you can create the local copy directly on VTS virtual volumes, then copy those volumes to non-VTS tape drives, or to a remote VTS subsystem.

  Having a local copy of the logs written inside the VTS allows you faster recovery, because the data will stay in the tape volume cache for some time.

  When recovering a database, you can complete backout operations in significantly less time with the VTS, because, when reading logs from tape, IMS uses the slow *read backward* operation (100 KB/s) on real tape drives. With the VTS, the same operation is much faster, because the data is read from TVC.

  Another benefit VTS gives to recovery operations is the availability of up to 64 virtual drives, allowing you to mount several logs concurrently and thus to back out the database to be recovered faster.

  The IMS change accumulation utility is used to accumulate changes to a group of databases from several IMS logs. This implies the use of many input logs that will be merged into an output accumulation log. Using the VTS, you can use more tape drives for this function.

- **Image copies**

  Image copies are backup copies of the IMS databases. IMS can create only full image copies. To create an image copy of a database, use a batch utility, copying one or more databases to tape.

  With the VTS you do not have to stack multiple small image copies to fill a tape cartridge. Using one virtual volume per database does not waste space, because the VTS then groups these copies into a stacked volume.

  IMS, unlike DB2, has a batch function that works with databases through an IMS batch region. If you do not use logs when running an IMS batch region, then in order to recover the database, you must use an image copy taken before running the batch job. Otherwise, you can use logs and checkpoints, which allows you to restart from a consistent database image taken during the batch execution processing. Using VTS, you can access these image copies and logs at a higher speed.

The VTS volume stacking function is the best solution for every database backup, because it is transparent to the application and does not require any JCL procedure change.

6.5.3 Batch Data

Other applications that write to tape and benefit from using the VTS include:

- VSAM REPRO

- IEBGENER / IEBCOPY / ICETOOL

- DSS data set COPY or DUMP

- Any other tape copy utility

The amount of data from these applications can be huge if your environment does not use TMM or if you do not have DFSMShsm installed. All such data benefit from using the VTS subsystem for output.

With VTS, the application can write one file per volume, using only part of the volume capacity, and VTS takes care of completely filling the stacked cartridge for you, without JCL changes.

The only thing you must remember is that, if you need to move the data offsite, you must address a device outside the VTS, or use other techniques to copy VTS data on other movable tapes, as described in Section 6.6.6, "Moving Data out of VTS" on page 153.

6.6 Moving Data into and out of VTS

In this section, we discuss techniques for moving data in and out of VTS. You can start using the VTS by moving data into it. The best method depends on the application you want to manage with the VTS subsystem. We describe two methods:

- *Phased method*—This method consists of starting to use VTS with new allocations. The migration of data takes longer, but it can be more controlled and flexible.

- *Quick method*.—Use this method when you want to move existing data into the VTS. It is called *quick* because it swiftly puts all data you want to move under VTS control.

Section 6.6.6, "Moving Data out of VTS" on page 153 provides some hints on how to move data out of the VTS. However, the VTS is a closed-storage method, so you must be careful in selecting data to move into it. You do not want to store a large amount of data in the VTS that will need to be moved back out.

Section 6.7, "Physical Cartridge Movement" on page 156 provides a way of moving all data belonging to one VTS to another VTS by using physical cartridge movement.

6.6.1 Moving Data into the VTS: Phased Method

The data movement techniques outlined here depend more on changes in parameters, routines, or procedures than on overt data movement.

A phased method, independent of the data you are moving into the VTS subsystem, is illustrated in Figure 44:

PHASED METHOD

Select data
✓ HSM data
✓ DSS data
✓ Database data

Update parameters
✓ ARCCMDxx
✓ ACS routines
✓ JCL UNIT

Update tms catalog
✓ Update VRSs
✓ Update tms

Watch data move
✓ New allocations
✓ Verify data
✓ Play with data
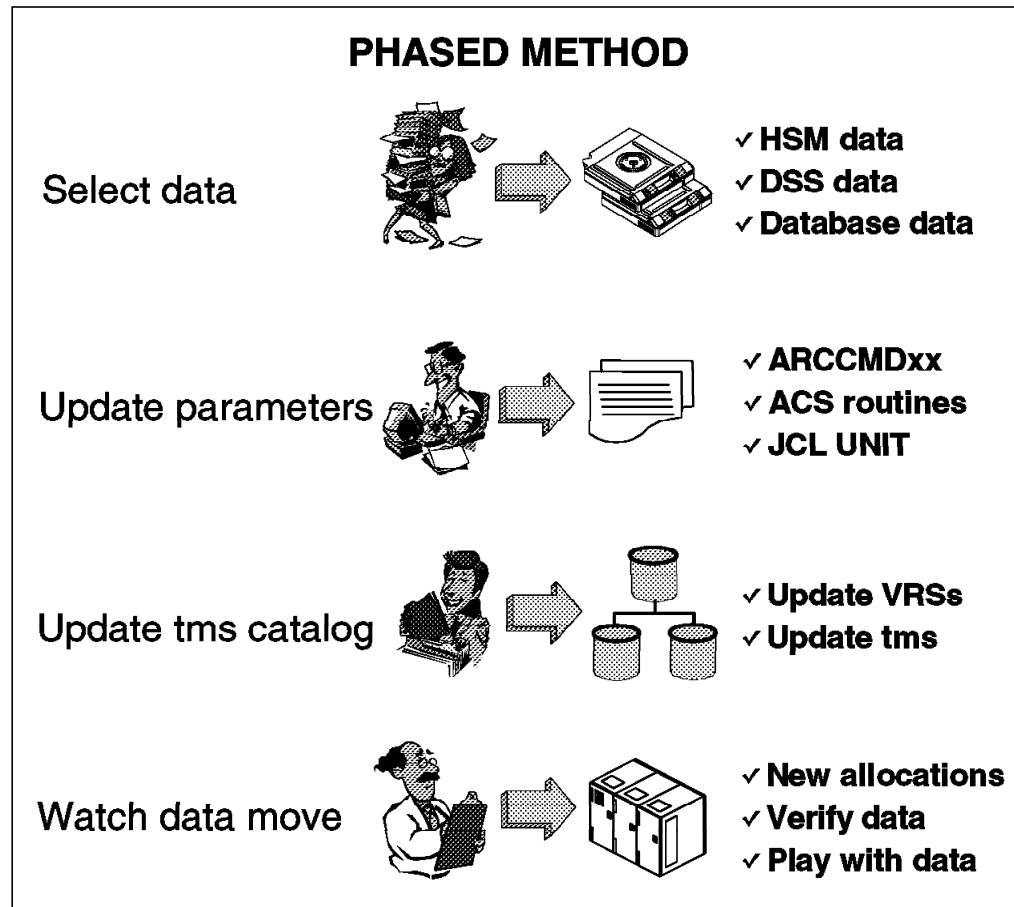
Figure 44. Sample Process Flow to Move Data in the VTS: Phased Method

- **Select the data**

  If you select DFSMShsm-owned data, you can choose one of the following:

  - Migration data (DFSMShsm level 2)
  - Backup copies (user data, CDS data, or both)
  - Dump copies
  - All of the above

  You can select data based on data set name, by application, or by any other variable that you can use in the ACS routines.

  You can also select data based on type, such as SMF data, or DASD DUMP data.

- **Update the applicable parameters**

  If you select DFSMShsm-owned data, review the ARCCMDxx member and update:

  - The data class ACS routines (if you are using data class)
  - The storage class ACS routines (required)

- The storage group ACS routines (required)
- For BTLS, the unit parameter in the JCL

For DFSMSdss, update:

- The data class ACS routines (if you are using data class)
- The storage class ACS routines (required)
- The storage group ACS routines (required)
- For BTLS, the unit parameter in the JCL

If you use database data, such as logs or image copy, direct new allocations into the VTS by updating:

- The data class ACS routines (if you are using data class)
- The storage class ACS routines (required)
- The storage group ACS routines (required)

If you are using BTLS with the VTS to store database data,

- For DB2 archive log, update the archive log data set parameters in the DB2 DSNZPARM initialization member.
- For IMS logs, tailor the appropriate IMS proclib member.
- For CICS logs, update your journal archive procedures.

For data other than DFSMShsm and DFSMSdss, if you are using SMS tape, update the ACS routines to include the data you want to move. You decide what you filter for, and how you write the ACS routines. If you are using BTLS, update the UNIT parameter in the JCL to reflect the applicable unit for the VTS.

- **Update the tape management system**

  Even though you are not overtly copying data in this option, be sure to update the TMS catalog to reflect the changes that you expect. Check the retention rules and limits and update accordingly. Refer to Section 6.4.2, "DFSMSrmm and Tape Management Systems" on page 135 for more information.

- **Watch the data move to the VTS**

  Data movement using this option does not involve overt actions, such as COPY, RECYCLE, or DUMP. When you activate the ACS routines containing the code for the VTS, all new data allocations for the data you have selected are written to the VTS subsystem. You simply verify that data is going where you expect it to go, and you add code to the ACS routines to manage more data as you see fit.

  You can select data types that create large quantities of data, like SMF records or DASD DUMPS, and you can also select data types that create many very small data sets. By observing how the VTS handles each type of data, you become familiar with the VTS, its functions, and capabilities.

6.6.2 Moving Data into the VTS: Quick Method

The steps outlined in this section involve overt actions on your part to move data into the VTS subsystem. As with the techniques outlined in Section 6.6.1, "Moving Data into the VTS: Phased Method" on page 147, you choose the data you want to move to the VTS subsystem. A quick method, independent of the data you are moving in the VTS subsystem, is illustrated in Figure 45 on page 149.

QUICK METHOD

Select data to copy
✓ RMM extract
✓ tms report

Copy selected data
✓ IEBGENER
✓ DFDSS copy

Update tms catalog
✓ RMM OW26348
✓ tms utility

Update ICF catalog
✓ DEL NSCR
✓ DEF NVSAM

Release input volumes
✓ RMM DELVOL
✓ tms command
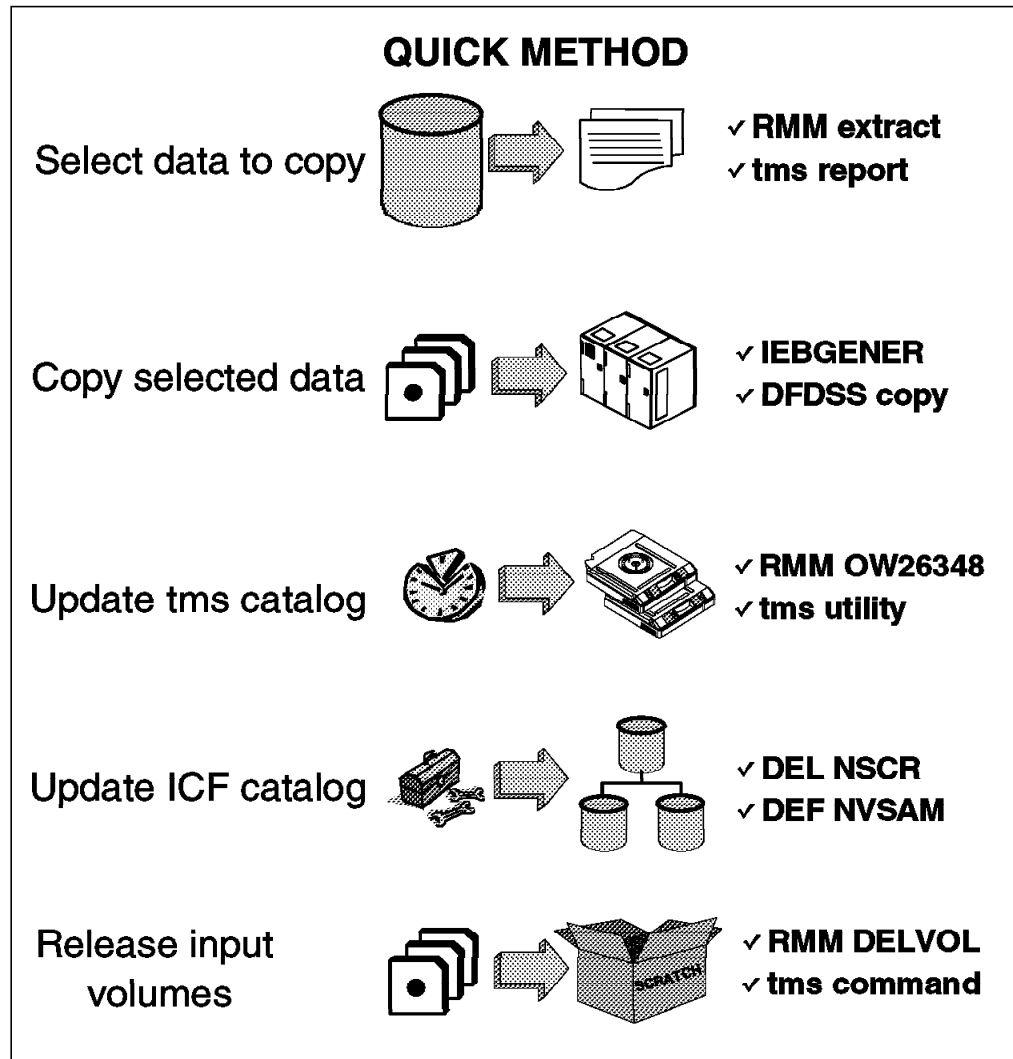
Figure 45. Sample Process Flow to Move Data in the VTS: Quick Method

- **Select the data to copy**

    The data you select influences all subsequent steps in this process. If you select DFSMShsm-owned data, the process for moving the data to the VTS will be different from the process that you use for DFSMSdss data. You can select data based on the data's attributes, as when using expiration date as a basis for your choice. For example, you could select data that you keep for 7 years. The choice is yours, because it is your data and your environment, and you understand it better than anyone else. Probably the best method of selecting data to copy in the VTS is based on the data set name, application by application.

    You need to be aware that some applications have knowledge of the volser where the data is stored. There are special considerations for these applications. If you change the volser that the data is on, the application will have no way of knowing where the data resides. For more information about this topic see 6.6.4, "Considerations for Static Volsers" on page 152.

    An easy method is to gain information from the TMS database. Some reports can give you details on the data you actually have in the tape shop, helping to select the input volumes.

If you are using RMM, you can easily acquire data from an RMM EXTRACT file, then with a REXX EXEC you extract the information needed, such as data set name, volser, and file sequence of the input volumes.

- **Copy data with a tape copy utility**

  If you are using SMS tape, update the ACS routines to include the data that you are copying to the VTS. If you are using BTLS, update the UNIT parameter in the JCL to include the valid unit for the VTS.

  After selecting data, the next step is to create a job stream that copies the data with the right utility from tape to tape.

  If you selected DFSMShsm-owned data, use DFSMShsm recycle to move the data to the VTS. Use a COPYDUMP job to move DFSMSdss data to the VTS.

  The utility to use depends on the data selected. In most cases, it is sequential data that can be copied using the IEBGENER utility, DITTO/ESA. If you have DFSORT or a similar utility, ICEGENER and ICETOOL can probably give better performance.

  You must use a specific utility when the input data is in a special format, for example, DFSMSdss dump data. DFSMSdss uses a 64 KB block size and only the proper DSS utility, like COPYDUMP, can copy with that blocksize.

- **Update TMS with the correct retention information**

  When the copy operation has been successful, update the tape management system catalog. This data must be updated on the output volume:

  - File sequence number
  - Creation date and time
  - Last read and last write date
  - Jobname

  Optionally, you can also update:

  - Stepname
  - DDname
  - Account number
  - Device number

  In RMM, this can be easily done with a CHANGEDATASET command with special authority to update O/C/EOV recorded fields (OW26348).

- **Update the ICF catalog with the correct output volume**

  The next step is to uncatalog the input data sets (if they were cataloged) and recatalog the output data sets with the new volume information.

- **Release the input volume for SCRATCH processing**

  Finally, release the input volumes for scratch processing. This needs to be done after you are sure the data has been correctly copied. You also need to verify that the retention and catalog information is correct.

Using this sequence, you can copy every kind of tape data, including (GDGs), without modifying the generation number.

In an RMM environment, you can use a REXX CLIST and RMM commands, listing data from the input volumes and then using the RMM REXX variables with the CD command to update the output. Afterward call IDCAMS to update the ICF catalog. When the operation completes and all errors have been corrected, use the RMM DELETEVOLUME command to release the input volumes.

Refer to the *DFSMS/MVS DFSMSrmm Guide and Reference*, SC26-4931, for more information about RMM commands and REXX variables.

If you are using a TMS other than RMM, refer to the appropriate product functions to obtain the same results.

The first approach when migrating data inside the VTS can be easier with products like DFSMShsm or Tivoli Storage Manager. If you are planning to put DFSMShsm or Tivoli Storage Manager data in the VTS, See section 6.4.1, "DFSMShsm" on page 132 and section 6.4.3, "Tivoli Storage Manager" on page 137.

With DFSMShsm, you can change the ARCCMDxx tape device definitions addressing an esoteric name with VTS virtual drives (in a BTLS environment) or changing SMS ACS routines to direct DFSMShsm data in the VTS. The DFSMShsm RECYCLE command can help speed the movement of the data.

A similar process can be used with Tivoli Storage Manager, changing the device class definitions for the selected data to put in the VTS and then invoking the space reclamation process.

If you are moving DB2 data into the VTS, be sure that, when copying the data, the DB2 catalog is also updated with the new volume information. You can use the DB2 MERGECOPY utility to speed up processing, using VTS virtual volumes as output.

6.6.3 Products to Simplify the Task

You may want to consider using a product designed to copy data from one medium to another. Be sure to consider these factors when evaluating a tape copy product:

- Interaction with your tape management system
- Degree of automation of the process
- Speed and efficiency of the copy operation
- Flexibility in using the product for other functions such as duplicate tape creation
- Ease of use
- Ability to create a pull list for any manual tape mounts
- Ability to handle multivolume data sets
- Ability to handle volume size changes whether from small to large or large to small
- Ability to review the list of data sets before submission
- Audit trail of data sets already copied
- Flexibility in being able to filter the data sets by wild cards or other criteria such as expiration or creation date
- Ability to handle failures during the copy operation such as input volume media failures

Table 23 on page 152 lists the tape copy products that we are aware of. You can choose one of these products or perhaps you have your own utility for tape copy. Certainly you do not need any of these products, but a tape copy product will make your job easier if you have many tapes to move into the VTS.

Table 23. Tape Copy Products

	Vendor	Web Address for More Information
Beta55	Beta Systems Software AG	*http://www.betasystems.com*
CA-1/TLMS Copycat	Computer Associates International, Inc.	*http://www.cai.com/products/ca1.htm*
CARTS-TS or CARTS-MC	Technologic Software Concepts, Inc.	*http://www.technologic.com/products/carts/cartsh.html*
FATAR	Innovation Data Processing	*http://www.innovationdp.com/*
TapeSaver®	Technologic Software Concepts, Inc	*http://www.technologic.com/products/tapesaver/tapesaverh.html.*
Tape/Copy	OpenTech Systems, Inc.	*http://www.opentechsystems.com/copy.htm*
Zela	Software Engineering of America	*http://www.seasoft.com/zela.html*

In addition to using one of these products, consider using IBM Global Services to assist you in planning and moving the data into the VTS. For more information about these services, see 2.7, "Implementation Services" on page 36.

6.6.4 Considerations for Static Volsers

Some applications have knowledge of the volser of the volume where the data is stored. One example of an application that has this knowledge is DFSMShsm. When moving data for these applications, you have two choices. You can utilize instructions from the application author to copy the data or you can copy the data to a volume with the same volser. For assistance with DFSMShsm tapes, see 6.6.2, "Moving Data into the VTS: Quick Method" on page 148.

The preferred method for moving this type of data is to utilize instructions from the application author. If, however, you must copy the data to a volume with the same volser, take these points into consideration:

- If the source tape is system-managed tape, you cannot have two volumes with the same volser.

- The source and target media may not be the exact same size.

- You cannot mount two volumes with the same volser at the same time.

This is not the preferred method for moving data to the VTS. This method applies only if you have to maintain the data-set-to-volser relationship, and it has limitations and weaknesses.

1. Copy the non-VTS tape volumes to DASD or other tape volumes.[2]

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[2] The size of the DASD buffer needed to perform this step could be huge. Be sure to have enough space.

2. If the source volume is 3494-resident, eject the cartridge from the Magstar 3494 Tape Library, using the LIBRARY EJECT command or the ISMF EJECT line operator command from the ISMF panel.

3. Delete the ejected volume from the tape management system.

4. Define the volser range, including the once-duplicated number, to the VTS.

5. Update ACS routines so that the data is directed to the VTS. For BTLS, update the UNIT parameter in the JCL.

6. Create a job to copy the data currently on DASD to the VTS.[3]

7. Run the copy job.

8. Update the tape management system records and any other catalog structures.

6.6.5 Combining Methods to Move Data into the VTS

You will most likely want to use a combination of the phased and quick methods for moving data into the VTS. One approach is to classify your data as static or dynamic.

Static data is data that is going to be around for a long time. This data can only be moved into the VTS with the quick method. You have to decide how much of this data is to be moved into the VTS. One way to make this decision is to examine expiration dates. You can then set a future time when all volumes or a subset is copied into the VTS. There may be no reason to copy volumes that are going to expire in two months. By letting these volumes go to scratch status, you will save yourself some work.

Dynamic data is data that is of temporary nature. Full volume backups and log tapes are one example. These volumes typically have a very short expiration period. You can move this type of data with the phased method. There is no reason to copy these volumes if they are going to expire soon.

6.6.6 Moving Data out of VTS

There are many reasons why you would want to move data out of the VTS. The most common reason would be for disaster recovery or data interchange. You can move data out of the VTS in three ways (see Table 24 on page 154).

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[3] Be sure that the size of the non-VTS volume previously copied to disk is compatible with the VTS volume sizes, 400 or 800 MB (times the compression ratio if EHPO installed).

	Import/Export	Host Copy	ABARS
Table 24. Methods of Moving Data out of the VTS			
Source copy retained	No	Yes	Optional
Compatibility	With another VTS	Depends on target	Depends on target (must have DFSMShsm)
Target aggregation (volser selection)	Yes	Maybe	Yes
Requirements	VTS	Standard tools or product	DFSMShsm
Data stacked on output media	Yes	Possibly	Yes
Source aggregation multiple sources	No	No	Yes
Outboard data movement	Yes	No	No

You can use the Import/Export feature of the VTS to move data out of a VTS. This data can only be brought into the same or another VTS. This method is useful if you are relying on the availability of another VTS available at the recovery site. It can also be used for data interchange between two sites that both have a VTS. For more information about the Import/Export feature, refer to Chapter 9, "IBM Magstar VTS Advanced Function" on page 245.

With DITTO/ESA for MVS you have the alternative to create copies of exported logical volumes outside the normal Export/Import procedure. For more information about the new DITTO/ESA function, refer to 9.12, "DITTO VTS Functions" on page 285.

The second method of moving data out of the VTS is to use a host-based tool to copy the data from the VTS to the target. With this method the data is reprocessed by the host and copied to another medium.

This method is described in Section 6.6.1, "Moving Data into the VTS: Phased Method" on page 147. The only difference is that you need to address the VTS as input and the non-VTS drives as output.

The third method is to copy the data with the DFSMShsm ABARS function. This method is described below.

ABARS is the command-driven DFSMShsm function that backs up a user-defined group (called an *aggregate group*) of data sets (usually for recovery purposes) at another computer site or at the same site. ABARS can be used to back up and recover both SMS- and non-SMS-managed data, on DASD and on tape.

Using the DFSMShsm ABARS function, group the data you want to move outside the VTS, then start addressing other tape drives outside the VTS subsystem. In this way, you obtain an exportable copy of the data that can be put in an offsite location.

Here is an overview of the process:

- **Create selection data set**

Before you can run aggregate backup, you have to create one or more selection data sets. The selection data set lists the names of the data sets to be processed during aggregate backup.

You can identify the data set names in a single selection data set, or you can divide the names among as many as five selection data sets. You can specify six types of data set lists in a selection data set. The type you specify determines which data sets are backed up and how they are recovered.

An INCLUDE data set list is a list of data sets to be copied by aggregate backup to a tape data file where they can be transported to the recovery site and recovered by aggregate recovery. The list can contain fully qualified data set names or partially qualified names with place holders. DFSMShsm expands the list to fully qualified data set names.

Using a selection data set with the names of the data sets you want to export from the VTS subsystem, you obtain a list of files on logical volumes that the ABARS function copy to non-VTS drives.

- **Define aggregate group**

  You have to define an aggregate group and related management class to specify exactly which data sets are to be backed up.

  You define the aggregate group and management class used for aggregate backup to DFSMS through ISMF panels.

  The aggregate group lists the selection data set names, instruction data set name, and additional control information used by aggregate backup in determining which data sets are to be backed up.

- **Execute ABACKUP VERIFY command**

  You have two options with the ABACKUP command. You can choose to verify the contents of the aggregate backup without actually backing up any data sets, which is the same as performing a test run of aggregate backup.

  An example of the ABACKUP command is:

```
HSEND ABACKUP agname VERIFY UNIT(non_VTS_unit) PROCESSONLY(USERTAPE)
```

  With the PROCESSONLY(USERTAPE) keyword, only tape data sets are processed. In this way you can be sure that only the input data from VTS logical volumes is used.

- **Execute ABACKUP EXECUTE command**

  When you are ready, you can perform the actual backup, using this command:

```
HSEND ABACKUP agname EXECUTE UNIT(non_VTS_unit) PROCESSONLY(USERTAPE)
```

  When you issue the ABACKUP command with the execute option, the following tape files are created for later use as input to aggregate recovery:

  – Data file

    Contains copies of the data sets that have been backed up

– Control file

  Contains control information needed by aggregate recovery to verify or recover the application's data sets

– Instruction/activity log file

  Contains the instruction data set, which is optional

At the end of this process, you obtain an exportable copy of the VTS data, which can be used for disaster recovery and stored offsite using other physical tapes.

For more information about using the DFSMShsm ABARS function, refer to the *DFSMS/MVS DFSMShsm Storage Administration Guide*, SH21-1076.

6.7 Physical Cartridge Movement

Figure 46 shows the source and target configuration when you migrate all data belonging to one VTS to another by using physical cartridge movement. Just as a sample the source VTS is an IBM 3494 Model B16, and the target VTS is an IBM 3494 Model B18.

This method cannot be used to move the workload from an IBM 3494-B18 with EHPO to a non-EHPO IBM 3494 Model B18 or from an IBM 3590 Enhanced Model based VTS to an IBM 3590 Base Model based VTS. This method requires close cooperation between the customer and the responsible IBM Service Representative during the planning and execution of the physical cartridge movement.
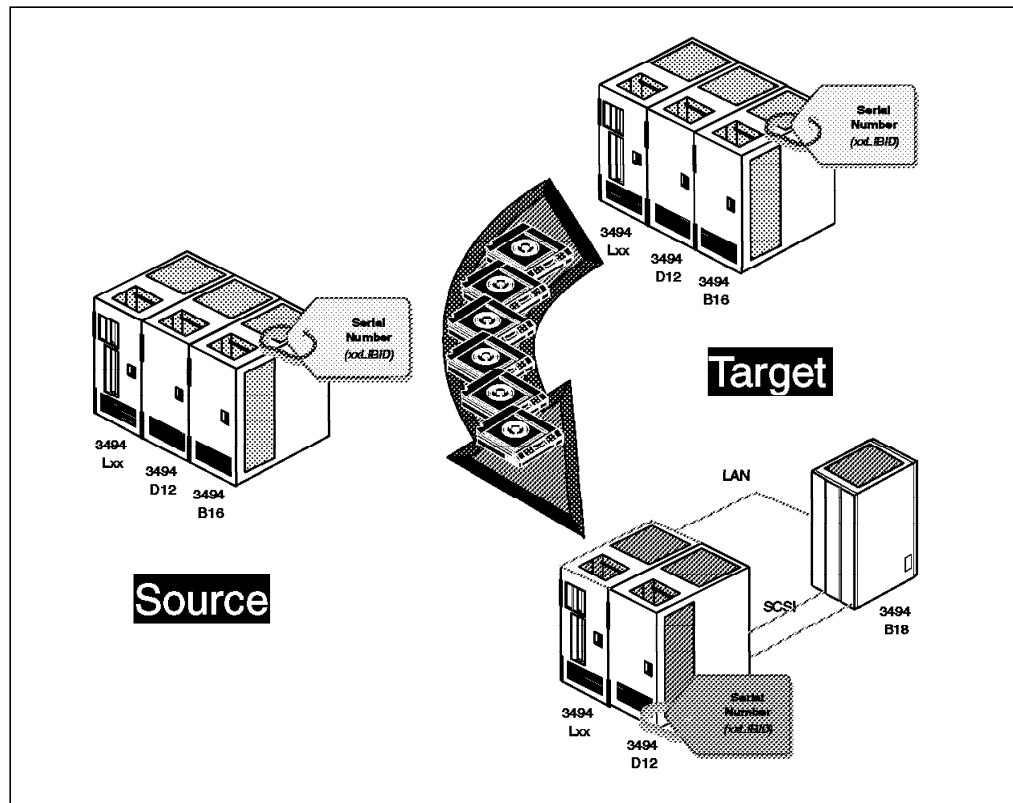
Figure 46. Physical Cartridge Movement

The steps to be executed are:

- Install a target Virtual Tape Server, e.g. an IBM 3494 Model B18

  - At least one IBM 3494-D12, and one IBM 3494-B18 frame, when the Target VTS is installed in a new IBM 3494 ATL one IBM 3494-L1x Control Unit frame is needed as well

  - Define the HCD definitions for the new library

  - Define the new library through ISMF

  - Define or update SMS constructs for the new 'logical' library, especially storage groups

  - Prepare ACS routine changes

  - If applicable, update JES3 definitions

  - Vary the new IBM 3494-B18 VTS online

  The subsequent tasks are done by the IBM service representative using specialized tools.

- Move the content of the Source VTS to the Target VTS

  - Initialize concurrent force migrate to drain the TVC of the Source VTS

  - Vary the Source VTS offline

  - Copy all TVC resident logical volumes to stacked cartridges using Force Migrate function.

  - Copy TVC fragments and VTS database to service cartridge (3590)

  - Copy Library Manager database to diskette

  - Move stacked cartridges to IBM 3494-B18

    This might involve physical transportation of data if the new VTS is in a different location. The duration and difficulty of this step should not be underestimated.

  - Make sure the Target IBM 3494-B18 is empty and load stacked cartridges

  - Update the Library Manager database with entries from the Source VTS

  - Restore the VTS database and the TVC fragments

  - Reinventory the library for physical cartridges, keeping the logical volumes

  - Vary the Target IBM 3494-B18 online

  - Update TCDB and tape management system CDS regarding location of the logical volumes if needed.

- Redirect the workload to the Target IBM 3494-B18 library, using nondisruptive adjustments in the DFSMS ACS routines and constructs

6.8 VM/VSE Considerations

In this section we discuss the considerations for using the VTS in a native VM environment through DFSMS/VM and in a VSE/ESA environment as a VM/ESA guest.

6.8.1 VM/ESA Native Support Using DFSMS/VM

DFSMS/VM Function Level 221 (FL221) is the only way for a VM/ESA system to communicate with a VTS subsystem.

RMS function of DFSMS/VM provides VTS support in VM/ESA environments at Version 1 Release 2 and all higher levels, as described in Section 3.5.4, "VM/ESA" on page 89.

Figure 47 shows the VM/ESA native support for the VTS subsystem.
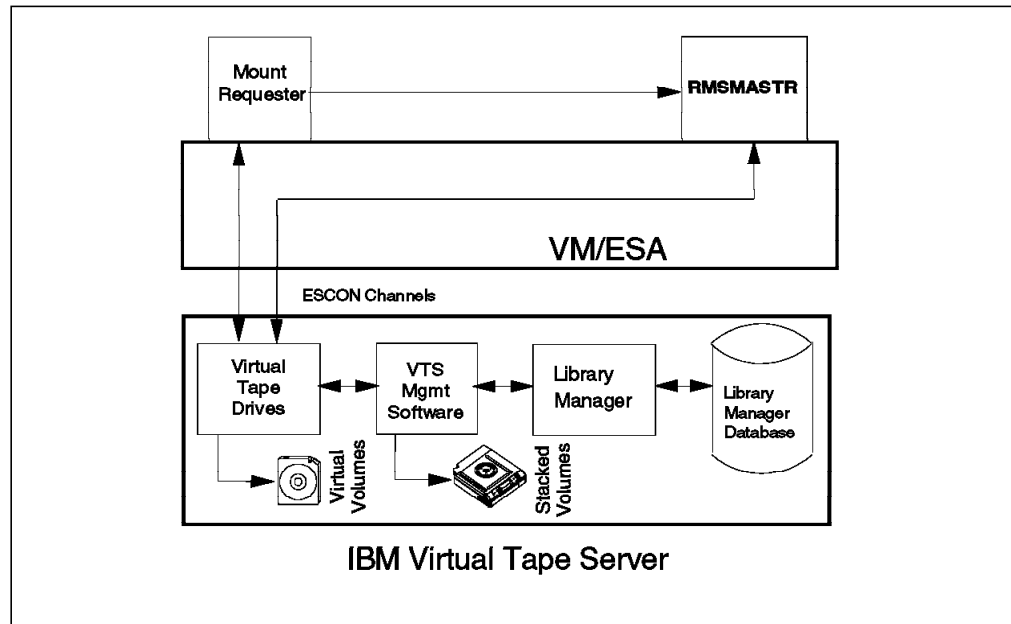
Figure 47. VTS in a Native VM/ESA Environment Using DFSMS/VM

When you use the VTS subsystem in a VM environment, consider that many VM applications or system utilities use specific mounts for scratch volumes, so every time a mount request is issued from the host, VTS has to recall the requested logical volume from the stacked cartridge if it is not already in the TVC. This can lead to performance degradation when writing data in a VM environment. In addition, VM backups usually require offsite movement, so the VTS is not the best candidate for this data.

6.8.2 VSE/ESA As a VM/ESA Guest Using a VSE Guest Server

When a VSE/ESA guest machine uses a tape drive in the VTS subsystem, the virtual tape drive must be attached to that machine and the virtual tape volume must be mounted on the drive. Because as a virtual machine VSE/ESA cannot communicate with the Library Manager to request a tape mount, RMSMASTR (a VM/ESA machine) must attach the tape drive and mount the volume. VSE/ESA cannot use RMSMASTR directly, however, because RMS functions run only in (CMS) mode.

Therefore some VSE/ESA guest scenarios use the CMS service machine, called the VSE Guest Server (VGS), to communicate with RMSMASTR. VGS uses the standard facilities of RMS to interact with the Magstar 3494 Tape Library and the virtual drives of the VTS subsystem. In Figure 48 on page 159, you can see the flow and connections of a VTS subsystem in a VSE/ESA environment under VM.
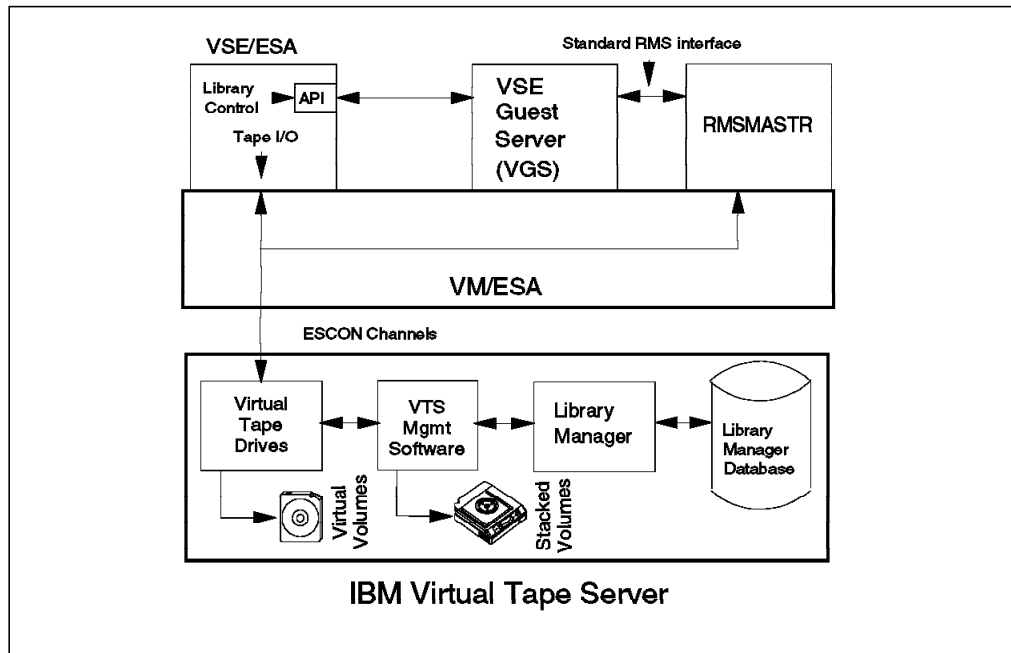
Figure 48. VTS in a VSE/ESA Environment As a VM Guest

Some vendor tape management support scenarios do not use VGS. Figure 49 shows the case of CA-DYNAM/T VSE.
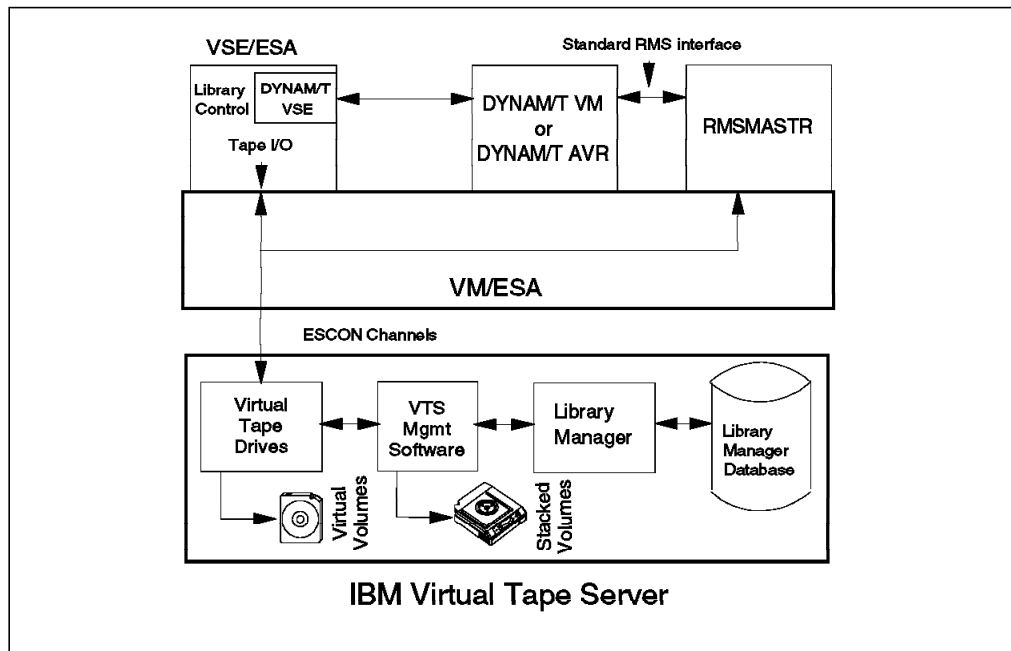
Figure 49. VTS in a VSE/ESA Environment As a VM Guest (No VGS)

VSE uses OEM tape management products that support scratch mounts, so if you are using VSE under VM, you have the benefit of using the fast-ready attribute for the VSE Library Manager scratch category.

6.9 Summary

The VTS is an excellent choice for storing most tape data, with the possibility to handle offsite backups and interchange data that need to be taken out of the library using the Advanced Function feature. The VTS utilizes cartridge capacity fully, is easy to use, enables you to run more concurrent tape applications, and in many cases offers very fast mount times by eliminating physical mounts entirely.

Native tape drives, particularly Magstar 3590 drives, or a TMM implementation may in some cases offer advantages over the VTS. Remember, however, that directing tape data to different media on a selective basis requires more tuning effort from the storage administrator than an "all-in-VTS" solution. If you have native tapes drives or have implemented TMM and want to keep using them for storing part of your tape data, consider the following points when you decide when to use each:

- The VTS can be used for any sequential data. You have to evaluate placing data that needs to be taken out of the library, such as offsite backups and interchange data on the VTS. Make sure that the time requirements meet your needs. A second VTS at the offsite location may also be used for offsite copies. The maximum ESCON distance of the VTS is 43 km.

- The VTS offers better response times for scratch mounts than native tapes. Write-intensive functions, such as backup and dump, benefit particularly from fast VTS scratch mounts.

- The VTS offers better response times for private mounts than native tapes, provided the referenced volume resides in the VTS TVC. Intermediate data sets that are used by several jobs or job steps in succession benefit from this and are good candidates for the VTS.

- Applications that require very high tape bandwidth and fill up the Magstar cartridge may be more effective if kept on native IBM 3590 drives that offer higher megabytes/second throughput rates than the VTS.

- With VTS, we recommend that you write only one data set per volume if you are not going to use all the data sets on the volume at once. When you have more than one data set on a logical volume, the VTS recalls the whole volume in the tape volume cache even if you need only one of the data sets. This lengthens mount times and fills the tape volume cache unnecessarily.

- Small data sets, when stored one per logical volume, quickly increase the number of logical volumes you have to insert in the VTS. This increases the number of entries in the Library Manager database, in the VTS database, in your tape management system catalog, and in the SMS volume catalog. If you have already implemented TMM, you will need to evaluate the costs of managing these small data sets in the VTS. The maximum of 150,000 logical volumes per VTS or 300,000 logical volumes per IBM 3494 Tape Library will have to be taken into consideration also.

- To protect your data against media failures, do not store a data set and its backup in the same VTS because you have no control over which logical volumes end up on which stacked volumes. For example, a data set on a DFSMShsm ML2 volume and its backup on an DFSMShsm backup volume may end up on the same stacked volume.

- If you regularly need to append a data set daily, native tape drives may offer better performance, because a logical volume has to be recalled into the

TVC before it can be appended. This will, of course, depend on the size of your TVC and the activity that has taken place since the last append.

- As a general rule we recommend that you use ECCST emulated logical volumes, so that you can maximize the storage capability of your VTS. Remember that you do not waste stacked volume capacity if not writing a logical volume full.

- Use of small logical volumes improves recall performance. Functions that can benefit from small logical volumes are, DFSMShsm RECALL, Tivoli Storage Manager RESTORE, and OAM object RETRIEVE. Remember, each of these products provides a command or parameter that enables you to limit the amount of data that they write on tape volumes; you can thus achieve the performance of CST emulated volumes even when using ECCST emulated volumes.

- Some functions restrict the media type you can use. For example, DFSMShsm TAPECOPY requires that the input and output volumes are of the same media type. Thus your physical cartridges may dictate the VTS logical volume type you can use.

Table 25 summarizes our considerations regarding placement of different types of tape data sets. When VTS is not an obvious first choice, we indicate an alternative.

Table 25 (Page 1 of 3). Tape Data Placement		
Data Type	**Device**	**Comments**
Batch		
Small data sets	1. VTS 2. TMM	Prefer VTS for small data sets as long as the number of logical volumes is not a constraint. Each VTS can have a maximum of 150,000 logical volumes. TMM is also a possibility especially if you are already using it.
Medium and large data sets	1. VTS	These go well in the VTS. VTS does not waste cartridge capacity like native 3590 and requires less cartridge shelf space in the library than native 3490.
Very large data sets	1. 3590 2. VTS	Native 3590 offers better performance for very large batch data sets. Use 3590 if you can do it without wasting too much cartridge capacity.
Intermediate data sets	1. VTS	The VTS is well suited for data sets that pass information from one job or job step to the next. With the VTS, you avoid mount delays if the data set is referenced before it is deleted from the VTS TVC.
DFSMSdss		
Physical dumps	1. 3590 2. VTS	Prefer native Magstar drives for performance reasons. Concurrent full-volume physical dumps with OPT(4) quickly use more bandwidth than a VTS can offer. VTS may be an option for physical dumps without OPT(4). You need to design your jobs so as to stack multiple dumps on one volume to utilize 3590 cartridge capacity.

Table 25 (Page 2 of 3). Tape Data Placement		
Data Type	**Device**	**Comments**
Logical dumps	1. VTS	VTS is good for logical dumps which require less bandwidth than physical dumps. With VTS it is easy to utilize cartridge capacity. You also benefit from fast virtual scratch mounts.
DFSMShsm		
ML2	1. 3590 2. VTS	DFSMShsm can use the full capacity of native 3590. Recalls from 3590 are generally faster.
Backup	1. VTS	Although recovery from native 3590 is generally faster, it is less of a concern because you should only seldom need to recover backups. By using the VTS, you can benefit from fast scratch mounts during backup.
CDS backup	1. VTS 2. TMM	With the VTS you can benefit from fast scratch mounts. If you are already utilizing TMM, you may want to keep them in TMM.
Volume dumps	1. 3590 2. VTS	With the prerequisite DFSMS/MVS maintenance, DFSMShsm can stack multiple dumps on one volume. APAR OW27973 allows you to add this functionality. With the VTS you can also stack many dumps on one physical cartridge. You also benefit from fast scratch mounts.
ABARS	1. Offsite	Typically needs to go offsite
Tape copy	1. Offsite	Typically needs to go offsite
Tivoli Storage Manager		
Tape storage pools	1. 3590 2. VTS	Tivoli Storage Manager can use the full capacity of native 3590. Restores from 3590 are generally faster.
Storage pool backups, incremental	1. VTS	Good for VTS use. You benefit from fast scratch mounts and can fully use cartridge capacity. If the primary storage pool is on native 3590, the backup cannot end up on the same volume as the primary data.
Storage pool backups, full	1. Offsite 2. VTS	Often need to go offsite.
Database backups, incremental	1. VTS 2. TMM	These are typically small, so they should work fine in the VTS. Could stay in TMM if you already are utilizing it.
Database backups, full	1. Offsite 2. VTS	Good for the VTS, if backup must go offsite, use Advanced Function feature. The VTS does not waste cartridge capacity, as native tapes do, and gives you fast scratch mounts.
OAM Objects		
OBJECT storage groups	1. 3590 2. VTS	OAM can use the full capacity of native 3590. Retrieval from 3590 is generally faster.

Table 25 (Page 3 of 3). Tape Data Placement		
Data Type	**Device**	**Comments**
OBJECT BACKUP storage groups	1. Offsite 2. VTS	Often need to go offsite. When the primary object is on native 3590, there is no danger that it and its backup will end up on the same physical volume.
Database Systems		
Archive logs and journals	1. VTS	These go well in the VTS. You benefit from fast scratch mounts.
Dual archive logs and journals	1. Offsite	These typically go offsite.
Local image copies, incremental	1. VTS 2. TMM	The VTS should be fine for these data sets. TMM should work if you are already utilizing it.
Local image copies, full	1. VTS	The VTS good here.
Note: The Device column indicates the primary, and optionally a secondary, recommendation for storing the data type. The key to the Device column is: **VTS** Use VTS. **3590** Use native 3590 drives, if available. **TMM** Refers generally to an implementation where data is initially written on DASD and later migrated to tape with DFSMShsm. **Offsite** Use preferably native 3590 or 3490 drives (stand-alone or in the 3494), use a VTS at the remote site, if available, or use the Advanced Function feature Import/Export component.		

Chapter 7. Operating the VTS

In this chapter we describe operational considerations unique to the IBM
Magstar Virtual Tape Server. For general guidance on how to operate a Magstar
3494 Tape Library, refer to the *Magstar 3494 Tape Library Operator Guide*,
GA32-0280, and *IBM Magstar Tape Products Family: A Practical Guide*,
SG24-4632.

We first summarize the key concepts and components you need to understand to
successfully operate a VTS. Refer to Chapter 1, "Introducing the IBM Magstar
Virtual Tape Server" on page 1 for more details.

Virtual Devices

The VTS subsystem looks to the host system like two or four IBM 3490E tape
subsystems, each with 16 drives and associated tapes. Each of the devices,
called *virtual drives*, shows the functional characteristics of an IBM 3490E tape
drive; it looks to the host like a physical 3490E drive. For example, a virtual
drive has a host device address, processes all 3490E tape commands, and can
be brought online and offline to the host.

Some 3490E operations, such as a media failure, are handled differently on a
virtual device. We discuss their impact on operations in this chapter.

Virtual and Logical Volumes

The volumes accessed by the host software are called *virtual volumes*. Virtual
volumes are stored in the VTS in a disk buffer called the *tape volume cache*, and
show the functional characteristics of a cartridge system tape (CST) or an
enhanced capacity cartridge system tape (ECCST). For example, a virtual
volume has a unique volume serial number (volser) known to the host and is
loaded and unloaded on a virtual drive.

When a virtual volume is moved from the tape volume cache to a physical
cartridge, it becomes what is called a *logical volume*. A virtual volume cannot
be physically removed from the tape library in which it was created, because it
exists only in the disk buffer. Even when a virtual volume becomes a logical
volume, it still cannot be removed using the traditional EJECT method. This is
because the logical volume is placed on the physical cartridge with many other
logical volumes. The logical volume can, however, be moved using one of the
methods described in 6.6.6, "Moving Data out of VTS" on page 153.

Stacked Volumes

The VTS uses physical Magstar 3590 cartridges for storing logical volumes. We
call them *stacked volumes*. Stacked volumes are under the exclusive control of
the VTS subsystem. The host operating system has no knowledge of stacked
volumes.

Stacked volumes are assigned to a specific VTS subsystem and must remain in
the Magstar 3494 Tape Library that contains the VTS. You cannot move data out
of a VTS by removing stacked volumes from the library; data on a stacked
volume is usable only within the VTS where it was created. The Library
Manager provides a function to eject a stacked volume from the library, but

during the eject processing the system copies all active data off the volume before it is ejected.

Magstar 3494 Tape Library

A VTS is always installed in a Magstar 3494 Tape Library, by itself, with a second VTS, or together with IBM 3490E or IBM 3590 tape drives that are not part of a VTS subsystem. To operate a VTS, you need to understand how to operate a Magstar 3494 Tape Library.

Library Manager

You perform the set of unique operational tasks associated with a VTS through the Magstar 3494 Library Manager console, is the primary operational interface to the VTS. The Library Manager has been enhanced with new functions and windows to support the VTS. The storage administrator and operator use the Library Manager Console to define the VTS environment, to initiate VTS functions, and to view VTS statistics. The VTS in turn reports its error and status conditions through the Library Manager, and the operator uses the Library Manager Console to determine required actions.

The Library Manager Console is located in the back of the 3494 Model L1x frame. This console can be used to respond to actions or initiate other actions. If you have ordered the Remote Library Manager Console feature you can control the Library Manager from the Remote Library Manager Console. For more information about ordering the Remote Library Manager Console feature, see 2.8.5.7, "Remote Library Manager Console (FC 5226)" on page 47. For more information about setting up the Remote Library Manager Console, talk to your IBM service representative. For information about operating and starting the Remote Library Manager Console, see the *Magstar 3494 Tape Library Operator Guide*, GA32-0280.

An additional possibility to monitor key Library Manager events is to use an SNMP monitor station and the SNMP trap facility. Refer to section 7.4.3, "Simple Network Management Protocol Traps" on page 170 for details.

Logical Libraries

When you install a VTS subsystem in a Magstar 3494 Tape Library that also has non-VTS tape subsystems, or a second VTS subsystem, the Library Manager logically splits the physical library into multiple logical libraries, one logical library for each VTS subsystem and a one logical library that contains the native tape drives that are not managed by a VTS. The system administrator defines each logical tape library to the host; each has its own library sequence number (Library ID) and name by which the host recognizes it. Each logical library looks to the host as if it were a separate IBM Magstar 3494 Tape Library.

When a Magstar 3494 Tape Library is split into multiple logical libraries, the Library Manager maintains up to three sets of category tables and keeps the stacked volumes and native volumes separate. Each logical library has its full set of Library Manager volume categories, which can overlap. Physical volumes are dedicated for use in a specific logical library only.

7.1 Powering on the VTS

The VTS is powered on as part of the Magstar 3494 Tape Library power-on sequence. The Unit Emergency switch on the 3494 model B18 must be set to the ON position.

Once the VTS has been powered on, ensure that all virtual drives are varied online to the appropriate host.

7.2 Powering Off the VTS

The VTS is powered off as part of the Magstar 3494 Tape Library power-off sequence. You should not power off a VTS independent of the rest of the Magstar 3494 Tape Library where it resides by using the B18 Unit Emergency Switch.

Ensure that all virtual devices are varied offline from the host before you power off the tape library that contains a VTS. Please note that the VTS will not go offline if there is a *Reclamation* task currently active. Please make sure you *Inhibit Reclamation* processing at least three hours before you are planning to power down the VTS. See 3.4.7, "Define Management Policies" on page 77

In a library with a VTS, the system can take up to 20 minutes to shut down. When the shutdown completes, the 3494 (including the B18, if installed) is powered off.

To service the VTS, the IBM service representative can take a VTS offline from the Library Manager and shutdown and restart the VTS controller independent of the rest of the Magstar 3494 Tape Library by using the Library Manager's Service Mode menus.

Attention: Using the Unit Emergency switch for immediate power off can cause database problems or check disk (CHKDSK) problems with the Library Manager or VTS controller. The 3494-B18 VTS will not be powered off by the 3494 Unit Emergency switch, but the associated tape drives will have power removed.

7.3 Operational States and Modes

The installation of the VTS does not bring any changes to the operational modes and states of the Magstar 3494 Tape Library. For a detailed explanation of the modes and states, refer to the *Magstar 3494 Tape Library Operator's Guide*

The modes are:

> Auto
> Pause
> Manual

The operational states are:

> Library manager initialization
> Initialization complete
> Online
> Offline
> Shutdown pending

Library manager switchover in progress (only the IBM 3494 with Model HA1 installed)
Accessor switchover in progress (only the IBM 3494 with Model HA1 installed)
Dual active accessor enabled/disabled (only the IBM 3494 with dual active accessor feature)
Dual active accessor transitioning (only the IBM 3494 with dual active accessor feature)

While an Import/Export operation is performed at the VTS, an attempt to vary the library offline will be ignored (Figure 50):
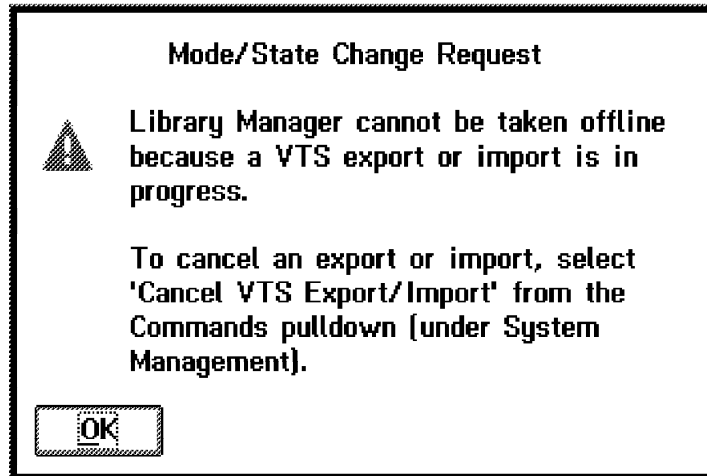
Figure 50. Mode/State Change Request Warning

The informational states are:

Degraded operation
Safety interlocks open
Bar code or vision system not operational
Intervention required
Library manager check-1 condition
All storage cells full
Out of cleaner volumes
Dual write disabled
Dual library manager status (only the IBM 3494 with Model HA1 installed)
Accessor status (only the IBM 3494 with Model HA1 installed)

The modes and states apply to the Magstar 3494 Tape Library as a whole; you cannot set the mode or state of logical libraries independent of each other.

Note in particular that the Manual mode is supported by the VTS. In Manual mode the Library Manager console provides the necessary information for the operator to manually mount stacked volumes to satisfy mount requests from the VTS controller.

A Magstar 3494 Tape Library with a VTS subsystem can operate in either fixed home cell mode or floating home cell mode. For the floating home cell mode, the dual gripper feature (FC 5215) or the dual active accessor feature (FC 5050) has to be installed.

7.4 Conditions That Require Intervention

The existing intervention-required facility of the Library Manager is used to report error and status conditions specific to the VTS subsystem and to indicate that assistance is required. When the Library Manager determines that an error or exception condition has occurred within the library that requires operator assistance to correct, it performs the following actions:

1. Adds the condition detected to the list of outstanding operator intervention required conditions maintained by the Library Manager

2. If not previously in the intervention required state, places the library in that state and notifies all attached hosts of the state change.

The Library Manager notifies all attached hosts of an intervention-required condition in a Magstar 3494 Tape Library regardless of which logical library (VTS or non-VTS) generated the intervention.

The Library Manager keeps track of the outstanding intervention required conditions. The operator can display the associated intervention required messages in the Operator Intervention window on the Library Manager console (Figure 51) and on the host consoles (refer to 7.4.1.1, "Messaging Enhancements" on page 170) and can subsequently indicate which conditions have been resolved. To display the messages, and to determine the cause of an intervention required condition and the steps required for its resolution, select **Operator Intervention** from the **Commands** pull-down menu.
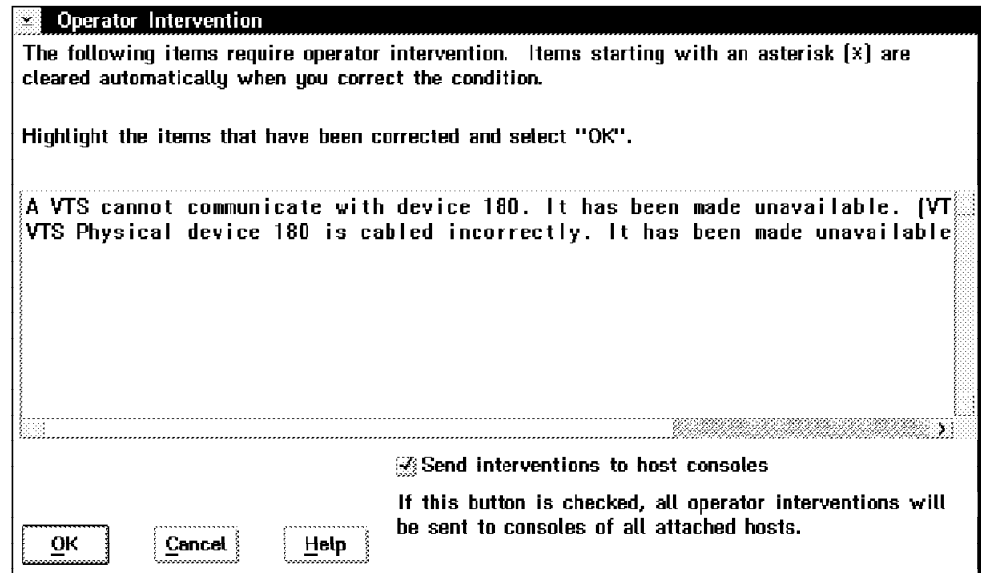
Figure 51. Library Manager Operator Intervention Window

The notification that the Magstar 3494 Tape Library is in the intervention required state will generate the following host console message for libraries managed under the DFSMS/MVS managed tape environment:

CBR3762E Library <library-name> intervention required.

The message is retained on the console until all intervention required conditions have been cleared. When both logical libraries of a logically partitioned 3494 are connected to the host, the message is issued twice on the host console.

7.4.1 Intervention-Required Messages

Additional intervention required conditions with associated messages are generated when a VTS is included in a Magstar 3494 Tape Library. These are of two types:

- Conditions detected by the Library Manager during normal (non-failure) VTS operations that require operator action. An example is when the total effective storage space of the stacked volumes in the library falls below a threshold set by the system administrator.

- Errors and failures detected within the VTS subsystem, including its TVC, managed 3590 volumes, and Magstar 3590 tape drives.

7.4.1.1 Messaging Enhancements

If ″**Send Interventions to Host Console**″ is enabled on the Operator Intervention screen (as shown on Figure 51 on page 169), a broadcast message of the operator intervention text is sent to all attached hosts. For libraries managed under the DFSMS/MVS system managed tape environment, this results in the following message being displayed at the host console:

CBR3750I Message from Library *Library-name: message*

The Intervention Message text is truncated at 70 characters.

7.4.1.2 Prerequisites

With the Library Manager code for the advanced functions of VTS you get the support for the extended messaging function as well. The advanced function option is supported on S/390 systems with the appropriate software support as described in 2.5, "Software Requirements" on page 32.

If you want to exploit the new messaging functionality but you don't want to change the current software level running your S/390 system, install LM521.08 on your library manager. This code level contains the messaging improvements only.

See the *Magstar 3494 Tape Library Operator Guide*, GA32-0280 for a summary of intervention-required messages relating to VTS in general and the Advanced Function feature specifically.

7.4.2 SIMS

When the MVS maintenance listed in 2.5, "Software Requirements" on page 32 is on the system, the VTS generates SIMS. Message IEA480E is generated for supported hardware problems and lists the severity of the problem. The possible types are ACUTE, SERIOUS, MODERATE, or SERVICE. ACUTE is the most severe and SERVICE is the least severe. Contact your IBM service representative when you receive one of these messages.

7.4.3 Simple Network Management Protocol Traps

In this section we discuss the Library Manager and how it supports SNMP. If you need more information about SNMP, consult *Magstar 3494 Tape Library Operator Guide*, GA32-0280.

If you decide to take advantage of the IBM 3494's ability to send SNMP traps, you will need to have connectivity to a LAN through either the Token Ring Adapter (FC 5219) or the Ethernet Adapter (FC 5220) feature.

Along with these features you need to have an SNMP monitoring stations capable of processing the traps sent by the IBM 3494. The IBM 3494 will send the traps to a maximum of five of these stations. The SNMP monitoring stationss and the various software components needed to capture the traps are standard and are available from IBM and other vendors. Selection of the SNMP monitoring stations hardware and software is not covered in this book. Figure 52 shows one possible way of configuring two IBM 3494s with two SNMP monitoring stations.
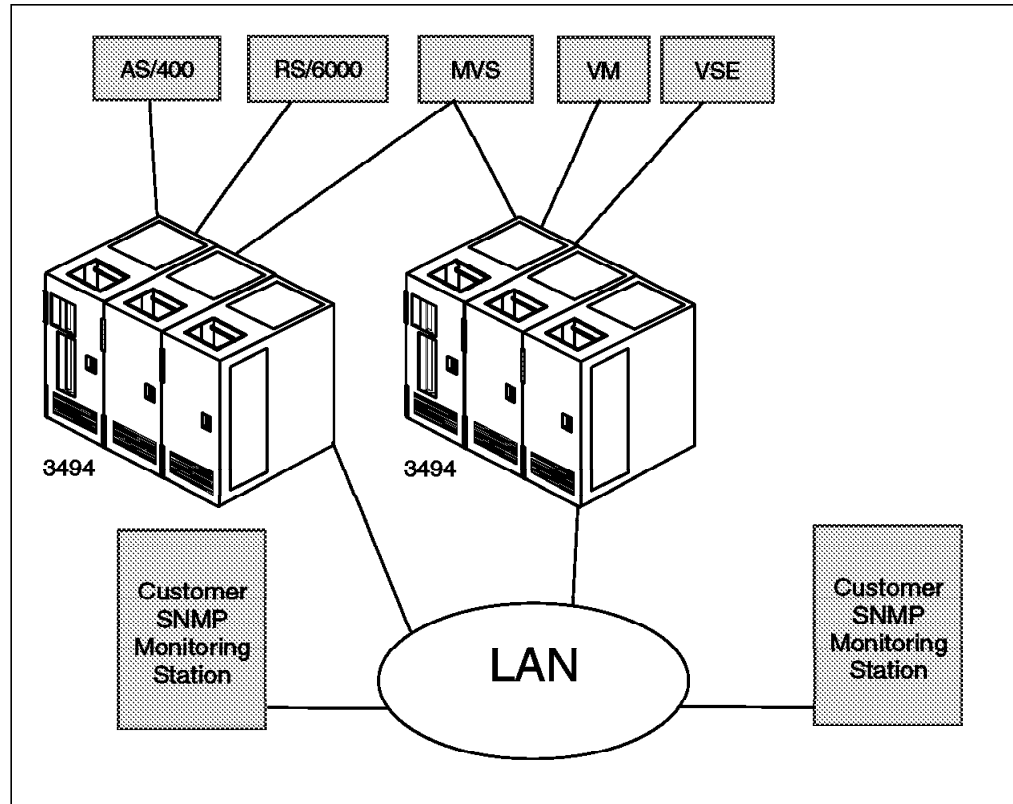
Figure 52. SNMP Configuration Diagram

The IBM 3494 offers limited SNMP support and does not contain any SNMP Management Information Base support. When certain events occur on the IBM 3494, an SNMP trap message is sent out. The following IBM 3494 events are currently defined:

- OPINT - Operator Interventions. These events inform the SNMP monitoring stations of the state of the IBM 3494. They can signify problems and also signal a need for a service call. The OPINT messages are listed in the OPINT message table in the *Magstar 3494 Tape Library Operator Guide*, GA32-0280. These traps should be selected as they are very useful for monitoring the IBM 3494.

- UNSOL - Unsolicited Attention Messages. These events offer additional information but are not as useful as OPINT events. They can signify drive availability and volume movement, among other activities. To send the messages, the IBM 3494 must be online and at least one host must be active. The UNSOL messages are listed in the UNSOL message table in the *Magstar 3494 Tape Library Operator Guide*, GA32-0280.

- SERVC - Service Request Messages. These messages are not currently supported.

- CHCK1 - Library Manager Check1 Conditions. These events are posted when the IBM 3494 has a problem that requires reinitialization.

- TESTM - Test SNMP Trap Messages. These events are used to test the ability of the SNMP monitoring stations to receive SNMP traps. They are used to setup the SNMP environment.

7.4.3.1 Selecting SNMP Traps

The first thing you do to set up SNMP is to select the types of traps you would like the IBM 3494 to generate. To set the types, select **commands** from the main menu and then **SNMP Options** to display the SNMP Trap Types window (Figure 53). Select the traps that you would like generated and select **OK** when finished.

Figure 53. SNMP Select Trap Types Window

7.4.3.2 Configuring SNMP Trap Destinations

After the trap types have been selected, you have to specify where the IBM 3494 will send the traps. Select **SNMP Options** from the **Commands** pull-down menu, and then select **Change SNMP Trap Destinations**. You will now see the window shown in Figure 54 on page 173.

Note: If the IBM 3494 is an HA1, the standby Library Manager does not need to be configured for SNMP. The active Library Manager will configure the standby Library Manager when it becomes active. The standby Library Manager will not send SNMP traps while it is in standby mode.

The SNMP Trap Destinations window is displayed by the HRMCNFIG external process. Once it is displayed select the **trap destination** radio button. Selecting this button causes the Network Mask field to be grayed out because it will not be used. Now for each SNMP monitoring stations, select **UDP** in the Protocol field and enter the SNMP monitoring stations name and address. After typing in all this information, select **Add**. After all you have added SNMP monitoring stations, **OK**.

Note: The HRMCNFIG process is external to the IBM 3494. SNMP support will not be enabled until the process completes. When you see that **Change SNMP trap destinations** is selectable (not grayed out), the process is complete, and you can use the SNMP features.

You highlight the SNMP trap destination in the list box when you need to delete it. Then select the **Delete** push button and select **OK**. The SNMP trap

destination will be deleted as soon as **Change SNMP trap destinations** is selectable (not grayed out).
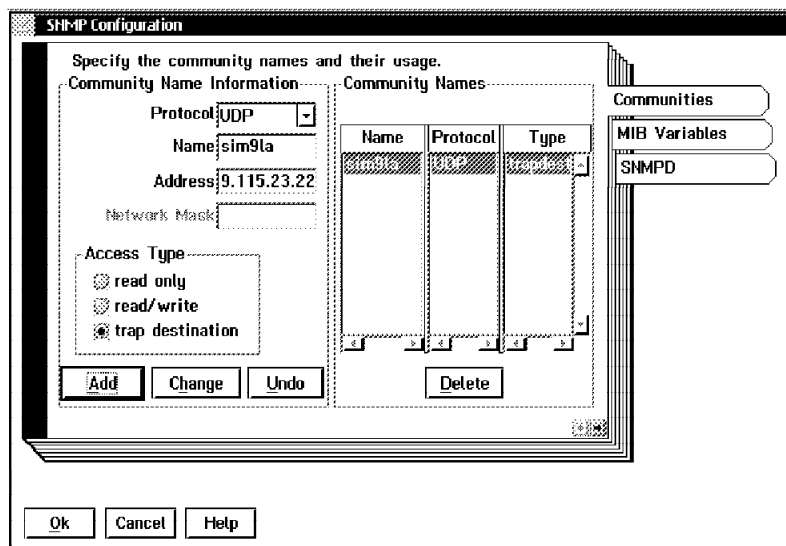
Figure 54. SNMP Trap Destinations Window

7.4.3.3 Starting SNMP

After you have selected the trap types and configured the destinations, you have to enable the Library Manager SNMP support. Select **Start SNMP** from the SNMP Options window. To ensure that the SNMP daemon has started press the Control and Escape (Ctrl+Esc) keys simultaneously to bring up a list of the windows. If the SNMP daemon has started, SNMPD will be listed.

7.4.3.4 Stopping SNMP

To disable SNMP support, select **Stop SNMP** in the SNMP Options window. The Library Manager will not generate SNMP traps until you start up SNMP again.

7.4.3.5 Sending TESTM Trap Messages

You can verify that the Library Manager is set up correctly by sending an SNMP TESTM trap. This will send a test message to every SNMP monitoring stations that has been configured. Select **Send TESTM Trap** from the SNMP Options window. You are presented with a dialog box where you can type in a text string. After you type in the test text string and select the **Send** button, the message will be sent to all SNMP monitoring stations.

The most common problems encountered with SNMP messages are in the network area. You can confirm that the network is working by sending a test message.

7.5 Defining Volser Ranges for Stacked Volumes

Stacked volumes must be defined to the Library Manager before you can insert them in the Magstar 3494 Tape Library. Library Manager volser ranges are used for this purpose. A range definition associates a range of volsers and tape media with a logical library; when a cartridge is inserted in the Magstar 3494 Tape Library, the Library Manager checks the range definitions to see to which

logical library the volume is assigned. If a volume does not fall in any existing volser range, it is assigned to the non-VTS logical library, if such exists.

We recommend that you fully define your volser ranges during VTS installation even if you do not initially insert all the volumes in the library. No penalty is associated with defining long volser ranges, but such definition enables you to quickly insert new cartridges when needed, without having to first define volser ranges. It also ensures that you cannot inadvertently insert logical volumes that conflict with your planned ranges of stacked volumes. If needed, you can later add more ranges, up to a total of 50.

Volser range definitions are preserved during inventory operations and the Teach New Operation of the IBM 3494 library.

To define volser ranges, select **System management** from the **Commands** pull-down menu, then select **Volser range for media types** to display the Volser Ranges window (Figure 55). By using this window you can:

- Add, modify, and delete volser ranges.
- Check whether a volser belongs to a specified range.
- Query the number of volumes in the library that belong to a selected range.
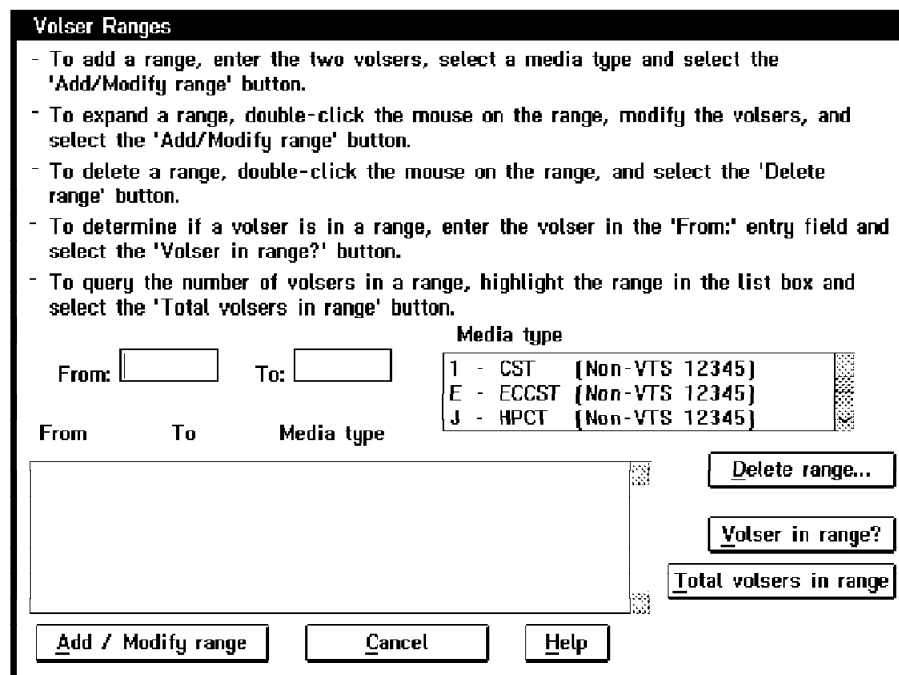
Figure 55. Library Manager Volser Ranges Window

To add a new range:

1. Enter the first and last volsers of the range in the From and To fields.
2. Highlight the desired media type of the range in the Media type list box. This must be J or K for a VTS entry.
3. Select **Add / Modify range**.

Volser range specification

Volser entry fields must contain six alphanumeric characters. The two volsers must be entered in the same format. Corresponding characters in each volser must be either alphabetic or numeric. For example, AAA998

and AAB004 are of the same form, whereas AA9998 and AAB004 are not. The range includes all volsers that fall between the two volsers (inclusive) in a collating sequence where alphabetic characters are incremented alphabetically and numeric characters are incremented numerically. For example, volser range ABC000 through ABD999 would include 2 000 volsers (ABC000 - ABC999 and ABD000 - ABD999).

Media type

The Media type list box contains the following entries:

```
1 - CST   (Non-VTS xxxxx)
E - ECCST (Non-VTS xxxxx)
J - HPCT  (Non-VTS xxxxx)
K - EHPCT (Non-VTS xxxxx)
J - HPCT  (VTS 1 yyyyy)
K - EHPCT (VTS 1 yyyyy)
J - HPCT  (VTS 2 zzzzz)
K - EHPCT (VTS 2 zzzzz)
```

where xxxxx, yyyyy, and zzzzz are the library sequence numbers. Only those options that correspond to an existing logical library in the IBM 3494 are available.

The entry you select defines the media type of the volser range and at the same time associates the range with a logical library.

When a volser range is added or modified, the Library Manager automatically combines overlapping ranges with the same media type and makes checks to ensure that the range does not conflict with existing volumes or volser ranges that are of different media type. If a conflict exists, the Library Manager rejects the add or change request. Note that from the Library Manager's point of view, VTS and non-VTS cartridges have a different media type.

To check whether a range contains volumes, highlight the range in the volser range list box and select **Total volsers in range**.

You can change the media type of a volser range definition by deleting the range and then redefining it, provided that no range conflicts exist.

Volser range definitions are required for stacked volumes but are optional for native library volumes. The volser ranges help the Library Manager to determine a physical volume's media type when it is inserted into the library. The Library Manager determines a volume's media type at insert time by using the following rules:

1. The media type returned by the vision system is used as a first choice.

2. If the media type returned is for a Magstar 3590 type cartridge and there is more than one logical library in the physical tape library, the volser ranges are used to determine to which logical library the volume is assigned.

3. The volser ranges are used to determine a volume's media type if it cannot be determined by the vision system. If the volume being inserted appears within one of the ranges, the range's associated media type is used. The search of the ranges is an inclusive search.

4. The system uses the default media type defined during the teaching process by the IBM customer service representative to determine the media type if the volser does not fall into one of the ranges.

5. The volume is ejected if there is no default media type.

Rules 4 and 5 do not apply to stacked volumes because they always fall into a range.

7.6 Deleting Volser Ranges for Stacked Volumes

The Library Manager lets you delete a volser range definition at any time regardless of whether the range contains volumes or not. The range definition is only used at cartridge insert time to define a volume's media type and to assign the volume to a logical library.

We recommend that you not delete volser ranges that contain volumes. Deleting a volser range does not have any immediate effect on volumes that are in the range; the volumes remain in the same logical library as before. However, if a complete reinventory of the Magstar 3494 Tape Library is required, all cartridges in the library are reassigned to logical libraries according to the volser range definitions that are in effect during the reinventory. If you have deleted a stacked volser range definition, all stacked volumes in that range are assigned to the non-VTS logical library and become unavailable to the VTS subsystem. There is also a potential for data loss, as the volumes could be assigned to a scratch category and subsequently used to satisfy scratch mounts on native Magstar drives. As a safeguard against this, we recommend that you use your tape management system to deny any use of stacked volumes on the host, as described in 6.4.2, "DFSMSrmm and Tape Management Systems" on page 135.

7.7 Tape Labels

Each stacked volume, like any other physical volume in a Magstar 3494 Tape Library, must have a unique external machine and operator-readable bar code label. The label identifies the volume to the Library Manager.

The only exception to this label requirement is when you use the **Insert Unlabeled Cartridges** function on the library manager **Commands** pull-down menu. However, we do not recommend that you insert volumes for the VTS by using this facility. If the external label on a volume becomes damaged, you can use this facility to reinsert the volume until its external label can be replaced. The Library Manager will eject from the library volumes that you insert using the Insert Unlabeled Tape function during any subsequent reinventory complete system or inventory new storage of the library.

Volsers of all volumes, including native, stacked, and logical, must be unique within a Magstar 3494 Tape Library. You have to use distinct volser ranges for the three volume types. Figure 56 on page 177 shows an example of possible volsers for the different volume ranges.
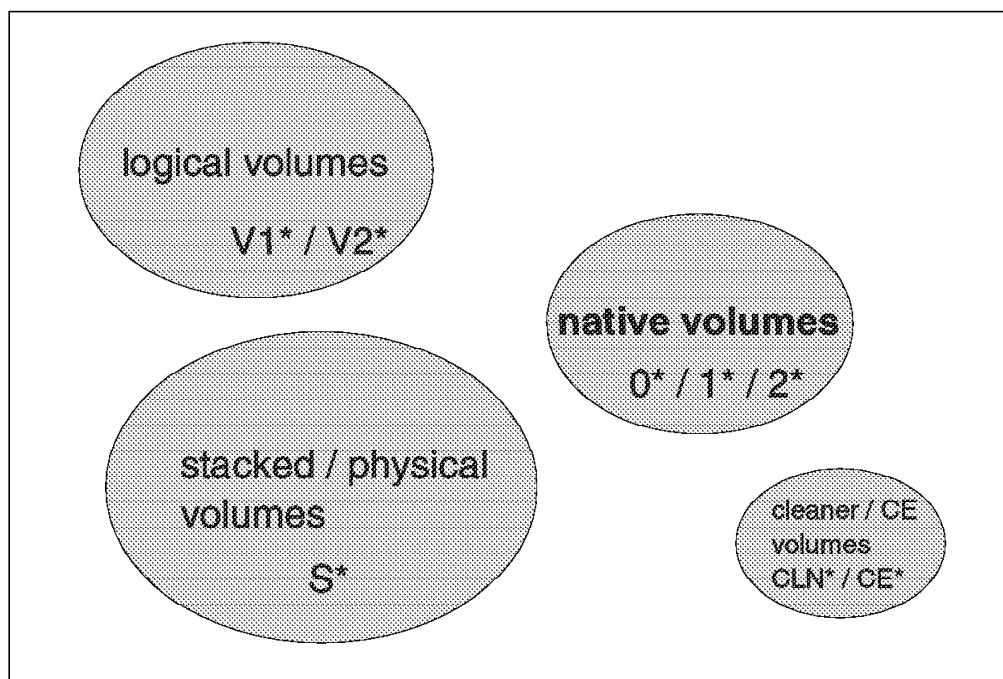
Figure 56. Unique Volumes Within Library and Within TCDBplex

Use the first characters of the volsers to indicate the volume′s type. It will help the operator to define volser ranges and insert logical volumes in the library and to distinguish native volumes from stacked volumes. To further help the operator, you can use different-colored labels for stacked and native volumes.

The media type of each volume in the library must be identified to the Library Manager. Typically, Magstar cartridges are delivered with an external seventh-character media-type label, in which case the Library Manager uses that as the volume′s media type. If not, the Library Manager uses the media type of the volser range in which the volume belongs. Because each stacked volume belongs to a volser range, it is not necessary for volumes to have a media-type label. However, we recommend that you use cartridges that have an external media type label.

7.8 Inserting Stacked Volumes in the VTS

The command

D SMS,LIBRARY(libname),DETAIL

has been enhanced (with the PTFs enabling Advanced Function feature) to list the numbers of scratch stacked cartridges:

```
┌─────────────────────────────────────────────────────────────────────────┐
│                                                                           │
│  CBR1110I OAM library status:                                             │
│  TAPE     LIB DEVICE    TOT ONL AVL TOTAL EMPTY SCRTCH  ON OP             │
│  LIBRARY  TYP TYPE      DRV DRV DRV SLOTS SLOTS  VOLS                     │
│  ATLBA035 VL  3494-L10   16   2   2   494    13  1743   Y  Y              │
│  ------------------------------------------------------------------       │
│  MEDIA       SCRATCH     SCRATCH                                           │
│  TYPE         COUNT     THRESHOLD                                          │
│  MEDIA1       1063          0                                              │
│  MEDIA2        680          0                                              │
│  ------------------------------------------------------------------       │
│  OPERATIONAL STATE:  AUTOMATED                                             │
│  ERROR CATEGORY SCRATCH COUNT:              0                             │
│  SCRATCH STACKED VOLUME COUNT:             79                             │
│  ------------------------------------------------------------------       │
│  Operator intervention required.                                          │
│  Convenience I/O station installed.                                       │
│  Convenience I/O station in Output mode.                                  │
│  Bulk input/output not configured.                                        │
│                                                                           │
└─────────────────────────────────────────────────────────────────────────┘
```

You can use this number or the Free Storage Threshold library manager definition (see 3.4.7, "Define Management Policies" on page 77) to find out if additional scratch stacked cartridges are needed.

When a physical volume is added to the tape library inventory, the Library Manager checks the volser to ensure that it is readable and is not already in the inventory. The convenience I/O station is in either *Import Mode* or *Insert Mode* depending on the capabilities of the VTS subsystems in the library and the configuration of the library.

The convenience I/O station is in Insert Mode if any of the following is true:

- There are no VTS subsystems in the library.
- There are no VTS subsystems in the library with the Advanced Function feature enabled.

The convenience I/O station is in Import Mode if the following is true:

- There is at least one VTS subsystems in the library with the Advanced Function feature enabled.

In the Import Mode, any 3590 J-type cartridge which is found in the convenience I/O station is moved into the library and assigned to the Unassigned category (FF16). An operator must then use a library manager panel (Figure 113 on page 278) to move an exported stacked volume into the Import category (FF14), to move a 3590 J-type cartridge into the Insert category for native 3590 use, for VTS Stacked Volume use, or to eject the cartridge.

Volumes assigned to the Insert category can then be handled using the panel in Figure 57 on page 179.

You insert stacked volumes in the VTS library in the same way you insert native cartridges, by using either the convenience input/output station, the high capacity input/output facility, or empty cells in the library.

When you insert a cartridge in the Magstar 3494 Tape Library, the Library Manager checks the volser range definitions and determines whether the volume should be assigned to a VTS logical library. If so, the Library Manager places

the volume in the VTS insert category (FF01) and notifies the corresponding VTS controller, which takes ownership of the volume and changes it to the appropriate stacked volume scratch category. The volume is dedicated for use in that VTS only; the Library Manager does not use it to satisfy mount requests for drives in the other logical libraries. Because the Library Manager does not place a stacked volume in the normal insert category (FF00) or notify the host that a cartridge was inserted, the host does not gain any knowledge of stacked volumes.

A library manager function is provided to manage the insert process. The Manage Insert Volumes panel (Figure 57) allows for actions to be taken for physical volumes that are in the insert category (FF00). The purpose of this panel is to allow unclaimed physical volumes to be ejected.

They could be unclaimed, because the library is a VTS-only library (no native 3590 drives) or the cartridge is a CST or ECCST cartridge, and the library manager volser ranges did not cover some volumes.
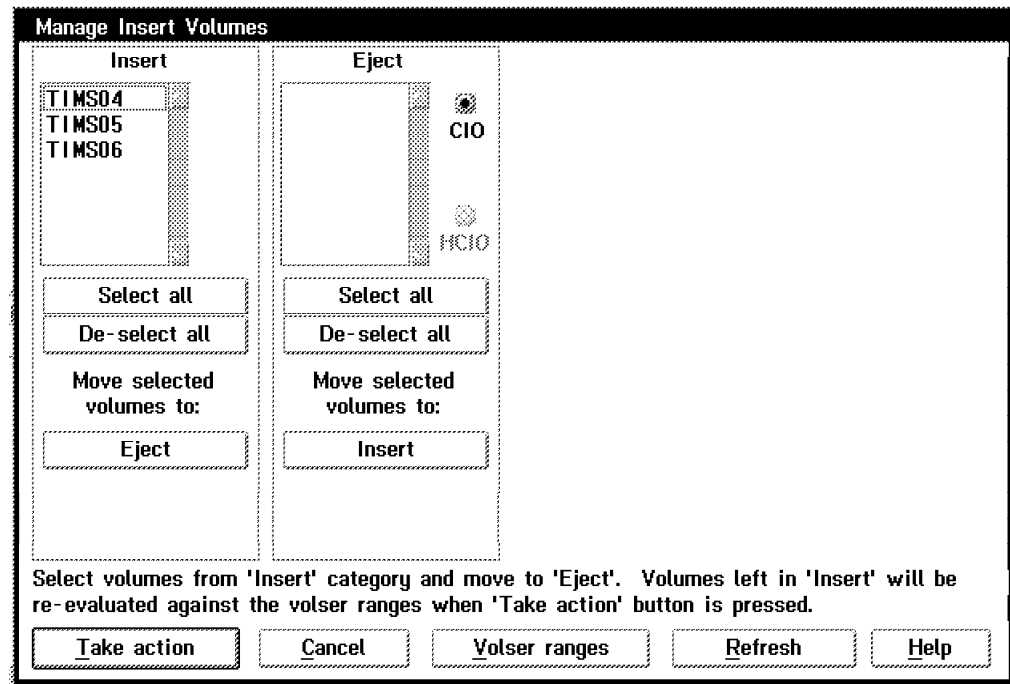
Figure 57. Manage Insert Volumes

The Library Manager makes checks to ensure that the volume you insert is not in the Magstar 3494 Tape Library as a physical (stacked or native) or logical volume and rejects the insert as a duplicate volume if it is.

You do not need to initialize stacked volumes. The VTS automatically checks a stacked volume for an internal volume label when the volume is used for the first time and labels it with an IBM standard label if there is no internal volume label. If there is an internal volume label and it does not match the volser expected, the Library Manager ejects the stacked volume to the convenience I/O station and notifies all attached hosts of an Intervention-required with this message:

```
A stacked volume has a label mismatch and has been ejected to the
convenience I/O station. Internal: xxxxxx, External: yyyyyy
```

Note that the VTS does not check the internal label at cartridge insert time but when the VTS tries to mount the stacked volume for the first time.

We recommend that you have at least 50 extra stacked volumes inserted because of the way reclaim processing works. If you have more than 50 scratch Magstar cartridges, reclaim will be enabled when it will be non-invasive to VTS activity and according to the inhibit reclaim schedule. See 3.4.6, "Reclamation and Reconciliation" on page 75 for more information about reclaim processing. When the number of empty stacked volumes falls below the number required for GB of data specified by the Free Storage Threshold on the Library Manager VTS Management Policies window (see 3.4.7, "Define Management Policies" on page 77), the Library Manager raises an intervention required condition indicating that:

Free storage threshold has been crossed.

To resolve the condition, insert more stacked volumes into the library. A subsequent reclamation process may also increase the number of empty stacked volumes but does not automatically clear the intervention required condition; the operator has to clear it manually. The condition does not trigger VTS space reclamation to start.

In a logically partitioned library, physical shelf space is not dedicated to the logical libraries; stacked volumes can reside anywhere on the library shelves among native volumes. Because stacked volumes are mounted only on the Magstar 3590 drives in the VTS, you can minimize accessor movement by having stacked volumes in cells close to the VTS drives. Having cartridges next to the 3590 drives where they can be mounted will also help the tape operator if he or she ever has to operate the library in Manual mode. To achieve this, insert stacked volumes manually in empty cells in the VTS frames or adjacent library frames.

Note: If your VTS is Import/Export capable, use care; an Exported Stacked Volume will become a VTS Scratch Stacked Volume using this process.

If your tape library operates in fixed home cell mode, the cartridges always stay in the cells where you initially inserted them. If your library operates in floating home cell mode, the cartridges will be placed where they optimize performance. They may gradually move around the library but generally tend to stay close to the VTS drives.

When you insert cartridges in empty cells in the library by opening the doors, you have to update the Library Manager inventory by selecting **Perform Inventory Update** from the **Commands** pull-down menu. If you have **Enable Inventory** Update selected in the **Commands** pull-down menu, frames are automatically inventoried when the doors are closed and the Library Manager is placed in Auto mode.

See 7.16, "Inventory Update" on page 198 on how to perform inventory update.

7.9 Ejecting Stacked Volumes from the VTS

Stacked volumes are dedicated to a specific VTS subsystem and must remain in the Magstar 3494 Tape Library that contains the VTS. You cannot move data out of a VTS by ejecting stacked volumes from the library; data on a stacked volume is usable only within the VTS where it was created. However, you may need to

eject stacked cartridges from a VTS for media or maintenance reasons. The VTS enables you to do that.

Notes:

1. The VTS provides a disaster recovery function that enables data on stacked volumes to be recovered on another VTS subsystem. See 10.3, "Disaster Recovery at Another Site" on page 297 for details.

2. The Advanced Function feature with the Import/Export component allows you to move logical volumes in and out of a VTS. The operations described here relate to ejecting stacked volumes, *not* exported stacked volumes as the stacked volumes holding logical volumes to be exported are called.

To eject a stacked volume, use the Library Manager **Commands** pull-down menu and select **System management** followed by **Eject a VTS stacked volume**. Specify the volser of the stacked volume on the **Eject A Stacked Volume** window (Figure 58).
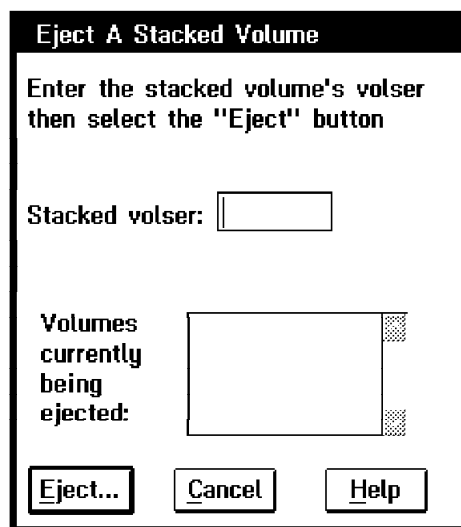
Figure 58. Library Manager Eject a Stacked Volume Window

When a stacked volume eject is initiated, the eject process of the VTS subsystem gets a list of all logical volumes on the stacked volume. Once it has the list, it recalls the active logical volumes into the TVC. After that, the logical volumes are placed on the copy queue. When all active data has been copied, the VTS requests the Library Manager to eject the volume.

You will want to schedule this ejection process during a low usage time for the VTS subsystem because each logical volume occupies space in the TVC that could have held other logical volumes. Although the wait should be minimal, there could also be a delay for host requests looking for logical volumes on the stacked volume being ejected. Be aware that this can be a time-consuming process as up to 60 GB user data (assuming a 3:1 compaction ratio) may have to be copied to other stacked volumes.

If you need to eject a volume for use outside the VTS, select an empty stacked volume; the ejection of an empty volume is a quick operation. To find out which stacked volumes are empty, use the Library Manager Search Database for Volumes window to display volumes in VTS stacked volume scratch categories FF02 and FF03. See 7.14.1, "Search Database for Volumes" on page 190.

You cannot eject a stacked volume from the tape library by using host system commands. For example, in a DFSMS/MVS-managed tape environment, IDCAMS command LIBRARY EJECT,volser against a stacked volume fails with this message because the tape configuration database does not contain a record for stacked volumes:

```
CBR1064I Command rejected. Volume serial number <volser> undefined
```

Do not manually remove a stacked volume from the Magstar 3494 Tape Library. Doing so will cause jobs to fail that try to access logical volumes resident on the stacked volume.

When the Library Manager cannot mount a stacked volume to satisfy a mount request from the VTS, it raises an intervention required condition indicating one of the following reasons:

```
Mount of logical volume xxxxxx on physical volume yyyyyy failed

Mount of logical volume xxxxxx failed because physical volume yyyyyy
is misplaced

Mount of logical volume xxxxxx failed because physical volume yyyyyy
is inaccessible

Mount of logical volume xxxxxx failed because physical volume yyyyyy
is not in the library
```

The VTS subsystem indicates to the host that the mount was completed. When the host issues the first I/O operation to the virtual device, the subsystem will fail the command and indicate an equipment check. The host will then fail the job and generate console messages. The only command that will actually do anything is the Rewind/Unload command.

For example, the following messages are generated as a result of a logical volume mount failure for volume V00001 on device 1FD5:

```
Mount Request
IEC501A M 1FD5,V00001,SL,NOCOMP,GENVTSP8,STEP4,VTS42.TEST74

Error Messages
IOS000I 1FD5,AD,EQC,**,0600,,**,,GENVTSP8613
 10488035000000206011(B310000102004113)0000(500007FF)CE3FD69000050500

IEC147I 613-54,IFG0194K,GENVTSP8,STEP4,SYSUT2,1FD5,OAM274 VTS42.TEST74
```

The IOS000I message reports that an equipment check was received for device 1FD5 and contains the sense data returned by the subsystem. When a logical volume recall fails, the volume is not available in the TVC. Sense byte 14 contains X′02′ which indicates this condition. The IEC147I message reports that the failure was detected as the tape volume was opened. The abend and return code (613-54) indicates that the volume serial number was unreadable, had no label, or the volume was uninitialized, however in a VTS it is also the indication that the recall failed. When a logical volume mount is failed in this way, the operator will need to review the intervention required conditions at the library and based on the intervention reported, take action prior to resubmitting the job. Use the **Find logical volume's home** function of the Library Manager to find out which stacked volume the logical volume resides on, then use the **Search database for volumes** function to determine the status of the stacked volume. See 7.14, "Querying the Library Manager Database" on page 190.

When the VTS determines that a stacked volume is damaged, it notifies the operator of the problem and does not write any more data on the stacked volume. VTS determines that a stacked volume is damaged if the volume gets a permanent I/O error on two different drives. See 10.2, "Failure and Recovery Scenarios" on page 290 for more details.

7.10 Selecting Logical Volume Serial Numbers

You need to give some thought to selecting the logical volume serial numbers that you use in the VTS. You will also want to keep in mind any local considerations for these ranges and any future growth.

If you are going to use (BLP) mounts outside the VTS, you can run into problems when using a volser range beginning with L (Lxxxxx). When you mount an NL or BLP scratch tape, an Lxxxxx volser is generated unless overridden by a tape management system or installation exit. If this Lxxxxx volser is later cataloged, it will conflict with any Lxxxxx volser that you have defined with the same xxxxx. You should avoid using the Lxxxxx volsers within the VTS.

Virtual volumes in the VTS subsystem are stored in two (216 and 432 GB TVC, assuming a 3:1 compression ratio with EHPO) or four (648 and 864 GB TVC, assuming a 3:1 compression ratio with EHPO) SSA disk arrays. The VTS subsystem runs two file systems for storing data in and retrieving data from the TVC. One file system is for even volume serial numbers and the other for odd volume serial numbers. Each of the two file systems maintains a pointer which designates the next volume (ordered by category orer number) to be selected for a mount from category (thus a non-specific mount). This assignment of odd or even volsers to a file system helps to balance workload and increase performance in conjunction with the method used by the Library Manager to select a volume from a category. At any given time when the Library Manager has the opportunity to make a volser selection, the number of odd volumes mounted is compared to the number of even volumes mounted, and an odd or even volser is selected for approaching a balance.

Note: You may have noted that the VTS supports alphabetic characters for the logical volume serial numbers. All logical volume numbers are converted to ASCII when referenced in the VTS. Whether or not the logical volume′s number is even or odd is then determined by whether or not bit 7 is on.

The Library Manager maintains an ordering by time for each volume entered into a category. When a logical volume is moved to a category, it is placed at the bottom of the ordered list, using the highest category order number. When a volume is requested from a category, the next in order, odd or even, volume will be selected based upon the balance of odd and even volumes mounted in the VTS.

As an example of the above, assume that we have a VTS with the volsers listed in Table 26 on page 184. Each volser has a category order number that the Library Manager uses to keep track of which logical volumes to mount next for a nonspecific request.

Table 26. Scratch Tape Order Example		
Volser	**Cat.**	**Cat. Order**
V00012	0002	010
V00015	0002	012
V00011	0002	782
V00003	0002	783
V00026	0002	785

Now assume we start out with the Library Manager pointer specifying volser V00011 as the next odd and V00026 as the next even to be selected.

When the first request comes in, the VTS selects an odd volser due to activity. This would result in volser V00011 being mounted in response to the scratch request.

Now another request comes in for a scratch mount, and the VTS chooses even. This would result in volser V00026 being mounted in response to the scratch request.

Now for our next scratch request the VTS chooses odd. This results in volser V00003 being chosen. This logical volume is the next highest one in the category order that is odd.

For our last scratch request the VTS chooses even. This results in volser V00012 being chosen. This logical volume is the next highest one in the category order that is even. The category order "wrapped" around to the low number because there were no more even logical volumes higher than V00026.

Let's summarize some of the important facts here:

- Table 26 represents one scratch category, but there may be many such categories in a single library.
- Volumes are arranged in sequence of category order number, not by volser
- The two pointers (even/odd) to the next volume move in ascending category order sequence.
- Volumes returned to scratch (reassigned to this category) are given a new, higher category order number.
- Volumes inserted into the library (and assigned to this category) are given a new, higher category order number.
- Category order numbers are virtually infinite.
- If volumes are assigned to a category, by insertion or return-to-scratch, faster than they are selected for use, the pointer will not start over at the beginning of the category order number list unless the library manager is restarted.
- Category order numbers are never reused. A volume returned to this category will be given a new (higher) number.

Figure 63 on page 191 shows the library manager display that can be used to identify category order numbers.

7.11 Inserting Logical Volumes in the VTS

You insert logical volumes in a VTS by defining their volsers and their media type in the Library Manager's Insert Logical Volumes window (Figure 59). Physical cartridge movement is not involved. To access the window, select **System management** on the Library Manager **Commands** pull-down, then select **Insert VTS logical volumes**.
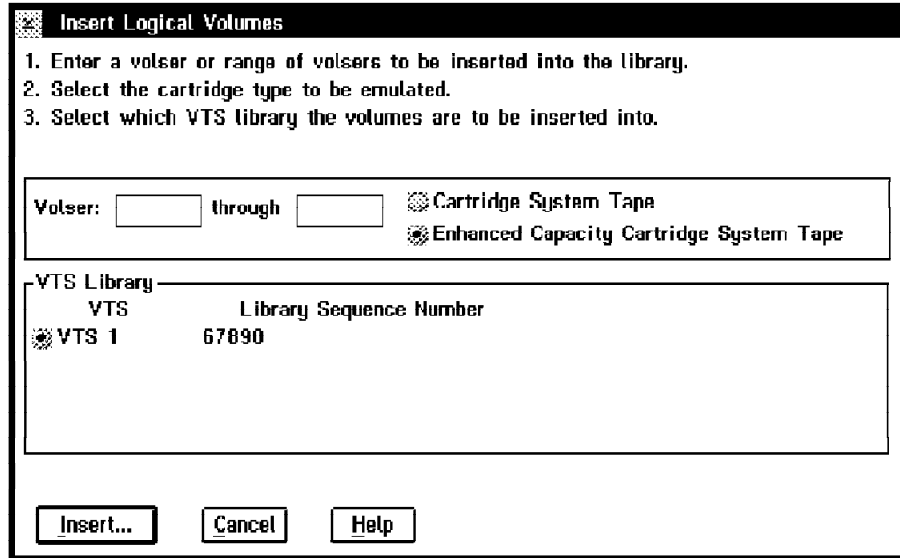
Figure 59. Library Manager Insert Logical Volumes Window

To insert logical volumes:

1. Enter a volser or a range of volsers in the *Volser* and *through* fields.
2. Select the cartridge type to be emulated.
3. Select into which VTS library the volumes are to be inserted.
4. Select the **Insert** button.

Volser range specification

Volser entry fields must contain six alphanumeric characters. The two volsers must be entered in the same format. Corresponding characters in each volser must both be either alphabetic or numeric. For example, AAA998 and AAB004 are of the same form, whereas AA9998 and AAB004 are not. The range includes all volsers that fall between the two volsers (inclusive) in a collating sequence where alphabetic characters are incremented alphabetically and numeric characters are incremented numerically. For example, volser range ABC000 through ABD999 would result in an insert of 2 000 logical volumes (ABC000 - ABC999 and ABD000 - ABD999).

Up to a total of 150,000 logical volumes can be inserted in a Magstar 3494 Tape Library for each of the two VTS installed. If the insert would cause more than 300,000 logical volumes in a Magstar 3494 Tape Library or more than 150,000 in a single VTS, the insert is aborted.

Volsers must be unique within a physical library. The Library Manager makes checks to ensure that the logical volumes you define do not conflict with existing volumes in the library or with any of the physical volser ranges defined for the library. If the logical volser range overlaps with a physical volser range, the

logical volume insert is refused; no logical volumes are inserted. If there is no range conflict, the logical volumes are inserted, except for those whose volser is a duplicate of an existing volume in the library.

Unlike physical volser range definitions, a logical range definition cannot be displayed after the insert has completed. However, there is no limit on how many times you can insert new logical volume ranges.

You do not have to initialize logical volumes. The VTS automatically initializes virtual volumes with an IBM standard label when they are mounted for the first time.

When you insert logical volumes in a Magstar 3494 Tape Library, the Library Manager assigns them to the insert category (FF00) just as it does with non-VTS volumes. The newly added logical volumes then go through the normal cartridge insert processing; the Library Manager notifies attached hosts of volumes in the insert category, and the host subsequently assigns them to another Library Manager category.

Be aware that cartridge insert processing is a time-consuming process. You can roughly estimate that it takes one second per volume. If you add all 150,000 logical volumes at one time, insert processing could take many hours.

We recommend that you initially insert only the number of logical volumes that are required to handle the workload you put in the VTS in the near future, and gradually add new ones as more scratch volumes are required. Inserting volumes in small increments is fast and does not cause unnecessary overhead in the form of logical volumes that the system has to manage.

Be aware that the VTS does not invalidate a logical volume when the host returns it to scratch. Data on the logical volume is preserved and continues to take up stacked volume space. From the point of view of VTS, a scratch logical volume is an active volume even though from the application's point of view it no longer contains valid and usable data. The Library Manager selects volumes from a category to satisfy nonspecific mounts in a first-in, first-out order. When a volume returns to the scratch category, it goes at the end of the selection list, so the Library Manager selects all volumes in the category before re-selecting that volume. Eventually, all logical volumes in the VTS get used and contain some data. Therefore, if you define more logical volumes than your operations require, you end up wasting space.

To illustrate this point we give you an example of the extra physical cartridges you would require. Here are the assumptions that were made for this example:

1. Using a VTS with 3590 B1A drives
2. Average logical volume size of 400 MB
3. Number of free stacked volumes is 50
4. Stacked volume utilization of 50%
5. Average compression ratio of 2.5 to 1

Using the above assumptions, we run through the calculations in 2.3.2.2, "Sizing the Number of Stacked Volumes" on page 28 With 20 000 logical volumes, we end up with 690 stacked volumes needed Using the same assumptions with 150 000 logical volumes, we end up with 4 850 stacked volumes needed.

Note: From a VTS perspective, it doesn't matter if these 150 000 logical volumes have a SCRATCH or PRIVATE status in the host tape management

system. Once used, they will all occupy space on stacked cartridges. Refer to 8.7, "A VTS Capacity Planning Walk Through" on page 233 for details.

As you can see there is a significant difference in the number of stacked volumes needed.

If you find you have defined too many logical volumes, the best solution is to follow the procedure in 7.12, "Ejecting Logical Volumes from the VTS" on page 188 to delete them. If your operational procedures do not let you easily eject all of the extra logical volumes, there is another solution. You can issue jobs to write over the unneeded logical volumes with a single record. This will invalidate the data on the previous logical volumes and take a minimal amount of space on the stacked volume.

To change the media type of logical volumes, you need to eject the volumes first, then re-insert them as new. Data on the volumes will be lost.

In a DFSMS/MVS managed tape environment, we recommend that you set the Entry Default Use Attribute for your VTS library to PRIVATE to make sure that logical volumes you insert into the library are protected. The tape management system should handle the process of switching the volumes to a scratch category as required.

Use the ISMF Tape Library application to set the Entry Default Use Attribute on the Tape Library Define panel (Figure 60).

```
                         TAPE LIBRARY DEFINE                 Page 1 of 2

  Command ===>

  SCDS Name    : SMS.SCDS
  Library Name : VTS1

   DESCRIPTION ===> 'Virtual Tape Server 1'

   LIBRARY ID                  ===> _____     (00000 to FFFFF)
   CONSOLE NAME                ===> _____
   ENTRY DEFAULT DATA CLASS    ===> _____
   ENTRY DEFAULT USE ATTRIBUTE ===> P         (P=PRIVATE  S=SCRATCH)
   EJECT DEFAULT               ===> P         (P=PURGE  K=KEEP)

   SCRATCH THRESHOLD (0 to 999999):

       MEDIA1  ===> 100___           MEDIA2  ===> 100___
       MEDIA3  ===> _____            MEDIA4  ===> _____
```

Figure 60. ISMF Panel: Tape Library Define

When the number of scratch volumes in the library falls below the media type's scratch threshold specified on the ISMF Tape Library Define panel, OAM issues the following message:

```
  CBR3660A Enter {MEDIA1|MEDIA2} scratch volumes into library
           <library-name>
```

To resolve the condition, insert new logical volumes, or run tape expiration processing to return expired logical volumes to scratch status.

To display the number of scratch volumes in the library and the corresponding thresholds, use the DISPLAY SMS,LIBRARY(library-name),DETAIL command.

7.12 Ejecting Logical Volumes from the VTS

Logical volumes are not physical entities that can be individually removed from the library. They reside on stacked volumes with many other logical volumes. If you issue an EJECT for a logical volume, all data on that volume will be lost.

> **Note**
>
> There is no way to recover the data on the logical volume once the EJECT command is processed.

Due to the permanent nature of the EJECT, the VTS subsystem only allows you to EJECT a logical volume that is in either the INSERT or SCRATCH (defined with fast- ready attribute) category. If a logical volume is in any other status, the EJECT will fail.

Note: This fact has proven to be cumbersome for volumes that happen to be in the error category (000E). An easy way to eject such volumes is to use ISMF panels to set these volumes to the PRIVATE status. The volume status is propagated to DFSMSrmm and you can use DFSMSrmm to subsequently assign the volume to the SCRATCH status and eject it.

Tapes that are in INSERT status can be ejected by the setting of the return code by the CBRUXENT exit. This exit is usually provided by your tape management system vendor.

Once the tape is in SCRATCH status, follow the procedure for EJECT processing based on whether your environment is system-managed tape or BTLS. You will also need to follow the procedure specified by your tape management system vendor. For DFSMSrmm issue the RMM CHANGEVOLUME volser EJECT command. If your tape management system vendor does not specify how to do this, you can use one of the following commands:

1. MVS command LIBRARY EJECT,volser
2. IDCAMS command LIBRARY EJECT,volser (for BTLS)
3. ISMF EJECT line operator for the tape volume

The eject process fails if the tape is in another status or category. For libraries managed under DFSMS/MVS system managed tape, system command LIBRARY EJECT,volser issued to a logical volume in PRIVATE status fails with this message:

```
CBR3726I Function incompatible error code 6 from library <library-name>
         for volume <volser>.
```

Note: In a DFSMS/MVS system-managed tape environment, if you try to eject a logical volume and get this error, OAM notifies the tape management system. This is done through the OAM eject exit CBRUXEJC before the eject request is sent to the tape library. The Library Manager will eventually fail the eject, but the tape management system has already marked the volume as ejected. There is no notification back that the eject has failed.

If your tape management system is DFSMSrmm, you can use the following commands to clean up the RMM CDS for failed logical volume ejects and to resynchronize the TCDB and RMM CDS:

```
RMM SEARCHVOLUME VOL(*) OWN(*) LIM(*) INTRANSIT(Y) LOCATION(vts) -
    CLIST('RMM CHANGEVOLUME ',' LOC(vts)')

EXEC EXEC.RMM
```

The first RMM command asks for a list of volumes that RMM thinks it has ejected and writes a record for each in a sequential data set called 'prefix.EXEC.RMM.CLIST'. The CLIST then checks that the volume is really still resident in the VTS library and, if so, it corrects the RMM CDS.

7.13 Cleaning

The same cleaning recommendations and rules apply for VTS-resident drives as for native Magstar 3590 drives in a Magstar 3494 Tape Library. The Magstar 3590 drive itself requests cleaning on the basis of drive performance and, independently of the drive, the Library Manager can initiate cleaning on the basis of its cleaning settings.

We recommend that you let cleaning be based on requests from the Magstar 3590 drive. To do this, minimize cleaning initiated by the Library Manager by setting the *Usage clean* value for the 3590 drive to 999 on the Library Manager Clean Schedule window (Figure 61). To access the Clean Schedule window, select **Cleaning** from the Library Manager **Commands** pull-down menu.
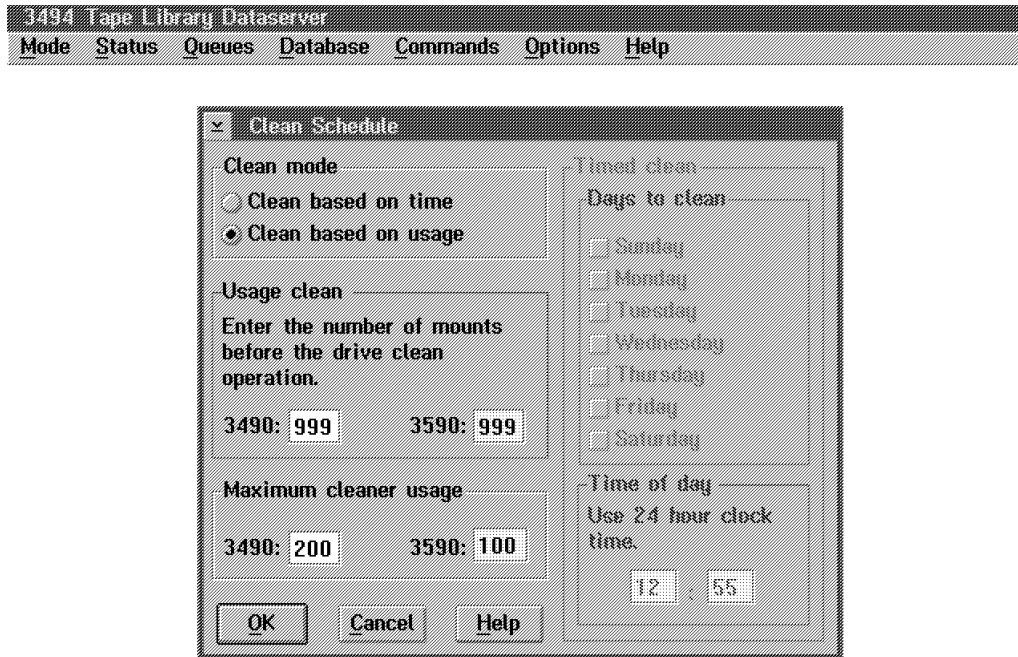
Figure 61. Clean Schedule Window

The Magstar 3590 drive requests cleaning on the following basis:

- Amount of data transferred (read from and written on the medium). Requests cleaning if more than 180 GB has been processed since the last cleaning.

- Number of mounts. Requests cleaning if more than 1800 mounts have been done.
- Temporary error rates. Clean if the number of (ECC) corrections is high.

The drive counters that trigger cleaning are preserved when the Magstar 3590 drive is reset or powered off.

When the drive determines that it needs to be cleaned, it requests the Library Manager to queue a cleaning operation. The Library Manager subsequently mounts a cleaning cartridge on the drive.

A Magstar cleaning cartridge should be used no more than 100 times. The Library Manager ejects a cleaner cartridge from the library when its maximum usage count has been reached. You should then dispose of the cartridge to ensure it does not get reinserted in the library by mistake. If it does, the Library Manager would treat it as a new cleaner cartridge without any knowledge of its previous use.

Always handle 3590 cartridges carefully to prevent dirt from getting on the tape. Do not try to pull the tape out of the cartridge, and never touch the tape. Keep the cartridge cover clean. Refer to the *IBM Magstar 3590 Tape Subsystem Operator's Guide*, GA32-0330, for details on how to handle 3590 cartridges.

7.14 Querying the Library Manager Database

The Library Manager enables you to search the Library Manager database and view selected volumes in the Magstar 3494 Tape Library according to specified search criteria. You can search for both logical and physical volumes.

Use the **Database** pull-down menu (Figure 62) on the action bar to select one of three search functions.
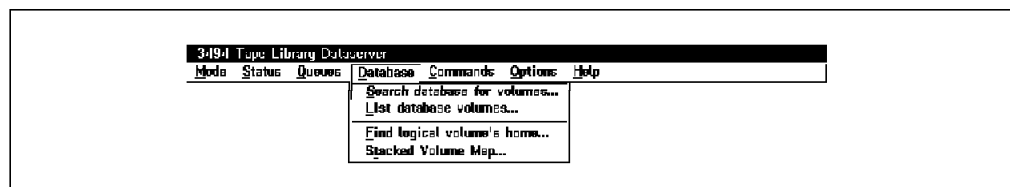
Figure 62. Library Manager Database Pull-Down Menu

7.14.1 Search Database for Volumes

Select the **Search database for volumes** function to view selected volume information on the Library Manager console. Specify your search criteria in the Search Database for Volumes window (Figure 63 on page 191).

Note: Figure 63 on page 191 is captured from a test system where volumes are kept in an insert category (FF00 or FF01). In a production system, volumes are removed from the insert category before they can be mounted.
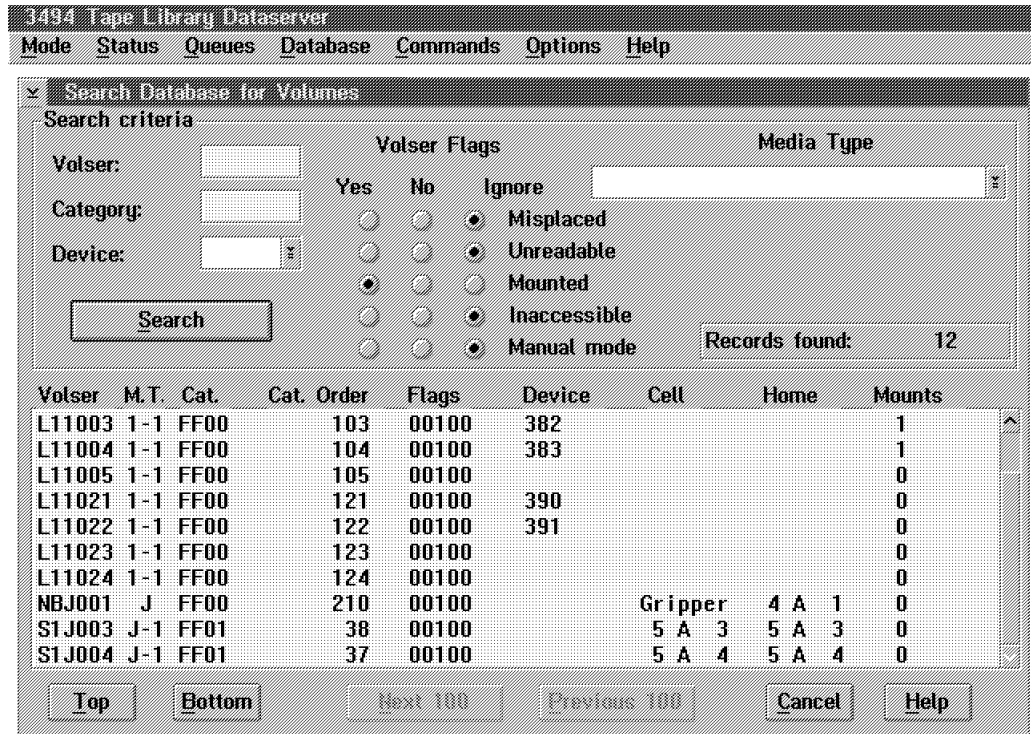
Figure 63. Library Manager Search Database for Volumes Window

The media type (M.T.) field of the resulting display for VTS-resident volumes (logical and stacked) is of the format *T-L*, where *T* indicates the media type, and *L* indicates the VTS library in which the volume resides. With one VTS in a Magstar 3494 Tape Library, *L* will always be 1. The media type codes are:

1   Cartridge system tape in non-VTS logical library
E   ECCST in non-VTS logical library
J   High performance cartridge system tape in non-VTS logical library
1-1   Logical cartridge system tape in VTS 1 logical library
E-1   Logical ECCST in VTS 1 logical library
J-1   Stacked high performance cartridge system tape in VTS 1 logical library
1-2   Logical cartridge system tape in VTS 2 logical library
E-2   Logical ECCST in VTS 2 logical library
J-2   Stacked high performance cartridge system tape in VTS 2 logical library
?   Unknown

The Cat field indicates the volume's Library Manager category. The following category numbers are assigned to the 3590 cartridges owned by the VTS subsystem:

FF01   Stacked volume insert category
FF02   Stacked volume scratch category 0
FF03   Stacked volume scratch category 1
FF04   Stacked volume private category
FF05   Stacked volume disaster recovery category
FF06   VTS backup volumes
FF07   VTS transaction log volumes
FF14   Import volume category
FF16   Unassigned category (convenience I/O station)
FF17   Export hold category

FFFA Manually ejected

The categories assigned to logical volumes depend on the host system. The following are predefined categories:

FF00 Insert category
FF12 Export pending
FF13 Exported
FF15 Import pending

The Cat Order (category order) field shows the order in which the Library Manager selects volumes in the category to satisfy mounts from category (nonspecific mounts).

The Flags field is made up of five digits where the digit 1 indicates, from left to right, that the volume is:

> Misplaced (1nnnn)
> Unreadable (n1nnn)
> Mounted (nn1nn)
> Inaccessible (nnn1n)
> Has been used in manual mode (nnnn1)

The Device field indicates the virtual device ID where the volume is mounted. When a mount is in progress but not yet complete, the Device field is empty, and the Flags field indicates that the volume is mounted.

The Cell and Home fields indicate the volume's current cell location and its home location. If the cartridge is currently in the gripper, the Cell field indicates it. If a cartridge is currently in a drive, the Cell field indicates which drive.

For logical volumes, the Cell and Home fields are empty.

The Mounts field indicates how many times the volume has been mounted.

7.14.2 Find Logical Volume's Home

Select **Find logical volume's home** to find out on which stacked volume a logical volume resides. Specify the logical volume's serial number on the resulting Find A Logical Volume's Home window (Figure 64 on page 193).

```
┌─────────────────────────────────────┐
│ Find A Logical Volume's Home         │
├─────────────────────────────────────┤
│ Use this panel to find which stacked │
│ volume a logical volume resides on.  │
│                                      │
│ Enter the logical volume's volser    │
│ and select the "Find" button.        │
│                                      │
│                                      │
│ Logical volser:  │          │        │
│                                      │
│      Resides on stacked              │
│               volser:                │
│                                      │
│                                      │
│                                      │
│  ┌──────┐  ┌────────┐  ┌──────┐      │
│  │ Find │  │ Cancel │  │ Help │      │
│  └──────┘  └────────┘  └──────┘      │
└─────────────────────────────────────┘
```
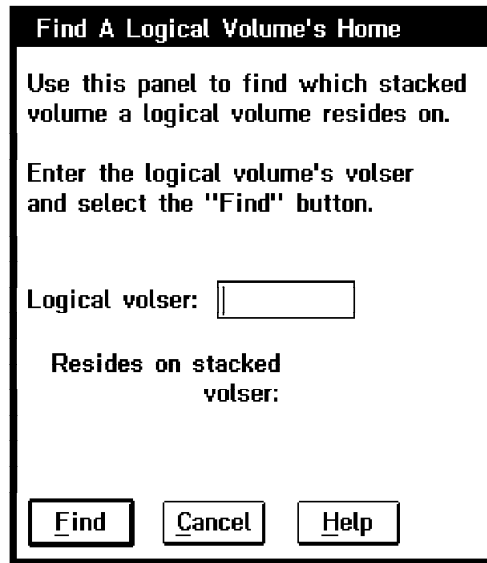
Figure 64. Find a Logical Volume's Home Window

If the logical volume has been written on a stacked volume, the volser of the stacked volume that holds the active copy of the logical volume is displayed in the window. The search cannot succeed if the volume has not yet been copied on any stacked volume.

If a logical volume is in use at the time you issue the query, the window indicates that the volume is open.

7.14.3 List Logical Volumes on Stacked Volume

There may be certain situations where you would like to find out which logical volumes are on a stacked volume. If you have a stacked volume that is marked Read-Only, you may want to find out which logical volumes are on the stacked volume before issuing the eject. The list produced by the VTS will be stored on a standard floppy disk which can be removed and read on a personal computer.

Before proceeding you need to obtain a blank, formatted diskette and have your IBM service representative place it in the Library Manager's A drive. Then select **Stacked Volume Map** from the **Database** selection. You are presented with window shown in Figure 65 on page 194. After typing in the volser of the stacked volume, click on the **Get map** icon. You are presented with a Search in Progress message while the search is occurring. You see a message when the operation is complete. At this point have your IBM service representative remove the diskette from the A drive.
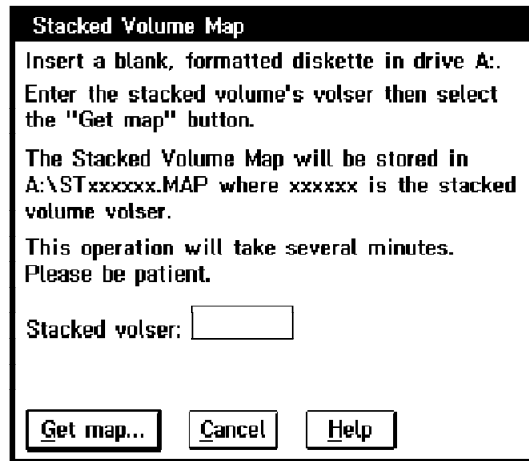
Figure 65. Library Manager Operator Stacked Volume Map

The diskette will have a file named STxxxxxx.MAP, where xxxxxx is the volser of the stacked volume. The file will contain some header information and a list of all of the logical volumes on the stacked volume.

Some of the volumes may be in the form L1-nnn where nnn is a number. The L1-nnn volumes are log files that are created by the VTS. They are used by service and are listed so service can find them easily.

If a logical volume spans a second stacked volume, the text 'SPAN' will be in the record. See the *Magstar 3494 Tape Library Operator Guide*, GA32-0280 for more information.

Note: This function is available only on VTS B18 models.

7.14.4 List Database Volumes

The **List database volumes** function enables you to create a flat file containing a customized list of selected database columns. Specify your selection criteria in the List Database Volumes window (Figure 66 on page 195).
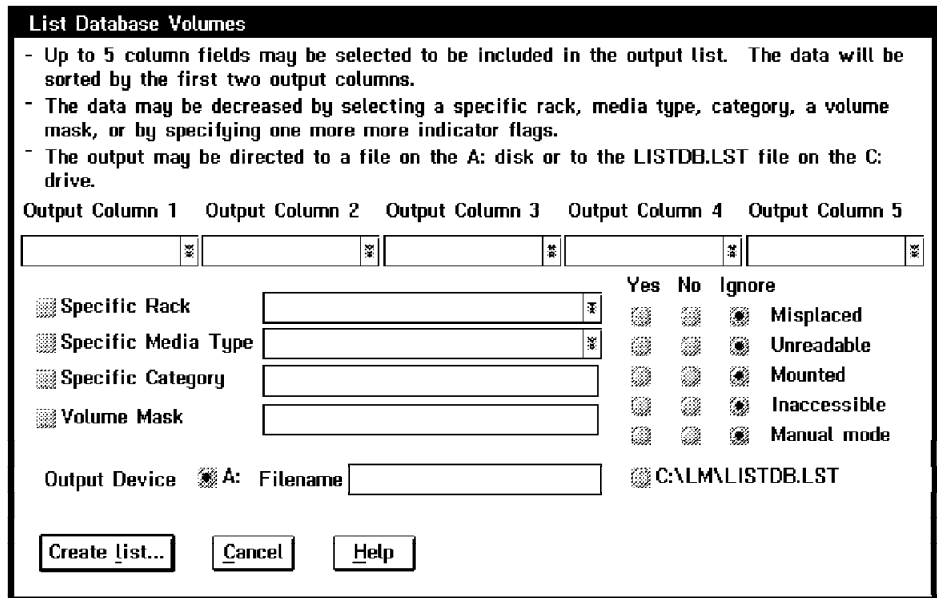
Figure 66. List Database Volumes Window

Use the Output Column fields to specify which columns to include in the output file. Use the various search criteria fields to specify which volumes to include in the output file.

The **List Database Volumes** function lets you use the same volume selection criteria as the **Search Database** for Volumes function. In addition, it enables you to find out which volume is in a specific rack in the Magstar 3494 Tape Library.

You can write the flat file to a selectable file name on a diskette in the Library Manager floppy disk drive, or to the C:\LM\LISTDB.LST file on the Library Manager hard disk.

Note: The Library Manager must be offline for the List Database Volumes operation.

7.15 Inventory New Storage or Re-inventory Complete System

The inventory new storage or re-inventory complete system selections are typically system administrator password-protected. The inventory process can be performed only when:

- The Library Manager is offline and in Auto mode.
- The teach process is completed by the IBM service representative.
- The cleaner volume masks are set.
- The volser ranges are set.

Select a type of inventory:

- **Inventory new storage** (at subsystem installation time)

  Start an inventory of any storage components not previously inventoried. The Library Manager database will be updated with information about cartridges in the inventoried library frames.

- **Re-inventory complete system** (at any time)

Inventory all storage components. The Library Manager database will be
initialized and all physical cartridges set to an insert category.

Note: If either of these processes finds any cartridges with unreadable external
labels, they will be ejected. If this happens you need to fix the external
label and reinsert the cartridge into the library.

Refer to Figure 67 for the window that allows you to save the logical volumes.
When a complete inventory is requested and the tape library contains a VTS, the
operator is prompted to save the logical volumes. Answering **Yes** will save the
logical volumes. The volumes do not have to be reinserted after the inventory is
completed. This is the normal recommended selection. Answering **No** will
remove the logical volumes from the Library Manager database. When the
volmes are reinserted at the Library Manager, the hosts are notified and the
logical volumes are returned to their correct categories. The VTS and Library
Manager databases are then back in synch.
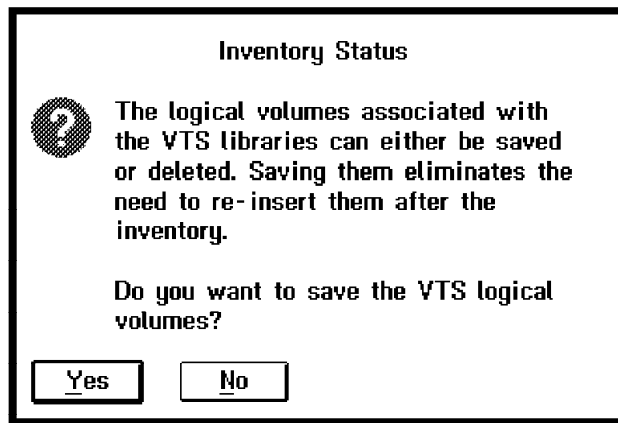
Figure 67. Inventory Status Window Save Logical Volumes:

As part of the inventory, you are presented with the option to set the volser
ranges on the Inventory - Volser Ranges window (Figure 68 on page 197).

```
Inventory - Volser Ranges

- To add a range, enter the two volsers, select a media type and select the
  'Add/Modify range' button.
- To expand a range, double-click the mouse on the range, modify the volsers, and
  select the 'Add/Modify range' button.
- To delete a range, double-click the mouse on the range, and select the 'Delete
  range' button.
- To determine if a volser is in a range, enter the volser in the 'From:' entry field and
  select the 'Volser in range?' button.
- To query the number of volsers in a range, highlight the range in the list box and
  select the 'Total volsers in range' button.

                                          Media type
                                     ┌──────────────────────────┐
   From: [        ]  To: [        ]  │ 1 - CST    [Non-VTS 12345]│
                                     │ E - ECCST  [Non-VTS 12345]│
   From        To        Media type  │ J - HPCT   [Non-VTS 12345]│
                                     └──────────────────────────┘

                                              ┌──────────────────┐
                                              │ Delete range...  │
                                              └──────────────────┘
                                              ┌──────────────────┐
                                              │ Volser in range? │
                                              └──────────────────┘
                                              ┌──────────────────────┐
                                              │ Total volsers in range│
                                              └──────────────────────┘

   [ Add / Modify range ]  [ Cancel inventory ]  [ Help ]  [ Start inventory... ]
```

Figure 68. Inventory Volser Ranges Window

See 7.5, "Defining Volser Ranges for Stacked Volumes" on page 173 for more information about setting the volser ranges. Once you have defined the ranges, select the **Start Inventory** button to allow inventory to continue.

You are also presented with the option to set the cleaner volume masks. At least one mask must be set (for example, CLN***). With the cleaner mask you define to the Library Manager the 3590 cleaner cartridges that can be used to clean Magstar 3590 drives in the 3494 library, including those associated with the VTS.

Before selecting the **Re-inventory complete system**, the VTS stacked volumes are mounted on the 3590 tape drives associated with the VTS must be returned to the 3494 Tape Library cartridge storage cells. Set the VTS subsystem to the OFFLINE state from the host system, and then set the 3494 Tape Library to the OFFLINE state.

Refer to the *Magstar 3494 Tape Library Operator Guide*, GA32-0280, for more information about performing Inventory new storage and Re-inventory complete system.

Note: After the inventory operation is complete, it may take a while until the VTS database is synchronized with the Library Manager. You will find the stacked volumes in the Insert Category (FF01) until the synchronization is completed.

7.16 Inventory Update

The Inventory Update facility allows for the following operations, which you can select from the **Commands** pull-down:

- **Disable inventory update** — Disables inventory update, allowing doors to be opened and closed without performing inventory update.

- **Enable inventory update** — Enables inventory update to take place whenever the tape library system is returned to Auto/Online mode after an enclosure door is opened and closed.

- **Perform inventory update (Full)** — Performs an immediate inventory update. This option is available only if the tape library system is in Auto/Online mode.

- **Perform inventory update (Partial)** — Performs inventory on just the frames on which the doors have been opened.

During inventory update processing, the actuator checks all cartridge cells and drive feed slots for cartridges, reads all bar code labels, and updates the Library Manager database as follows:

- Cartridges not previously in the Library Manager inventory are set to insert category (FF00).
- Cartridges that are in the Library Manager database but not found during the inventory are placed in the Manually ejected category (FFFA).
- Cartridge cell locations are updated if necessary.

Logical volumes are not affected by inventory update.

Note: All other library activity (mounts, demounts,...) is held during inventory update processing. Requests from the hosts are queued until the library is back in Auto mode.

When the **Enable inventory update** option is selected, a partial inventory update is automatically performed on those library frames whose front door has been opened while the library was in Pause or Manual mode. This process checks all of the cartridge storage cells in the frames that had doors opened, and depending on the selection made during the teach process by the IBM service representative, may also check any adjacent frames to the frames that had doors opened. When the **Disable inventory update** option is selected, you must manually start the Inventory update process.

Refer to the *Magstar 3494 Tape Library Operator Guide*, GA32-0280, for more information about the Inventory update facility.

7.17 Operating the VTS from a Host

One of the original design objectives of the IBM Magstar VTS was that it would not require host software changes. In consequence, no new host commands or new host messages are associated with the VTS. The VTS Advanced Function feature requires host software changes and introduces new messages to facilitate the Import/Export processing. Refer to Chapter 9, "IBM Magstar VTS Advanced Function" on page 245 for details. At the host, you use the same commands and procedures as you use with the Magstar 3494 Tape Library today.

Error and status conditions noted at the library that relate to a VTS are handled using existing software facilities. For a Magstar 3494 Tape Library managed under DFSMS/MVS, intervention required conditions are reported on the host console with this message, with no indication of severity:

```
CBR3762E Library <library-name> intervention required
```

Note: New, condition-specific, host console messages are generated, if "Send Interventions to Host Console" is enabled. See 7.4.1.1, "Messaging Enhancements" on page 170 for further explanation.

When your Magstar 3494 Tape Library is logically partitioned, you operate the logical libraries as you would operate separate IBM 3494 tape libraries. For example, you can vary the logical libraries online and offline to the host independent of each other.

Note that the physical Magstar 3590 drives inside the VTS subsystem are not known to the host operating system and are not directly accessible by host programs.

Refer to the following product manuals for guidance on how to operate a Magstar 3494 Tape Library on the different host platforms:

- *DFSMS/MVS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC26-3051.

- *Basic Tape Library Support User′s Guide and Reference*, SC26-7016.

- *VM/ESA DFSMS/VM Function Level 221 Removable Media Services User′s Guide and Reference*, SC35-0141.

- *3494 Tape Library Dataserver User′s Guide: Library Control Device Driver for VSE/ESA*, GC35-0176.

7.18 Data Security Erase

In some systems, execution of the data security erase channel command causes random data patterns to be written on a volume to its end-of-tape. Instead, with VTS, the end-of-data (EOD) mark is repositioned at the logical block location at which the command was issued. Any data beyond that logical block location is no longer accessible.

When the virtual volume is copied to a stacked volume, only the data up to the EOD mark is written. Any data beyond that point is ignored; it is no longer accessible by the host.

The VTS does not take any action or provide any function to erase data on invalidated copies of a logical volume. Although the previous copies of a logical volume are not readily accessible, data on them remains on physical volumes. These copies are not written over until the corresponding stacked volume is reclaimed and the space occupied by the data is subsequently overwritten by new logical volumes.

7.19 Stand-Alone Support

The Library Manager provides a Stand-Alone Device facility that allows you to set a tape device (virtual or native) in a Magstar 3494 Tape Library in stand-alone mode. To the host, the device then appears as if it was not in a tape library. This mode allows you to use devices in the Magstar 3494 Tape Library with stand-alone programs that cannot issue a command to mount and demount volumes in the library. It also allows you to IPL from a tape-library-resident drive. Examples of stand-alone programs are stand-alone dump and stand-alone restore.

The Stand-Alone Device facility supports virtual devices with the exception that the Mount from Input Station feature is not supported with virtual devices. Using the Stand-Alone Device facility, you can:

- IPL from a virtual tape device

- Use virtual tape volumes with stand-alone programs that do not support mounting of tapes on Magstar 3494 Tape Library resident drives.

To set a virtual device in stand-alone mode and to request the Library Manager to mount a virtual volume on it, select **Stand-alone device** from the **Commands** pull-down menu, then select **Setup stand-alone device.** Provide the following input on the Setup Stand-alone Device window (Figure 69 on page 201):

1. Enter a virtual device address in the Enter device field.

2. Enter the volser of the virtual volume in the Volser field.

3. Select **Mount a single volume** to mount the specified volume into the specified virtual drive.

4. Select **Do not change volume category**.

When you select **OK**, the Library Manager requests the VTS to mount the virtual volume and make the virtual device ready. If necessary, the VTS then recalls the virtual volume from the stacked volume into the TVC.

Figure 69. Setup Stand-alone Device

Notes:

 1. Vary off the device that is being used in stand-alone mode from all hosts
    except the host that is being used in this special mode. This will prevent
    unwanted interaction from other hosts connected to the VTS.

 2. You cannot set the physical Magstar 3590 drives associated with a VTS in
    stand-alone mode.

To unload and demount a virtual volume from a drive that is in stand-alone
mode, select the **Demount a single volume** and **Do not change volume category**
push buttons on the Setup Stand-alone Device window, then select **OK**.

To take a virtual device out of stand-alone mode, use the Reset Stand-alone
Device window, which you can access by selecting **Stand-alone device** from the
Commands pull-down menu, and then selecting **Reset stand-alone device**.

See 6.4.6, "Stand-Alone Services" on page 140 for an example of how to IPL
Stand-Alone Services of DFDSS V2.5 and DFSMS/MVS V1 from a virtual device
and use it to restore a dump data set from virtual tapes.

Chapter 8. VTS Performance

This chapter describes the underlying elements that determine and influence the performance of the VTS and, when necessary, take actions to improve VTS performance.

This chapter includes:

- a detailed overview of the shared tasks which are running in the VTS controller.
- a detailed description of a VTS monitoring and performance evaluation methodology.
- a walk through of a VTS capacity planning case study.

We will discuss the VTS shared resources so that you can understand the impact that contention for these resources has on the performance of the VTS.

The monitoring section will help you to understand the important values recorded in the SMF94 type record. By using these records, you will be able to perform simple health checks as well as in-depth investigations on performance issues that may arise with the VTS. It will also help you in recognizing the symptoms that indicate the VTS is at or near its maximum capacity. By using the information provided, it will help you to evaluate the options available to improve the throughput or performance of the VTS.

The capacity planning case study will illustrate some guidelines and techniques for the management of virtual and stacked volumes associated with the VTS.

8.1 Introduction

The virtual tape subsystem requires that we take a new view of tape performance as opposed to older non-virtual tape systems. This is due to the number of new elements brought in to the overall solution, including Tape Volume Cache (TVC), a VTS controller running AIX and storage management software, virtual tape drives, virtual and logical volumes, and stacked volumes. This architecture can provide significant benefit to the tape processing environment, but a new approach must be taken in order to effectively size, monitor, and manage the performance of the VTS.

8.2 VTS Model Performance Attributes

Since its introduction, significant improvements have been made in VTS capacity and performance. At this time, there are basically three configurations of the VTS in use at customer sites: the VTS model B16 and model B18 without EHPO, the VTS model B18 with EHPO, and the VTS B18 with the Performance Accelerator feature (PAF).

The model B16 introduced the concept of virtual tape and provided automatic tape stacking capability.

The introduction of the B18 included the following enhancements over the B16:

- A new 2-way VTS controller with six times the processing power of the previous B16 controller.

- The EHPO feature which provided compression of host data at the VTS channel adapter.
- A new standalone frame configuration with more room inside, allowing larger physical cache size configurations of up to 288 GB uncompressed.

All of these changes combined resulted in significant throughput and effective cache size increases.

The B18 PAF included the following enhancements which have resulted in significantly increased throughput over the B18 EHPO:

- Increased CPU power and memory
- A new high speed file system for tape volume cache
- Extended performance ESCON channel adapters

In this chapter, we address primarily the performance attributes for the model B18 with EHPO. Where appropriate, we will differentiate the performance capabilities of the B18 with the PAF.

8.3 Shared Resources

In the process of writing scratch volumes or copying and recalling virtual volumes on physical stacked volumes, components are shared by tasks running on the VTS controller. Some of these tasks represent customer work (such as scratch mounts) and other tasks are associated with the internal operations of the VTS. All these tasks must share the same resources, especially the RS/6000 processor and the TVC. Contention may occur for these resources when heavy demands are placed on the VTS subsystem. To mange the use of shared resources the VTS uses various resource management algorithms, which can have a significant impact on the level of performance achieved for a specific workload.

In the next several sections, we will discuss the effects on performance of the following shared resources:

- The RISC/6000 processor cycles
- The Tape Volume Cache (TVC) management
- The 3590 B1A or E1A physical drives in the VTS D12 frame
- The physical stacked volumes

8.3.1 Processor Cycles

All tasks running in the VTS controller require a share of processor cycles. Some of these tasks include the emulation of each virtual drive in use, each copy task, and each recall task. If there are eight active virtual drives, two copy tasks, and one recall, this is a total of eleven tasks. The processor cycles would have to be shared by all these tasks through a time-slicing multiprocessing algorithm.

The VTS monitors the utilization of the processor and uses processor utilization or idle time in many of its internal task management algorithms. High processor utilization can adversely effect channel throughput and logical volume mount times.

The VTS does not report processor utilization as part of its performance statistics, and, therefore, you cannot monitor this metric.

Figure 70 on page 205 shows examples of functions which use RS/6000 processor cycles.
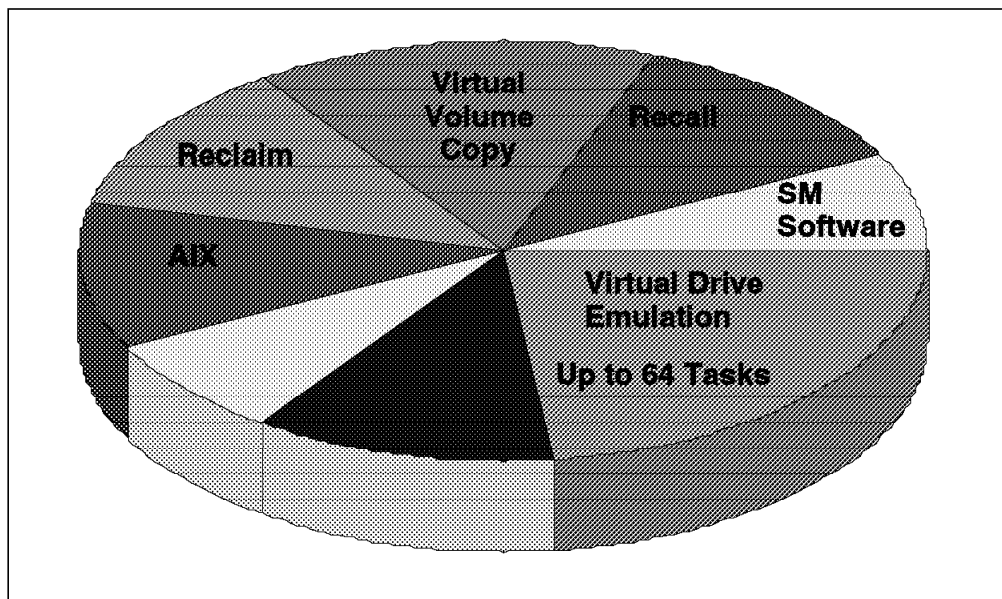
Figure 70. RS/6000 Processor Cycles

8.3.2 Tape Volume Cache Management

All virtual volumes are written and read by the host into and out of the TVC. The process of copying virtual volumes to stacked volumes and the recall of the virtual volumes from stacked volumes is transparent to the host.

The primary objectives of TVC management are to insure that sufficient freespace is available for new or old virtual volumes and to maximize the number of read cache hits. The primary mechanisms which are used by the VTS to manage the cache are the internal allocation of physical drives, logical volume fragmenting, and throttling.

Note: The software management algorithms used by the VTS for TVC management, including throttling values, are internal processes which cannot be controlled by the customer. These are subject to change without notification.

Figure 71 on page 206 shows the TVC processes.
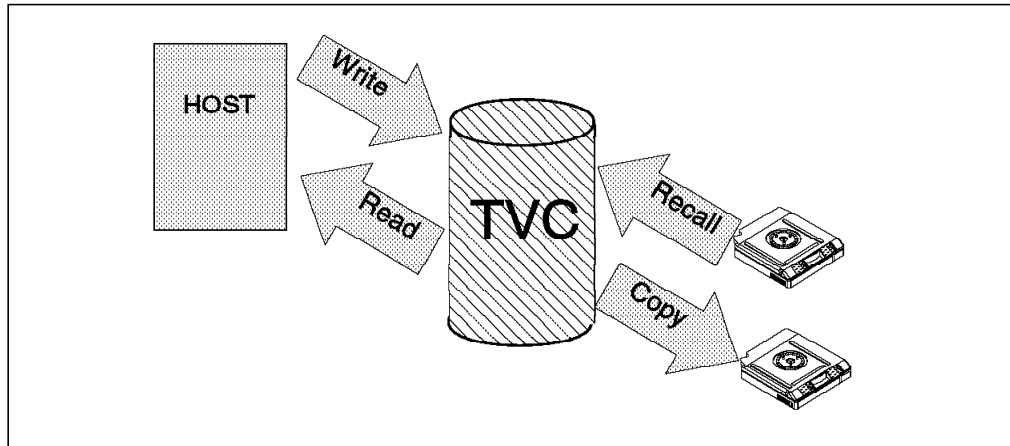
Figure 71. Tape Volume Cache Processes

8.3.2.1 Physical Drive Allocation

Write operations for new volumes, appending to old volumes, and read operations, requiring the recall of a volume into TVC, all require free space in the TVC for storage of data. When freespace becomes too low, or the space occupied by volumes which are closed and ready to be copied to stacked volumes (copy queue) becomes too high, the VTS will increase the number of copy tasks allowed, if possible. In addition, if free space becomes too low, the VTS reduces the number of recall tasks allowed, if possible, thus, making more 3590 drives available for copying. The VTS will always reserve at least one drive for the copy function and one drive for recalls.

8.3.2.2 Logical Volume Fragmenting

Copied volumes are eligible for fragmenting, which is the process of reducing the data portion of the virtual volume in cache down to a 'fragment'. A fragment is 4KB in size, and it contains information, such as headers. Fragmenting works on a first in, first out basis. Fragmenting creates the TVC free space required for new volumes to be written and old volumes to be recalled. The VTS will fragment logical volumes in the cache, only when cache freespace becomes low. Before a logical volume can be fragmented, it must have been copied to a stacked volume.

Figure 72 on page 207 shows a typical example of the TVC contents.
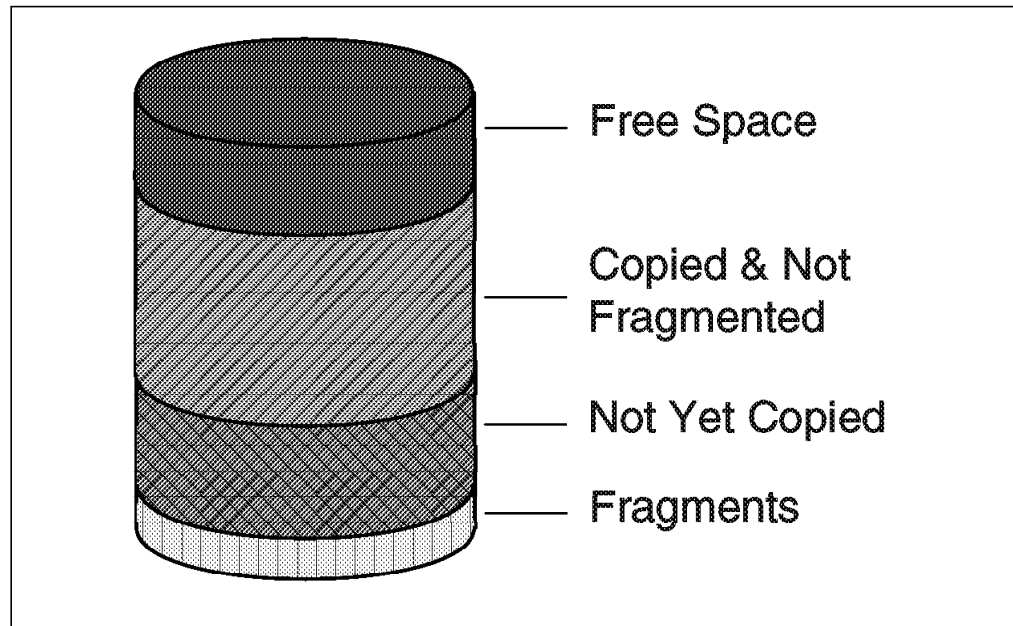
Figure 72. Tape Volume Cache Contents

8.3.2.3 Host Write Throttling

In order to make sure that there are sufficient processing cycles available to perform high priority tasks, the VTS may introduce a delay in response to host write operations. This is called throttling. High levels of throttling can cause a reduction in host write activity, which may result in elongated or erratic job run times.

The VTS calculates throttling values for each of the following on a regular interval:

- Amount of TVC freespace
- Number of active recalls
- Size of the copy queue
- Number of entries in the copy queue

The actual amount of throttling that the VTS applies at any given time depends on the above factors and may vary depending on the VTS model and/or LIC level.

Freespace Throttling: Once the low freespace threshold is crossed, the amount of free space throttling is inversely proportional to the amount of TVC free space remaining. As long as the amount of freespace is above the threshold, freespace throttling will not occur.

Figure 73 on page 208 shows VTS actions when cache freespace is low.
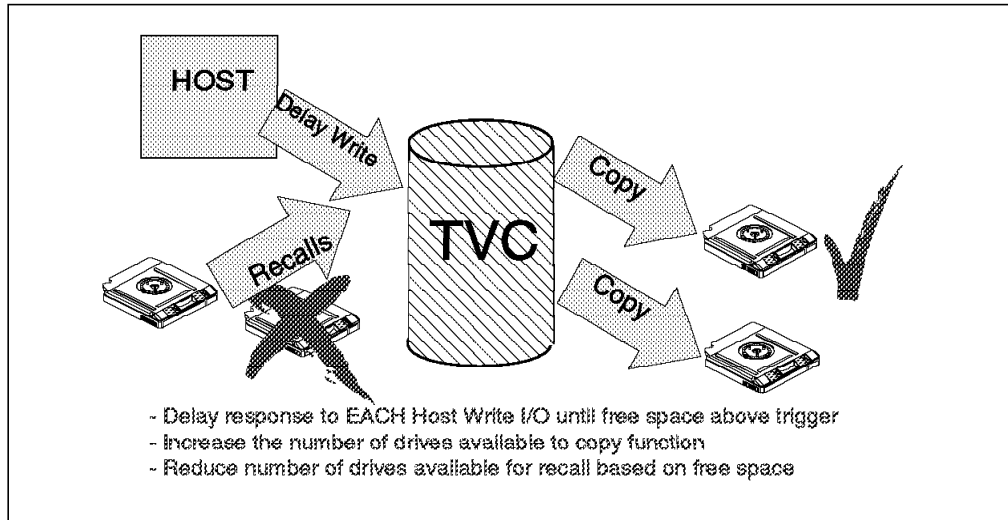
Figure 73. Cache Free Space Low Actions

Recall Throttling: The VTS introduces host write throttling whenever recalls are
in progress. The amount of delay is proportional to the number of recalls
currently active. This throttle is no longer used in B18s with the Performance
Accelerator Feature.

Figure 74 shows actions during recall.
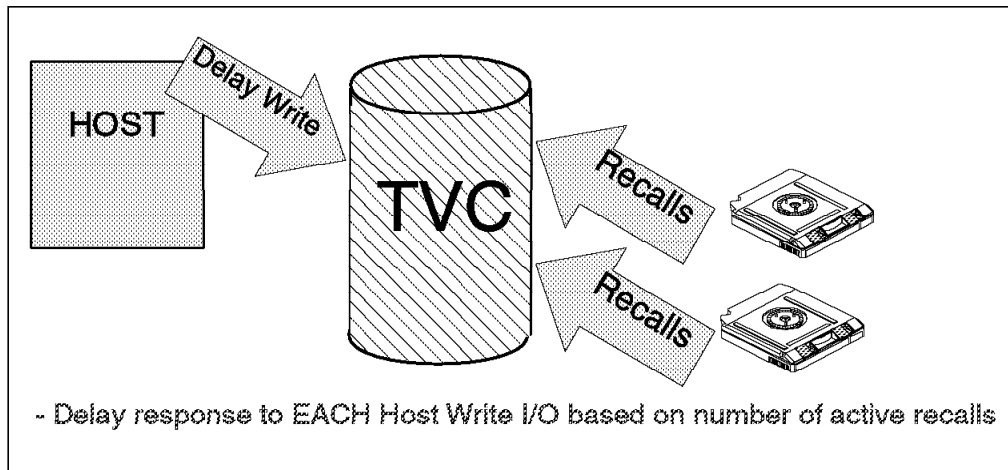
Figure 74. Actions during Recall

Copy Queue Throttling: The VTS introduces host write throttling if either the
number of copy tasks or the amount of data waiting to be copied exceeds certain
thresholds. This throttle is no longer used in B18s with the Performance
Accelerator Feature.

Figure 75 on page 209 shows actions when the copy queue value is high.
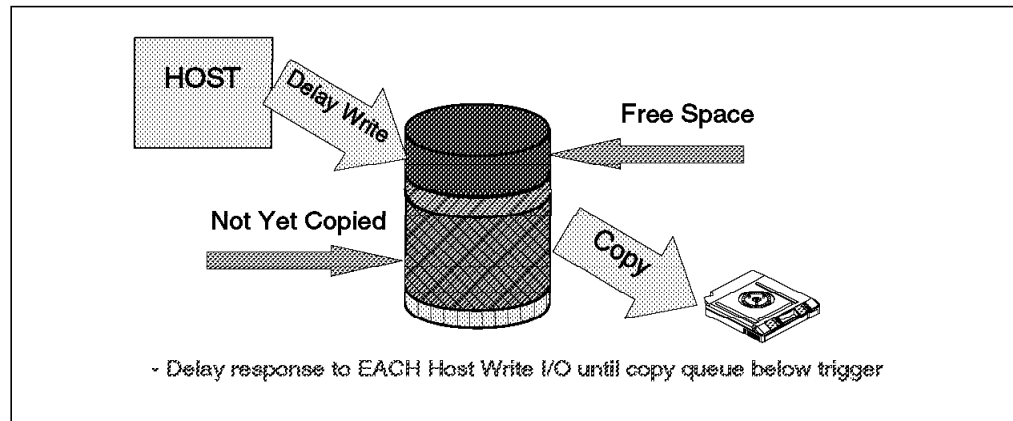
Figure 75. Copy Queue High Actions

8.3.3 Physical Drive Availability

The 3590 B1A or E1A drives in the VTS D12 frame are managed by the VTS internal management software and cannot be accessed from any attached host. These drives are used by the VTS for the mounts required for copying virtual volumes to stacked volumes, recalling virtual volumes into the cache, and reclaiming stacked volume space.

The availability of VTS physical drives for certain functions can significantly effect VTS performance. The VTS will manage the internal allocation of these drives as required for various functions, but it will always reserve at least one physical drive for recall and one drive for copy.

Tape Volume Cache Management algorithms will also influence the allocation of physical drives. For example:

- **Cache Freespace Low:** The VTS will increase the number of drives available to the copy function and reduce the number of drives available for recalls.
- **Copy Queue High:** The VTS will reduce the number of drives available for recall down to a minimum of one drive in order to make drives available for the copy function.

The number of drives available for recall or copy will also be reduced during reclamation or Import/Export processing.

If the number of drives available for copy is restricted, this can lead to limiting the number of virtual volumes in the cache which are eligible to be migrated. This can lead to freespace or copy queue size throttling being applied.

If the number of drives for recall is restricted, this can lead to elongated virtual mount times for logical volumes being recalled.

8.3.4 Physical Stacked Volumes

There are two instances where physical stacked volumes can impact VTS performance.

The first instance is when multiple concurrent recalls occur for logical volumes that reside on the same stacked volume. These recalls will be processed serially. Although the VTS will not demount the stacked volume until all of the recalls currently queued for that volume are processed, the second and

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subsequent recalls from the same stacked volume will experience elongated mount times.

The second instance is when the minimum amount of scratch stacked volumes falls below 10. The VTS will automatically raise the priority of the reclamation process and will assign two 3590 physical drives and reclaim until it reaches 15 available scratch stacked volumes. If this happens the total number of drives available for copy or recall activity is reduced.

8.4 Monitoring and Evaluating VTS Performance

There are a number of techniques which you can use for monitoring and evaluating the performance of the VTS.

This section will describe some examples based on reporting tools called VTSSTATS and TAPECOMP. Please see 8.6.2, "Analyzing SMF Type 94 and LOGREC MDR Records" on page 232 for information on how to obtain these tools.

Every hour the 3494 Library Manager sends VTS statistics records to all attached MVS hosts. These statistics are recorded as SMF type 94 records. See Appendix B, "SMF Record Type 94 Format" on page 309 for a detailed description of the contents of this record. VTSSTATS produces reports and outputs flat files that are suitable for use with a spreadsheet program from SMF type 94 records.

TAPECOMP produces output reports and outputs flat files which provide data transfer, tape compression, and blocksize statistics. Input to TAPECOMP is LOGREC-data.

You can use EREPs MDR (miscellaneous Data Record) to obtain the data transferred over the channel and the data transferred to magnetic media (TVC). If you have a B18 EHPO or PAF, then the average compression ratio is derived from calculating the host write in MB divided by the MB written to the 3490E emulated virtual device or 3590 physical device with the standard B18. There is an MDR record for each tape de-mount. TAPECOMP will produce a report and flat file showing compression by hour and by shift. Please see page 232 for information on obtaining this tool.

To be able to make the best use of the information provided in the reports and files, you will need to have an understanding of some of the key fields in the type 94 records. Throughout this section, we will describe these key fields as necessary. In order to evaluate the performance of your VTS(s), you should note the following information regarding your configuration and setup:

- Model (Standard, EHPO or PAF)
- Cache size
- Number of physical 3590 drives in the VTS D12 frame
- Number of virtual volumes defined to the library manager
- Number of stacked volumes physically available in the ATL
- Number of ESCON channels attached to the VTS

You can find out the number of stacked and logical volumes in use by the VTS by interrogating the library manager console and searching for volumes in your specific category or range. Please see *Magstar 3494 Tape Library Operator Guide* for details on the VTS library manager console.

The following is a list of questions that you can use to evaluate the performance of the VTS. These questions have been formulated based on some rules of thumb or guidelines that have been developed, both from field experience and laboratory measurements, and have proven valuable in the evaluation of VTS performance.

1. **Is your ′Daily Average Virtual Volume Mount Time′ greater than 30 seconds?**

   Virtual mount response time will vary based on a number of factors, such as whether the mount request specifies a specific or non-specific volume to be mounted, whether a specific volume is in the tape volume cache or must be recalled from a stacked volume, and the overall workload of the library system.

   Figure 76 shows the VTSSTATS daily summary for the Virtual Drive Activity.

```
                                         DAILY VIRTUAL DRIVE ACTIVITY

     MAX      AVG     MAX TIME    AVG TIME  MAX HRLY AVG
  VIRTUAL  VIRTUAL   TO MOUNT    TO MOUNT    TIME TO    TOTAL   #FAST     #MNTS    #MNTS NOT %MNTS NOT   TIME ON VIRT DRIVE
  DRIVES   DRIVES    VIRTUAL     VIRTUAL    MOUNT VIRT VIRTUAL  READY   SATISFIED SATISFIED SATISFIED -------(SEC)---------
  MOUNTED  MOUNTED  DRIVE(SEC)  DRIVE(SEC)    DRIVE    MOUNTS    MNTS    IN TVC    IN TVC    IN TVC       MAX       AVG
   (vdx)    (vda)     (vrx)       (vra)                          (vfr)    (vmh)     (vms)                (vvx)     (vva)

    15       3.1        270        16.7         51      610      323       227        60        9.8     13733     603.9
```

Figure 76. VTS Daily Statistics Report Sample

VTSSTATS daily reports summarize the various SMF type 94 fields by day.

The field in question is called SMF94VRA (Average time in seconds used to complete a mount request on a virtual drive in the last hour).

A daily average virtual mount time of 30 seconds or less is usually considered an acceptable level of mount performance.

2. **Do you have any hourly ′Max Virtual Mounts′ greater than 900 seconds or any hourly ′Average Virtual Mounts′ greater than 300 seconds?**

   Figure 77 on page 212 shows the VTSSTATS Hourly Virtual Drive Activity Report.

```
              MAX       AVG      MAX TIME    AVG TIME                                                          VIRTUAL VOLUME RESIDENCY
            VIRTUAL   VIRTUAL    TO MOUNT    TO MOUNT    TOTAL    #FAST     #MNTS     #MNTS NOT  %MNTS NOT       TIME ON VIRTUAL DRIVE
            DRIVES    DRIVES     VIRTUAL     VIRTUAL    VIRTUAL   READY   SATISFIED  SATISFIED  SATISFIED    ------------(SEC)------------
     HOUR   MOUNTED   MOUNTED   DRIVE(SEC)  DRIVE(SEC)  MOUNTS    MNTS     IN TVC     IN TVC     IN TVC        MAX        MIN       AVG
   smf94==>(vdx)      (vda)       (vrx)       (vra)              (vfr)     (vmh)      (vms)                   (vvx)      (vvn)     (vva)

      08       6         2         232          39        27       11        9          7        25.9         1339        8        353
      09       5         2         191          24        42       16        20         6        14.2         1357        5        171
      10       5         1         197          15        24       11        11         2         8.3         1457        5        226
      11       6         1         244          51        43        8        23        12        27.9         2104        9        175
      12       9         4         259          28        35       16        14         5        14.2         2554       10        429
      13       9         3         198          18        32       16        12         4        12.5         1751        9        384
      14       5         2         243          23        35       14        16         5        14.2         1562        9        245
      15       6         2         152          15        60       11        42         7        11.6         1544        3        131
      16       3         1         190          29        23        5        14         4        17.3          718        9         84
      17       5         1         198          15        31        7        21         3         9.6          711        5        160
      18       5         1           1           1         5        0        5          0         0.0         1642       19        502
      19       5         2           5           1        20       13        6          1         5.0         1354        1        432
      20       8         2         204           9        27       19        7          1         3.7          965        9        396
      21       8         2           8           1         8        7        1          0         0.0         2311       12        751
      22       5         2         245          18        26       16        8          2         7.6         1253        6        391
      23      15         9         270          11        28       18        9          1         3.5         2413        9        608
      00      10         5           9           2        22       19        3          0         0.0         4214       36       1572
      01      10         7           8           1        19       19        0          0         0.0         2490       67       1074
      02      11         9          10           1        25       23        2          0         0.0         4908      128        847
      03       9         6           2           1        11       11        0          0         0.0         6015       67       1551
      04      10         5           3           1        17       15        2          0         0.0        13733        2       2366
      05       8         3           7           2        20       20        0          0         0.0         1229       70        494
      06       6         2           3           1        18       17        1          0         0.0         3628       10        665
      07       5         1           3           1        12       11        1          0         0.0         1207       12        487
                                                        -------   -----   --------   -------   ------
   DATE                                                   610      323      227        60         9.8
```

Figure 77. Sample VTS Hourly Virtual Drive Activity Report

The two fields in question are called SMF94VRX and SMF94VRA (Maximum and Average time in seconds used to complete a mount request on a virtual drive in the last hour).

If you have exceeded any of the two guidelines indicated for these records, it is likely to be caused by virtual volumes having to be recalled from the stacked volumes when drives are not available. This is an indication that the physical IBM 3590-B1A or E1A tape drives are over committed. See question 5 on page 215. In the sample report, you can see that the two fields in question do not have any values exceeding the guidelines.

Recall is driven by specific mounts that are cache misses. See question 3 on page 213.

During the recall process, the VTS subsystem needs to mount the physical stacked volume that holds the logical tape volume that is being requested by the host. The number of concurrent recall operations that are allowed is a function of several factors including the number of tape drives available and the amount of free space in the TVC. Queuing delays may occur, if the VTS is recalling multiple logical volumes which are located on the same stacked volume. Another possible cause of long mount times could be accessor contention for non-VTS drives which are in the same 3494.

Please also be aware of these factors:

- If there are no 3590 drives available, the recall mount will be queued until a drive becomes available.
- If the virtual volume to be recalled resides on a stacked volume that is in use by a copy task or another recall task, the recall mount will be queued until the copy or other recall task completes.
- If the virtual volume to be recalled resides on a stacked volume that is in use by a reclaim task (target or source), then the mount will be queued until the reclamation completes processing the current logical volume, after which the reclamation task will be terminated, and the recall mount will be processed.

Jobs requiring access to multi-volume datasets on virtual volumes, no longer in the TVC, are likely to see some delays in their mount times.

Other fields in the Hourly Virtual Drive report are explained here:

 # Fast Ready Mnts (SMF94VFR) should be a nonzero value during a time period when scratch mounts are occurring. If a scratch mount occurs for a tape that is not in the fast ready category, the VTS has to mount the old stacked volume in order to recall the logical volume before it is reused as a scratch tape. If the category has fast-ready turned on, the old stacked volume will not be mounted. Failure to establish proper fast ready category definitions obviously will increase physical drive and accessor activity and will have a negative effect on performance, especially on virtual mount times. Refer to 3.4.5, "Define Fast Ready Categories" on page 73 for more information about setting up the fast-ready categories.

 # Mnts Satisfied in TVC (SMF94VMH) shows the number of specific mounts for a logical volume which have been satisfied without having to mount the stacked volume (cache hits). These types of mounts will be satisfied very quickly. The number depends on the effective size of the TVC and the time between references of logical volumes. When we say "effective size," we are referring to the size of the TVC, regardless of whether or not you have the EHPO feature, which provides compression before data is written in the TVC. With the EHPO feature installed, you can fit more logical volumes in the TVC, thus, allowing all of the logical volumes to stay in the TVC for a longer period of time.

 # Mnts Not Satisfied in TVC (SMF94VMS) shows how many times stacked volumes were mounted to satisfy a request for a specific virtual mount (cache miss). This number may be different from the physical stage number because the VTS attempts to keep a stacked volume mounted. If another recall is attempted for a different logical volume on the same stacked volume, another mount is not needed, thereby, reducing accessor activity.

Virtual Volume Residency Time (SMF94VVX,VVN,VVA) specifies the maximum, minimum, and average time in seconds that a virtual volume was mounted on a virtual drive in this VTS during the last hour. Time is accrued from completion of the mount until a demount is issued.

3. **Are the Hourly % Mounts Not Satisfied in TVC greater than 20%?**

See Figure 77 on page 212 - Virtual Drive Activity Report.

The percentage is shown in the report. It also can be calculated by dividing the number of virtual mounts not satisfied in TVC (SMF94VMS) by the total virtual mounts, times 100. If you are not using VTSSTATS, then the total virtual mounts is the sum of (SMF94VFR,SMF94VMH and SMF94VMS).

Typically, if the number of cache misses is less than 20%, then the overall average virtual mount time should be about 30 seconds or less.

If you are constantly exceeding this guideline, and your overall average mount time is greater than 30 seconds, you may want to investigate why you are having so many recalls. If you cannot prevent or reduce these recalls by

rescheduling or removing workload, then a larger cache capacity may improve your cache hit ratio.

4. **How much data is my VTS managing and how much more data can it store before it becomes full?**

This is measured by capacity used in MB (SMF94VBA) and capacity available in MB (SMF94VEC) of the defined and inserted stacked volumes. These volumes store virtual volumes and are either scratch, full, filling, or partially full (once full but now holding virtual volumes that have expired).

For a detailed analysis of the management of these volumes, please refer to 8.7, "A VTS Capacity Planning Walk Through" on page 233.

Figure 78 shows the VTSSTATS Hourly Tape Volume Cache Activity Report.

HOUR smf94==>	MBYTES WRITTEN TO TVC (vbw)	MBYTES READ FROM TVC (vbr)	CHANNEL MBYTES PER SECOND	MBYTES WRITTEN TO PHYSICAL (vtw)	MBYTES READ FROM PHYSICAL (vtr)	AVG MINS SINCE VV LAST REF (vca)	AVG SIZE OF VIRT VOLUME(MB) (vcz)	# VIRTUAL VOLUMES IN TVC (vnm)	VIRTUAL VOLUMES PREMIGED (vmp)	#LOG VOLS MANAGED BY VTS (vla)	CAPACITY USED (MB) (vba)	CAPACITY AVAILABLE (MB) (vec)
08	10152.2	6330.8	4.57	11557.3	4928.7	1122	440	649	21	14088	6192748	2263000
09	15605.3	752.9	4.54	9954.6	2943.6	1054	440	636	25	14105	6201455	2247500
10	9052.8	1667.2	2.97	5486.1	892.3	1058	440	634	12	14120	6206929	2232000
11	6237.2	1753.6	2.21	15232.5	5949.9	1009	440	627	28	14128	6209599	2232000
12	17758.4	6352.0	6.69	10002.7	2933.1	922	439	601	18	14135	6212104	2216500
13	21993.7	1543.0	6.53	16250.4	1058.5	898	440	595	31	14148	6219390	2216500
14	13729.9	659.4	3.99	8756.5	1804.1	847	440	579	22	14167	6228839	2201000
15	15082.1	1825.0	4.69	14911.3	1544.0	833	440	582	33	14183	6234680	2170000
16	4856.0	1974.2	1.89	6162.2	1760.2	846	440	573	15	14195	6239216	2170000
17	3433.2	7000.3	2.89	3701.6	1294.6	869	440	571	9	14201	6241596	2170000
18	5404.6	1275.3	1.85	4460.4	0.0	916	439	573	7	14206	6243403	2170000
19	19899.6	579.6	5.68	3292.4	0.0	926	440	572	6	14210	6245360	2154500
20	20758.7	83.1	5.78	12617.9	714.6	926	440	571	23	14219	6250171	2154500
21	14358.3	6.6	3.99	6203.8	0.0	949	440	578	15	14234	6257135	2154500
22	19258.9	4143.1	6.50	7917.2	1482.0	937	440	571	14	14249	6263339	2123500
23	25790.0	13158.7	10.81	5555.9	785.8	942	440	562	16	14260	6268228	2123500
00	26048.4	5707.9	8.82	10839.6	0.0	927	439	561	21	14272	6272077	2123500
01	34841.6	0.0	9.67	8531.4	0.0	908	440	561	16	14294	6283510	2108000
02	38033.5	2519.4	11.26	17574.1	0.0	869	440	549	26	14309	6291285	2092500
03	21432.1	0.0	5.95	7981.9	0.0	881	440	546	13	14106	6207912	2077000
04	15340.1	0.0	4.26	8245.3	0.0	883	440	541	17	14120	6216300	2061500
05	24299.0	0.0	6.74	7370.6	0.0	882	440	543	18	14137	6224546	2032800
06	19487.2	3.9	5.41	6533.4	0.0	898	440	547	15	14157	6232808	2032800
07	17077.8	8.7	4.74	9324.2	0.0	902	440	547	18	14172	6239341	2002000
DATE	419930.6	57344.7		218463.3	28091.4				439			

Figure 78. VTS Hourly TVC Activity Report

A description of the appropriate SMF fields are explained here:

# of Logical Volumes Managed by VTS (SMF94VLA) This field indicates the number of logical volumes managed by VTS. This actually includes all the logical volumes that have ever been used by the VTS, PLUS every instance of every volume that has been used by the VTS since the VTS has last performed reconciliation. Reconciliation is the process during which the VTS determines the most recent copy of a virtual volume, and it deletes all other instances of that volume from the active volume list. Therefore, once all the volumes have been used at least once, the SMF94VLA value should be at least as large as the total number of logical volumes defined. The difference between SMF94VLA and the total number of defined logical volumes is the number of instances that logical volumes have been used since the last reconciliation. Thus, the number would show an increase as the logical volumes are being used until the next reconciliation. Reconciliation is run every 18 hours unless the system is very busy. After 24 hours, it will run regardless of how busy the system is. After reconciliation has identified any volumes eligible for reclamation, then reclamation will start unless it is inhibited by

schedule or lack of drives. Virtual volumes that exist in the TVC but have not been copied to tape are not included. Please see 3.4.6, "Reclamation and Reconciliation" on page 75 for a detailed overview.

Capacity Used in MB (SMF94VBA) This field contains the sum of the compressed megabytes accumulated on the SMF94VLA logical volumes.

Capacity Available in MB (SMF94VEC) is calculated from the number of stacked volumes in the scratch category. Partially filled stacked volumes are not included in this calculation. The number of empty stacked volumes is multiplied by the estimated amount of data that could be stored on one of these volumes. For a 3494 Model B18 without EHPO, this number would be 20 GB for the 3590-B1A tape drives and 40 GB for the 3590-E1A tape drives, which is obtained by assuming a 2:1 compression ratio. For a 3494 Model B16, this number would be 20 GB for the 3590-B1A tape drives.

The 3494 Model B18 VTS with enhanced ESCON host attachments provides compression into the TVC; therefore, further compression when writing to the stacked volume is unlikely, and the capacity of a stacked volume will be approximately 10 GB of TVC data for the 3590-B1A tape drives and 20 GB of TVC for the 3590-E1A tape drives. With this configuration, the value presented has been interpreted into host data capacity by multiplying the number of scratch physical volumes times 10 (or 20 for 3590-E1A), multiplied by the historic compression ratio. Because the compression ratio can fluctuate, the value presented can also fluctuate.

 # Virtual Volumes Premigrated (SMF94VMP) refers to the number of copy to tape processes that have been completed. A high number here indicates high write activity, which is normal after heavy application write activity in prior intervals, where the VTS might not have been able to keep pace with the host data rate.

Average Size of Virtual Volume (SMF94VCZ) specifies the average size in MB of all logical volumes that are managed by the VTS. It does not include any volumes that are in cache. It is a calculated field, (SMF94VBA divided by SMF94VLA). The size is reported as the compressed size in case of an EHPO or PA configuration.

 # Virtual Volumes in TVC (SMF94VNM) specifies the number of logical volumes held in the TVC. If any of these volumes were requested by the host, it would result in a cache hit.

5. **Is performance constrained by the number of drives available?**

   Background tasks within the virtual tape server controller can also influence overall performance. Those background tasks include space reclamation, logical volume recalls(cache misses) and the copy process, all of which use the 3590 B1A or E1A drives managed by the VTS in the D12 frame. If your analysis proves that you are constrained by the total number of drives you have defined, then you may consider upgrading up to the maximum of six drives.

   Figure 79 on page 216 shows the VTSSTATS Hourly Physical Drive Activity

HOUR smf94==>(vta) PHYS DRIVES AVAIL.	MAX PHYS DR MOUNTED (vtx)	AVG PHYS DR MOUNTED (vtv)	MAX SECS TO MOUNT PHYS DR. (vmx)	MIN SECS TO MOUNT PHYS DR. (vmn)	AVG SECS TO MOUNT PHYS DR. (vmv)	_MOUNTS BY__ ACCESSOR -A- (aca)	-B- (acb)	TOTAL PHYSICAL MOUNTS	PHYSICAL MNTS FOR RECALL (vps)	PHYSICAL MNTS FOR COPY (vpm)	PHYSICAL MNTS FOR RECLAIMS (vpr)	VIRTUAL VOLUMES PREMIGED (vmp)
08	6	6	4	56	30	36	0	0	14	4	10	0	21
09	6	4	2	59	30	39	0	0	9	6	3	0	25
10	6	4	2	42	33	36	0	0	7	4	3	0	12
11	6	6	4	110	31	45	0	0	19	13	6	0	28
12	6	5	2	37	33	35	0	0	9	5	4	0	18
13	6	5	2	51	34	38	0	0	8	4	4	0	31
14	6	6	3	52	32	36	0	0	10	6	4	0	22
15	6	5	3	83	31	40	0	0	14	7	7	0	33
16	6	5	2	38	33	34	0	0	7	5	2	0	15
17	6	5	1	37	31	33	0	0	5	3	2	0	9
18	6	2	1	45	39	42	0	0	2	0	2	0	7
19	6	2	1	40	30	35	0	0	3	0	3	0	6
20	6	4	2	47	31	34	0	0	9	1	8	0	23
21	6	4	2	49	33	37	0	0	7	0	7	0	15
22	6	3	1	39	33	35	0	0	7	3	4	0	14
23	6	2	1	63	29	42	0	0	3	1	2	0	16
00	6	5	2	61	29	45	0	0	6	0	6	0	21
01	6	3	1	35	31	33	0	0	4	0	4	0	16
02	6	6	3	56	33	39	0	0	5	0	5	0	26
03	6	3	1	43	33	36	0	0	3	0	3	0	13
04	6	4	1	120	31	56	0	0	6	0	6	0	17
05	6	5	2	55	30	37	0	0	5	0	5	0	18
06	6	3	1	51	33	37	0	0	6	0	6	0	15
07	6	3	1	50	36	39	0	0	4	0	4	0	18
DATE									172	62	110	0	439

Figure 79. VTS Hourly Physical Drive Activity

A description of the associated SMF records are shown here:

Mounted physical drive count (SMF94VTA,VTX,VTV) numbers (actual, maximum, and average) should indicate how busy the drives are. If the average numbers are close to the number of drives that you have configured, you may be constrained by the number you have. These values are established by periodic sampling. Tape drive residency time for stacked volumes tends to be high during periods of low host activity because of asynchronous copy processes to write logical volumes from TVC to stacked volumes. That is why you should use a daily summary to evaluate the physical drive usage.

Alternatively, you may be constrained by the size of your TVC, because a constrained TVC tends to cause excessive movement of logical volumes to and from the stacked volumes.

Physical mount activity (SMF94VPS,VPM,VPR) numbers (recall, copy, reclaim) are used to determine the usage of the physical tape drives.

Recall indicates how many times stacked volumes were mounted to copy virtual volumes back into the TVC. The number of mounts for **copy** tells you how much physical mount activity is related to writing new data out to the stacked volumes. This number may not be very high because the VTS tries to keep the stacked volumes mounted when it can. **Reclaim** is used to move active data from one stacked volume to another once it has reached its reclamation threshold, thus, returning the source to scratch. A high reclaim mount number could indicate that you have set the reclaim threshold at too high a value. Please refer to 3.4.6, "Reclamation and Reconciliation" on page 75 for a detailed overview.

Other possible reasons for high reclaim mount numbers include:

- A previous time interval with high cache usage rate prevented reclamation.

- There has been a recent change of reclaim threshold on the Library Manager.

- A recent heavy use of virtual scratch volumes that had been previously used and, thus, became eligible for reclamation from the stacked volumes.

- The average expiration period is very small.

- You have reached the minimum amount of stacked volumes that the VTS allows before making reclaim a priority. You can issue the **D SMS(libname),DETAIL** command which will show you the number of Scratch Stacked Volumes that you currently have available.

6. **Is the VTS throughput constrained?**

The throughput of the VTS depends on many factors which include the model type, the mixture of host read and writes, block sizes, number of channels, compression ratio of the data, number of D12 3590 B1A or E1A drives you have configured, and the size of the tape volume cache.

Given your configuration and data characteristics you can estimate the theoretical throughput capabilities for your VTS.

The basis for evaluating VTS throughput is a set of laboratory measurements for three different environments: sustained write, peak write and mixed.

The **sustained write** measurement is the key performance measure of the VTS. It is best described as the amount of data transferred in one hour from the host, through the ESCON channel adapters, through the virtual tape drives onto the tape volume cache and then onto the 3590 B1A or E1A drives. There is no host read or recalls. The VTS can sustain this rate of throughput indefinitely.

The **peak write** measurement is best described as the amount of data transferred in one hour from the host, through the ESCON channel adapters, through the virtual tape drives onto the tape volume cache. There is no data movement between the tape volume cache and the tape drives, and there is no host read. The VTS can sustain this rate of throughput only until the TVC freespace threshold is exceeded.

Mixed is described as a typical workload, where data is being written from the host, through the ESCON adapters, through the virtual tape drives onto the tape volume cache and onto the 3590 B1A or E1A drives. Data is also being read from the tape volume cache, through the virtual tape drives and ESCON channel adapters to the host, and data is also being read from the 3590 B1A or E1A tape drives through the tape volume cache, through the virtual tape drives and ESCON channel adapters to the host. The mixed workload measurements are based on a workload of 60/40 mix of writes/reads. The writes are all scratch writes and the reads are based on a 50% cache hit ratio. Therefore we have 20% cache miss rate, each miss invoking a recall from a stacked cartridge. This rate of throughput is, for practical purposes, equal to the sustained write rate. The VTS can sustain this rate of throughput indefinitely.

The following graphs were constructed by using data from laboratory measurements for the three environments discussed above. Figure 80 on page 218 and Figure 81 on page 218 show the maximum throughput in host

Mbytes/second for various data blocksizes and ESCON channel configurations. Figure 80 on page 218 applies to VTS's without Extended Performance ESCON Channel Adapters (FC 3412).
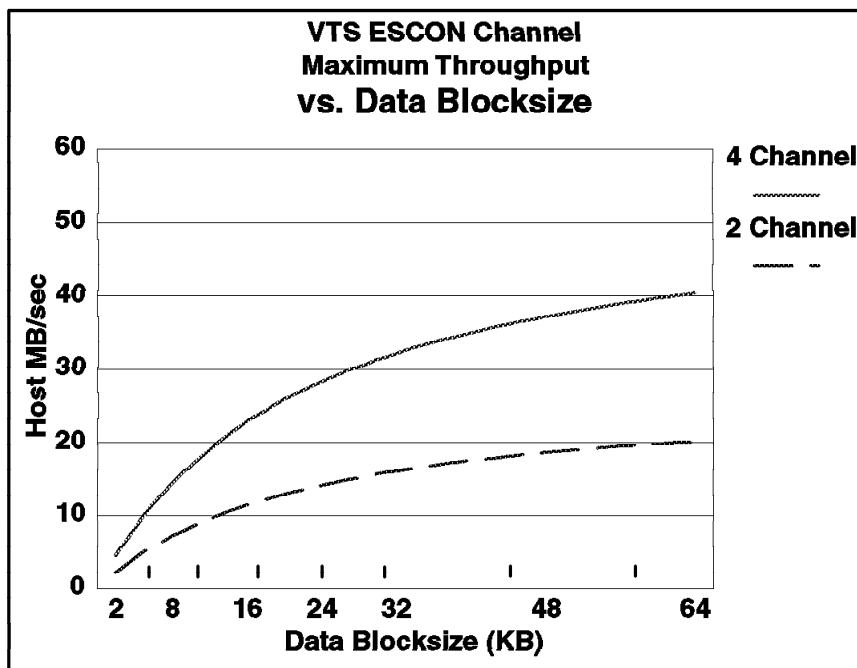

Figure 80. VTS ESCON Channel Throughput

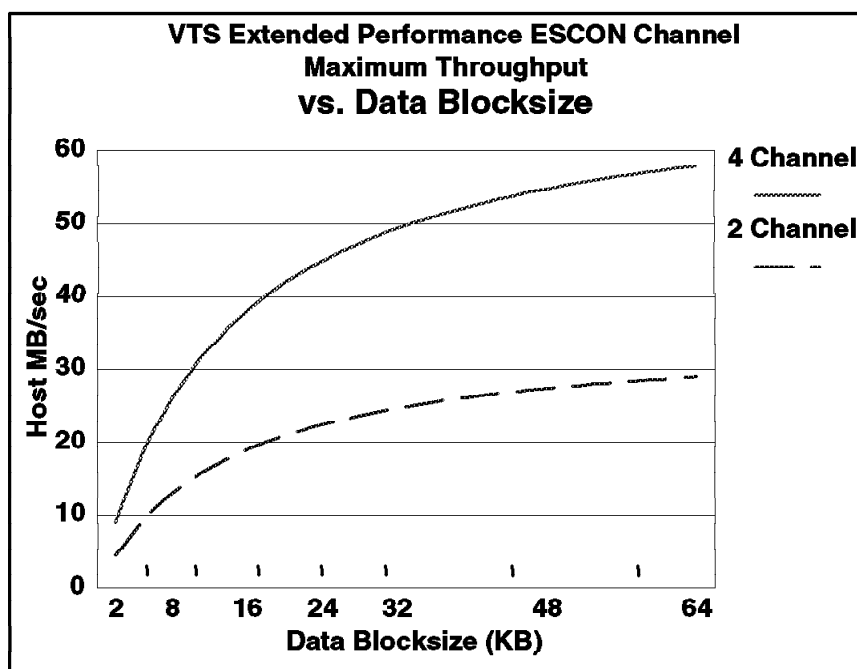Figure 81 applies only to VTS with FC 3412.

Figure 81. VTS Extended Performance ESCON Channel Throughput

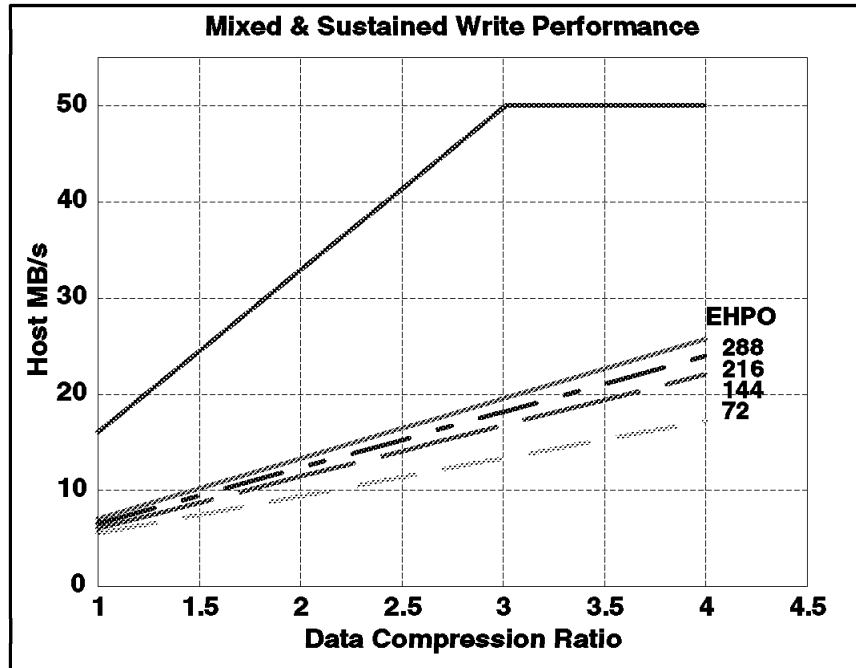Figure 82 on page 219 shows the maximum mixed and sustained write throughput in host Mbytes/second for various VTS cache sizes and data compression ratios.

Figure 82. Mixed and Sustained Write Performance

Figure 83 shows the maximum peak write throughput in host Mbytes/second for various VTS cache sizes and data compression ratios.
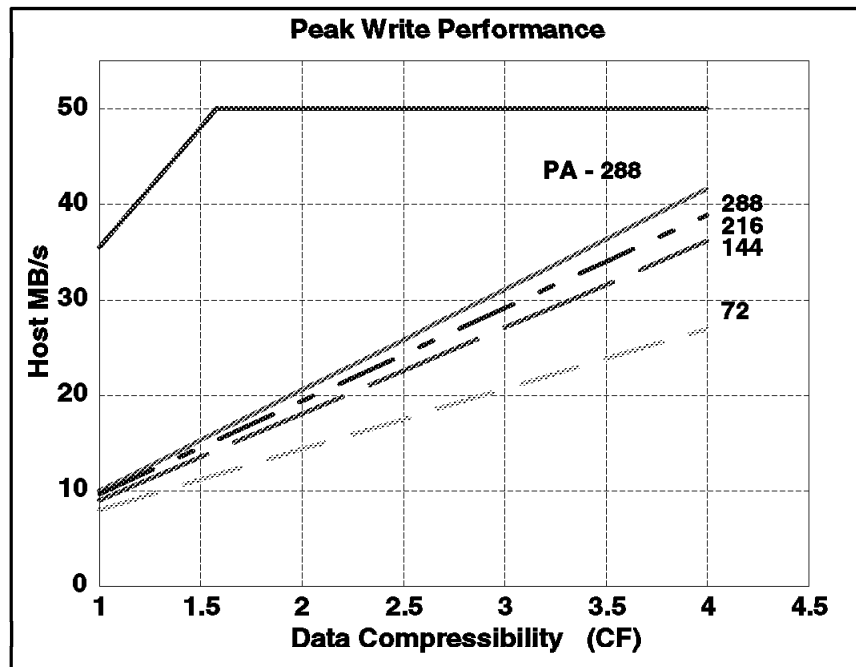
Figure 83. Peak Write Performance

In order to determine the sustained, mixed, and peak Mbytes/Sec throughput values for your configuration, follow these steps:

a. Determine whether you should use Figure 80 on page 218 or Figure 81 on page 218 based on the type of channel adapters on your VTS.

b. Determine the average data blocksize and compression ratio for the period you wish to evaluate by using TAPECOMP.

c. Find and note the maximum throughput value on the appropriate channel throughput graph by using blocksize and number of channels.

d. Find and note the maximum throughput value on the mixed and sustained and peak write performance charts by using the data compression ratio for the period you wish to evaluate and the appropriate cache size. If you are evaluating a PAF, use the PAF line for both 144 and 288 GB cache sizes.

   Note: If you wish to evaluate a model B16 or model B18 without EHPO, you should assume a compression ratio of 1:1.

e. Your theoretical maximum throughput for the period being evaluated is the LOWER of the value obtained from the channel throughput chart and the mixed and sustained or peak write performance chart.

Example 1

- VTS model: B18 EHPO
- Cache size: 144 GB
- Number of ESCON channels: 2
- Type of ESCON channel adapter: Non FC 3412
- Average data blocksize: 28KB
- Average Compression ratio: 3.5:1

From Figure 80 on page 218, the maximum throughput value is approximately 15 Mbytes/second.

From Figure 82 on page 219, the maximum mixed and sustained throughput value is approximately 21 Mbytes/second. In this case, the lower value is the ESCON throughput value, 15 MBytes/second. Therefore, the maximum mixed and sustained throughput for the period being evaluated is 15 MBytes/second.

From Figure 83 on page 219, the maximum peak throughput value is approximately 32 Mbytes/second. In this case, the lower value is the ESCON throughput value, 15 MBytes/second. Therefore, the maximum peak throughput for the period being evaluated is 15 MBytes/second.

Example 2

- VTS model: B18 PAF
- Cache size: 288 GB
- Number of ESCON channels: 4
- Type of ESCON channel adapter: FC 3412
- Average data blocksize: 32KB
- Average Compression ratio: 2.5:1

From Figure 80 on page 218, the maximum throughput value is approximately 49 Mbytes/second.

From Figure 82 on page 219, the maximum mixed and sustained throughput value is approximately 42 Mbytes/second. In this case, the lower value is the write performance value, 42 MBytes/second. Therefore, the maximum mixed and sustained throughput for the period being evaluated is 42 MBytes/second.

From Figure 83 on page 219, the maximum peak throughput value is approximately 50 Mbytes/second. In this case, the lower value is the ESCON

throughput value, 49 MBytes/second. Therefore, the maximum peak throughput for the period being evaluated is 49 MBytes/second.

Once you have determined the theoretical maximum MBytes/second throughput capability for the period being evaluated, compare it to the actual throughput achieved for the period. You can calculate the achieved MBytes/second value by using the SMF94VBW and SMF94VBR (MBytes Written/Read to and From the TVC) values from the SMF type94 data for the period being evaluated. Even though the graphs are for write and mixed performance, use the total aggregate read plus write values from the Type 94 records for this evaluation. Figure 78 on page 214 contains these values.

If the theoretical maximum level of mixed and sustained throughput is never exceeded, that is, there are no hours above x Gbytes/hour data transfer (where x is your mixed and sustained value), then the VTS has room for workload growth.

If the theoretical maximum mixed and sustained level of throughput is occasionally exceeded, such as on busy days, or only once per day, then the VTS should be giving good performance overall, but there is likely little or no room for additional workload during these hours. New workloads should be scheduled for other periods.

If the theoretical maximum mixed and sustained throughput level is exceeded for multiple hours per day, or for multiple consecutive hours, then it may be necessary to remove workload, upgrade the VTS or add an additional VTS to improve performance.

In the above case, you most likely will be experiencing other symptoms of performance degradation, as described in this section.

Note: During periods of heavy VTS throttling, host write activity is severely constrained. For this reason, an examination of VTS throughput during such periods may not indicate that maximum sustained and mixed throughput is being exceeded, and, in fact, it would likely appear that the VTS is running at rates far below this maximum. In this case, however, other performance degradation symptoms would be occurring (see "Are you experiencing elongated or erratic job run times?" below).

Here are the descriptions of the SMF94 records that you will be using from the VTSSTATS report.

Mbytes Written/Read to and From the TVC (SMF94VBW,VBR) can be used to analyze how much data is going to the VTS and how much is being read back from the VTS. These numbers are data amounts as measured from the host. These numbers are shown as uncompressed data. You can also obtain this information from EREP as the MDR records cut to the recorder file (LOGREC) that contain the data transferred over the channel and the data transferred to magnetic media (TVC).

Mbytes Written to Physical (SMF94VTW) specifies how much data has been written from the TVC to a stacked volume (Copy). These numbers reflect compressed data if reported from an EHPO or PAF configuration.

Mbytes Read from Physical (SMF94VTR) specifies how much data has been read back in from the stacked volume, when the data did not already reside in the TVC (Cache miss). These numbers reflect compressed data if reported from an EHPO or PAF configuration.

You may see a large number of MB written down the channel in one hour, and then, the following hour, you may see a large number written to the physical 3590. The VTS has a buffering effect on workloads that tend to have peaks. It allows the heavy host write to occur in one period and can use excess bandwidth in a subsequent period to write the data to a stacked volume.

7. **Are you experiencing elongated or erratic job run times?**

Elongated or erratic job run times can be caused by a high level of throttling by the VTS. Throttling is not directly reported by the VTS, however, RMF Disconnect Time can be used as an indication of VTS throttling. RMF reports the VTS delay on the host write I/O as Disconnect Time.

You can use RMF reports or monitors in conjunction with the VTSSTATS report to check the times when you suspect VTS throttling may have occurred. If you have 15 minute intervals when the disconnect time for VTS virtual drives exceed 500ms, then this is an indication that throttling is occurring. Please see Chapter 8, "VTS Performance" on page 203 for more details on throttling.

8.4.1 Hardware Capacity

If the workload is appropriate or, in any case, a given, and the VTS is indicating signs of stress, then it may be necessary to add system capacity.

Upgrading the TVC capacity can provide improvements in virtual mount times, throughput, and read cache hits and offer protection against throttling.

If the VTS subsystem is configured with less than six 3590 drives in the VTS D12 frame, and you are suffering from long virtual mount times or throttling is occurring, consider installing the full complement of 3590s.

Also, depending on your current system configuration, consider upgrading to either EHPO or the Performance Accelerator feature. Please see Chapter 4, "VTS Performance Accelerator" on page 99 for more details.

8.5 Using Library Manager Windows to Monitor the VTS

In this section we show and describe a few useful windows which can be used to display information on performance and capacity of the VTS subsystem and how they relate to the SMF94 type record. We will not cover all windows available on the library manager here. Please see *Magstar 3494 Tape Library Operator Guide* for more detailed information on Library Manager windows.

You can access the windows from the **Status** pull-down menu (Figure 84 on page 223) on the Library Manager action bar.
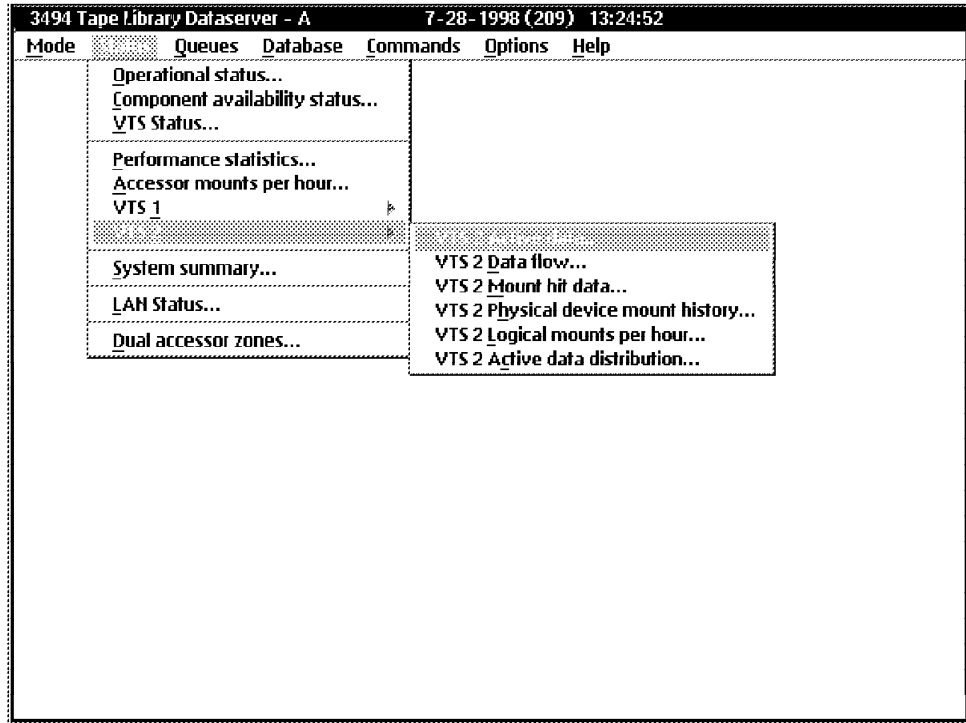
Figure 84. Status Pull-Down Menu

8.5.1 Performance Statistics

The Performance Statistics window (Figure 85) displays statistics related to physical activity in the library. This includes a brief mount summary for the 3590-B1A or 3590-E1A drives in the VTS D12 frame. Actions involving VTS logical volumes are not part of these statistics.
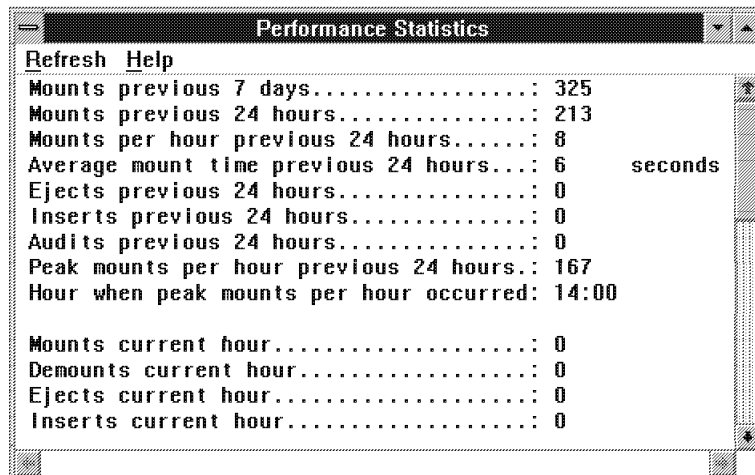


```
─         Performance Statistics            ▼ ▲
Refresh  Help
Mounts previous 7 days..................: 325          ⬆
Mounts previous 24 hours...............: 213
Mounts per hour previous 24 hours......: 8
Average mount time previous 24 hours...: 6      seconds
Ejects previous 24 hours...............: 0
Inserts previous 24 hours..............: 0
Audits previous 24 hours...............: 0
Peak mounts per hour previous 24 hours.: 167
Hour when peak mounts per hour occurred: 14:00

Mounts current hour....................: 0
Demounts current hour..................: 0
Ejects current hour....................: 0
Inserts current hour...................: 0
                                                       ⬇
```

Figure 85. Performance Statistics Window

8.5.2 VTS Active Data

The Active Data window (Figure 86) displays a graph showing the amount of active data, amount of free storage, maximum active data, and a free storage alarm level for the stacked volumes in a VTS. The data stored on stacked volumes is from the TVC and may be compressed when the VTS has the EHPO feature; therefore, the graphs do not represent actual host data bytes, but they represent the compressed volume sizes as stored in the TVC. A separate graph is available for each VTS in the library. Data is displayed for the previous 29 days as of midnight and for the current day on an hourly snapshot.
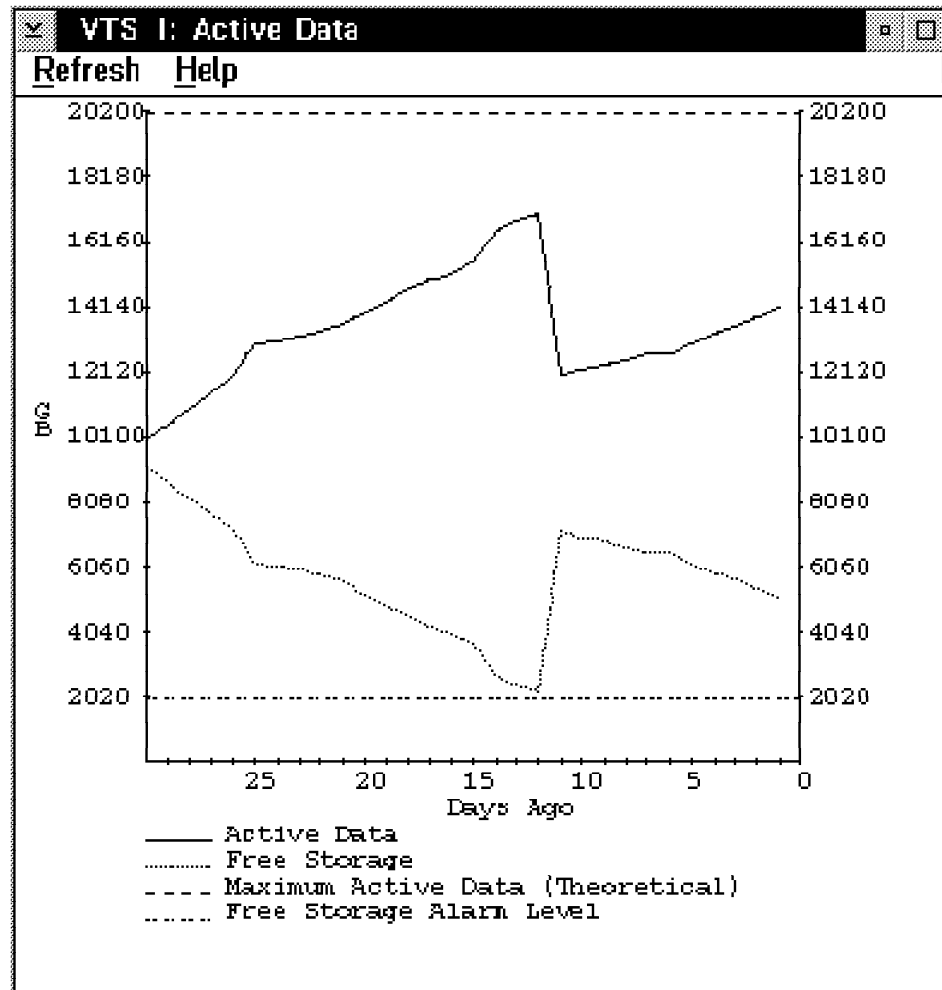
Figure 86. VTS Active Data Window

Active Data (SMF94VBA Capacity Used in MB) is the total size, as stored in the TVC, of all active logical volumes that have been copied to stacked volumes. Virtual volumes that exist in the TVC but that have not been copied to tape are not included. Invalidated copies of logical volumes (duplicate volumes which have not been deleted from the active volume list during the reconciliation process) are included in this field.

Note: Invalidated copies of logical volumes reduce the amount of active data you can store on the stacked volumes. Please see 3.4.6, "Reclamation and Reconciliation" on page 75 for a detailed description.

Maximum Active Data is the total capacity of all stacked volumes that have been inserted in the VTS. For the model B16, the Maximum Active Data is a theoretical value computed by assuming that stacked volumes are filled with a 2:1 compression ratio. The VTS model B18 with EHPO or Performance Accelerator Feature uses the actual compression ratio achieved for all data copied from the TVC to full stacked volumes to calculate the Maximum Active Data. Because data received from the EHPO host attachments has previously been compressed into the TVC, compression to the stacked volume from the TVC will be approximately 1 to 1 for the B18.

Free Storage (SMF94VEC Capacity Available) is the total capacity of all empty stacked volumes in the library calculated by using a compression ratio as described for Maximum Active Data above. Partially filled stacked volumes are not included in this calculation. Free Storage gives an indication of how much data from the TVC can be added to stacked volumes currently in the VTS. You can display, via the Library Manager, how many scratch stacked volumes you have currently available by searching on category FF03. Please see *Magstar 3494 Tape Library Operator Guide*.

Free Storage Alarm Level is a threshold to warn you when to add more stacked volumes to the VTS library. If the number of empty stacked volumes available is less than the number of stacked volumes required to store the amount of TVC data specified by the Free Storage Threshold (GB), the Library Manager signals an intervention required condition to notify the operator to add more stacked volumes. See 3.4.6, "Reclamation and Reconciliation" on page 75 for information on the recommended threshold settings. You can modify the alarm threshold on the Library Manager's VTS Management Policies window (see *Magstar 3494 Tape Library Operator Guide*).

8.5.3 Virtual Tape Server Data Flow

The Data Flow window (Figure 87 on page 226) displays a graph showing the amount of data written to and read from the channel **(SMF94VBW and SMF94VBR)**. Data is displayed for the previous 24 hours and is unique to the particular VTS that was selected. The numbers are based on the amount transferred at the channel interface, though, they reflect the (uncompressed) amount of host data. The current hour's data is designated by a diamond-shaped marker.
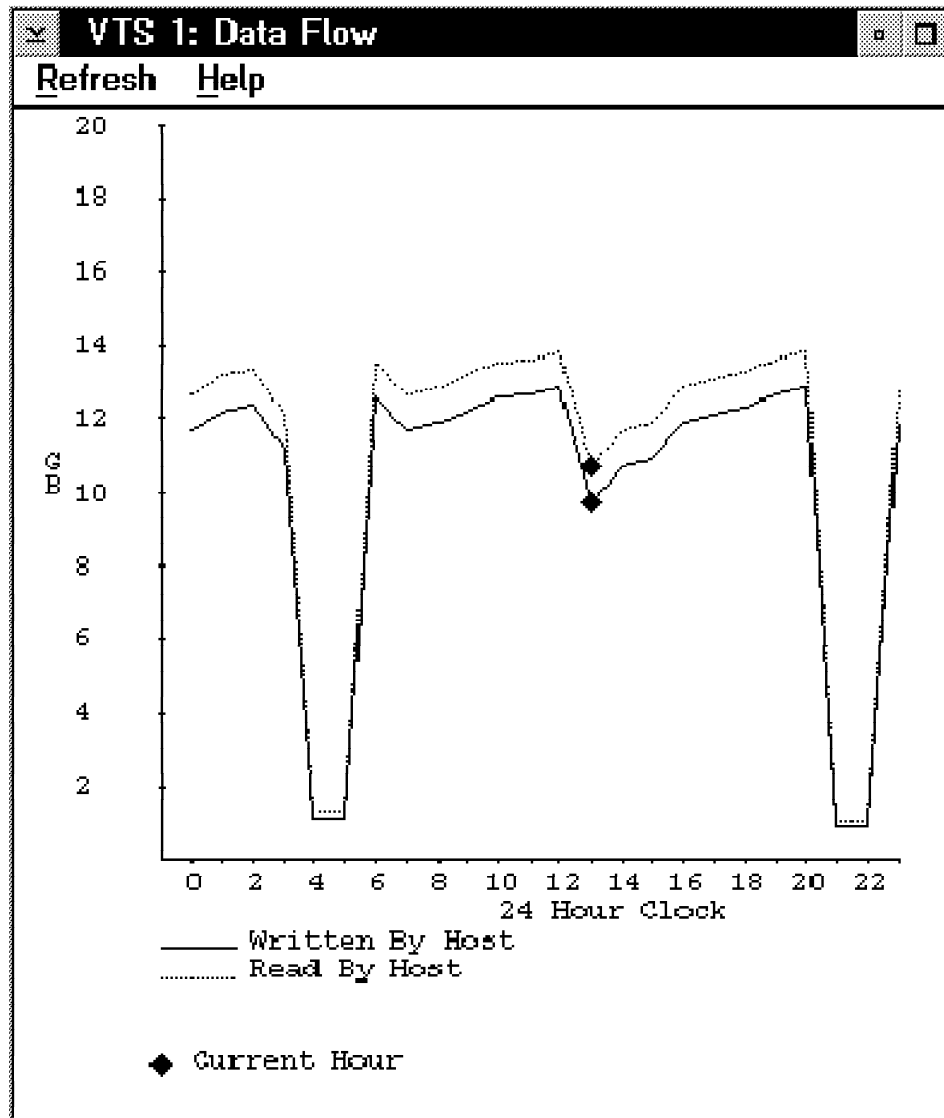
Figure 87. VTS Data Flow Window

The Written By Host and Read By Host curves show the amount of data successfully transferred through the host channels to and from virtual volumes during the hour. The bytes are credited to the hour in which the virtual volume is closed.

8.5.4 Virtual Tape Server Mount Hit Data

The Mount Hit Data window (Figure 88 on page 227) shows the distribution in percentage of three types of logical mounts:

- **Fast-ready hits (SMF94VFR)**
- **Cache hits (SMF94VMH)**
- **Cache miss, mounts requiring a recall (SMF94VMS)**

Data is displayed for the previous 24 hours. The current hour's data is designated by a diamond-shaped marker.

The graph displays three lines, one for each type of mount, indicating its percentage of the total number of mounts for an hour. To display the total

number of logical mounts per hour, use the Logical Mounts Per Hour window
(Figure 90 on page 229).
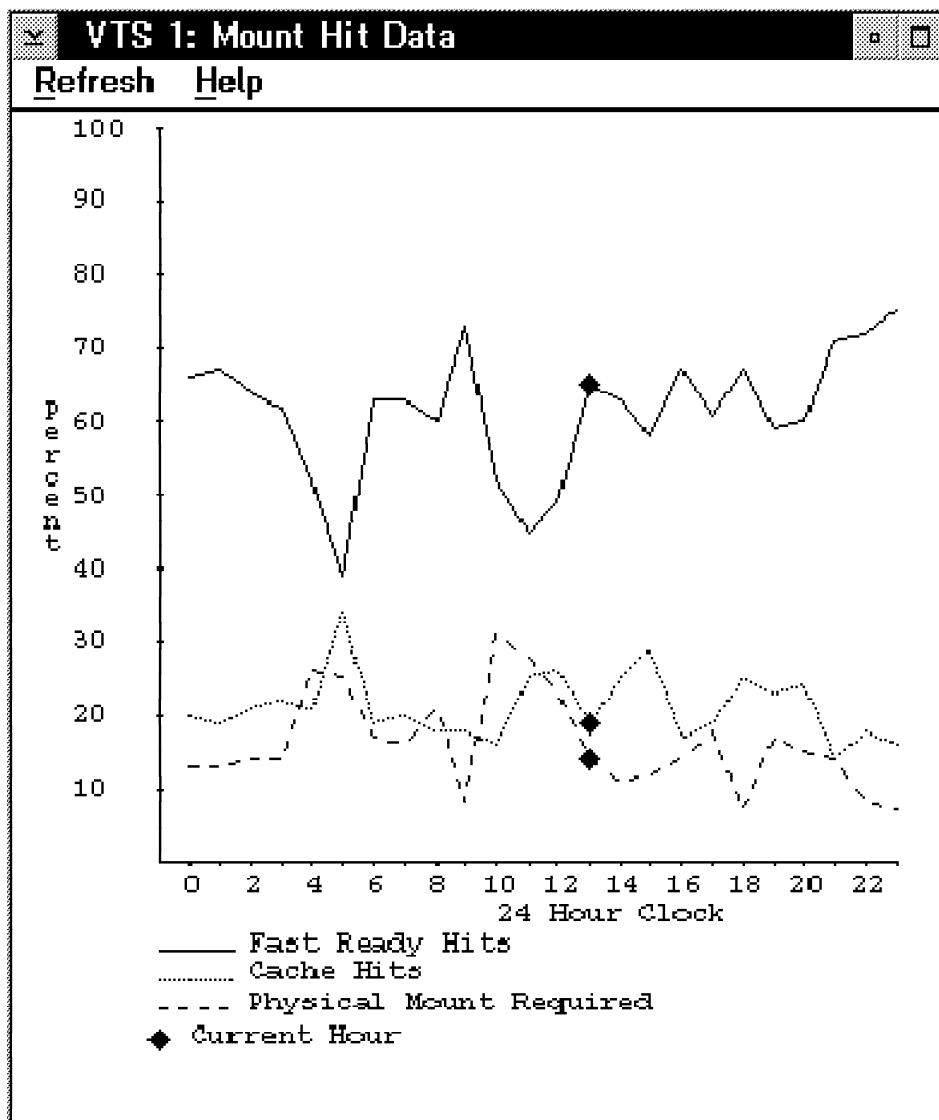
Figure 88. VTS Mount Hit Data Window

Fast Ready Hits (SMF94VFR) is the number of times the host requested a mount
from a specific volume category, and the category was designated as
"fast-ready." Typically, these are scratch mounts. Because this type of mount
does not require any recall of data from tape, it is the fastest. To benefit from
fast ready hits, assign the fast ready attribute to your scratch volume categories.
If this value is 0 you should check your fast ready categories settings described
in 3.4.5, "Define Fast Ready Categories" on page 73.

The Cache Hits (SMF94VMH) curve shows the number of virtual mounts, where
the volume to be mounted still resides in the TVC. This type of mount does not
require any recall of data from tape.

Physical Mount Required (SMF94VMS) is the number of times a logical volume
had to be recalled from a stacked volume into the TVC to satisfy a virtual mount
request. While a stacked volume is mounted, the VTS can recall more than one

logical volume from it. Therefore, the graph does not represent the number of times a stacked volume actually had to be mounted in response to a virtual mount request. This is the slowest type of virtual volume mount.

8.5.5 VTS Physical Device Mount History

The Physical Device Mount History window (Figure 89) displays a graph showing the average, maximum, and minimum number of physical tape drives used at one time to mount stacked volumes. Data is displayed for the previous 24 hours. The current hour's data is designated by a diamond-shaped marker.
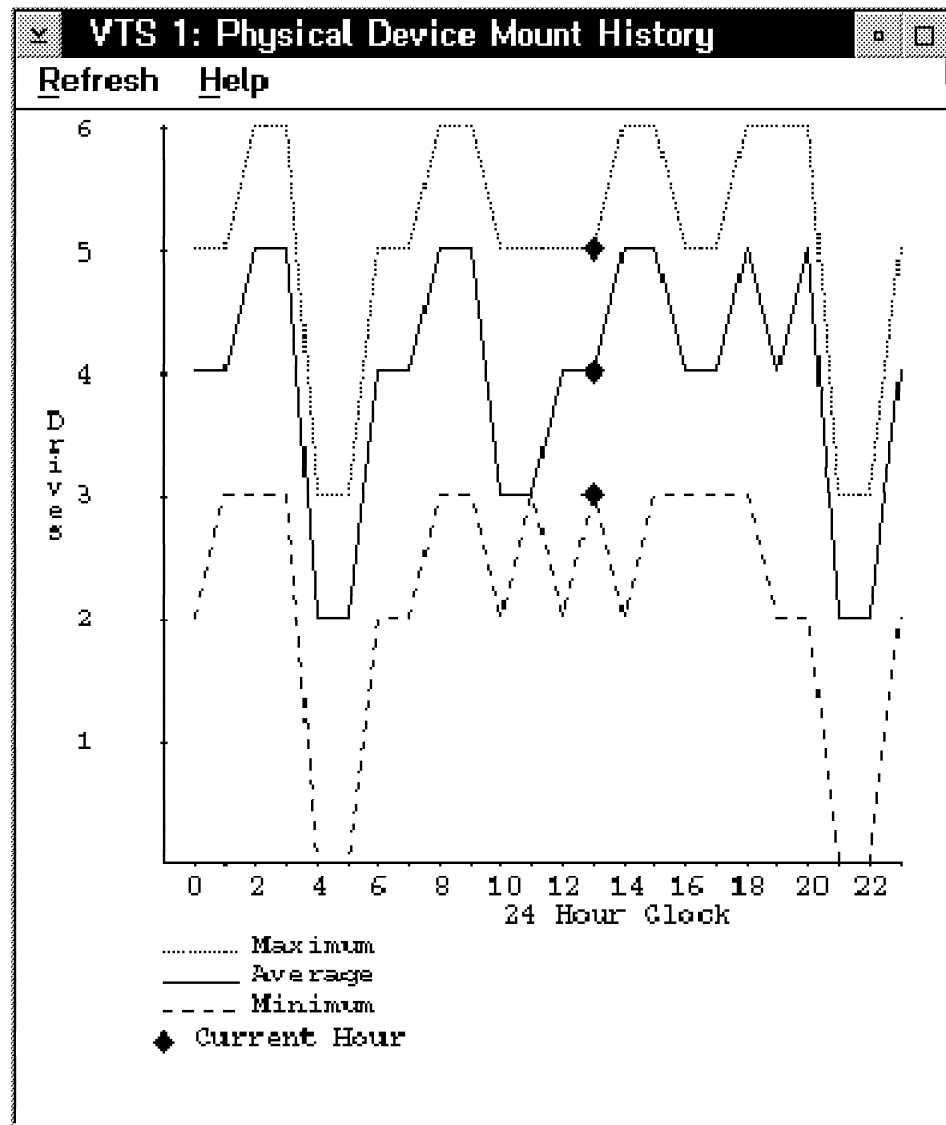
Figure 89. VTS Physical Device Mount History Window

Average (SMF94VTV) is the average number of physical drives that were used concurrently to mount stacked volumes during the hour. The sampling rate for calculating the average is 10 seconds.

Maximum (SMF94VTX) is the maximum number of physical drives used concurrently to mount stacked volumes during the hour.

Minimum (SMF94VTN) is the minimum number of physical drives used concurrently to mount stacked volumes during the hour.

8.5.6 Virtual Tape Server Logical Mounts Per Hour

The Logical Mounts Per Hour window (Figure 90) shows the number of logical mounts per hour. The figure is the sum of fast ready mounts, cache hit mounts, and cache misses (Recall). Data is displayed for the previous 24 hours. The current hour's data is designated by a diamond-shaped marker.

To display the percentage distribution of logical mounts, use the **Mount Hit Data** window (Figure 88 on page 227).
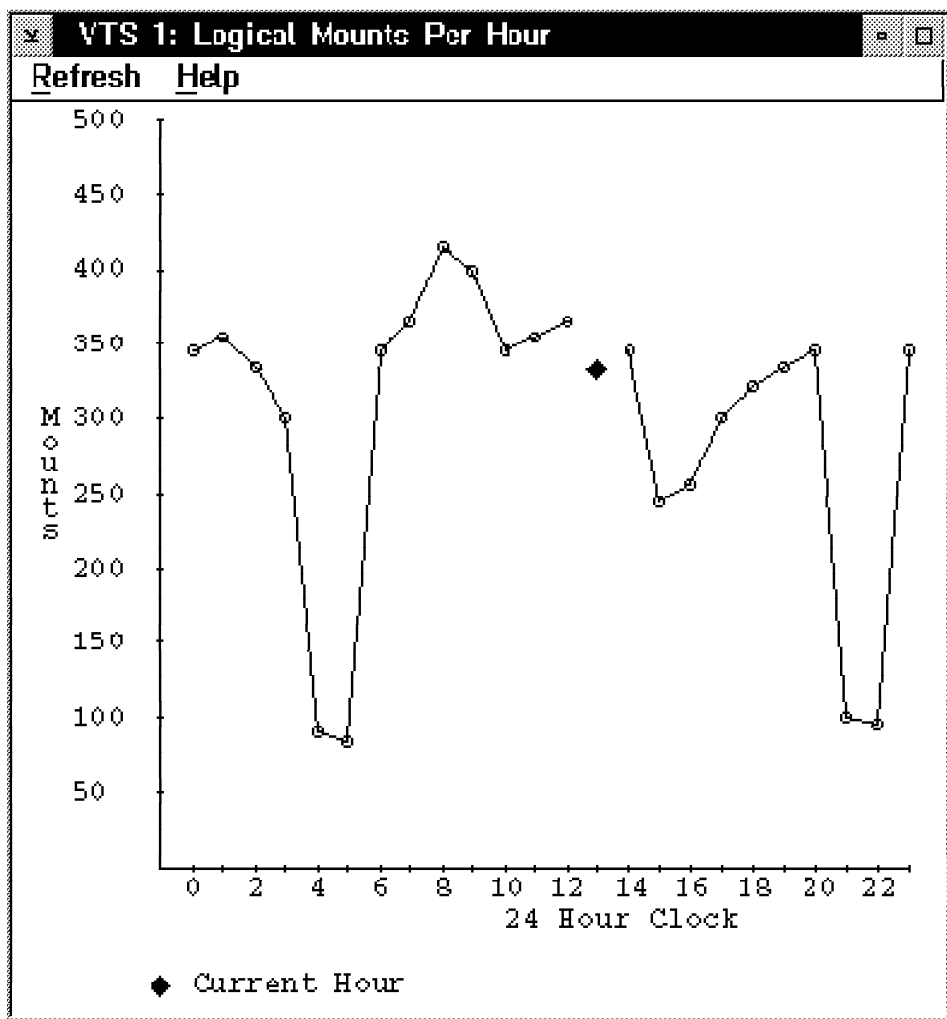
Figure 90. VTS Logical Mounts Per Hour Window

8.5.7 Active Data Distribution

The Active Data Distribution window (Figure 91 on page 230) displays a graph showing the distribution of the data on the stacked volumes. Each bar goes to the height that signifies the number of tapes in that group. There is a bar for each 5% increment in active data. You use this window to identify the number of tapes that will be freed up if you were to change the reclaim threshold. Please see 3.4.6, "Reclamation and Reconciliation" on page 75 for more details.

At the bottom of the window you can identify the number of active volumes, that is, the number of stacked volumes that have active data on them. This does not include stacked volumes that are in the process of being filled with new data. Please see 8.7, "A VTS Capacity Planning Walk Through" on page 233 for an description on managing stacked volumes.
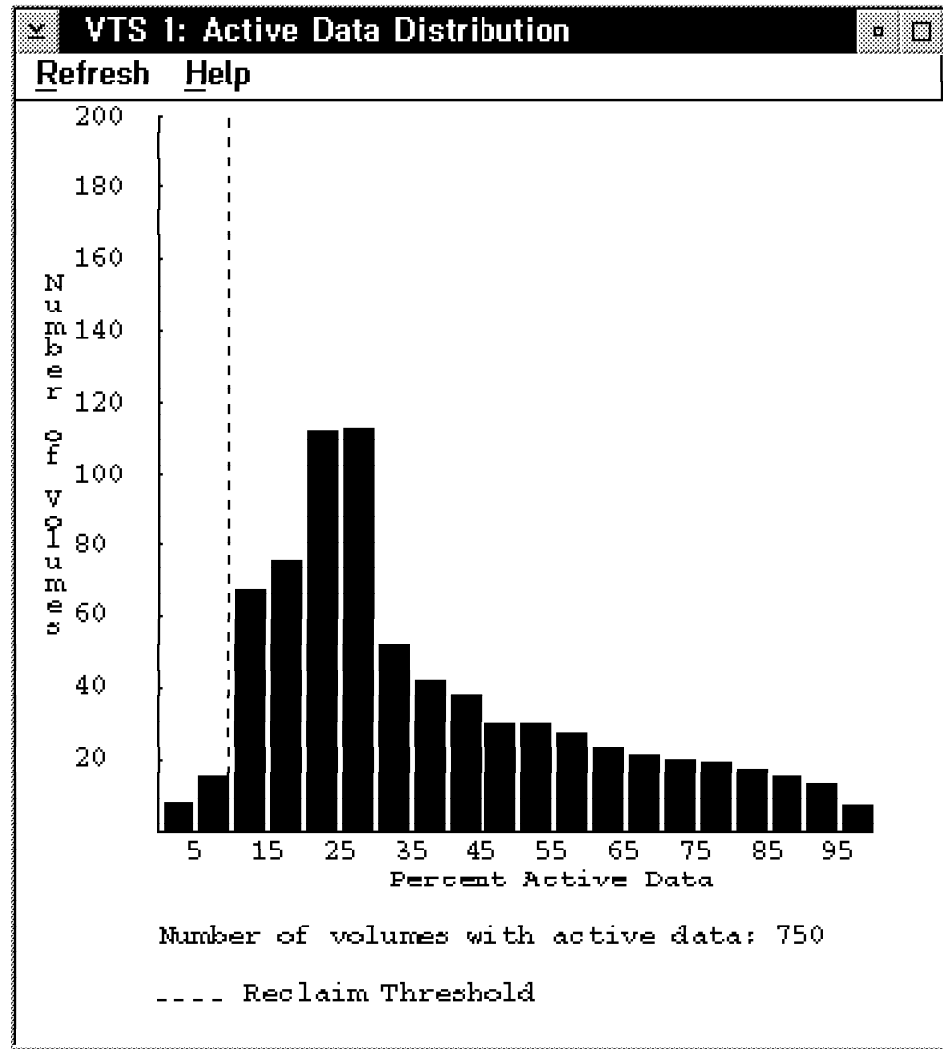

Figure 91. VTS Active Data Distribution

8.5.8 VTS Specific Logs

The VTS subsystem keeps track of certain events that occur in a wraparound log. This log contains only a limited number of events or activities. When diagnosing certain software situations, you may want to look at these logs. If there is a situation that arises where the logs are needed, contact your IBM service representative.

8.5.9 Other Considerations

Keep in mind the following:

- For host commands that display the number of storage slots in the tape library (for example, DISPLAY SMS,LIBRARY(library-name),DETAIL), that number reflects the physical storage slots in the entire Magstar 3494 Tape Library and is not a count of the virtual volume capability of the library.

```
CBR1110I OAM library status:
TAPE      LIB DEVICE    TOT ONL AVL  TOTAL EMPTY SCRTCH ON OP
LIBRARY   TYP TYPE      DRV DRV DRV  SLOTS SLOTS  VOLS
ATLBA035  VL  3494-L10   16   2   2    494    13  1743 Y  Y
------------------------------------------------------------------
MEDIA       SCRATCH     SCRATCH
TYPE         COUNT     THRESHOLD
MEDIA1       1063             0
MEDIA2        680             0

------------------------------------------------------------------
OPERATIONAL STATE:  AUTOMATED
ERROR CATEGORY SCRATCH COUNT:                 0
SCRATCH STACKED VOLUME COUNT:                79
------------------------------------------------------------------
Convenience I/O station installed.
Bulk input/output not configured.
```

- An SMF type 21 record (Error Statistics by Volume) is written when a tape volume is demounted. This record contains the statistics for the volume while it was mounted.

  For a virtual volume, the fields in the SMF type 21 record that represent activity at the physical tape drive contain zeros. These fields include:

  - Number of temporary errors
  - Number of permanent errors
  - Number of erase gaps
  - Number of cleaner actions

  The number of bytes read and written is reported for a virtual volume on the SMF type 21 record.

- Mount messages for virtual volumes are reported in the same way as for native volumes in a Magstar 3494 Tape Library. In MVS, mount messages are written in the Syslog and Joblog but are not displayed on the system console.

8.6 VTS Statistical Data

The Magstar 3494 Tape Library accumulates statistics on the activity of the tape library that results from responding to all hosts attached to the library. At the end of an hour, the Library Manager calculates composite statistics about the activity of all devices in the library during the hour and sends the statistics to all MVS attached hosts.

The library statistical record presents current information on the library's status and summarizes activity during the last hour.

The library statistical record has a length of 256 bytes; only the first 128 bytes contain values if a VTS is not installed in the 3494. When a VTS is installed in a Magstar 3494 Tape Library, the bytes above 128 contain virtual mount statistics

and operational information about the VTS. The existing statistics in bytes 0 through 127 continue to reflect all physical movement of cartridges within the Magstar 3494 Tape Library, including the movement of VTS stacked volumes. When a VTS is not installed, bytes above 128 contain X'00'.

8.6.1 Collecting the Statistical Records

In SMS managed tape and BTLS environments, the MVS tape error-recovery program (module IGE0001E) reads the statistical record sent by the Library Manager and writes an SMF type 94 record (IBM Tape Library Dataserver Statistics) that includes the activity of all devices in the tape library. The SMF type 94 record has been enhanced to support the new statistics related to the VTS. Section 2.5, "Software Requirements" on page 32 lists the maintenance that is needed to get this support. Appendix B, "SMF Record Type 94 Format" on page 309 shows the format of the SMF type 94 record. The new statistics for the VTS are generated by the IECSMF94 macro.

If you have Performance Reporter for MVS (5695-101), support is provided for the new VTS related fields in the SMF type 94 record. The maintenance required to support these new fields is listed in 2.5, "Software Requirements" on page 32.

In a non MVS environment, the VTS statistical records are not collected by any host. This applies to VM hosts and SCSI hosts connected to a VTS. However, the VTS operating system collects the statistical data, so they can be browsed in the library manager's log files.

In order to collect the statistical data when no MVS system is connected to the Library Manager, you need to extract them directly from the Library Manager. Please see 8.8, "Monitoring the VTS with VTSLOGRP" on page 241.

8.6.2 Analyzing SMF Type 94 and LOGREC MDR Records

The SMF type 94 record is sent to each attached MVS host on an hourly basis. Because the VTS does outboard data management, it is a little different from other tape devices. The SMF type 94 records can be used to analyze the VTS for capacity and performance planning. You can use any of the standard tools to print out the SMF type 94 records. We give some examples in 8.4, "Monitoring and Evaluating VTS Performance" on page 210 on how to use these records to monitor the workload currently running within the VTS.

TAPECOMP is a tool used to report data blocksize and compression ratios. In conjunction with VTSSTATS, this data can be used to evaluate VTS performance. A methodology for this evaluation is given in 8.4, "Monitoring and Evaluating VTS Performance" on page 210.

VTSSTATS and TAPECOMP can be downloaded from the following Intranet site: *http://w3.rmss.tucson.ibm.com*

Business Partner and customers access is through: *ftp://index.storsys.ibm.com/tapetool*

8.6.3 Collecting and Analyzing Statistical Data

The statistical records are retrieved from the library manager log files and written to a file. The extraction program and the data reduction program are available from the following Intranet site: *http://w3.rmss.tucson.ibm.com*

Business Partner and customers access is through:
ftp://index.storsys.ibm.com/tapetool

8.6.4 Monitoring

RMF may be used to monitor disconnect time for the VTS virtual drives. Disconnect time is reported by RMF and not by the SMF type 94 records from the VTS. Please see page 222 for more information on RMF processing.

8.7 A VTS Capacity Planning Walk Through

Estimating the number of stacked volumes that are required and managing the stacked volume inventory can be a complex undertaking. This section uses a *"case study"* or *"walk through"* to illustrate some guidelines and techniques for stacked volume management.

There is no set relationship between the number of virtual volumes defined to a VTS and the number of physical volumes required to stack and store them. This fact can lead to questions from VTS operators and capacity planners who are puzzled as to why the inventory of physical volumes is not static and, in many cases, seems unpredictable. This seemingly uncertain behavior may be explained once you understand the factors that determine the relationship.

A brief explanation of some key points followed by a walk through of a typical installation should help you better understand this relationship.

Once virtual volumes have been defined to the Library Manager and associated Tape Management System they are in one of the following states:

- Never mounted (typically a scratch volume)

- Mounted at least once and returned to scratch

- Mounted at least once and currently containing active data (Private / Master)

Once stacked volumes have been defined to the Library Manager and entered into the library, they are in one of the following states:

- Scratch (Empty)

- Filling (in the process of been written to by the VTS)

- Full

- Partially Full (once full but now holding virtual volumes that have expired)

See Appendix A, "Library Manager Volume Categories" on page 301 for a more detailed explanation of Library Manager categories.

In the remainder of this section, we will walk through the life of a VTS as seen through the eyes of the storage administrator, Charlie. We will be starting from its installation as a B16, upgrade to a B18 with the EHPO compression feature, and on to the present day.

DAY ONE

The B16 is installed with six 3590 B1A drives and 72 GB of TVC. Charlie defined (inserted) 15,000 virtual volumes. He also defined and inserted 300 stacked cartridges.

We will track the changes to the VTS virtual and stacked volumes by using a volume distributions table.

The values used in this table and the way to determine them from various sources are (Table 27):

Table 27. Sources and Calculations	
Description	**Obtained from/by**
Virtual volumes Inserted	Total number of volumes defined for the VTS library within specific volume range in the host TCDB or tape management system (summarized if multiple systems are attached).
Virtual volumes Never Mounted	Can be calculated by subtracting SMF94VLA from "Virtual volumes Inserted".
Virtual volumes in Scratch	Use D SMS,LIB(libname), DETAIL and field "SCRTCH VOLS".
Virtual volumes in Private (unexpired)	Can be calculated by subtracting "SCRTCH VOLS" from "Virtual volumes Inserted".
Average Size of Virtual volumes	Use SMF94VLZ.
Stacked cartridges inserted	Use Library Manager "Volser Range" panel display. Summarize numbers by Media Type for VTS library.
Stacked cartridges in Scratch (freespace volumes)	Use D SMS,LIB(libname), DETAIL and field "SCRATCH STACKED VOLUME COUNT" or library manager "Search Database" and use "By Category" FF03.
Stacked cartridges in use (Private)	Can be calculated by subtracting "SCRATCH STACKED VOLUME COUNT" from "Stacked cartridges inserted".

When the VTS is initially brought online this is what the table looks like (Table 28):

Table 28. Initial Volume Distribution	
Description	**Count**
Virtual volumes Inserted	15,000
Virtual volumes Never Mounted	15,000
Virtual volumes in Scratch	15,000
Virtual volumes in Private (unexpired)	0
Average Size of Virtual volumes	0
Stacked cartridges inserted	300
Stacked cartridges in Scratch (freespace volumes)	298
Stacked cartridges in use (Private)	2 (mounted automatically)

SIX MONTHS LATER

Charlie had the B16 in production for six months. Charlie noticed that there was some reclaim activity in the SMF 94 statistics. The library had also alerted the operator that the freespace threshold had been crossed. Charlie was puzzled by this and thought: "I have not added virtual volumes since the VTS was installed. All the applications that I run in the VTS expire the data written within 30 days. Why have I not reached equilibrium? Why is the freespace continuing to shrink?"

Here was the data at this time (Table 29):

Table 29. Volume Distribution after Six Months	
Description	**Count**
Virtual volumes Inserted	15,000
Virtual volumes Never Mounted	2,512
Virtual volumes in Scratch	7,155
Virtual volumes in Private (unexpired)	7,845
Average Size of Virtual volumes	224 MB
Stacked cartridges inserted	300
Stacked cartridges in Scratch (freespace volumes)	20
Stacked cartridges in use (Private)	280

At this point the B16 was still consuming freespace, because all of the virtual volumes originally inserted had not been mounted for the first time. After a virtual volume is mounted and copied to a stacked volume for the first time, the virtual volume will occupy space on a stacked cartridge forever after, whether expired (scratch) or not (private), unless it is ejected or exported from the VTS. Please see 3.4.6, "Reclamation and Reconciliation" on page 75 for a detailed explanation.

Although, the 15,000 virtual volumes inserted is far less than allowable, it is still more than Charlie needed. The result of this was the presence of many scratch virtual volumes on stacked cartridges. With a retention period of less than 31 days and 7,845 private volumes, Charlie only needed to insert about 8,500 virtual volumes. The VTS would have reached equilibrium with only about 190 stacked cartridges being required.

Reasoning: With 7,845 private volumes and a 30 day retention, then the average volumes scratched and rewritten per day is 261. Double this to provide ample virtual volumes in the scratch pool, so 7,845 plus 522 = 8,367, which is then rounded up to 8,500. 8,500 X 224 = 1,904,000 megabytes. For the B16 with 3590 B1A drives, assuming 2:1 compression is achieved in the drive drawer, and stacked cartridges at 50% average fullness means 10,000 megabytes per stacked cartridge. Divide 1.904,000 by 10,000 and the result is 190 stacked cartridges required.

Charlie could have started with a smaller number of virtual volumes and inserted them gradually, by using the scratch threshold in the library definition (one for each media type) as a trigger to alert the operators that the VTS was running low on scratch virtual volumes.

Here is a formula which may be used to determine the number of virtual volumes that a user should insert at the beginning of VTS operations. Some of the values in the formula may have to be estimated.

```
┌─ Number of Virtual Volumes at Install ──────────────────────┐
│                                                             │
│  Vv = T + (Ax + Si)N                                        │
│                                                             │
└─────────────────────────────────────────────────────────────┘
```

Where

- Vv = Number of virtual volumes

- T = Scratch threshold for media 2 set in the library definition in ISMF

- Ax = The average expiration period in days for the workload going into the VTS or the number of days that the VTS was designed and sized to operate, whichever is smaller

- Si = The interval in days between scratch processing by the tape management system

- N = The number of scratch volumes mounted per day

The number of virtual volumes in the VTS inventory that have never been mounted is not reported in the SMF 94 record. It is generally possible to use the tape management system to determine the number of virtual volumes in a given volser range that have never been mounted (refer to Table 27 on page 234 for ways to find this information). As long as there are virtual volumes that have never been mounted, the demand for stacked cartridge capacity will climb. Obviously, inserting new virtual volumes will also increase the demand for stacked cartridges, as these too, are mounted for the first time.

So, Charlie defined and then inserted another 100 stacked cartridges, reasoning that this is a 33% increase, and there are 17% of the virtual volumes that have never been mounted.

TWELVE MONTHS LATER

After this time, the VTS again signals that the freespace threshold has been crossed.

Here was the data at that time (Table 30):

Table 30. Volumes Distribution after Twelve Months	
Description	**Count**
Virtual volumes Inserted	15,000
Virtual volumes Never Mounted	411
Virtual volumes in Scratch	6,995
Virtual volumes in Private (unexpired)	8,005
Average Size of Virtual volumes	260 MB
Stacked cartridges inserted	400
Stacked cartridges in Scratch (freespace volumes)	20
Stacked cartridges in use (Private)	380

By comparing with earlier data, Charlie found that another 2,101 virtual volumes had been mounted for the first time and the virtual volumes average size had increased from 224 MB to 260 MB. Charlie rightly assumed that the additional space was required by application growth due to a growing business. Charlie added another 200 stacked cartridges to the VTS inventory.

15 MONTHS LATER

Three months after that, the library signaled that it needed more scratch virtual volumes. This had not occurred for over a year because of the generous amount inserted at install time. Charlie inserted an additional 2,000 virtual volumes.

17 MONTHS LATER

Two months after that, the data looked like this (Table 31):

Table 31. Volume Distribution after Seventeen Months	
Description	**Count**
Virtual volumes Inserted	17,000
Virtual volumes Never Mounted	1,522
Virtual volumes in Scratch	3,002
Virtual volumes in Private (unexpired)	13,998
Average Size of Virtual volumes	304 MB
Stacked cartridges inserted	600
Stacked cartridges in Scratch (freespace volumes)	130
Stacked cartridges in use (Private)	470

At this time the VTS was upgraded to a B18 with compression (EHPO).

TWO WEEKS LATER

Two weeks after the upgrade Charlie noticed, first, a dramatic improvement in performance and virtual mount time, and second, that the average virtual volume size began to fall (Table 32). Charlie reasoned that the EHPO feature would be compressing the virtual volumes, so stacked cartridge capacity would be freed up over time. However, freespace began to fall even faster.

Table 32. Volumes Distribution after Upgrade to B18 EHPO	
Description	**Count**
Virtual volumes Inserted	17,000
Virtual volumes Never Mounted	614
Virtual volumes in Scratch	2,120
Virtual volumes in Private (unexpired)	14,880
Average Size of Virtual volumes	256 MB
Stacked cartridges inserted	600
Stacked cartridges in Scratch (freespace volumes)	40
Stacked cartridges in use (Private)	560

Then he remembered that compression had been occurring in the B16 also, just at a different point in the stacking process. In the B16, the compression was done in the 3590 B1A drive drawer, while in the B18 it is done in the channel attachment cards (Input/Ouput Processors), as well as in the drive. While compressing data twice may add additional compression, it is not much, and sometimes, the data even expands slightly. Also, application blocksize can affect compression ratio in the B18, because the compression processors operate better on large blocksizes than on small, and this is to a greater extent than the compression processors in the 3590 B1A drive drawers are affected by blocksize.

Note: The chip sets used in the ESCON cards are different from those used in the drive drawer. This compression engine is optimized for maximum throughput, not maximum compression ratio. For some data patterns the ratio achieved by the cards is better than the drive, but for most it is not. Also once the data has been compressed by the cards at a relatively low ratio, the compressibility realized at the drive may also be low, such that the overall ratio is less than it would be if the drive was doing all the compression.

The effect of this is usually negligible, but, in some cases, it is more than nominal. The benefit of front-end compression is throughput, since the data handled by the processor and the TVC is reduced by this compression. Any future increase in native cartridge capacity due to drive and cartridge technology advances will serve to obviate this difference.

Charlie also realized that the virtual volumes size reported in the SMF 94 record was now a compressed volume. This would explain the decrease. In fact, the actual virtual volumes size as stored on the stacked cartridges had increased. The application owners were taking advantage of improved performance by adding workload to the VTS. One characteristic of this added workload was larger dataset sizes than the workload that had been so carefully scrutinized in the B16. Jobs were completing sooner, allowing more work to get done in a day, so the whole business was benefiting by doing more work in the same amount of time. So, Charlie added another 200 Stacked cartridges.

Charlie had been thinking about what is happening in the VTS at this point. There were some virtual volumes that are uncompressed and some that were compressed. Where were they? Were they all on the same stacked cartridges, or were they getting mixed up together? What was the effect of this? What happened when a B16 virtual volume was scratched and then reused?

Charlie came to two conclusions based on careful thought.

- His virtual volume scratch pool was growing in terms of total capacity. For any application that writes full volumes, as B16 virtual volumes were scratched and re-used, they get larger in terms of the host data written to them. Instead of being ″full″ at 800 MB, the virtual volumes hold 800 MB multiplied by the compression ratio. This meant that they were occupying more space on the stacked cartridges as well. Therefore, he could allow the number of scratch virtual volumes to drop over time, since more data may be written to each scratch, reducing the number required to satisfy the demands of a week′s processing.

- The B16 virtual volumes that were stored on stacked cartridges that have been reclaimed since the conversion made the new stacked cartridges seem

more full than they really were, which tended to suppress reclaim. The reason for this is that the VTS calculates the fullness of a stacked cartridge by comparing the maximum amount that was written to the stacked cartridge the last time it was closed for output (the high water mark), against the total size of all the virtual volumes which are valid (not scratched and reused) that are still stored on it. When some of these are B16 virtual volumes (because the stacked cartridge was filling when reclaim was running) and some are B18 virtual volumes, the VTS may see the percentage of valid data stored on the tape as higher than it really is. This is because the B16 virtual volumes are much more compressible by the drive drawer than B18 virtual volumes that have passed through the ESCON card compressors before being "measured" by the VTS.

The effect of this is heightened when a mix of long-term B16 data and short term B18 data is present in the machine. As the percentage of B16 data drops, the effect is diminished, so this is also a transitory state. It should be pointed out that the best way to approach this is to adjust the threshold, such that the same number of stacked cartridges are being reclaimed each week after the conversion as were being reclaimed before the conversion.

So, Charlie decided to measure the compression ratio, since the installation, and allow the scratch pool to go down by some amount, based on his understanding of the workload that fills virtual volumes to EOT. This meant adjusting the scratch threshold count in the LIBRARY DEFINITION panel in ISMF.

He also decided not to raise the reclaim threshold on his VTS, because his B16 virtual volumes have a short expiration period and would be purged quickly from the VTS. If he had a mix of long term volumes that would remain in the VTS for years, it may have been wise to raise the reclaim threshold until the long-term virtual volumes became such a small percentage of stored volumes that the effect on reclaim was negligible.

TWO MONTHS LATER

Two months later, the SMF 94 data indicated that the B18 was not nearly operating at peak throughput and had plenty of horsepower for additional workload. The freespace began to drop faster than Charlie had predicted and the number of available slots in the library was now becoming an issue. He realized that the present rate of consumption would demand additional storage slots and media in six weeks or less. Note that the reported virtual volumes size had continued to drop, and Table 33 now reflects all compressed volumes.

Table 33. Volume Distribution Two Month after the B18 Installation	
Description	**Count**
Virtual volumes Inserted	17,000
Virtual volumes Never Mounted	204
Virtual volumes in Scratch	1,867
Virtual volumes in Private (unexpired)	15,133
Average Size of Virtual volumes	198 MB
Stacked cartridges inserted	800
Stacked cartridges in Scratch (freespace volumes)	81
Stacked cartridges in use (Private)	719

Charlie then had to determine why the freespace was being consumed more quickly than he had predicted.

Combing through the SMF 94 data did not clearly indicate why the utilization of the inventory of stacked cartridges seemed to be dropping. Charlie reread the *IBM 3494 Tape Library Dataserver Operator Guide* to see if there was something within his control that could improve the operation. He discovered the Active Data Distribution graph available from the library manager console. A quick glance at this chart told the tale: In this VTS, with the present workload, the percent of ″unexpirable″ data had grown beyond the reclaim threshold percent set in the machine, which was 10% (the default).

The data distribution graph (Figure 92) looked like this:
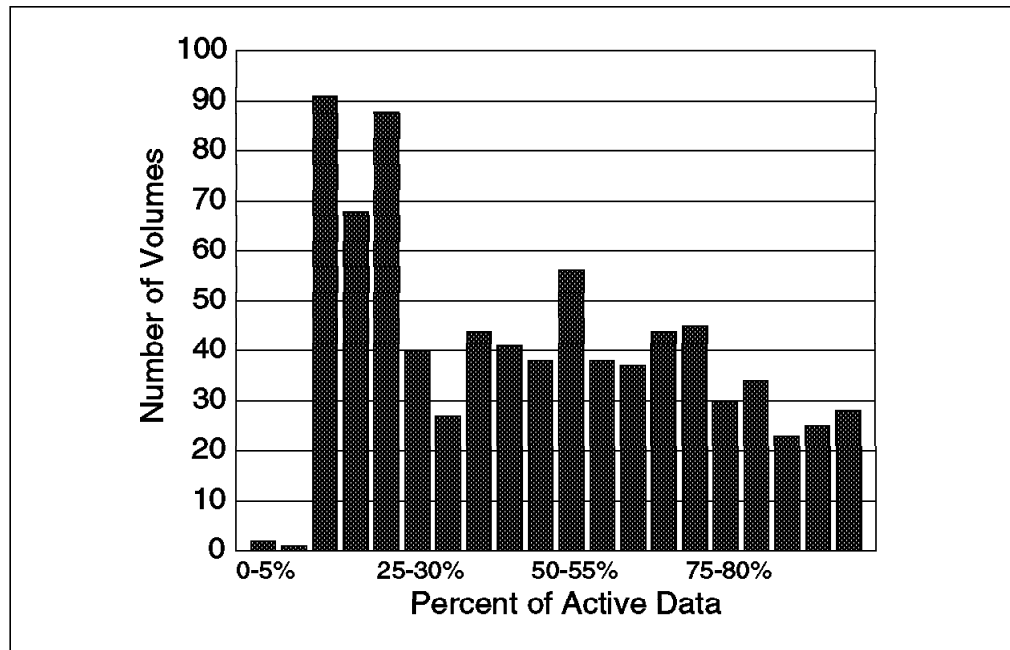
Figure 92. Active Data Distribution

A large number of stacked cartridges were ″stuck″ just above the reclaim threshold because they contained large proportions of unexpirable virtual volumes. Charlie adjusted the reclaim threshold to be somewhat higher than the percentage of long-retention data being stored, allowing more thorough reclamation of the stacked cartridges.

Reasoning: With 719 volumes in use, assuming a 1:1 compression in the drive, and assuming that the volumes continue to be 50% full on average, 719 X 5,000 MB = 3,595,000 MB. Average volume size is 198, so 3,595,000 divided by 198 = 18,157 virtual volumes that should be stored, but there are only 17,000 - 204 = 16,796 stored. Therefore, the stacked cartridges are less than 50% full, on the average. The same observation made in the other direction would be: 16,796 virtual volumes stored at 198 MB each = 3,325,608 MB. Divide this by 719 stacked cartridges and you get 4,625 MB per stacked volume. This is 46% full on average.

TODAY

Charlie continues to track the growth of workload in the machine. He has certainly seen that there is no simple rule of thumb based on the number of

virtual volumes inserted. Instead, this storage is a complex function of many variables. The values of these variables are likely to change as the workload changes.

The variables pointed to in this example are:

- Number of virtual volumes defined (and mounted at least once)
- Size of the virtual volumes stored (reported as uncompressed in the B16 and compressed in the B18 EHPO)
- Retention period of virtual volumes
- Reclaim Threshold (which may be affected by the presence of long-term B16 virtual volumes)
- Differences in compression ratio achieved by different hardware compressors.

It is also important to point out that physical storage requirements are not a function of scratch vs. private status, as far as virtual volumes are concerned. Whether a virtual volumes is scratch or private does not matter. Once mounted the first time, the virtual volumes will forever occupy space somewhere on a stacked cartridge. The level of scratch tapes should be maintained at a reasonable level, and this applies to both virtual volumes and stacked cartridges.

Adding physical storage capacity to a VTS is certain, if long term data is being stored. Only by expiring virtual volumes and allowing them to be reused, can stacked cartridges be freed up by the reconciliation and reclaim processes.

8.8 Monitoring the VTS with VTSLOGRP

The library manager of a VTS builds statistical data every hour. This data contains information for all activities relevant to the VTS. On the MVS host these records are recorded in the SMF type 94 record and can be processed by your normal SMF reporting tools.

In a non MVS environment, the VTS statistical records are not collected by any host. This applies to VM hosts and SCSI hosts connected to a VTS.

The VTS operating system collects the statistical data to its own library managers log files.

In order to collect the statistical data when non MVS system is connected to the Library Manager, you need to extract them directly from the Library Manager.

VTSLOGRP was developed as a reporting package which can be used to analyze the data from the library manager log files for performance and capacity planning.

VTSLOGRP can be run on multiple platforms, including the S/390 platform running MVS. Currently, the supported platforms are OS/2, VM, MVS and Windows. For Windows you must have the OBJECT REXX package installed.

The main reports are broken down into the same categories as VTSSTATS which is covered in detail in section 8.4, "Monitoring and Evaluating VTS Performance" on page 210. The reports have the following headings:

- **Physical:** Reports physical drive activity for the 3590 drives in the VTS D12 frame.
- **Cache:** Reports on the transient volume cache activity.
- **Virtual:** Reports on virtual volume activity, count, time, and category.

There are a number of reports which have already been built which you can use. One of the most useful reports is the *Hit Parade Report* (Figure 93) which focuses on key fields of the statistical record.

```
VTSLOGRP V1.L3                              VTS LIBRARY STATISTICS
                            DAILY HIT PARADE              FOR VTS 60499

  CACHE MISS COMPARED TO VIRTUAL MOUNTS & STAGE

             CACHE    TOTAL FAST RDY CACHE HT PHYSICAL
  DATE       MISS VIRT.MNT    MNT     MNT STAGE MT

  27APR1999    54     482     299     129      59
  28APR1999    44     398     250     104      55
  29APR1999    42     472     316     114      55
  30APR1999    28     453     306     119      39
  01MAY1999    24     340     248      68      24
  02MAY1999     2     217     206       9       9
  03MAY1999    75     491     311     105      84


 % CACHE MISS COMPARED TO VIRTUAL MOUNTS & STAGE

             CACHE    CACHE    TOTAL FAST RDY TVC  HIT PHYSICAL
  DATE       MISS %   MISS      MNT     MNT      MNT STAGE MT

  27APR1999   11.2     54      482     299     129      59
  28APR1999   11.1     44      398     250     104      55
  29APR1999    8.9     42      472     316     114      55
  30APR1999    6.2     28      453     306     119      39
  01MAY1999    7.1     24      340     248      68      24
  02MAY1999    0.9      2      217     206       9       9
  03MAY1999   15.3     75      491     311     105      84
```

Figure 93. Daily Hit Parade - Cache Miss

This report can be used to analyze your cache activity for the relevant day. Key things to look for in this report are:

- Total amount of cache misses.
- Total virtual mounts, this is the value of cache hits, cache misses and fast ready mounts.
- Total fast ready mounts, this is the number of mounts for scratch processing.
- Total physical stage mounts, this number shows you how many times a stacked volumes was mounted to stage a virtual volume back into cache.

Please see section 8.4, "Monitoring and Evaluating VTS Performance" on page 210 for more detailed descriptions of these values.

Other reports and files are produced which can be uploaded to spreadsheet packages, such as Lotus 123 or Microsoft Excel. Please see page 232 for information on downloading this product from the intranet site.

Chapter 9. IBM Magstar VTS Advanced Function

The Advanced Function feature Import/Export operations provide a way to move logical volumes out of a VTS subsystem to physical cartridges and to return them back to the same or another VTS. This function of the IBM Magstar VTS removes the "closed store" limitation of the VTS. This function allow customers to move data between Virtual Tape Servers without having to copy the logical volumes back through the host channels or lose the VTS benefits of volume stacking which exploits the storage capacity of the 3590 cartridge.

In this chapter, we provide information to help you to use the Import/Export operations of the IBM Magstar VTS.

If you are uncertain about the ability of your VTS to perform the Advanced Function feature Import/Export operations, use the VTS Status Library Manager panel (Figure 94) and check the Exp/Imp Capable field:
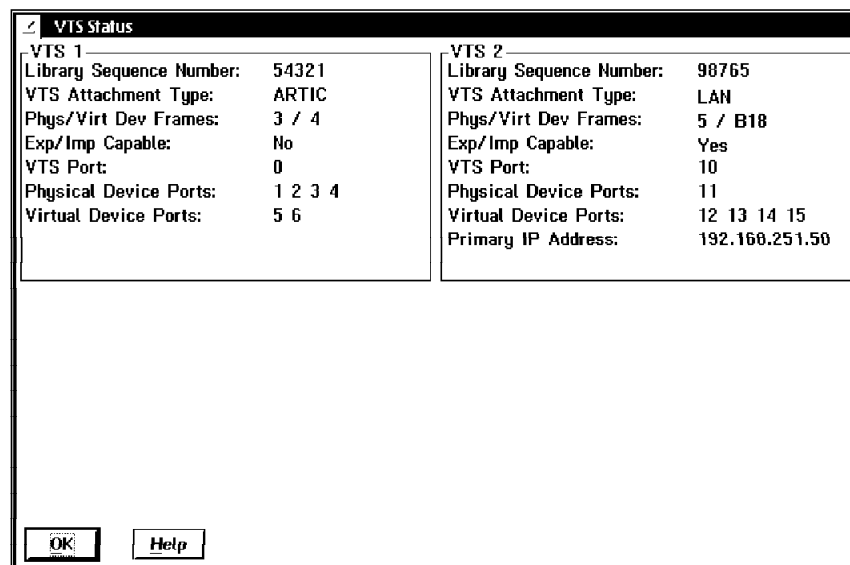
Figure 94. Display VTS Status

Export is a host initiated operation which copies one or more logical volumes to physical cartridges and deletes the logical volumes from the VTS. Since exported logical volumes are deleted from the VTS as part of the export process, an exported volume is not a duplicate of the original; it is the only version of an active logical volume. Thus it is a data move, not a copy operation. Wherever the word 'host' is used, it is implied to be an ES/3090, ES/9000 or S/390 processor running DFSMS/MVS System-managed tape with the appropriate support for the Export/Import function. The output volumes are called *exported stacked volumes* and they contain *logical volumes* which have been exported.

Import is a host initiated operation that can be used to copy one or more previously exported logical volumes from exported stacked volumes into a VTS.

You can use Import/Export for the following purposes:

- To move logical volumes to another location for long term archiving or for backup purposes

- For workload balancing by moving logical volumes from one VTS subsystem to another

- For data interchange with another VTS subsystem

The support for The Import/Export function is included within DFSMSrmm with PTFs. The functional specifications are made available to other vendors like:

- Computer Associates (CA-1, TLMS)

- Platinum (AutoMedia, formerly ZARA)

- BMC (Control-T)

- BETA Systems (BETA51)

How CA-1 supports the Import/Export function is described in 9.11, "CA-1 Support of the Import/Export Function" on page 283

9.1 Configuration and Feature Requirements

The Import/Export function of the VTS requires the following features and configuration:

- The Advanced Functions feature code 4000 (Refer to 2.8.1.11, "Advanced Function (FC 4000)" on page 40 for ordering and configuration guidelines)

- 3494-B18 with feature code 3200 (ESCON High Performance Option) or feature code 3400 (Extended High Performance Option)

- A minimum of four Magstar 3590 drives. We recommend that you have six drives when using Import/Export. Copy is always done from tape to tape; the Tape Volume Cache is not used or involved. Therefore, both operations, export and import, need two physical drives.

- The 3494 library must have a convenience I/O station. The high capacity I/O facility cannot be used for Import/Export.

Figure 95 shows the reason for our recommendation to have six tape drives if the Import/Export operations are used:

- One drive may be used for recalls.
- One drive may be used for the copy task.
- Two drives may be used for reclamation.
- Two drives may be used for Import/Export.
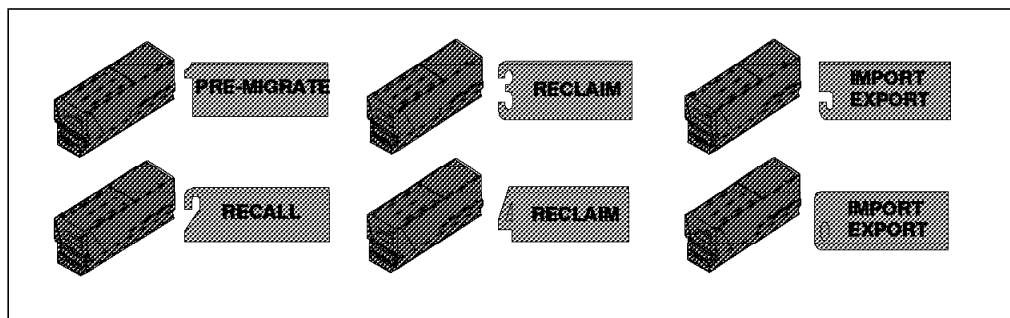
Figure 95. VTS Use of Back-end Drives

9.2 Software Requirements

Import/Export is available only in a DFSMS/MVS System-managed tape environment. The software support is provided as SPEs on DFSMS/MVS 1.4, and on DFSMS/MVS 1.5.

Table 34 lists the APAR numbers.

Table 34. Import/Export Prerequisite Software		
Component	**1.4**	**1.5**
RMM	OW36349	OW36350
OAM	OW36342	OW36343
ISMF	OW36351	OW36352
SMS	OW36526	OW36527
Device Services	OW36360	OW36362
Device Services	OW36363	OW36364

In order to allow Import/Export enhanced hosts to share an Advanced Function feature capable VTS with other S/390 host systems that do not have Import/Export capability, toleration PTFs are provided for DFSMS/MVS V1.1 and later:
Toleration maintenance for DFSMS/MVS 1.1.0, 1.2.0, 1.3.0, 1.4.0, and 1.5.0 is available with OW36674. Toleration maintenance for DFSMSrmm is available with OW37516.

The cartridge entry and cartridge eject installation wide exits (CBRUXENT and CBRUXEJC) have been enhanced in support of the Import/Export function. The sample exits provided by DFSMSrmm have been updated accordingly and DFSMSrmm itself has been enhanced in support of Import/Export. The support for DFSMSrmm is provided by the SPEs on DFSMS/MVS 1.4 and 1.5. If you are using another tape management system product, contact your vendor for details on Import/Export support.

9.3 General Considerations

The following are general considerations regarding Import/Export operations:

- A logical Volume, called the Export List Volume, in the VTS performing the Export operation, is used to pass the list of logical volumes to export and to return status to the host about the processing of each logical volume. The list may include logical volumes, that are not in the VTS, which is performing the Export operation. The data records on the volume are written using the EBCDIC character set and compression has to be turned off (TRTCH=NOCOMP).

- An optional destination may be specified for each logical volume to be exported. All logical volumes on a Exported Stacked Volume have the same destination.

- All logical volumes to be exported are copied from the Tivoli Storage Manager managed storage pool to Exported Stacked Volumes.

- The Exported Stacked Volumes are written in Tivoli Storage Manager's data format.

- All data to be exported must be on stacked volumes. Any data that is resident in the cache is first copied to stacked volumes by the VTS and then removed from the cache (fragmented). This occurs as an integral part of the export operation.

- Exported Stacked Volumes created on 3590 E1A models cannot be imported into a VTS with B1A models.

- The Export operation is stopped by the VTS when less than four physical drives are found. The operation in process will be completed for the current exported stacked volume.

- The VTS must have at least one available scratch stacked cartridge for the export operation to be accepted.

- Only one Export/Import process can be active in a VTS subsystem at a time.

- Only one import process can be active in a 3494 library at a time.

- Import and export can run concurrently in a 3494 library with more than one VTS subsystem.

- The exported stacked volume is designed to be imported again by the import function. If there is no VTS with the Import/Export function available and you need access to an exported logical volume, you may copy single logical volumes by using DITTO/ESA plus PTFs to native volumes on native drives. Refer to 9.12, "DITTO VTS Functions" on page 285 for further information.

- New library manager categories associated with Import/Export are these:

    FF12 Export pending category
    FF13 Exported category
    FF14 Import category
    FF15 Import pending category
    FF16 Unassigned category
    FF17 Export hold category

- The Import/Export operations, while they can only be initiated from DFSMS/MVS, are not restricted to logical volumes created from the initiating host. In an environment where the VTS is shared by multiple hosts (such as VM/ESA, or SCSI attached hosts), logical volumes belonging to these hosts can be exported from a host running DFSMS/MVS. However, there is no way to track and control the exported logical volumes from a host other than DFSMS/MVS.

- Import/Export statistics are written in SMF94 records.

9.4 Library Manager Enhancements

The library manager has been enhanced with a set of panels and menus to control and manage Import/Export. All panels can be found under *Commands* in the *System management* menu (Figure 96 on page 249). The panels are used to:

- Manage unassigned volumes
- Manage import volumes
- Manage insert volumes
- Manage export hold volumes
- Cancel VTS Import/Export

```
 3494 Tape Library Dataserver                    01-27-1999 (27)   09:55:23
  Mode  Status  Queues  Database   Commands  Options  Help
                                    Cleaning                        ➔
                                    Send message to host consoles...
                                    Promote a command in the queue...
     Volser range for media types...  System management             ➔
     Insert VTS logical volumes...    Inventory                     ➔
     Eject a VTS stacked volume...
     Set VTS category attributes...   Stand-alone device...         ➔
     Set VTS management policies...   Insert Unlabeled Cartridges...
     Manage unassigned volumes...     LAN options                   ➔
     Manage import volumes...         Operator intervention...
     Manage insert volumes...
     Manage export-hold volumes...    Change system administrator password
     Cancel VTS export/Import...      Service access                ➔
                                      SNMP options                  ➔
```

Figure 96. Import/Export Panels on the Library Manager

To verify pending Import/Export operations in an IBM 3494, the Operational
Status panel (Figure 97) or the

D SMS,LIBRARY(libname),DETAIL

host command (9.7.4, "Run Export" on page 255) can be used.


```
 Operational Status                                              ☑ ◻ ◻
 Refresh   Help
                         Pending Operations

     Mounts.....:  0              Inserts....:  0
     Demounts...:  0              Audits.....:  0
     Ejects.....:  0              Cleans.....:  0
     Exports....:  0              Imports....:  0

                   Library sequence numbers

              Non-VTS      VTS 1       VTS 2
               12345       54321       98765

  Subsys IDs:  1-6,C,7-B

                         Capacity
                   Storage        High-Capacity
  Total cells...:  2148               100
  Empty cells...:  2086               100

                      Home Cell Mode

  Current mode...:  Fixed
```
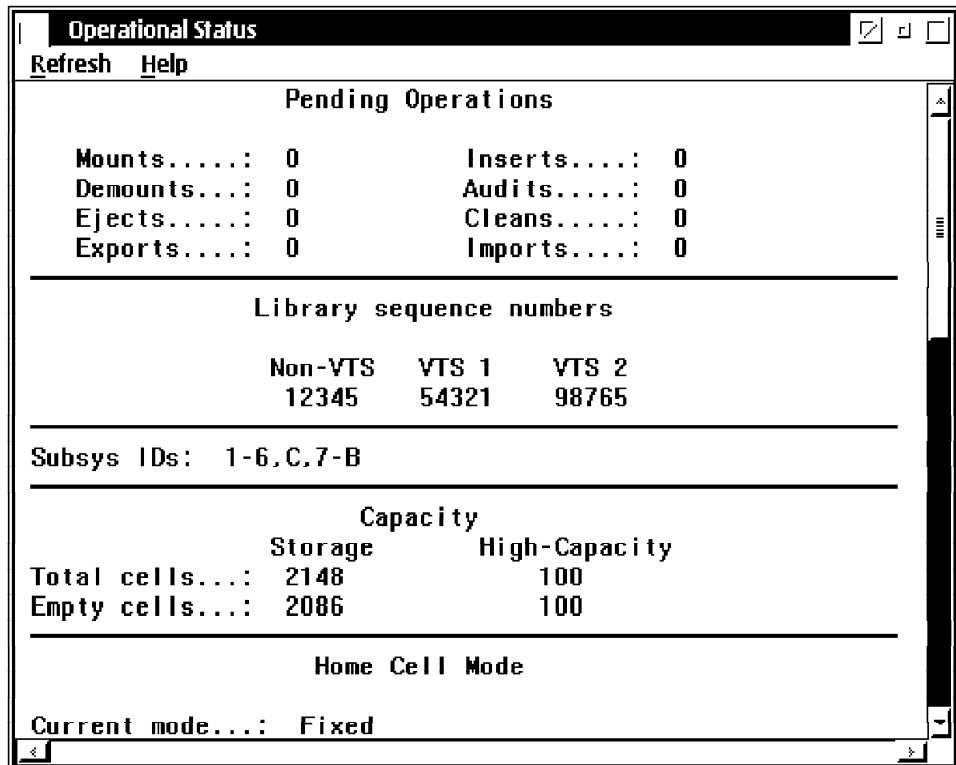
Figure 97. Operational Status Panel

To display volume status for cartridges related to Import/Export operations, the
Display VTS Export/Import Volumes panel in Figure 98 on page 250 can be used:

```
┌─────────────────────────────────────────────────────────────┐
│ Display VTS Export/Import Volumes                             │
├─────────────────────────────────────────────────────────────┤
│ A reinventory of the complete system cannot be executed while │
│ there are VTS export/import volumes in the library.           │
│                                                               │
│                                                               │
│                                                               │
│  ┌─Number of Volumes─────────────────────────────────────┐   │
│  │   Unassigned category:           4                     │   │
│  │   Import category:               4                     │   │
│  │   Export-Hold category:          0                     │   │
│  └───────────────────────────────────────────────────────┘   │
│                                                               │
│ These stacked volumes can be moved to the insert category or  │
│ ejected from the library by using the following panels under  │
│ 'System Management' from the 'Commands' pulldown:             │
│                                                               │
│                                                               │
│          - Manage Unassigned Volumes                          │
│          - Manage Import Volumes                              │
│          - Manage Export-Hold Volumes                        │
│                                                               │
│  ┌──────────┐                              ┌──────────┐       │
│  │   OK     │                              │  Help    │       │
│  └──────────┘                              └──────────┘       │
└─────────────────────────────────────────────────────────────┘
```

Figure 98. Display VTS Import/Export Volumes

9.5 Import/Export Terms

Export List Volume

- Logical volume within VTS that contains

  - Export List file
  - Export Status file

Import List Volume

- Logical volume within VTS that contains

  - Import List file
  - Import Status file

Exported Stacked Volume

- Physical cartridge used as a container

  - Holds the exported logical volumes
  - The volser is reported to tape management system via CBRUXEJC exit
  - Selected randomly at time of Export

9.6 Import and Export List Volumes

When a host initiates an export or import operation, it has to inform the VTS subsystem which volumes are to be exported or imported. An **export list volume** or an **import list volume** is used for this purpose. The VTS also uses the list volumes to store operation status information. You can access the status file after the operation has completed.

A list volume is a logical volume in the VTS which is executing the Import/Export operation. You need to create the list volume before starting the operation. The volser of the list volume is passed to the VTS when the Import/Export operation is started. The list volumes must have a standard IBM tape label and contain a predefined set of files, as we describe below.

Note: Do not use compaction when writing the import and export list volume files. If compaction is on, data written on a 3494-B18 EHPO is compressed at the ESCON channel attachment. When the VTS controller internally reads the import or export list file, the data does not pass through the ESCON adapter and therefore does not get decompressed. Either use an appropriate data class, or JCL parameter TRTCH=NOCOMP to prevent the files from being compressed.

In order to ensure that a scratch logical volume is allocated in the target library for the operation, the ACS routines need to have logic to allocate a virtual drive in the target VTS. To accomplish this, you need to have a storage group unique to the VTS library. However, the export and import list volumes do not have to be in SCRATCH status; you can decide to use a predefined volume serial in PRIVATE status to communicate the export and import lists to the VTS.

You can name the import and export list volume files freely; the VTS does not set any requirements on the data set names. Choose the names to fit your naming conventions and, in the case of a scratch allocation, to steer the allocation to the target IBM Magstar VTS.

9.7 The Export Operation

The export operation allows you to move logical volumes from the VTS to tape cartridges that are subsequently removed from the VTS. The basic steps of an export operation are:

- Determine the volumes that are to be removed from the VTS.

- Create an export list volume that contains the list of logical volumes to export.

- Check for enough scratch stacked volumes

- Start export. The VTS copies the logical volumes to a set of tape cartridges, and deletes all internal references to the exported logical volumes.

- Check export results.

- Eject the exported stacked volumes from the library.

Next we look at these steps in more detail.

9.7.1 Determine Volumes to Be Exported

Your tape management system keeps track of tape volume vaulting rules and typically provides the information for selecting the volumes that need to be exported to particular destinations.

Run DFSMSrmm storage location management processing (DSTORE) or your tape management system equivalent utility to set the destination for any new volume moves that are required. The required moves would have been determined by normal DFSMSrmm vital record processing or via the DFSMSrmm CHANGEVOLUME subcommand prior to the DFSMSrmm DSTORE processing.

After successful DSTORE processing, you can build a list of volumes to export using DFSMSrmm SEARCHVOLUME command:

```
// EXEC PGM=IKJEFT01
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD *
 RMM SEARCHVOLUME VOLUME(*) LIMIT(*) LOCATION(vtsname) -
   DESTINATION(dest) CLIST('','',dest') INTRANSIT(N)
```

The resultant output file (EXEC.RMM.CLIST) can be used as input to the export list logical volume file. Use the sample EDGJIMPC to reformat the CLIST output file records to fixed, unblocked format, LRECL 80.

9.7.2 Create the Export List Volume

Write the required export list volume files on a logical volume in the VTS containing the logical volumes you want to export.

If the volumes you want to export reside in multiple VTS subsystems, you can create one combined export list file and copy it to the export list volumes of each VTS. As export is then run on one VTS subsystem, it skips those volumes that reside in the other VTS subsystems. When finished, you need to combine the export status files from all the export list volumes to check that every volume was successfully exported.

9.7.2.1 The Export List Volume

The export list volume is used to pass to the library the list of volumes that you want to export from the VTS and to store status information of the export process (Figure 99).
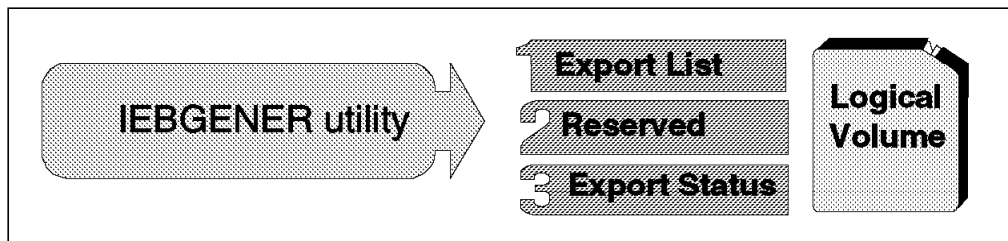
Figure 99. Export List Volume Contents

From a VTS perspective, the export list volume is handled as any other logical volume, thus it might be copied and fragmented, and consequently be recalled upon execution of the export function. It must contain the following three files in this order:

1. **Export list file**

   The export list file contains a list of the volumes to be exported along with their destinations (Figure 100 on page 253) and may contain volumes that are not contained in the library in which the export volume is being created.
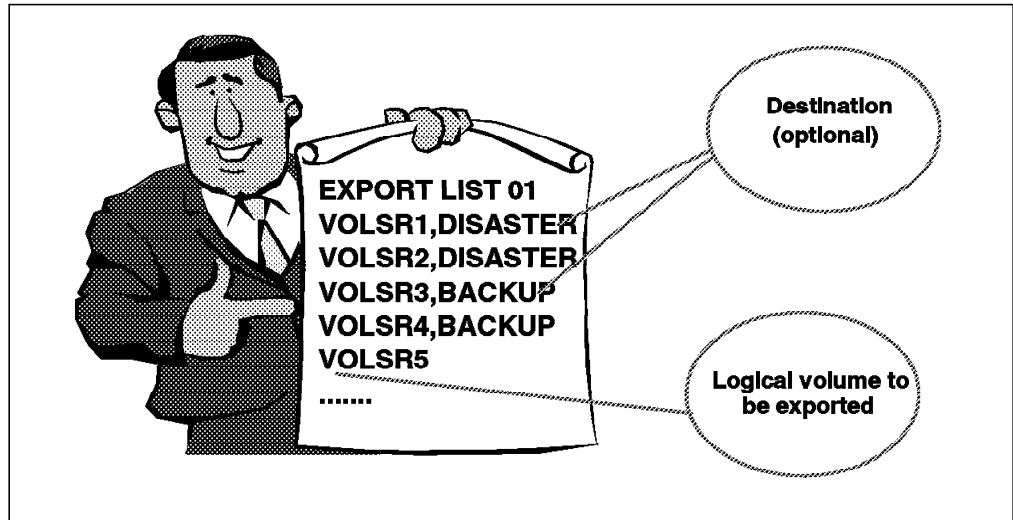
Figure 100. Export List Volume Contents

All volumes with the same destination are grouped together on the same set of stacked volumes. A blank destination is valid.

The first record of the export list file is the file identifier and version number and must be specified as illustrated below, starting in the first column:

```
EXPORT LIST 01 <user field>
```

The optional user field is a maximum of 16 characters long, separated with a blank from the version number.

Following the export list file identifier record there is a list of volume records. An export list file record contains two fields, volser and destination, which identify the logical volume to be exported and its destination. The fields must appear in that order separated by a comma. For example:

```
VOLSR2,DISASTER
```

The volser field is 6 characters long.

The destination field for the logical volume is a maximum of 16 characters long. A blank destination is also valid. Use the destination to group the exported logical volumes. Each group of logical volumes to be exported is written on a different set of exported stacked volumes which may then be stored at different locations.

Note: Because the VTS sorts the logical volumes by destination, the exported stacked volumes may be not be completed in the order listed in the export list file.

2. **Reserved file**

   The second file on the export list volume is reserved for future use. Even though it is presently not used, you must create this file. It contains one arbitrary record, for example:

   ```
   RESERVED FILE
   ```

3. **Export status file**

   The third file on the export list volume is used for storing status information from the export process. The file identifier and version number is defined in the first record and must be exactly as illustrated below, starting in the first column:

```
EXPORT STATUS 01 <user field>
```

The optional user field is a maximum of 16 characters long, separated with a blank from the version number.

After the export operation is completed, this file contains individual volume export results, including the volser of the exported stacked volume.

Following is sample JCL which writes the required files on the export list volume using a scratch volume:

```
//EXPORT   JOB 1,'EXPORT',MSGLEVEL=(1,1)
//***************************************
//* FILE 1: EXPORT LIST
//***************************************
//STEP1     EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=HILEVELQ.EXPLIST,
//            UNIT=VTS1,DISP=(NEW,KEEP),LABEL=(1,SL),
//            VOL=(,RETAIN),
//            DCB=(RECFM=FB,BLKSIZE=80,LRECL=80,TRTCH=NOCOMP)
//SYSUT1   DD *
EXPORT LIST 01
VOLSR1,DISASTER
VOLSR2,DISASTER
VOLSR3,BACKUP
VOLSR4,BACKUP
VOLSR5
/*
//***************************************
//* FILE 2: RESERVED FILE
//***************************************
//STEP2     EXEC PGM=IEBGENER,COND=(4,LT)
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=HILEVELQ.RESERVED,
//            UNIT=VTS1,DISP=(NEW,KEEP),LABEL=(2,SL),
//            VOL=(,RETAIN,REF=*.STEP1.SYSUT2),
//            DCB=*.STEP1.SYSUT2
//SYSUT1   DD *
RESERVED FILE
/*
//***************************************
//* FILE 3: EXPORT STATUS FILE
//***************************************
//STEP3     EXEC PGM=IEBGENER,COND=(4,LT)
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=HILEVELQ.EXPSTATS,
//            UNIT=VTS1,DISP=(NEW,CATLG),LABEL=(3,SL),
//            VOL=(,,REF=*.STEP1.SYSUT2),
//            DCB=*.STEP1.SYSUT2
//SYSUT1   DD *
EXPORT STATUS 01
/*
```

You may want to consider designating a dedicated export list volume for use with all exports from a VTS. If no longer needed, it can be deleted.

By using a private volume instead of a scratch volume you can write the export list volume files and start the export process within one batch job.

JCL samples for import and export volume list creation are provided in SYS1.SAMPLIB members

- CBRSPSIM (import list volume scratch request)
- CBRSPPIM (import list volume private request)
- CBRSPSXP (export list volume scratch request)
- CBRSPPXP (export list volume private request)

9.7.3 Check for Scratch Stacked Volumes

Before you start export, make sure there are enough scratch stacked volumes in the library to contain the exported logical volumes.

Use

D SMS,LIBRARY(libname),DETAIL

to list the numbers of scratch stacked cartridges, find if there is already an Import or Export operation active, and verify the status of the Convenience I/O station:

```
CBR1110I OAM library status:
TAPE      LIB DEVICE    TOT ONL AVL TOTAL EMPTY SCRTCH ON OP
LIBRARY   TYP TYPE      DRV DRV DRV SLOTS SLOTS VOLS
ATLBA035  VL  3494-L10  16   2   2   494    13   1743 Y  Y
-----------------------------------------------------------------------
MEDIA       SCRATCH      SCRATCH
TYPE         COUNT     THRESHOLD
MEDIA1        1063            0
MEDIA2         680            0
-----------------------------------------------------------------------
OPERATIONAL STATE:  AUTOMATED
ERROR CATEGORY SCRATCH COUNT:             0
SCRATCH STACKED VOLUME COUNT:            79
-----------------------------------------------------------------------
Operator intervention required.
Host initiated export in process.
Convenience I/O station installed.
Convenience I/O station in Output mode.
Bulk input/output not configured.
```

If necessary, insert more stacked volumes.

9.7.4 Run Export

The Export Operation request is initiated by sending a Perform Library Function command that specifies the Library Export order code and the volume serial number of the logical volume that contains the export list file.

To initiate Export, issue the console command:

LIBRARY EXPORT,volser

where volser is the volume serial number of the export list volume.

You can initiate the export operation from a batch job using the CBRXLCS program from SAMPLIB which has been updated to support Import/Export functions. Alternatively, you may execute a utility capable of issuing the LIBRARY EXPORT operator command.

```
//****************************************
//* WRITE TRANSACTION RECORD IN A TEMP FILE
//****************************************
//STEP1    EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=&&TEMP,UNIT=SYSDA,DISP=(NEW,PASS),
//            DCB=(RECFM=FB,BLKSIZE=80,LRECL=80),SPACE=(TRK,(1,1))
//SYSUT1   DD *
X  volser
/*
//****************************************
//* START EXPORT
//****************************************
//STEP2    EXEC PGM=CBRXLCS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//INDD     DD DSN=&&TEMP,DISP=OLD
//OUTDD    DD DSN=HILEVELQ.TRANSOUT.EXPORT,UNIT=SYSDA,
//            SPACE=(TRK,(1,1)),DISP=(,CATLG)
```

Column 1 in the input transaction record (INDD statement) contains the transaction code which indicates the requested action. 'X' indicates export. The volser of the export list volume must start in column 4. The CBRXLCS program only initiates the export process without waiting for it to complete. See *DFSMS/MVS V1 OAM Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC26-3051 for additional information on the CBRXLCS program.

9.7.5 Export Process Flow

The Export Process Flow is described as follows: (Figure 101).
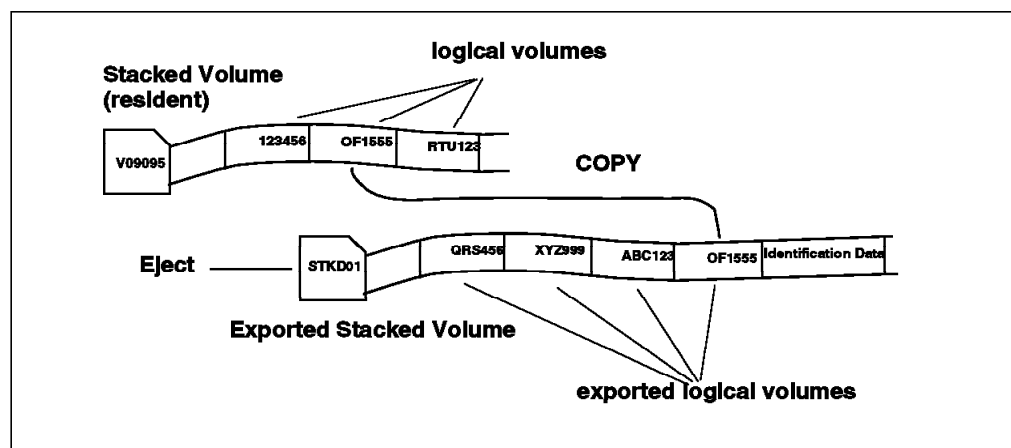
Figure 101. Export Process Flow

- When export is started, Library Manager first verifies that the export list volume is available, and if so queues the export operation. Export has the same priority as a logical mount. Library manager also turns on an in-use

attribute for the export list volume so that it cannot be used by the hosts while export is running.

When the export operation begins, the VTS first opens and reads the export list and assigns all exportable logical volumes on the list to the export pending category (FF12). A volume is not exportable if it is in use, or not in the VTS executing the export operation. The VTS opens the export status file where it writes records during the export process. A record is written to the status file indicating the reason for a volume not being exportable; the volume is not processed further.

The original category for the logical volume is preserved to allow it to be restored in the event that the volume cannot be successfully exported, or the export operation is terminated or cancelled before the volume is exported. Any attempt by a host to mount, audit, or change the category of a volume assigned to the export pending category fails.

- The VTS groups the exportable volumes by their destination and processes one destination at a time. Volumes having the same destination are copied to one set of exported stacked volumes. When all volumes for a destination have been processed, the VTS starts exporting volumes for the next destination to a new scratch stacked volume. An exported stacked volume thus contains only volumes going to the same destination.

  The VTS also groups the logical volumes within a destination by the source stacked volume and copies all logical volumes for a destination from a source volume during one mount. An input stacked volume has to be mounted more than once during the export operation, if it contains logical volumes for more than one destination.

- The VTS fragments all exportable volumes that are still resident in the TVC: The volumes are copied to tape, if not previously copied, deleted from the TVC and replaced by a fragment. The actual export thereafter is a tape-to-tape operation; from the TVC only the fragments are copied on the exported stacked volume. The time required to perform this step depends on the amount of data that has to be copied. Note that exporting volumes which have been fragmented is faster than exporting newly written volumes which have not yet been copied to stacked volumes.

- As each Exported Stacked Volume is filled or there are no more logical volume to export for the destination, a 'volume map' file is written on the Exported Stacked Volume that identifies the logical volumes contained on it. This includes each logical volume's volser and its location on the volume.

  Note: There is a limitation of 1000 logical volume per Exported Stacked Volume. Very repetitive data in logical volumes may allow the native cartridge capacity to be exceeded on the exported stacked volume.

- After the volume map is written, a file containing the fragment information from the Tape Volume Cache for the logical volumes on the Exported Stacked Volume is written on the Exported Stacked Volume.

- When the fragment information file has been written, the logical volumes on the Exported Stacked Volume are assigned to the 'Exported' category and the attached hosts are notified. The host passes the information to the tape management system. The Tape Management System is then updated to indicate that the logical volume has been exported and the Exported Stacked Volume it resides on. OAM requests the list of volumes in the exported category from the Library Manager. The list indicates the exported logical

volumes and the exported stacked volumes on which they were written. For each volume on the list, OAM takes the following actions:

– OAM calls the CBRUXEJC eject exit and, via the exit, notifies the tape management system of the exported logical volume and the exported stacked volume on which it now resides. The tape management system can then record this information in its database but has no opportunity to fail the subsequent purging of the volume.

Note: VTS Import/Export support today assumes that there is a one to one relationship between the tape management system control dataset (CDS) and the tape configuration database (TCDB). So if multiple systems are sharing the TCDB, it is assumed that the tape management system CDS was also being shared. Not all existing customers run with the recommended shared CDS, and as such, the VTS export support will not work with this type of configuration. To support this type configuration, a RC=12 (ignore) option has been added with **APAR OW40969** to the cartridge eject installation exit (CBRUXEJC): If the eject exit is passed an exported logical volume serial number that it does not know about in it's CDS, it can now return back with RC=12, leaving the volume in the exported category to be processed by a system that knows about the volume.

DFSMSrmm stores the volser number of the exported stacked volume in the logical volume record's "In container" field (Figure 102 and Figure 103 on page 259):

```
   Panel   Help
 ------------------------------------------------------------------------------
 EDGPT110              DFSMSrmm Volume Details - A05000
 Command ===>

 Volume . . . . . . : LOGCL1       Rack number  . . . . . . . :
 Media name . . . . : 3490         Status . . . . . . . . . . : MASTER
                                                           More:    +
 Volume type  . . . : LOGICAL      Expiration date  . . . . . : 1999/017
 Retention date . . :              Original expiration date . :
 Description  . . . :

 Data set name  . . :
 Media type . . . . : *            Release actions:
 Label  . . . . . . : SL              Return to SCRATCH pool . : YES
   Current version  :                 Replace volume . . . . . : NO
   Required version :                 Return to owner  . . . . : NO
 Density  . . . . . : *               Initialize volume  . . . : NO
 Recording format . : *               Erase volume . . . . . . : NO
 Compaction . . . . : *               Notify owner . . . . . . : NO
 Attributes . . . . : NONE            Expiry date ignore . . . : NO
 Availability . . . :                 Scratch immediate  . . . : NO

 Owner  . . . . . . : RMMUSER      Owner access . . . . . . . : ALTER
 Assigned date  . . : 1999/012     Assigned time  . . . . . . : 04:44:44
```

Figure 102. DFSMSrmm Volume Details Panel 1

```
┌─────────────────────────────────────────────────────────────────────────┐
│                                                                           │
│  Actions pending:                                                         │
│    Return to SCRATCH pool . : NO     Initialize volume  . . . . : NO      │
│    Replace volume . . . . . : NO     Erase volume . . . . . . . : NO      │
│    Return to owner  . . . . : NO     Notify owner . . . . . . . : NO      │
│                                                                           │
│  Location . . . . . : SHELF          Destination  . . . . . . . :         │
│  Location type  . . :                In transit . . . . . . . . : NO      │
│                                                                           │
│  In container . . . : STKD01                                              │
│                                                                           │
│  Storage group  . . :                Home location  . . . . . . : SHELF   │
│                                      Required location  . . . . :         │
│  Move mode  . . . . : AUTO           Movement tracking date . . :         │
│                                                                           │
│  Bin number . . . . :                Media name . . . . . . . . :         │
│  Old bin number . . :                Media name . . . . . . . . :         │
│                                                                           │
│  Product details:                                                         │
│    Product number . :                                                     │
│    Level  . . . . . :                                                     │
│    Feature code . . :                                                     │
│                                                                           │
│  Enter SCROLL commands for more volume information, or END command to CANCEL. │
│                                                                           │
└─────────────────────────────────────────────────────────────────────────┘
```

Figure 103. DFSMSrmm Volume Details Panel 2

- OAM requests the Library Manager to purge the logical volume entry from the library inventory.

- Depending on the installation exit, or the EJECT DEFAULT set for the library in SCDS (PURGE or KEEP), OAM either deletes the TCDB entry, or updates the entry to indicate that the volume has been exported.

  If the volume record disposition returned from the exit indicates that the volume's TCDB record should be kept and the shelf location returned from the exit is all blanks, OAM automatically stores the container volser in the shelf location field of the volume record as STACKED=volser. This information can later be used in the volume not in library installation exit (CBRUXVNL) to assist the operator in importing a logical volume. OAM also stores this information if the eject exit is not invoked, the volume record disposition is KEEP, and the shelf location in the TCDB record is blank.

  Note that when the eject exit supplied by DFSMSrmm is used, the TCDB entry is always deleted regardless of the PURGE/KEEP setting, as all the required information regarding the exported volume is stored by DFSMSrmm. The DFSMSrmm supplied Volume-Not-in-Library exit (CBRUXVNL) provides this information to the operator so that an import operation can be initiated for the required logical volume.

- When all of the volumes in the exported category are purged, the VTS deletes the exported logical volumes from the cache and generates status file records.

  Note: Export processing cannot continue until all volumes in the exported category are purged

- The Exported Stacked Volume is then moved to the Export-Hold category in the library and processing continues on to fill another volume for the

destination currently being processed. Once all of the logical volumes for a destination have been processed, processing for the next destination begins.

- When all logical volumes in the Export List File have been processed, a completion message is broadcast to all hosts attached to the VTS that performed the export process. The completion message results in the generation of a console message that includes the overall completion status of the export operation and metrics about the execution of the operation.

- A Library Manager dialog box, **Manage Export-Hold Volumes** (Figure 104 on page 263), allows an operator to move Exported Stacked Volumes from the Export-Hold category to the Eject category. Exported Stacked Volumes in the Eject category are moved to the Convenience I/O station by the Library Manager. If an Exported Stacked Volume is needed for an Import Operation, it may be moved to the Import category.

Exported logical volumes do not span physical volumes. If a logical volume does not fit on the current output stacked volume, the VTS changes output volumes and writes the entire logical volume on the next cartridge.

When export has completed, all logical volumes that could not be successfully exported are returned from the export pending category to their original category.

If you are sharing the library between multiple systems, a global resource serialization (GRS) ring allows OAM to serialize the purge processing associated with export. To prevent multiple sharing hosts from attempting to simultaneously process logical volumes in the exported category, OAM sends a SYSTEMS level ENQUEUE around the GRS ring. The resource names are:

QNAME - SYSZCBR
RNAME - EXPORTED_CATEGORY_library-name

There is no need to include the QNAME and RNAME in the system inclusion RNL, but for documentation purposes you may wish to do so. The library-name is the SMS name given to the library when it is defined through ISMF panels. Use of GRS in a shared environment is recommended, but not required.

9.7.6 OAM Messages Related to Export

In addition to the export completion message, status messages are generated during the execution of the export operation. These messages result in the generation of host console messages. See *3494 Tape Library Operator's Guide*, GA32-0289. for further information on host console messages. Messages are generated when:

- Export Operation has started

- Destination Processing begins

- When all volumes on an Exported Stacked Volume have been assigned to the exported category

- As each exported stacked volume is moved into the Export-Hold category

- When the processing for a destination has completed

- When an export operation is suspended

- When an export operation is resumed

- When the time limit of 60 minutes has been exceeded for providing scratch stacked volumes

- When an export operation has been terminated or canceled

- all export processing has been completed

Some examples for export related messages follow:

Successful completion of the export operation is indicated by the message:

```
CBR3855I Export operation for logical list volume volser in
         library library-name completed successfully.
```

If only some of the logical volumes were successfully exported, the completion is indicated by one of two messages:

```
CBR3856I Export operation for logical list volume volser in
         library library-name completed with exceptions or errors.
```

```
CBR3857I Export operation for logical list volume volser in
         library library-name completed with exceptions or errors.
         Statistics for the operation were not available.
```

Messages CBR3855I and CBR3856I include statistics for the operation, for example, the number of volumes and megabytes exported.

When you set up an export operation, you can define multiple export destinations. For each export stacked volume, OAM issues the message:

```
CBR3750 Message from library library-name: message-text
```

where *message-text* indicates the destination for the stacked volume. Once export has completed, the tape operator can use these messages to find out where each export stacked volume should be sent.

The following message tells which logical volumes have been exported on a stacked volume:

```
CBR3685I Export processing. Volumes exported from library
         library-name on stacked volume volser
         volser1 volser2 ... volser8
```

volser1 volser2 ... volser8 are logical volumes that were exported on exported stacked volume volser. The message contains a maximum of 48 logical volser numbers. If more volumes were exported on a stacked volume, the message is issued several times.

9.7.7 Analysis of the Export Status File

Unless the overall completion status of the export operation indicated that no processing exceptions were found, the Export Status File records must be analyzed. The export status file contains an entry for each volume specified on the export list indicating whether the export was successful or not. It is a flat file in EBCDIC format. You can use any standard tool to copy or print it.

The export list may contain volumes that do not exist in this VTS. A message is written in the status file to indicate this, and the process continues with the next volume.

Following is a sample JCL to read the export status file:

```
//STEP     EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT1   DD DSN=HILEVELQ.EXPSTATS,
//            UNIT=3490,DISP=OLD,LABEL=(3,SL),
//            VOL=SER=volser
//SYSUT2   DD SYSOUT=*
```

The status file might look like this:

```
EXPORT STATUS 01
VOLSR1,    ,18,*No Data Associated With Logical Volume
VOLSR4,    ,18,*No Data Associated With Logical Volume
VOLSR5,    ,05,*Logical volume not in VTS
VOLSR2,STKD01,00, DISASTER
VOLSR3,STKD02,00, BACKUP
```

In the above example, logical volume VOLSR1 was not exported (status code 18) because no data was associated with it, thus it probably was not used after it had been defined. Logical volume VOLSR5 (status code 05) was not found in this VTS. Logical volume VOLSR2 (status code 00) was successfully exported to export stacked volume STKD01 with destination DISASTER. Refer to *Magstar 3494 Tape Library Operator's Guide* for a complete listing of the fields and status codes.

9.7.8 Eject Exit

The export function requires that OAM is active, that the library for the export operation is online and operational, and that the eject installation exit CBRUXEJC is not disabled. The OAM address space does not have to remain active on the host which initiates the export operation, as long as it remains active in one of the hosts sharing the TCDB. If your tape management system does not supply an eject exit and you use the default provided by DFSMSrmm, the exit will be in bypassed state; this does not prevent the export function from working.

Use the following commands to check the status of the eject exit, and if necessary to enable it:

DISPLAY SMS,OAM
LIBRARY RESET,CBRUXEJC

Command

DISPLAY SMS,LIBRARY(libraryname)

indicates if export operations are in process in the library. Multiple export operations may run concurrently among the VTS subsystems in a physical library.

Use Library Manager console to eject the exported stacked volumes from the library in order to store them on shelf or to send them offsite.

9.7.9 Eject Exported Stacked Volumes

The exported stacked volumes are held in the library in the export hold category until an operator releases them. You can eject one exported stacked volume at a time, wait until export for the destination has completed, or eject all of them when the export operation has completed. Use Library Manager panels to eject the exported stacked volumes (Figure 104).
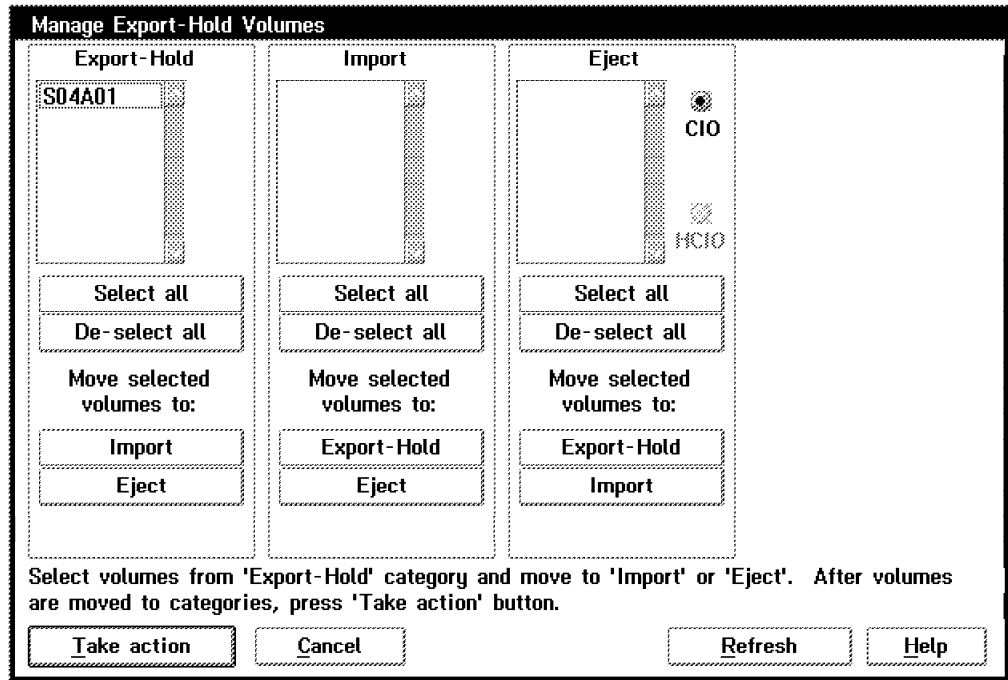
Figure 104. Manage Export Hold Volumes

9.7.10 Determine Exported Volumes

One method to find exported logical volumes and to locate the exported stacked volumes on which they reside is to use the RMM command (RMM SEARCHVOLUME) or the "In container" field on the panel in Figure 105 on page 264 and Figure 106 on page 264:

```
  ┌──────────────────────────────────────────────────────────────────────────┐
  │                                                                            │
  │    Panel  Help  Scroll                                                     │
  │  ------------------------------------------------------------------------- │
  │  EDGPT010                   DFSMSrmm Volume Search                         │
  │  Command ===>                                                              │
  │                                                                            │
  │                                                            More:     +     │
  │  Volume  . . . .            May be generic.  Leave blank for all volumes.  │
  │                                                                            │
  │  Owner . . . . .            Owned by a specific user. Default is your userid│
  │                                                                            │
  │  Media name  . .            Limit to a single media name                   │
  │  Pool  . . . . .            or to a particular pool                        │
  │                                                                            │
  │  Status  . . . .                                                           │
  │                             Select volume status.  Default is ALL.         │
  │  Since . . . . .            Volumes assigned since YYYY/DDD                 │
  │  Retention . . .            Volumes retained up to YYYY/DDD                 │
  │  Limit . . . . .            Limit search to first nnnn volumes             │
  │                                                                            │
  │  Home  . . . . .            Limit to volumes with this home location name  │
  │  Location  . . .            Limit to volumes in a single location          │
  │  In container               Physical stacked volser                       │
  │                                                                            │
  └──────────────────────────────────────────────────────────────────────────┘
```

Figure 105. DFSMSrmm Volume Search Panel 1

```
  ┌──────────────────────────────────────────────────────────────────────────┐
  │                                                                            │
  │  Volume type . .            ( LOGICAL or PHYSICAL )                        │
  │  Media type  . .            Tape media type ( *, CST, ECCST, HPCT or EHPCT)│
  │  Label . . . . .            Tape label standard ( for example SL )         │
  │    Current version          Label version number( for example 3 )         │
  │    Required version         Label version number( for example 4 )         │
  │  Density . . . .            Tape recording density                         │
  │  Format  . . . .            Tape recording format ( *, 18TRACK, 36TRACK or │
  │                                                   128TRACK )               │
  │                                                                            │
  │  Compaction  . .            Limit to volumes containing compacted data     │
  │  Attributes  . .            Tape special attributes ( NONE or RDCOMPAT )   │
  │                                                                            │
  │                                                                            │
  │  Destination . .            Limit by destination                          │
  │  Move mode . . .            Limit by move mode ( AUTO or MANUAL )          │
  │  Intransit . . .            Limit to volumes which are moving ( YES or NO )│
  │                                                                            │
  │  The following line commands are available when the list is displayed:     │
  │    C - Change volume information            E - Eject volume               │
  │    I - Data set information                 L - List volume chain          │
  │    O - Owner information                    R - Release volume             │
  │    V - Volume information                                                  │
  │  Enter SCROLL commands for more search values, ENTER to SEARCH or END to CANCEL.│
  │                                                                            │
  └──────────────────────────────────────────────────────────────────────────┘
```

Figure 106. DFSMSrmm Volume Search Panel 2

9.7.11 Canceling Export

Depending on the amount of data you are exporting, export can take a long time and you may need to cancel it; for example, to free the VTS resources used by export for other work. The first method of canceling an export operation is to issue this command:

`LIBRARY EXPORT,volser,CANCEL`

where `volser` is the volume serial number of the export list volume that was specified when the export operation was started.

You may cancel the export operation at any time. When the export is cancelled at the host:

- the VTS completes exporting the logical volume that is currently processing.

- The current exported stacked volume is processed and assigned to the export hold (FF17) category.

- All logical volumes still assigned to the export-pending category are reassigned to the category they were in prior to the start of the export operation.

- Status File Records are written for all logical volumes that had not completed processing

- A completion message is sent to all hosts indicating that the export operation was canceled via a host request.

- Any volumes that were successfully exported before the cancel command was issued, that is, volumes that were copied to exported stacked volumes and deleted from the VTS, are unaffected.

If you later want to rerun the export operation, you can use the same export list volume without having to modify it. Volumes in the export list file that have already been exported are skipped during the rerun, with a record written in the status file to indicate that it is no longer in the VTS. The VTS overwrites status records from the previous export run by writing new status records to the export status file.

A second method is to cancel an export operation from the library manager panel shown in Figure 107 on page 266. Canceling the operation through the library manager is a hard cancel; it will quickly terminate the operation and will not wait for the host to finish processing the volumes in the exported category. It should be used only when there is no functional host that can issue the cancel.
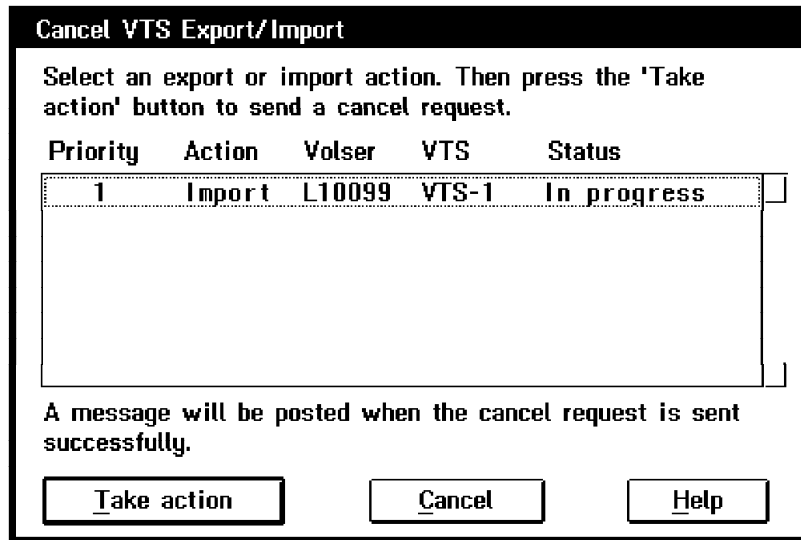
Figure 107. Cancel Export Using Library Manager Panels

Depending upon when the cancel is received, the VTS either:

- Places the logical volumes which had been copied to this incomplete Exported Stacked Volume (and purged by the host processing of the Exported category) into the Insert category for processing when the host becomes available again, or

- Returns the logical volumes which would have been exported to their original categories.

9.7.12 Export Performance

There are two considerations in defining the performance of an Export Operation. First the performance of the Export Operation itself and second, the impact that an Export Operation has on the overall performance of a VTS.

The performance of an Export Operation itself is defined in terms of its total elapsed time. The elements that influence the performance are:

- Number of logical volumes to export

  For each logical volume you should calculate a search time of 20 seconds to locate the logical volume on the stacked volume

- The amount of data to be copied

  It is assumed, that data can be moved from source stacked volume to exported stacked volume at a rate of 15 MB/s (3:1 Compression Ratio).

- The number of source stacked volumes to be mounted

  For each source stacked volume, there is a nominal processing overhead of 120 seconds to cover robotics mount and demount, load/thread and rewind/unload.

- The number of exported stacked volumes created

  For each exported stacked volume created, there is an overhead of 120 seconds to write the volume table of contents and the logical stub information files.

- Performance Tool

  A Spreadsheet to calculate estimated time to accumulate virtual volumes for export named **EXIMCALC.123** is available on:
  http://w3.rmss.tucson.ibm.com/softw/tapetool.htm

The impact on the overall performance of the VTS can be seen in two primary areas:

- Data Throughput

  Although export does not move data through the Tape Volume Cache, it uses 3590 SCSI bus bandwidth and RS/6000 processor cycles. The SCSI bandwidth is suspected to be sufficient to support maximum data throughput concurrently with an export operation. The throughput bandwidth of the VTS may be reduced slightly.

- Logical Volume Recall Time

  Since an export operation uses two physical drives of the VTS, fewer drives are available for use to recall logical volumes. This may result in longer logical mount times when the number of pending recalls exceed the number of physical drives less the two used for the export operation.

9.7.12.1 Import/Export Recommendations

1. It is recommended that Import/Export tasks be run during non-peak I/O activity times to minimize contention.

2. In order to reduce physical mounts required for Export, virtual volumes with similar creation dates should be exported together. This increases the probability that multiple volumes are found on the same physical source stacked volume.

9.8 Import Operation

The import process allows you to copy logical volumes from exported stacked volumes back to a VTS. The basic steps in an import process are:

1. Create an import list volume which contains the list of logical volumes you want to import.

2. Define the logical volumes you are importing to the receiving tape management system if required.

3. Insert the exported stacked volumes (cartridges containing volumes to be imported) into the target VTS library through the convenience I/O station.

4. Assign the exported stacked volumes to the import category (FF14) using library manager panels.

5. Run import. The VTS copies logical volumes from the exported stacked volumes onto stacked volumes already in the library and creates internal references to each imported logical volume.

6. Check import results.

7. Eject Exported Stacked Volumes after Import

We next look at these steps in more detail.

9.8.1 Assumptions and Definitions

There are several assumptions and definitions for the import operation as follows:

- Individual logical volumes or the entire contents of an Exported Stacked Volume can be imported.

- A logical volume, called the Import List Volume, is used to specify the logical volumes to import and to return status information. The Import List File can include either logical volumes, Exported Stacked Volumes pairs or just Exported Stacked Volumes. If only a Exported Stacked Volume is specified, all logical volumes that reside on that volume are to be imported.

- The library does not import a logical volume whose volser is a duplicate of one that is already resident in the library.

- All data to import is copied to the Tivoli Storage Manager managed storage pool.

- The exported stacked volume, that contains logical volumes to be imported, must be assigned to the import category by the operator prior to the initiation of the import operation

- The volumes moved to the import category by the operator remain in the library after an import operation completes. They can be ejected or assigned for use within native 3590 or VTS by an operator through the library manager console.

- While each exported stacked volume is being processed during an import operation, it is temporarily moved out of the import category to prevent an operator from attempting to eject or reassign the volume to another category.

- Import and Export are mutually exclusive in a VTS. Only one Import operation at a time is allowed in a physical library.

- Data being imported is not written into the TVC. The fragment information file on the exported stacked volume is read and the fragment files are written to the TVC.

- The import operation is stopped by the VTS when less than four physical drives are found.

- If you want to import logical volumes only to make the logical volumes available for reuse by the Tape Management System without importing any data there are two options available. First, specify that the volume contains scratched data and that only the prior volume label data needs to be kept in the VTS. Second, specify that the volume is to be reinitialized. None of the data from prior use is kept and the first time the volume is mounted, it contains only the data records of a newly initialized volume.

9.8.2 Create the Import List Volume Files

Write the required import list file on a logical volume in the VTS where you want to import the logical volumes. Refer to 9.6, "Import and Export List Volumes" on page 250. An import of one or more logical volumes can be initiated independently of DFSMSrmm by creating the import list volume files and requesting the import using the CBRXLCS macro or the LIBRARY command. You can use the DFSMSrmm SEARCHVOLUME command to build the list of logical volumes with their containing stacked volume and status:

```
RMM SV VOL(*) LIM(*) OWN(*) DEST(vtsname) TYPE(LOGICAL) CLIST
```

With the TYPE(LOGICAL) operand specified, the resulting output file contains:

```
STKD01,LOGCL1,status
```

The resultant output file can be used as input to the import list logical volume file. Use the sample EDGJIMPC to reformat the CLIST output file records to fixed, unblocked format, LRECL 80.

9.8.2.1 Import List Volume

The import list volume is used to pass to the library the list of volumes that you want to import into the VTS, and to store status information of the import process (Figure 108):
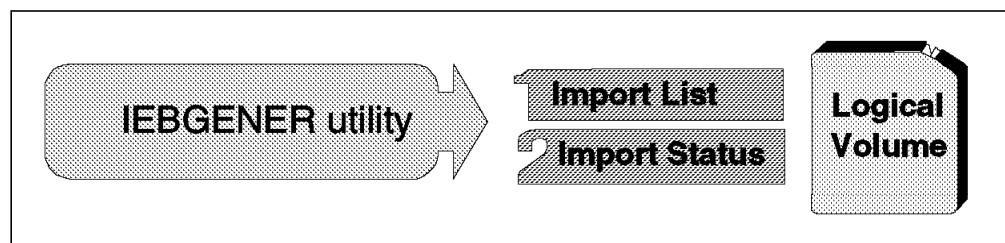
Figure 108. Import List Volume Contents

From a VTS perspective, the import list volume is handled as any other logical volume, thus it might be copied and fragmented, and consequently be recalled upon execution of the import function. It must contain the following two files in this order:

1. **Import list file**

   The import list file contains a list of volumes to be imported. You can import only selected logical volumes or all logical volumes from a stacked volume (see Figure 109).
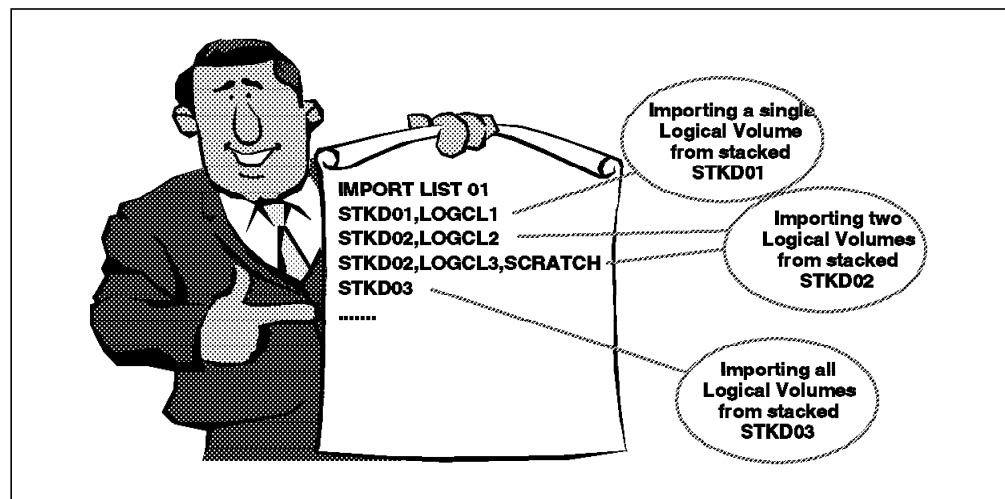
Figure 109. Import List Volume Contents

   The first record of the import list file is the file identifier and version number and must be specified as illustrated below, starting in the first column:

   ```
   IMPORT LIST 01 <user field>
   ```

The optional user field is a maximum of 16 characters long, separated with a blank from the version number.

Following the import list file identifier record there is a list of records containing up to three fields. The three fields consist of the exported stacked volume, the logical volser, and the import option. The fields must appear in that order separated by a comma. Both the logical volser and the import option are optional. For example:

STKD02,LOGCL3,SCRATCH

The exported stacked volume field is 1-6 characters long. This is the exported stacked volume containing logical volumes to be imported.

The logical volser field is 6 characters long. It identifies the logical volume to be imported. If the field is all blanks, all logical volumes on the specified exported stacked volume are imported.

The import option allows you to choose how the volume is handled during import. The options are:

Blank (Omitted) The import option can be omitted (blank) which indicates that the data content of the logical volume is copied into the VTS subsystem and a VTS database entry, a fragment entry in the TVC, and the Library Manager record for the volume are created. After the import has completed, the logical volume is available for processing in the VTS. If requested for input processing, the newly imported logical volume needs to be recalled from the stacked cartridge.

SCRATCH indicates that the data content of the logical volume is not copied into the VTS. The SCRATCH option can be specified when the data on the logical volume to import is known to have been expired and is not accessed after the volume is imported into the VTS subsystem. This option can be specified for individual logical volumes or the entire contents of an Exported Stacked Volume. An entry for the logical volume in the VTS database, a fragment in the TVC, as well as a Library Manager record are created. After the import has completed, the logical volume can be used as a scratch volume.

INITIALIZE option can be specified when the logical volume to import is to be initialized and any prior data on the volume discarded. This option can be specified for individual logical volumes or the entire contents of an Exported Stacked Volume. Data will not be copied to a resident stacked volume and fragment information with the volume label information will not be written to the cache. Only the Library Manager record for the volume is created. After the import has completed, the volume is like a newly inserted logical volume that has never been used.

Both keywords have to be spelled out to be correctly recognized.

If a logical volser is not included with an exported stacked volume, the import option specified applies to all logical volumes on the exported stacked volume.

The import list may include logical volumes or exported stacked volumes that are not found on the exported stacked volumes being used for the import operation.

Use import option 'SCRATCH' or 'INITIALIZE' to prevent unnecessary copying of the data contents of the logical volume. This is useful if the logical volume has expired or returned to scratch after it was exported.

Note: Data contents of logical volumes imported with the 'SCRATCH' or 'INITIALIZE' option cannot be recovered later on, because the exported stacked volume may be reused and overwritten as soon as all logical volumes have been successfully imported.

2. **Import status file**

The second file on the import list volume is used for storing status information from the import process. The file identifier and version number is defined in the first record and must be exactly as illustrated below, starting in the first column:

IMPORT STATUS 01 <user field>

The optional user field is a maximum of 16 characters long, separated with a blank from the version number.

After the import operation is completed, this file contains individual volume import results.

Following is sample JCL which writes the required files on the import list volume using a private volume:

```
//IMPORT  JOB 1,'IMPORT',MSGLEVEL=(1,1)
//***************************************
//* FILE 1: IMPORT LIST FILE
//***************************************
//STEP1    EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=HILEVELQ.IMPLIST,
//            UNIT=VTS2,DISP=(NEW,KEEP),LABEL=(1,SL),
//            VOL=(,RETAIN,,,SER=IMP001),
//            DCB=(RECFM=FB,BLKSIZE=80,LRECL=80,TRTCH=NOCOMP)
//SYSUT1   DD *
IMPORT LIST 01
STKD01,LOGCL1
STKD02,LOGCL2
STKD02,LOGCL3
STKD03
/*
//***************************************
//* FILE 2: IMPORT STATUS FILE
//***************************************
//STEP2    EXEC PGM=IEBGENER,COND=(4,LT)
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=HILEVELQ.IMPSTATS,
//            UNIT=VTS2,DISP=(NEW,CATLG),LABEL=(2,SL),
//            VOL=(,,,REF=*.STEP1.SYSUT2),
//            DCB=*.STEP1.SYSUT2
//SYSUT1   DD *
IMPORT STATUS 01
/*
```

9.8.3 Define Volumes to the Tape Management System

Your tape management system may require that the logical volumes you are importing are defined to the receiving tape management system. If necessary, use the appropriate tape management system commands to define the volumes before you run import. To find out which logical volumes are contained on an exported stacked volume, you need to check the export status file or the CBR3685I messages for the corresponding export operation.

Volumes being imported which are unknown to DFSMSrmm can be automatically added to the control data set in a fashion similar to that supported for native volumes being entered into a system-managed library. DFSMSrmm fails an import of a logical volume, if it has a record for the volume but the volume is not known to be an exported volume. If desired, an exported logical volume can be defined to DFSMSrmm. Use the TYPE and CONTAINER operands of the ADDVOLUME subcommand:

```
AV volser LOCATION(SHELF) CONTAINER(svol) STATUS(MASTER) TYPE(LOGICAL)
```

If you import a logical volume back to the same RMM environment from which it was exported, DFSMSrmm knows the volume as an exported logical volume.

9.8.4 Insert Exported Stacked Volumes in the Library

The insert process and the assigned categories are different for IBM 3494s without VTS subsystems and for IBM 3494s with VTS subsystems and the Advanced Function feature installed. Refer to 7.8, "Inserting Stacked Volumes in the VTS" on page 177 for a description of the process.

Use this host command to display the status of the convenience I/O station:

```
D SMS,LIBRARY(libname),DETAIL
```

Verify that the convenience I/O station is in *Import* mode (see 9.7.4, "Run Export" on page 255).

9.8.5 Assign the Exported Stacked Volumes

When 3590 cartridges are inserted into a 3494 library that has a VTS with Advanced Function feature installed, all cartridges are assigned to the unassigned category (FF16) in the Library Manager, and the operator, using a Library Manager menu, may move the cartridges into the import category, or the insert category, or may eject the cartridge (Figure 110 on page 273). Cartridges are placed by the library manager into insert (FF00) or VTS insert (FF01) categories based upon volume ranges previously defined. Insert the exported stacked volumes in the target library through the convenience I/O station. The Library Manager places the volumes in empty storage cells in the library and assigns them to the unassigned category (FF16). Once you have inserted all of the exported stacked volumes, use the Library Manager menus to move the cartridges from the unassigned category to the import category (FF14) where they must be when the import operation begins.
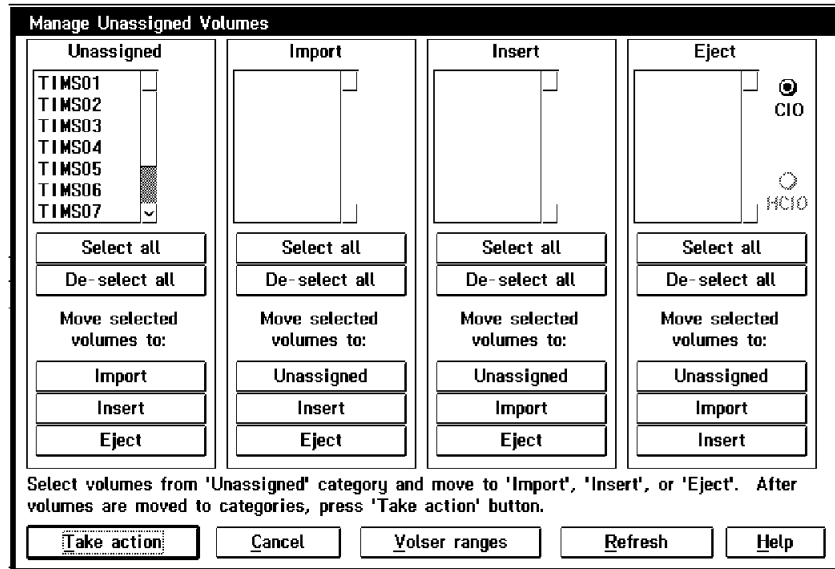
Figure 110. Manage Unassigned Volumes

Make sure you do not move an exported stacked volume into the insert category, since you loose all exported logical volumes on it when the VTS uses it as a scratch stacked volume or a native 3590 drive uses it as scratch cartridge.

Note: Cartridges inserted through the high-capacity I/O facility are not assigned to the Unassigned category but to an insert category, either FF00 or FF01 based upon volume ranges previously defined. Consequently, exported stacked volumes must not be inserted through the high-capacity I/O facility.

9.8.6 Run Import

Import increases the amount of data in your VTS. Before running import, make sure you have enough empty stacked volumes in the VTS to store the imported logical volumes.

Once you have added all the exported stacked volumes needed for the import into the library and moved them to the import category, you can start the import process. To initiate import, issue the operator command:

`LIBRARY IMPORT,volser`

where `volser` is the volume serial number of the import list volume. You can initiate the import operation from a batch job using the CBRXLCS program from SAMPLIB which has been updated to support Import/Export functions. Alternatively, you may execute a utility capable of issuing the LIBRARY IMPORT operator command.

```
//*****************************************
//* WRITE TRANSACTION RECORD IN A TEMP FILE
//*****************************************
//STEP1    EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT2   DD DSN=&&TEMP,UNIT=SYSDA,DISP=(NEW,PASS),
//            DCB=(RECFM=FB,BLKSIZE=80,LRECL=80),SPACE=(TRK,(1,1))
//SYSUT1   DD *
I  volser
/*
//*****************************************
//* START IMPORT
//*****************************************
//STEP2    EXEC PGM=CBRXLCS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//INDD     DD DSN=&&TEMP,DISP=OLD
//OUTDD    DD DSN=HILEVELQ.TRANSOUT.IMPORT,UNIT=SYSDA,
//            SPACE=(TRK,(1,1)),DISP=(,CATLG)
```

Column 1 in the input transaction record (INDD statement) contains the
transaction code which indicates the requested action. ′I′ indicates import. The
volser of the import list volume must start in column 4. CBRXLCS program only
starts the import process without waiting for it to complete. See *DFSMS/MVS V1
OAM Planning, Installation, and Storage Administration Guide for Tape Libraries*,
SC26-3051 for additional information on the CBRXLCS program.

The import function requires that OAM is active, that the library for the import
operation is online and operational, and that the entry installation exit
CBRUXENT is not disabled. The OAM address space does not have to remain
active on the host which initiates the import operation as long as it is active on
one of the hosts sharing the TCDB. Use the following commands to check the
status of the exit, and if necessary to enable the exit:

DISPLAY SMS,OAM

LIBRARY RESET,CBRUXENT

The following command indicates if an import operation is already in process in
the library:

DISPLAY SMS,LIBRARY(libraryname)

Only one import operation at a time can be initiated or be in execution in a 3494
library even if there are multiple VTS subsystems in the library.

9.8.7 Import Process Flow

The steps of the Import Process Flow are described as follows:
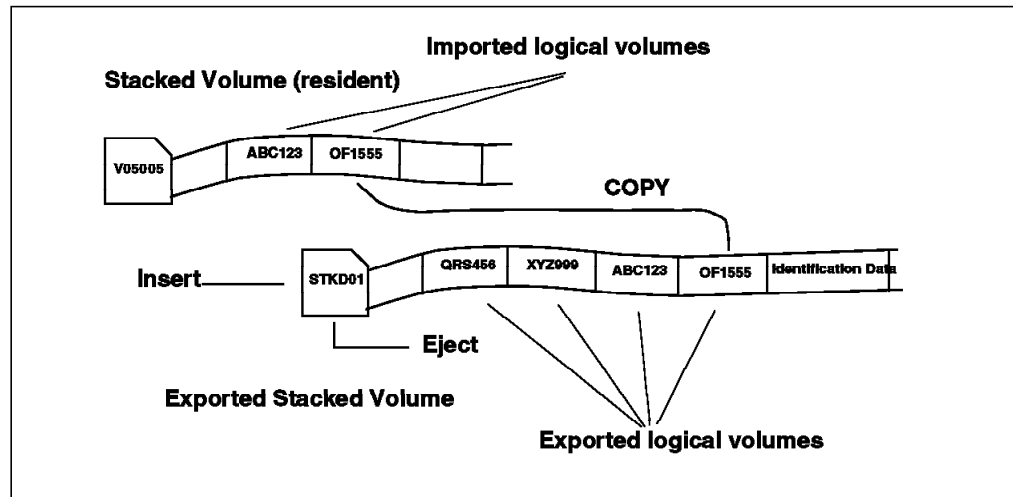
Figure 111. Import Process Flow

- First, the VTS checks that the exported stacked volume is in the import category (FF14). If not, a status record is written and the volume is not processed further.

- If the volume is in the import category, the VTS mounts it, reads the volume map file and compares it against the logical volumes specified in the import file list and creates a list of candidate volumes to be imported from the stacked volume. The list contains either all logical volumes on the exported stacked volume, or just the ones specified in the import list file. Import has the same priority as a logical mount. Library manager also turns on an in-use attribute for the import list volume so that it cannot be used by the hosts while import is running.

- A Library Manager entry with category set to import pending (FF15) is created for volumes which become candidates for import. If a candidate volume is a duplicate of an existing volume (native or virtual) in the library, it is not imported.

- The data for each volume on the Candidate list is moved from the exported stacked volume to a stacked volume managed by the VTS.

- Once all of the data have been moved, a fragment file is created in the TVC for each logical volume successfully imported.

- Once all fragment files have been written to the TVC, the imported volumes are assigned to the 'INSERT' category and the attached hosts are notified. Volumes that were not successfully imported, due to I/O errors for example, are purged from the Library Manager inventory. OAM then performs entry processing for volumes in the insert category, calling the tape management system from the CBRUXENT exit. Volumes are either accepted and assigned to a private or scratch category, or rejected and purged from the library.

- Tape Management System is informed to update its records for the logical volumes indicating that they are now resident in the library.

- The exported stacked volume is returned to the import category for further disposition by an operator.

- When all logical volumes in the Import List File have been processed, a completion message is broadcast to all hosts attached to the VTS that performed the import process. The completion message results in the
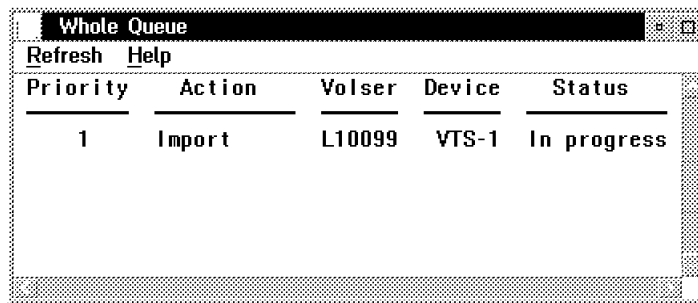
generation of a console message that includes the overall completion status of the import operation and metrics about the execution of the operation.

- All volumes which were moved by the operator into the Import category, including exported stacked volumes which contained logical volumes for the import operation, remain in the import category until the operator moves them to the insert category or ejects them.

Data contents of logical volumes with import option "SCRATCH" or "INITIALIZE" is not copied.

After all logical volumes from the exported stacked volume have been copied, the VTS copies the fragments from the file at the end of the volume into the TVC for each successfully imported logical volume. A fragment is not created for logical volumes with the "INITIALIZE" import option.

The process of the Import/Export operation can be monitored at the library manager, using the Queues display (Figure 112):

```
┌─────────────────────────────────────────────────────┐
│ Whole Queue                                     ▪  □ │
│ Refresh  Help                                        │
│ ─────────────────────────────────────────────────── │
│ Priority      Action      Volser   Device    Status  │
│ ─────────    ────────    ──────   ──────    ──────── │
│                                                      │
│    1          Import       L10099   VTS-1   In progress │
│                                                      │
│                                                      │
│                                                      │
│                                                      │
└─────────────────────────────────────────────────────┘
```

Figure 112. Queue Display with Import in Progress

Note: When a logical volume is successfully imported, the exported copy of the logical volume is not deleted from the exported stacked volume. You must take care not to import this level of the data again.

DFSMSrmm automatically prevents accidental re-imports of logical volumes. In order to do that, RMM allows import of one of its known volumes only if that volume is identified as being exported on the stacked volume where it is being imported from (identified by an ID in the container field). At import time, RMM removes the container information to prevent re-import of the same volume.

If you want to re-import a logical volume, once it is removed from the VTS, you must remove the volume from the RMM inventory so that it appears to be a foreign volume from another tape management environment, or tell RMM it is back on the stacked volume.

9.8.8 OAM Messages Related to Import

In addition to the import completion message, status messages are generated during the execution of this operation. These messages result in the generation of host console messages. See *3494 Tape Library Operator's Guide*, GA32-0289 for further information. Messages are generated when:

- Import Operation has started
- Import processing has begun for an exported stacked volume

- All logical volumes imported have been assigned to the insert category

- When the processing for an exported stacked volume has completed

- When a time limit has been exceeded for host response

- When an import operation has been terminated or canceled

- All import processing has been completed

Some examples for import related messages follow:

Successful completion of the import operation is indicated by message

```
CBR3860I Import operation for logical list volume volser in
         library library-name completed successfully.
```

If only part of the logical volumes were successfully imported, the completion is indicated by one of two messages:

```
CBR3861I Import operation for logical list volume volser in
         library library-name completed with exceptions or errors.
```

```
CBR3862I Import operation for logical list volume volser in
         library library-name completed with exceptions or errors.
         Statistics for the operation were not available.
```

Messages CBR3860I and CBR3861I include statistics for the operation, for example the number of volumes and megabytes imported.

9.8.9 Analysis of the Import Status File

Unless the overall completion status of the import operation indicated that no processing exceptions were found, the Import Status File records must be analyzed. The VTS generates status records for all logical volumes processed during the import operation. The records indicate the success or failure of the import for each volume. When the import operation has finished, the VTS appends the status records to the import status file on the import list volume.

The following is a sample JCL to read the import status file:

```
//STEP     EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DUMMY
//SYSUT1   DD DSN=HILEVELQ.IMPSTATS,
//            UNIT=3490,DISP=OLD,LABEL=(2,SL),
//            VOL=SER=volser
//SYSUT2   DD SYSOUT=*
```

9.8.10 Eject Exported Stacked Volumes after Import

The VTS does not automatically eject the exported stacked volumes at import completion. The exported stacked volumes are held in the library but are not used for storing any logical volumes because they are assigned to the import (FF17) category. You can select options at the Library Manager menus (Figure 113 on page 278) to either return the exported stacked volumes to the insert category (to be used for the VTS or native drives) or eject them and then return them to the original site.
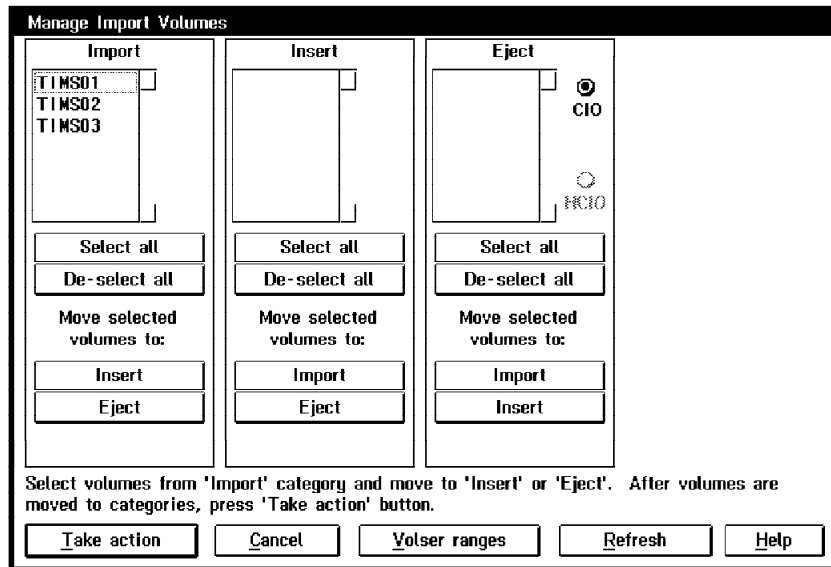
Figure 113. Manage Import Volumes

9.8.11 Canceling Import

Depending on the amount of data you are importing, import can take a long time and you may need to cancel it for example to free VTS resources for other tasks. The first method of canceling an import operation is to issue this command from any host attached:

`LIBRARY IMPORT,volser,CANCEL`

where `volser` is the volume serial number of the import list volume containing the list of volumes to be imported.

The VTS accepts a host request to cancel an import operation and process it as follows:

- Volumes imported successfully prior to the cancel command are indicated by status code of ″00″ in the Status File List.

- To ensure that the VTS, library manager and the host databases remain in synch regarding the logical volumes resident in the library, host processing of those volumes assigned to the insert category already, must complete, i.e. assignment to either eject, private or scratch category, before the cancel becomes effective.

- All logical volumes remaining in the import-pending category are deleted from the library inventory and any fragment files written to the cache are deleted.

- Status file records are written for all logical volumes or exported stacked volumes that did not complete the import process prior to the execution of the cancel request.

- A completion message is sent to all attached hosts indicating that the import was canceled.

If you later want to rerun the import operation on the same VTS subsystem, you can use the same import list volume without having to modify it. Volumes on the import list file that were imported during the previous run are found to be

duplicates and therefore will be skipped during the rerun, with a record written in the status file to indicate this. The VTS overwrites status records from the previous import run by writing new status records to the import status file.

A second method is to cancel an import operation from the library manager panel shown in Figure 114. Canceling the operation through the library manager is similar to the host cancel request. It should be used only when there is no functional host that can issue the cancel.

```
Cancel VTS Export/Import

Select an export or import action. Then press the 'Take
action' button to send a cancel request.

Priority    Action    Volser    VTS       Status

    1        Import    L10099    VTS-1     In progress




A message will be posted when the cancel request is sent
successfully.

     Take action           Cancel           Help
```
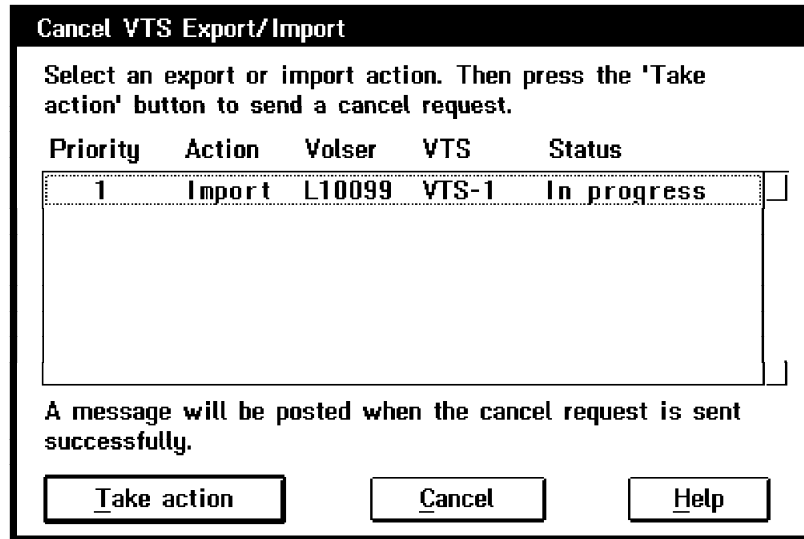
Figure 114. Cancel Import Using Library Manager Panels

The library manager cancel is processed as follow:

- If all logical volumes imported from an exported stacked volume and assigned to the insert category have been processed, cancel processing continues as for a host cancel.

- If this process is not yet finished, volumes that are still assigned to the insert category are left there.

- The status file records for those volumes indicate this condition

- The rest of the cancel processing continues as for a host cancel.

9.8.12 Handling Operator Errors

Operator errors which may be made during an import operation and the recovery actions are described below:

Error Scenario 1 An exported stacked volume with logical volumes not yet imported has been assigned to the Insert category and the volume serial number falls within the range defined for VTS stacked volumes. **Resultant VTS Action** The VTS/library adds the volume as a scratch stacked volume **Recovery Action** Eject the volume through the console using the **Eject a Stacked Volume** pop-up window

Error Scenario 2 An exported stacked volume with logical volumes not yet imported has been assigned to the Insert category and the volume serial number **does not** fall within the range defined for VTS stacked volumes. **Resultant VTS Action** The VTS/library assigns the volume to the insert category for 3590 native

use and notify all attached hosts **Recovery Action** Eject the volume from the library through host console commands, ISMF or tape management system.

Error Scenario 3 An exported stacked volume has been assigned to the Import category and has not been required for the import operation. **Resultant VTS Action** The volume remains in the Import category. **Recovery Action** Use the **Manage Import Volume** pop-up window to eject the volume

Error Scenario 4 An HPCT volume (not an exported stacked volume) which is needed as a scratch stacked volume or native 3590 volume has been assigned to the Import category. **Resultant VTS Action** The volume remains in the Import category. **Recovery Action** Use the **Manage Import Volume** pop-up window to move the volume to the Insert category defined by Volser ranges or eject the volume if it is not desired in the library.

9.8.13 Reuse of Exported Stacked Volumes

Once all of the logical volumes on an exported stacked volume have been imported, the exported stacked volume can be re-used for any 3590 application. No cleanup or special processing is required. However, the exported stacked volume remains in the Import category until operator action is taken. Use the host tape management system to verify that there are no logical volumes contained on a physical volume previously used for export. For example the RMM SEARCHVOLUME command:

 RMM SV CONTAINER(xxxxxx),

where xxxxxx is the volser of the exported stacked volume

Reuse of the physical volume is accomplished with operator action by using the library manager console **Manage Import Volume** pop-up window to move the Exported Stacked Volume out of the Import category or eject it.

9.8.14 Import Performance

There are two considerations in defining the performance of an Import Operation. First the performance of the Import Operation itself and second, the impact that an Import Operation has on the overall performance of a VTS.

The performance of an Import Operation itself is defined in terms of its total elapsed time. The elements that influence the performance are:

- Number of logical volumes to Import

  For logical volumes, that do not have the SCRATCH or INITIALIZE import option specified, you should calculate a search time of 20 seconds to locate the logical volume on the stacked volume If all logical volumes on a exported stacked volume have to be imported, then the seek time is eliminated.

- The amount of data to be copied

  It is assumed, that data can be moved from the exported stacked volume to target stacked volume at a rate of 15 MB/s (3:1 Compression Ratio).

- The number of exported stacked volumes to be mounted

  For each exported stacked volume, there is a nominal processing overhead of 120 seconds to cover robotics mount and demount, load/thread and rewind/unload. For each exported stacked volume created, there is an

overhead of 120 seconds to write the volume table of contents and the logical stub information files.

The impact on the overall performance of the VTS can be seen in two primary areas:

- Data Throughput

  Although export does not move data through the Tape Volume Cache, it uses 3590 SCSI bus bandwidth and RS/6000 processor cycles. The SCSI bandwidth is suspected to be sufficient to support maximum data throughput concurrently with an import operation. The throughput bandwidth of the VTS may be reduced slightly.

- Logical Volume Recall Time

  Since an import operation uses two physical drives of the VTS, fewer drives are available for use to recall logical volumes. This may result in longer logical mount times when the number of pending recalls exceed the number of physical drives less the two used for the import operation. If all the logical volumes to be imported have the SCRATCH or INITIALIZE option specified, only one drive is used.

9.9 Exported Stacked Volumes Consolidation

Along time, logical volumes that have been exported will expire and the valid space used on the exported stacked volumes will decrease. It is important to find rules and ways to return exported stacked volumes with a small percentage of active data, as well as to reduce the number of exported stacked volumes. On the other hand, exported stacked volumes contain vital data that are necessary to achieve a correct restart, and therefore cannot be returned to the VTS for consolidation.

The objective of this chapter is to describe ways of reducing the number of exported stacked volumes outside the VTS.

9.9.1 Links between Stacked and Logical Volumes

Logical volumes that are exported have completely disappeared from the VTS and from the Library Manager. They have also disappeared from the TCDB when the tape management system is RMM. They may or may not be in the TCDB when the tape management system is CA-1. However, the logical volume entries are present and managed by the tape management system, in all cases. Analyzing the tape management system based on container volumes subsequently pointing to the valid (not scratch) logical volumes can give accurate information on the topography of containers.

Such an analysis requires only access to the tape management system data base and can produce a cross reference of logical volume contents and megabytes, crossed by container volumes.

9.9.2 Links between Exported Logical Volumes and In-house Volumes

Most of the time, volumes that are exported contain a copy of the data sets that are kept on the creating system. The duplication can be controlled by software such as DFHSM that can create 2 copies of the same data. Alternately, other software or JCL can create a copy of the original data set. The naming rules for the copy are conventions.

When analyzing the topography of exported stacked volumes, we can find the name of the data set in the tape management system, but this name is the name of the copy. We have to find the name of the original data set in order to create a second copy of the data, as well as the adequate data mover.

9.9.3 Returning the Container or Making a Second Copy

Once the topography has been done and the original volumes identified, we can derive in GB, the amount of data to copy and export a second time. The list could look like:

```
STKEX0 0MB
     No valid logical volume

STKEX1 250MB
     DSN1 V00001 V00001 25KB ICEGENER
     DSN2 V00001 V00001 25KB ICEGENER
     DSN3 V00021 V00021 100KB DFDSS
     DSN4 V00023 V00023 100KB IDCAMS

STKEX2 1250MB
     DSN5 V00002 V00052 25KB ICEGENER
     DSN6 V00002 V00052 25KB ICEGENER
     DSN7 V00024 V00043 600KB DFDSS
     DSN8 V00025 V00057 387KB IDCAMS
     .....................

STKEXx yyyyMB

     .....................
```

In this list we find the name of the copy volume, the name of the original volume, the size and the creating program name.

With such a list one can derive the volser to return to the VTS and the value of initiating a subsequent copy and weight the workload in MB and data set to copy by host software, with the saving in exported cartridges that can be returned to the VTS as scratch.

9.10 Export/Import Programming Support

The Library Control System (LCS) External Services has been enhanced to support Import/Export. It provides the following general-use programming interfaces for Import/Export:

The LCS external service FUNC=EXPORT can be used to identify the export list volume and to initiate the export operation. The interface can also be used to

cancel an executing export operation. The syntax of the CBRXLCS Assembler H macro to perform the export function is:

```
CBRXLCS TYPE=TAPE
        ,FUNC=EXPORT
        ,VOLUME=volser
        [,CANCEL=YES | NO]
```

The LCS external service FUNC=IMPORT can be used to identify the import list volume and to initiate the import operation. The interface can also be used to cancel an executing import operation. The syntax of the CBRXLCS Assembler H macro to perform the import function is:

```
CBRXLCS TYPE=TAPE
        ,FUNC=IMPORT
        ,VOLUME=volser
        [,CANCEL=YES | NO]
```

The FUNC=QVR external service allows the caller to determine in which tape library a specified volume resides. If VOLINFO=YES is specified, a copy of the available information about the volume as contained in the TCDB and the library manager inventory is returned to the caller.

This interface is also extended to provide audit capabilities from a tape management system database with the new optional parameter, LIBNAME. Whereas the ISMF audit capability requires the presence of a TCDB record, this function does not. A tape management system can use this new capability to verify its inventory against the TCDB and LM inventory. It can also be used to track and verify the library residency of volumes that are not managed in the TCDB, such as the stacked volumes in a VTS.

```
CBRXLCS TYPE=TAPE
        ,FUNC=QVR
        ,VOLUME=volser
        [,LIBNAME=library-name]
        [,VOLINFO=YES | NO]
        [,SUBPOOL=subpool-number]
```

For more information, see *DFSMS/MVS V1 OAM Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC26-3051.

9.11 CA-1 Support of the Import/Export Function

The Advanced Function Feature Export/Import is supported by CA-1 Release 5.2 with the following PTF's applied:

- TF45102, CTS
- TF45103, CA-1
- TF45900, CBRUXENT
- TF45901, CBRUXEJC

Contact CA for the product information bulletin with the detailed information about VTS Import/Export support.

These Fixes supply samples for the exits CBRUXENT and CBRUXEJC. The exits are used to set the ROBTY and ROBID fields in the TMC when a tape is entered into the library and when a tape is ejected or exported. During export operation the tape is taken out of the scratch status or deleted. The EXPDT is set to PERM and the DSN to a pseudo data set name that has to be specified in the CBRUXEJC exit. The CDATE is set to the current date. The pseudo dataset name can be used for vaulting. The OUTCODE and SLOT of the physical tape are changed to match the first VTS tape to be exported.

ROBTY and ROBID are cleared when a tape is ejected. When a tape is exported, ROBID only is cleared. New values of 81 - 88 are added to the ROBTY field. The 8 in the first position indicates that it is a VTS tape and not a physical tape. The Earl program TMEEJECT, which reads the EARLOUT from TMSVMVLT, is modified to check the ROBTY field. If it is 81 - 88 then information to perform an export is generated, instead of control statements for an eject.

CTSSYNC is used to schedule an Import/Export operation (refer to Figure 115). There are new EXPORT/IMPORT DD statements available now to allocate an ′EXPORT.TAPE.LIST′ and an ′IMPORT.TAPE.LIST′ dataset. After the creation of one of these list files, the operation is scheduled. This is similar to the creation of the export and import file lists described in 9.6, "Import and Export List Volumes" on page 250. To support this new function, the ROBTY field has to be set properly prior to the execution of any EARL report. This can easily be accomplished with the TMSUPDTE program for the entire range of virtual volumes.

New mount messages have been added to CA-1 to indicate requests to mount an exported volume.

```
//*****************************************
//* CREATE EXPORT / IMPORT LIST DATASET
//*****************************************
//STEP1    EXEC PGM=CTSSYNC,PARM=′parmlist′
//SYSPRINT DD SYSOUT=*                          *Note 1
//STEPLIB  DD DSN=CAI.CAILIB,DISP=SHR
//EXPORT   DD DSN=EXPORT.TAPE.LIST,DISP=(,CATLG),   *Note 2
//            UNIT=virtual-addr,TRTCH=NOCOMP
//IMPORT   DD DSN=IMPORT.TAPE.LIST,DISP=(,CATLG),   *Note 3
//            UNIT=virtual-addr,TRTCH=NOCOMP
//SYSIN    DD *                                 *Note 4
(control-statements)
/*
```

Figure 115. New DD Statements

Note 1:   Optional statement, reports the volsers processed

Note 2:   Used for generation of an export list

Note 3:   Used for generation of an import list

Note 4:   Control statements may be entered here or as a parameter list

9.11.1 Export Tape List Example

In Figure 116, the logical volumes LV1233 and LV1244 are to be exported.

```
//****************************************
//* CREATE EXPORT LIST DATASET
//****************************************
//STEP1     EXEC PGM=CTSSYNC,PARM='parmlist'
//SYSPRINT DD SYSOUT=*
//STEPLIB  DD DSN=CAI.CAILIB,DISP=SHR
//EXPORT   DD DSN=EXPORT.TAPE.LIST,DISP=(,CATLG),
//            UNIT=virtual-addr,TRTCH=NOCOMP
//SYSIN    DD *
EXPORT,LV1233,OFFSITE1
EXPORT,LV1244,OFFSITE1
/*
```

Figure 116. Import JCL Example

An export-list-volume is created and uses the CBRXLCS IMPORT interface to schedule the list to be exported. When the export operation is completed, the logical volumes are stacked on a exported stacked volume, which is put in the export hold status, waiting to be ejected.

9.11.2 Import Tape List Example

In Figure 117, all logical volumes on exported stacked volume PV0011 will be imported.

```
//****************************************
//* CREATE IMPORT LIST DATASET
//****************************************
//STEP1     EXEC PGM=CTSSYNC,PARM='parmlist'
//SYSPRINT DD SYSOUT=*
//STEPLIB  DD DSN=CAI.CAILIB,DISP=SHR
//IMPORT   DD DSN=IMPORT.TAPE.LIST,DISP=(,CATLG),
//            UNIT=virtual-addr,TRTCH=NOCOMP
//SYSIN    DD *
IMPORT,PV0011
/*
```

Figure 117. Import JCL Example

An import list volume is created and uses the CBRXLCS EXPORT interface to schedule the list to be imported.

9.12 DITTO VTS Functions

In this section, we describe two of the new features of DITTO/ESA 1.3, Exported Stacked Volume Copy and Exported Stacked Volume List. You can also obtain the updated *Ditto User's Guide and Reference, (SH19-8221-02)* at *http://www-4.ibm.com/software/ad/ditto/library.html#ug*

9.12.1 Overview

IBM Data Interfile Transfer, Testing, and Operations Utility for ESA (DITTO/ESA) is a proven utility for working with data across a wide range of storage media and formats. You can use DITTO/ESA to access, display, edit, migrate, and maintain data in files and data sets on any System/390 storage device supported in the MVS/ESA, OS/390, VSE/ESA, or VM/ESA Environments.

These new features enable the user to physically copy a logical volume from an Exported Stacked Volume on to another physical cartridge. This can be useful for storing the logical volume in an offsite location for disaster recovery purposes or for sending it to an external bureau. A list function is also available which allows you to list the contents of an Exported Stacked Volume which can be used as input into the copy process.

9.12.2 VTS Terms

Exported Stacked Volume

This is a physical 3590 B1A or E1A cartridge (containing logical virtual volumes) that was created by using the VTS Export function. Please see Chapter 9, "IBM Magstar VTS Advanced Function" on page 245 for more information on the Export feature.

Internal Stacked Volume

This is a physical 3590 B1A or E1A cartridge used to stack virtual volumes which have been written from the Tape Volume Cache of the VTS. This volume is not in the same format as the Exported Stacked Volume.

Logical Volume

This is a tape volume created in the Tape Volume Cache in the VTS. The logical volume may be physically in the TVC, on an Exported Stacked Volume or on an Internal Stacked Volume. The logical volume is equivalent to a physical tape volume in a non VTS environment.

9.12.3 Requirements

All VTS export volumes are written on devices that support the locate block CCW. DITTO uses the locate block CCW to find the start of a logical volume, therefore, the input device for the exported volume must support the locate block CCW.

9.12.4 New Features

EVC - Exported Stacked Volume Copy

This is used to copy a logical volume from an Exported Stacked Volume to a physical volume. Up to five logical volumes can be copied in a single step to five physical volumes.

EVL - Exported Stacked Volume List

This is used to list the contents of an Exported Stacked Volume. You can choose a short listing, which prints only the logical volumes on the Exported Stacked Volume, or you can choose a long listing which prints the volume structure of the logical volumes.

9.12.5 How It Works

The process uses the standard DITTO interfaces, batch JCL, command mode and full screen mode.

This utility once invoked for COPY requires various parameters which enable it to select the source logical volume from the correct Exported Stacked Volume. These parameters also specify the target output volume required and the device type. Please see the latest DITTO User's Guide for a full description of required parameters.

The copy utility extracts a logical volume from an exported VTS volume. Thus, by definition, the exported volume no longer resides in the original VTS where it was created. The VTS export volume can be used as input on a standalone device or in another ATL library. This means that the VTS export volume is physically removed from the VTS, where it was created and loaded into another ATL library, where it is treated/defined the same as any other tape being brought into the library from another system.

The output device can be a 3490 or 3590, but the output volume must be large enough to contain the logical volume you are going to copy. If the output volume is to small then the process fails with an EOV message. You can copy up to five logical volumes during one step, and each logical volume must be written to a physical volume, so if you want to copy three logical volumes, then you need three physical output volumes to perform the copy.

The copy process reads the volser (VOL1) of the output volume and during the copy effectively renames the logical volume to the name that is on the output volume. If the output volume has no volser (VOL1) information, then the volser of the logical volume is used.

This copy process is a COPY only process, it does not remove or delete the source volume, hence, the procedure is repeatable if you wanted to make more than one copy of the source.

Figure 118 on page 288 shows the DITTO copy of logical volume VOL001 to a unique physical volume PHY001. Only the data is copied from VOL001 and not the volser (VOL1) information. PHY001 now contains the data copied from VOL001. A listing can also be produced to display the contents of the Exported Stacked Volume.
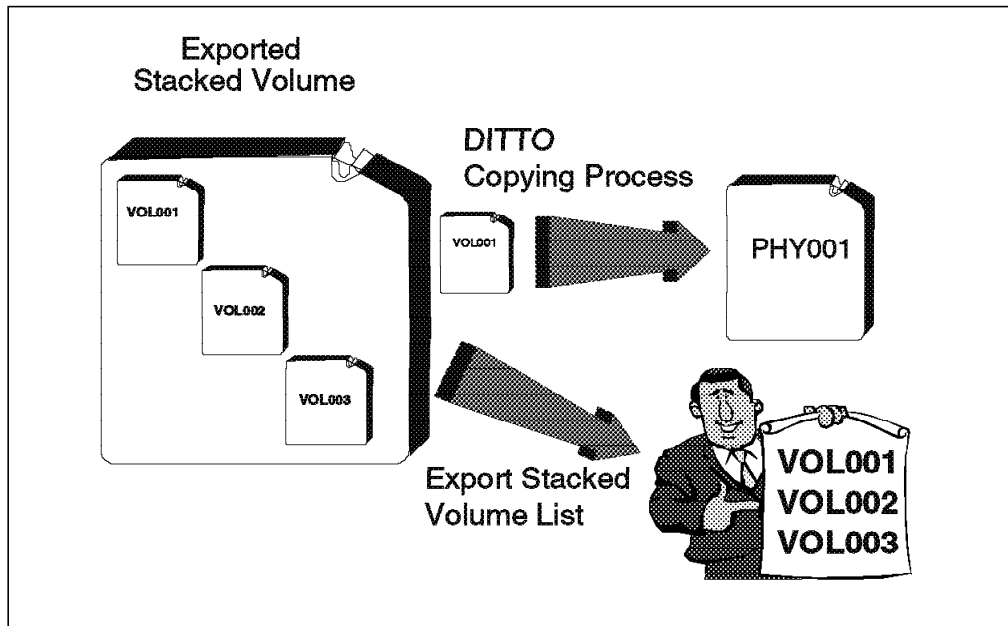
Figure 118. Exported Stacked Volume Copy and Stacked Volume List

The Exported Stacked Volume List function scans the VTS export volume and produces one of two reports. These are called the short or long lists. The short list produces a list of volumes contained on the export volume. The long list produces a list of all logical volumes on the export volume as well as the structure of these volumes. It also includes the dataset name on any HDR1 records located. This list can be used in conjunction with the copy command.

As with the copy function, the list function works only with exported stacked volumes and requires various parameters to be set. Please see the latest DITTO User's Guide for a full description of required parameters.

Note: Only exported stacked volumes created by the VTS export function are supported by the Export Volume Copy function. This function does not support internal stacked volumes that were not created by the VTS export function. Currently, an internal stacked volume is not compatible with an exported stacked volume.

The copy function extracts a block of data from an Exported Stacked Volume and writes the physical block of data on the output volume. A block of data may be user data or HDR, or EOF records. There is no open or close performed for each file on the logical volume. Hence, there is no interface to the tape management systems or to the Offline Control Dataset (OCDS) of DFSMShsm. Also, the OS/390 catalog information for individual datasets on the volume are not updated.

A spreadsheet to estimate the time required to perform the DITTO extract operation on exported stacked volumes is named **DITOFEAS.123** and is available on: *http://w3.rmss.tucson.ibm.com/softw/tapetool.htm*

Chapter 10. Error Recovery

In this chapter we document the error conditions that can occur in a VTS and where appropriate, the actions you should take to recover from them.

Because the VTS has been designed to operate with as little manual intervention as possible, many of the error conditions can be resolved with little or no action on your part.

10.1 IBM Magstar VTS Resilience

The VTS and the IBM Magstar 3494 Tape Library include a number of features that provide resilience or backup in the event of a failure, including:

- Holding the TVC on RAID fault-tolerant disk arrays
- Providing two SCSI paths to the IBM 3590 tape drive
- Providing two or four host ESCON ports
- Holding three to six IBM 3590 tape drives
- Offering a second Library Manager hard disk drive or Library Manager
- Making available an optional dual gripper
- Offering an optional second accessor and service bay with the High Availability Unit (HA1)

There are, however, some components that are not fully protected. In the event of a failure of one of the following unprotected components, the VTS will not be available for use:

- VTS controller

  If the VTS controller fails, the data stored on the VTS cannot be processed.

- Power distribution and line cords

  There is only one power distribution and line cord on each IBM 3494-L1x, IBM 3494-D12, and early manufactured IBM 3494-B18 frames. If any one of them fails, the data on the VTS is not available for processing.

  A Model B18 with two primary control compartments and two power cords allows continued availability of the VTS even in case of a failure of one power source.

  Note: Be aware that the Unit Emergency Switch (EPO) of the IBM 3494-B18 is separate from the switch on the Library Manager. Setting the IBM 3494-B18 EPO to the off position will not affect the power on the Library Manager. Setting the Library Manager EPO to the off position will not affect the power on the IBM 3494-B18. Please also be aware that removal of power in this manner can result in loss of customer data.

- SSA adapters

  Each of the SSA adapters controls part of the TVC. In the event an adapter fails, access to the TVC is lost and processing stops.

Any host jobs processing data at the time of failure will fail and will have to be rerun.

10.2 Failure and Recovery Scenarios

In this section, VTS failures and the recovery methods are discussed. When permanent read or write data errors occur on a 3590 tape drive used by the VTS, the stacked volume is swapped to another 3590 and the operation is attempted again.

This drive swap is an internal VTS process, it is transparent to the host and does not involve the dynamic device reconfiguration (DDR) MVS host processing. If the permanent error occurs on the second 3590 tape drive, the VTS protects against further errors by placing the stacked volume in a read-only status and providing the Intervention Required message

```
CBR3750I MESSAGE FROM LIBRARY lib:
Stacked volume xxxxxx is in Read-Only status with a
reason code of yyyyy. (VTS z)
```

Note: Refer to 7.4.1.1, "Messaging Enhancements" on page 170 for a description on how to activate the notification of the intervention conditions on the host.

The VTS performs a recovery of read-only status stacked volumes as an independent process. Customer data on logical volumes which reside on the stacked volume continues to be accessible, but no new data will be written to the volume. The Intervention Required notification will be sent to hosts for the first volume to be placed in read-only status within a 24 hour period. Any subsequent volumes that may have been placed in read-only status are visible at the library manager console though.

Note: A customer initiated eject operation is available from the Library Manager to force the VTS to copy the logical volumes from the stacked volume to a new stacked volume. See 7.9, "Ejecting Stacked Volumes from the VTS" on page 180 for details.

10.2.1 Read-only Status Volume Recovery

Automated read-only recovery is set as the default operation mode. Stacked volumes will be placed in read-only status if they experience one of the following:

- Permanent media error during copying, recall or reclamation
- Error when writing the VTS database on the stacked volume
- Excessive temporary media errors
- VTS drive conversion from 3590-B1A to 3590-E1A tape drives

The VTS manages volumes in read-only status in a transparent manner.

Once an hour, the VTS checks for the presence of stacked volumes in read-only status. For each stacked volume found in read-only status, the VTS recalls the logical volumes into the tape volume cache and makes them eligible to be copied to another stacked volume, thus removing the logical volumes from the damaged stacked volume one by one. Access to logical volumes on read-only status stacked volumes for recall is not impacted, except for the potential of re-occurrence of a permanent error if recalled again.

The VTS starts the read-only recovery as soon as it can. There is only one read-only recovery in process at any given time. It also could not occur while a 'eject volume' command is underway, or while reclamation is running.

When all stacked volumes of the read-only tape have been read into the cache and the tape ejects, then the read-only recovery was successful and the following intervention message is sent to the host:

```
CBR3750I MESSAGE FROM LIBRARY lib:
A Read-Only stacked volume xxxxxx has been
ejected to the Convenience Input/Output Station.(VTS z)
```

If an unrecoverable read error occurs on a logical volume in this process, the Intervention Required message

```
CBR3750I MESSAGE FROM LIBRARY lib:
Logical volume xxxxxx was not fully recovered from
damaged stacked volume yyyyyy. (VTS z)
```

is posted to the attached hosts.

If damaged logical volumes must be recovered from the ejected stacked volume, the IBM service representative should be called to open a PMR and initiate the recovery action at the IBM support center.

10.2.1.1 SARS -Statistical Analysis and Reporting System

It is a method for determining whether read and write errors are caused by the tape media or by the drive hardware. The SARS microcode runs in the drive and keeps information about how the tape media is performing (read/write errors, etc...) over its life. This media information (Volume SARS or VSARS) is saved in the VCR portion of the tape and travels along with the tape from drive to drive. Information about how the drive hardware (Hardware SARS or HSARS) is performing is written in the drive memory and is saved into the flash memory every 8 hours.

The SARS microcode runs when a cartridge is unloaded from the drive. At this time the media and hardware performance is updated and various algorithms are run to check if a media or hardware problem exists.

Volume SARS The volume information saved on the media includes various types of errors experienced by the tape (read/write, temporary/permanent, etc.), the physical location of the error on the tape, the serial number of the drive where the error occurred, and a judgement about the quality of the drive responsible for the error. The media algorithms (currently implemented in the code) are quite complicated and require the media to experience errors on multiple different drives before any media action is required. The number of different drives varies depending upon the type of error, the physical location of the error, and the quality of the drives involved in the error. When VSARS determines that there is a problem with the media, it generates a MIM (media information message) stating that the tape should be re-written or that the tape should be copied to a new tape and then discarded. If VSARS determines that a tape is bad, it can logically write-protect the tape.

Hardware SARS The hardware information kept for the drive includes various types of errors experienced by the drive, Error Correction Code (ECC) rates, and a SARS volume identifier for the media involved in the error. HSARS is intended to find hardware that is gradually going bad over a period of time causing read/write errors. It will not point to hardware that suddenly fails. HSARS is based on various software filters that charge up or down based on the number and type of errors and ECC rates that occur in a given number of Gbytes processed. A quality assessment of the drive hardware is generated based on

the value of the filters. When HSARS determines that hardware needs to be replaced, a Symptom Information Message (SIM) is generated that points to the hardware needing to be replaced.

10.2.1.2 SARS Impact on Read-only Recovery

With DC4 drive code (packaged with 17.10 and above), the SARS information previously written tapes will be accessed to identify the VTS tapes which should be considered read-only. The VTS has always had a number of conditions which turned a tape to read-only (permanent write error, database does not fit on the tape, etc.). Now, there is another source of read-only tapes: Those which had a high number of temporary errors, or other occurrence which causes SARS statistics to be high.

Note: You have to be aware of the fact, that after the activation of the new drive code the number of read-only tapes will temporarily increase.

10.2.1.3 Drive Swapping

On OS/390, both DFSMS/MVS and BTLS support automatic internal swap inside the tape library for non-VTS drives. When installing VTS in an existing IBM 3494 Tape Library, you can see DDR host messages for non-VTS drives in case of a media error, but not for VTS virtual IBM 3490E drives or VTS Magstar drives. Refer to the *OS/390 Recovery and Reconfiguration Guide*, GC28-1777, for more information about OS/390 DDR functions.

10.2.2 Failure Scenarios

In this section, we discuss a wide scope of possible failure scenarios, the most likely implications, and recommended actions.

10.2.2.1 Permanent Write Error

When the VTS attempts to copy a virtual volume from the TVC to a stacked volume and a permanent write error occurs, the stacked volume is swapped to another 3590 drive and the copy operation for the entire virtual volume is attempted a second time. If the second attempt fails, it is likely that the media is the problem.

The stacked volume is placed in read-only status, the copy of the virtual volume which could not be completed will not be included on the stacked volume and the stacked volume is unloaded. A new stacked volume is mounted and the copy operation of the virtual volume from the TVC is performed from the beginning.

10.2.2.2 Permanent Read Error

When the VTS attempts to recall a logical volume from a stacked volume and a permanent read error occurs, the stacked volume is swapped to another 3590 drive and the recall is retried. If the attempt to recall fails on the second 3590 drive, the VTS indicates on the first I/O operation issued by the host that a drive equipment check has occurred. The host job which requested the logical volume which cannot be made available will be terminated. The VTS places the stacked volume in read-only status.

When the host application attempts to read beyond the failure point or uses a tape positioning command that attempts to position the tape beyond the failure point, the application receives notification of a permanent error, as with a real IBM 3490E.

10.2.2.3 IBM 3590 Tape Drive Failure

When the VTS determines that the 3590 tape drive is not operating correctly and requires service (likely that the drive has excessive read or write errors), the drive is marked off-line and an IBM customer service representative must be called.

The following Intervention message is displayed on the Library Manager Console:

```
CBR3750I MESSAGE FROM LIBRARY lib:
Device xxx made unavailable by a VTS. (VTS z)
```

Operation of the VTS continues with a reduced number of drives until the repair action on the drive is complete.

To recover, the IBM customer service representative repairs the failed IBM 3590 tape drive.

10.2.2.4 SSA Adapter Failure

The TVC is unavailable for use and therefore the VTS and volumes stored on it are unavailable until the repair action is completed.

To recover, the IBM customer service representative repairs the failed SSA adapter. Once repair is completed, processing on the VTS can continue.

10.2.2.5 Channel Card Failure

If an ESCON channel adapter fails, it is marked unavailable and the VTS continues operation with one less ESCON channel until the repair action is completed.

To recover, the IBM customer service representative repairs the failed ESCON adapter. Once repair is completed, processing on the VTS can continue.

10.2.2.6 SSA Drive Failure

The VTS TVC uses a RAID fault-tolerant implementation stored on SSA drives. If a drive fails, the array automatically reconfigures itself, removing the failed drive from the array, adding the spare drive to the array, and rebuilding the data onto the new drive. Reconfiguration of the array and the repair of the failed drive are concurrent.

To recover, the IBM customer service representative repairs the failed SSA drive.

10.2.2.7 IBM Magstar VTS Controller Failure

If the controller fails, the VTS and volumes stored on it are unavailable until the repair action is completed.

To recover, the IBM customer service representative repairs the VTS controller.

10.2.2.8 Power Failure

User data is protected in the event of a power failure, as it is stored on the TVC. Any host jobs reading or writing to virtual tapes will fail as they would with a real IBM 3490E and will need to be restarted once the VTS is available again. When power is restored, the VTS recovers its TVC, using information available from the VTS database and logs.

Once power is restored, restart the IBM Magstar 3494 Tape Library. The Library Manager restarts the IBM Magstar VTS.

10.2.2.9 VTS Database Corruption

To recover from corruption of the VTS database you have to perform a so-called disaster recovery. This is a VTS process further described in Section 10.3, "Disaster Recovery at Another Site" on page 297.

The Virtual Tape Server controller maintains a database of information about the location and status of logical volumes on the stacked volumes it manages. When a stacked volume has been filled with logical volumes, a backup of the entire database is placed at the end of the filled stacked volume. The database contains a time and date stamp that identifies when the backup was performed.

When the database copy operation is complete, a message is sent to the attached hosts:

```
CBR3750I MESSAGE FROM LIBRARY lib:
VTS Database Backup written to Physical Tape  xxxxxx.
```

The disaster recovery process causes the VTS controller to load the stacked volumes, locate the latest version of the database, and restore it.

Any logical volumes written after the last backup of the VTS database are lost. When the restoration is complete, a message is displayed on the Library Manager console informing you of the date and time when the VTS database was restored.

10.2.2.10 IBM Magstar VTS Software Failure

If a problem develops with the IBM Magstar VTS software, the VTS issues an intervention message to the Library Manager and attempts to recover. In the worst case, this can involve a reboot of the RS/6000 system that makes up the VTS controller. If the problem persists, you need to contact your IBM service representative. The Intervention message sent to the Library Manager is:

```
CBR3750I MESSAGE FROM LIBRARY lib:
Virtual Tape System z has a CHECK-1 (xxxx) failure.
```

The VTS internal recovery procedures handle this situation and restart the VTS.

10.2.2.11 Library Manager Failure

If the Library Manager fails in an IBM Magstar 3494 Tape Library that contains a VTS, the situation is the same as with any other IBM 3494. If HA1 is installed, the second library manager takes over. The library will be taken offline from the hosts and will be unavailable until take over is complete. Then, the library has to be varied online, using operator commands. If the HA1 is not installed, the library (VTS) is unavailable until the repair action is complete and the Library Manager is restored.

For detailed scenarios on how to handle failure scenarios with HA1, refer to *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632.

Current tape tasks complete, but no new tasks can start until the Library Manager switchover is complete or the problem has been solved. To recover, fix the problem that caused the Library Manager to fail.

10.2.2.12 Accessor Failure

If HA1 is installed, the second accessor takes over. If the HA1 is not installed, failure of the accessor results in the library being unable to automatically mount volumes in response to host requests for data. When a host requests a logical volume, the request is converted into a message to mount a stacked volume. The message is displayed on the Library Manager Console.

If the HA1 feature is installed, you must call your IBM service representative to repair the failed accessor. The actions you perform if the HA1 is not installed are the same as those you would perform for the manual mount of a volume in the IBM Magstar 3494 Tape Library. For detailed information about running the IBM Magstar 3494 Tape Library in manual mode, see the *Magstar 3494 Tape Library Operator Guide*, GA32-0280.

10.2.2.13 Dual Gripper Failure

Not all VTS units have a dual gripper. However, if a gripper fails on a dual gripper accessor, the library operations will continue with one gripper.

While the gripper is being repaired, the accessor is not available, so the library should be run in manual mode until the repair is complete. If the HA1 is installed, the second accessor will be used until the gripper is repaired. For detailed information about running the IBM Magstar 3494 Tape Library in manual mode, see the *Magstar 3494 Tape Library Operator Guide*, GA32-0280.

10.2.2.14 Out of Stacked Volumes

If the Tape Library runs out of stacked volumes, then copying to the 3590 will fail and an intervention-required message is sent to the Library Manager. All further logical mount requests are delayed by the Library Manager until more stacked volumes are added to the Tape Library.

To recover, insert more stacked volumes. Copy processing can then continue.

10.2.2.15 Broken Leader Block

If a stacked volume has a broken leader block, it causes a load failure on the 3590 drive. The drive is made unavailable, the volume is marked as inaccessible, and an intervention-required message is generated indicating that a Load/Unload failure occurred. All subsequent accesses to logical volumes on the stacked volume fail because the stacked volume is unavailable.

To recover, follow the procedure for load failures to remove the cartridge from the drive, repair the leader block, and reinsert the stacked volume. Eject the volume as detailed in Section 7.9, "Ejecting Stacked Volumes from the VTS" on page 180, to force the VTS to copy the logical volumes from the stacked volume to a new stacked volume. Once the stacked volume has been copied and ejected again, destroy it. This is the same process as for IBM 3590 cartridges today.

10.2.2.16 Broken Tape

If a 3590 tape cartridge is physically damaged and unusable (the tape is crushed, or the media is physically broken, for example), the VTS subsystem cannot recover the contents. This is the same as for IBM 3590 cartridges today. You can generate a list of logical volumes that are on the stacked volume. See the Section 7.14.3, "List Logical Volumes on Stacked Volume" on page 193 for details.

10.2.2.17 Logical Mount Failure

When a mount request is received for a logical volume that is not resident in the Tape Volume Cache, the VTS subsystem must recall the volume from a physical tape. A logical mount failure could result from a number of problems, the most likely is that a stacked volume is removed accidentally, or a stacked volume is stuck in a drive. To recover, solve the problem with the stacked cartridge, and make it accessible to the VTS functions. For a stuck volume contact your IBM service representative.

If the subsystem cannot successfully recall the logical volume, it will still indicate to the host that the mount completed. When the host issues the first I/O operation to the virtual device, the subsystem will fail the command and indicate an equipment check. The host will then fail the job and generate console messages. For example, the following messages are generated as a result of a logical volume mount failure for volume **V00001** on device **1FD5**:

```
IEC501A M 1FD5,V00001,SL,NOCOMP,GENVTSP8,STEP4,VTS42.TEST74
```

The resulting error message on the host console would look similar to this one:

```
IOS000I 1FD5,AD,EQC,**,0600,,**,,GENVTSP8613
 10488035000000206011(B310000102004113)0000(500007FF)CE3FD69000050500

IEC147I 613-54,IFG0194K,GENVTSP8,STEP4,SYSUT2,1FD5,OAM274 VTS42.TEST74
```

The IOS000I message reports that an equipment check was received for device 1FD5 and contains the sense data returned by the subsystem. When a logical volume recall fails, the volume is not available in the Tape Volume Cache. Sense byte 14 contains X'02' which indicates this condition.

The IEC147I message reports that the failure was detected as the tape volume was opened. The abend and return code (613-54) indicates that the volume serial number was unreadable, had no label, or the volume was uninitialized, however in a VTS it is also the indication that the recall failed. When a logical volume mount is failed in this way, the operator will need to view the intervention required conditions and based on the intervention reported, take action prior to resubmitting the job.

10.2.2.18 Orphaned Logical Volume

This occurs when the VTS database has a reference to a logical volume but no reference to its physical location. This could result from hardware or internal software errors. When it does occur, any data on the logical volume is lost.

When this error occurs contact your IBM customer service representative.

10.2.2.19 Internal-External Label Mismatch

If a label mismatch occurs, the stacked volume is ejected to the convenience Input/Output station and the Intervention Required condition

```
CBR3750I MESSAGE FROM LIBRARY lib:
A stacked volume has a label mismatch and has been
ejected to the Convenience Input/Output Station.
Internal: xxxxxx, External: yyyyyy
```

is posted at the Library Manager console. The host is notified that Intervention Required conditions exist.

Investigate the reason for the mismatch. If possible, relabel the volume to use it again.

10.2.2.20 Host Failure

If a host failure occurs, the situation is the same as for an IBM Magstar 3494 Tape Library without a VTS, so use the same procedures as for an IBM Magstar 3494 Tape Library.

10.2.2.21 Failure during Reclaim

If there is a failure during the reclamation process, the process is managed by the VTS LIC. No user action is needed; recovery is managed internally.

10.2.2.22 Excessive Temporary Errors on Stacked Volume

When a stacked volume is determined to have an excessive number of temporary data errors, to reduce the possibility of a permanent data error, the stacked volume is placed in read-only status.

10.3 Disaster Recovery at Another Site

In the event that a VTS is not usable, because of interruption of utility or communication services to the site or significant physical damage to the site or the VTS itself, access to the data managed by the VTS is restored through automated processes designed into the product. The recovery process assumes that the only elements available for recovery are the stacked volumes themselves. It further assumes that only a subset of the volumes are undamaged after the event. If the physical cartridges have been destroyed or irreparably damaged, recovery is not possible, as with other cartridge types. It is important that you integrate the VTS recovery procedure into your current disaster recovery procedures.

The disaster recovery process is a joint exercise that requires your involvement as well as that of your IBM customer service representative.

Note: Data created on an IBM 3494-B18 EHPO VTS subsystem cannot be successfully recovered on an IBM 3494-B16 or an IBM 3494-B18 non-EHPO VTS subsystem.

In the sections that follow, we document the process for recovering the contents of a VTS.

10.3.1 Actions to Take at the Damaged Site

When the site is damaged so that it is no longer available, take the following actions to resume processing with the VTS:

1. If possible, have the Force Migrate function performed at the damaged site.

   If the 3494 and VTS are still functional, ask the IBM customer service representative to perform a Force Migrate operation through the Library Manager service panel. This operation ensures that all data has been moved from the TVC to a stacked volume and a complete database backup is performed.

2. Remove the stacked volumes from the 3494

   Remove the undamaged 3590 stacked volumes from the 3494. Ensure that all stacked volumes are removed. If you leave (or lose) any physical

cartridges, the logical volumes they contain are no longer available for processing and cannot be added at a later date.

3. Take the removed physical cartridges to the recovery site.

10.3.2 Actions to Take at the Recovery Site

Take the following actions at the recovery site:

1. Restore the tape management system catalog

   You must restore the tape management system catalog before invoking the disaster recovery operation at the Library Manager. Restoring the catalog allows correct synchronization between the tape management system and the Library Manager. If you do not restore the tape management system catalog before selecting the disaster recovery operation, any logical volumes for which the existing catalog does not have entries is returned, using the default use attribute specified in the ISMF panel. Normally, the default use attribute will be scratch, which may not be the required end result, as the logical volumes are scratched.

2. Set up the DFSMS tape catalog

   The 3494 library with the VTS must be defined before starting disaster recovery at the library. You must either define a new TCDB or, if you have restored the one from the disaster site, using IDCAMS IMPORT RECONNECT, you must alter the library definition to replace the library ID with the ID that identifies the recovery library. If you do not replace the ID, DFSMS will not accept the logical volumes because it thinks they are already in another library. You can use the ISMF Tape Library Application Selection panel, specifying the **Alter** option.

3. Invoke the Disaster Recovery process from the Library Manager

   Have the IBM customer service representative select the disaster recovery option on the Library Manager service panel. You will need to provide the IBM service representative with the volser ranges of the physical volumes that you are going to put into the recovery VTS.

4. Place the stacked volumes for the recovery into the library

   When the IBM customer service representative tells you to, place all of the physical stacked volumes into the library. As the number of volumes may be large, open the library frame doors and manually place the volumes into any library cell, except for the high capacity input/output cells (if configured). There are no specific cells for the location of the stacked volumes. Once the volumes are in the library, the customer service representative can continue with the recovery process.

5. Reinsert the logical volumes

   When the IBM customer service representative has indicated that the disaster recovery process is complete, there is still one more action that you must take: reinsert the logical volume serial number ranges into the Library Manager, with the library online to the attached hosts. As the Library Manager processes the volumes you are adding, it notifies the attached hosts, and the Library Manager inventory, the TCDB, and the tape management system are synchronized.

6. Once the hosts and the library have completed synchronization, the logical volumes managed by the VTS are available for host access.

10.3.3 Disaster Recovery Processing Time

The time taken to perform the disaster recovery process depends heavily on the number of stacked volumes, drives, and logical volumes you have. Several steps are involved in performing disaster recovery. The steps and their estimated times are described below. The times for steps 1 through 3 are sequential. The times for steps 4 and 5 can overlap.

1. Reinventory Library.
   Approximately 10 minutes per library frame

2. Find most recent database on physical volumes.
   Approximately 90 seconds per cartridge per 3590 drive. All 3590 VTS drives are used. Total time is:
   (number of cartridges * 90 seconds) / number of drives

3. Reload database and shut down/restart the VTS controller.
   Approximately 20 minutes

4. Add logical volumes to the Library Manager inventory.
   Approximately 4 minutes per 1000 logical volumes

5. Upload the Library Manager inventory and re-synchronize with the tape management system and operating system.
   Approximately 1 second per logical volume

Sample time, assuming:

- Three-frame library (L10, D12, B18)

- Eight hundred 3590 physical volumes

- Six 3590 drive configuration

- 25,000 logical volumes

Time for steps:

1. 3 * 10 min = 30 min

2. (800 * 90 sec)/6 = 200 min

3. 20 min

4. 25 * 4 min = 100 min

5. 25,000 * 1 sec = 417 min

Totals
Steps 1-3 = 250 min
Steps 4-5 = 417 min (step 5 overlaps 4)
Approximately 11 hours

10.3.4 Disaster Recovery Implications

At the completion of the recovery process, the VTS and the IBM 3494 Library Manager contain database and inventory records as well as status information for the logical volumes as found in the most recent database backup on the undamaged stacked volumes. Depending on the following conditions, some customer data and logical volumes may not have been recovered:

- The stacked volumes containing the latest database backups may have been destroyed.

  Any changes to the location or status of logical volumes since the last found database backup are lost. Some logical volume records may be lost. It is

possible, however, that the database will contain the location of the previous use of logical volumes and that data is accessible to the host.

- One or more stacked volumes found in the restored database may have been destroyed during the event.

  Although the VTS database and the Library Manager inventory may have a record of the logical volumes that resided on the missing stacked volumes, the data itself is lost.

- A virtual volume may not have been closed at the time of the event.

  The VTS database has no record of the virtual volume's location on a stacked volume, and the data is lost.

- Logical volumes may have been written to a stacked volume between the time the last database backup was made and the disaster.

  The VTS database has no record of the new logical volume locations on the stacked volume, and the data is lost. It is possible, however, that the database may contain the location of the previous use of the logical volume and that data is accessible to the host.

Appendix A. Library Manager Volume Categories

Table 35 lists all Library Manager volume categories, and the platforms on which they are used, and their definition.

Table 35 (Page 1 of 8). Library Manager Volume Categories		
Category (in hex)	**Used by**	**Definition**
0000	Null Category	This pseudo category is used in certain library commands to specify that the category which is already associated with the volume is to be used by default or that no category is specified. Use of the null category does not affect the volume's order within the category to which it is assigned. No volumes are associated with this category.
0001	DFSMS/MVS	Indicates scratch MEDIA1. MEDIA1 is a standard-capacity cartridge system tape.
0002	DFSMS/MVS	Indicates scratch MEDIA2. MEDIA2 is an enhanced-capacity cartridge system tape.
0003	DFSMS/MVS	Indicates scratch MEDIA3. MEDIA3 is the IBM 3590 High Performance Tape Cartridge.
0004 to 000D	DFSMS/MVS	Reserved
000E	DFSMS/MVS	Indicates an error volume. Volumes in this category are scratch volumes for which the software detected an error during processing.
000F	DFSMS/MVS	Indicates a private volume. Volumes in this category contain user data or are assigned to a user.
0010 to 007F	DFSMS/MVS	Reserved. These volume categories can be used for library partitioning.
0080	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH0
0081	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH1
0082	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH2
0083	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH3
0084	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH4
0085	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH5
0086	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH6
0087	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH7
0088	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH8

Table 35 (Page 2 of 8). Library Manager Volume Categories		
Category (in hex)	**Used by**	**Definition**
0089	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH9
008A	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHA
008B	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHB
008C	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHC
008D	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHD
008E	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHE
008F	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHF
0090 to 009F	-	Currently not assigned
00A0	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH00
00A1	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH01
00A2	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH02
00A3	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH03
00A4	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH04
00A5	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH05
00A6	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH06
00A7	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH07
00A8	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH08
00A9	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH09
00AA	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH10
00AB	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH11
00AC	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH12
00AD	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH13
00AE	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH14

Category (in hex)	Used by	Definition
		Table 35 (Page 3 of 8). Library Manager Volume Categories
00AF	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH15
00B0	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH16
00B1	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH17
00B2	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH18
00B3	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH19
00B4	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH20
00B5	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH21
00B6	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH22
00B7	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH23
00B8	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH24
00B9	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH25
00BA	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH26
00BB	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH27
00BC	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH28
00BD	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH29
00BE	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH30
00BF	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH31
00C0 to 00FF	-	Currently not used
0100	OS/400 (MLDD)	Indicates that the volume has been assigned to category *SHARE400. Volumes in this category can be shared with all attached AS/400 systems.
0101	OS/400 (MLDD)	Indicates that the volume has been assigned to category *NOSHARE. Volumes in this category can be accessed only by the OS/400 system that assigned it to the category.
0102 to 012B	-	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on request of a host.

Table 35 (Page 4 of 8). Library Manager Volume Categories		
Category (in hex)	Used by	Definition
012C	ADSM for AIX	Indicates a private volume. Volumes in this category are managed by ADSM.
012D	ADSM for AIX	Indicates an IBM 3490 scratch volume. Volumes in this category are managed by ADSM.
012E	ADSM for AIX	Indicates an IBM 3590 scratch volume. Volumes in this category are managed by ADSM.
012F to 0FF1	-	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on request of a host.
0FF2	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH2.
0FF3	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH3.
0FF4	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH4.
0FF5	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH5.
0FF6	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH6.
0FF7	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH7.
0FF8	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH8.
0FF9 to 0FFE	-	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on request of a host.
0FFF	BTLS	Indicates a scratch volume. Volumes in this category belong to the default scratch pool used by BTLS. **Note:** If you are planning to migrate to DFSMS/MVS, you should use this default scratch category only.
1000 to F00D	-	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on request of a host.
F00E	BTLS	Indicates a volume in error. Volumes are assigned to the error category during demount if the volume serial specified for demount does not match the external label of the volume being demounted.

Table 35 (Page 5 of 8). Library Manager Volume Categories		
Category (in hex)	**Used by**	**Definition**
F00F to FEFF	-	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on request of a host.
FF00	All	Insert category. Set when a tape volume is added to the inventory. Used for both native volumes and virtual volumes. In case of a physical volume, the vision system reads the external label on the volume. The Library Manager creates an inventory entry for the volume and assigns it to this category. The attached hosts are notified when one or more volumes are assigned to this category.
FF01	Virtual Tape Server	Stacked Volume Insert category for Virtual Tape Server subsystem. A volume is set to this category when its volume ID is in the range specified for stacked volumes for any VTS subsystem library partition.
FF02	Virtual Tape Server	Stacked Volume Scratch category 0 for Virtual Tape Server subsystem. . This category is currently unused.
FF03	Virtual Tape Server	Stacked Volume Scratch category 1 for Virtual Tape Server subsystem. This category is used by any VTS subsystem partition for its scratch stacked volumes.
FF04	Virtual Tape Server	Stacked Volume Private category for Virtual Tape Server subsystem. This category is used by any VTS subsystem partition for its private stacked volumes.
FF05	Virtual Tape Server	Stacked Volume Disaster Recovery category for Virtual Tape Server subsystem. A volume is set to this category when its volume ID is in range specified for stacked volumes for any VTS subsystem library partition and the Library Manager is in Disaster Recovery Mode.
FF06	Library manager	Used by the VTS for it's backup volumes.
FF07	Library manager	Used by the VTS for it's transaction log volumes.
FF08 to FF0F	-	Reserved for future hardware functions
FF10	Library Manager	Eject category. Set when the Library Manager accepts an eject request. The volume becomes eject pending and is queued to be moved to the convenience output station. When the cartridge accessor delivers the volume to the output station, it is deleted from the Library Manager's inventory.

Table 35 (Page 6 of 8). Library Manager Volume Categories		
Category (in hex)	**Used by**	**Definition**
FF11	Library Manager	Bulk Eject category. Set when the Library Manager accepts an eject request. The volume becomes eject pending and is queued to be moved to the high capacity output station. When the cartridge accessor delivers the volume to the output rack, it is deleted from the Library Manager's inventory.
FF12	Virtual Tape Server	Export Pending category. A logical volume to be exported is assigned to this category at the beginning of a Virtual Tape Server export operation. Logical volumes in this category are considered in use. Any attempt by a host to mount, audit, or change the category of a volume fails. The original category of the volume is restored if the export operation is terminated or canceled before the volume is exported.
FF13	Virtual Tape Server	Exported category. Set when the Virtual Tape Server has exported the logical volume. The attached hosts are notified when volumes are assigned to this category. Any attempt by a host to mount, audit, or change the category of a volume, other than to purge the volume from the Library Manager inventory, fails.
FF14	Virtual Tape Server	Import category. Set for exported stacked volumes which are inserted in the library in preparation for an import operation. The import operation only processes stacked volumes in this category.
FF15	Virtual Tape Server	Import Pending category. Logical volumes to be imported from a stacked volume are added to the Library Manager inventory and assigned to this category when the Virtual Tape Server starts importing them. At completion, successfully imported volumes are assigned to the insert category (FF00), and unsuccessfully imported volumes are purged from the Library Manager inventory. The attached hosts are then notified of volumes assigned to the insert category.
FF16	Virtual Tape Server	Unassigned Category. Physical Volumes are assigned to this category when the Virtual Tape Server detects cartridges in the convenience I/O station. Manual interaction is required to assign the cartridges to the proper category. For exported stacked volumes, this would be the import category (FF14).
FF17	Virtual Tape Server	Export Hold category. Physical Volumes are assigned to this category after export function completes.
FF18 to FFF5	-	Reserved for future hardware functions

Table 35 (Page 7 of 8). Library Manager Volume Categories		
Category (in hex)	**Used by**	**Definition**
FFF6	Library manager	Set when the Library manager detects that a 3590 volume has a unique service volser. Volsers that fit the mask CE xxx (where xxx represents any valid volser characters) are service volumes. The embedded blank makes these labels unique from customer volumes. Normally service cartridges have volsers with the prefix CE (for example, CE 099). The specific cell location is predefined. The host does not have a record of a volume in the service category. The volumes in that category are not reported in inventory data in response to a request from the host.
FFF7	Library manager	Volumes to be used in a mount from the input station operation are placed in this category during the operation.
FFF8	-	Reserved
FFF9	Library manager	Indicates Service Volume. Set when the Library Manager detects that a 3490E volume has a unique service cartridge volser. Volsers that fit in the mask CE xxx (where xxx represents any valid volume serial characters) are service cartridges. Specific cell locations (defined during the teaching process) are reserved for service cartridges. The hosts do not have a record of volumes in the service volume category. Volumes in this category are not reported in inventory data in response to a request from the host.
FFFA	Library Manager	Indicates manually ejected. Volumes are assigned to this category when they have been removed from the library under the control of an operator, not the host. Volumes in this category are no longer available for any other operations except Purge Volume category assignment. The Library Manager does not currently support operator initiated ejects.
FFFB	Library Manager	Indicates Purge Volume. Used only with the 3494. When it notices during an inventory update that volumes have been removed since its last update, it places such volumes in the manually ejected category. Hosts can list such volumes and assign them (temporarily) to this purge-volume category. This action deletes their database entries in the Library Manager. Also, as part of the export completion processing, after the host processes a volume in the exported category, it notifies the Library Manager by placing the volume in this purge category.
FFFC	Library Manager	Indicates Unexpected Volume. Reserved for future use

Table 35 (Page 8 of 8). Library Manager Volume Categories		
Category (in hex)	Used by	Definition
FFFD	Library Manager	Indicates a cleaner cartridge for the 3590 tape drive. Assigned to this category when the cleaner volumes are identified by the Library Manager. Cleaner volumes are recognized when their volume serial matches a mask set up by the operator through the Library Manager console. Cleaner volumes with the character *J* on the seventh position of the external volume label are assigned to this category. The hosts do not have a record of volumes in the cleaner volume category. Volumes in this category are not reported in inventory data in response to a request from the host.
FFFE	Library Manager	Indicates a cleaner cartridge for IBM 3490 drives. Assigned to this category when the cleaner volumes are identified by the Library Manager. Cleaner volumes are recognized when their volume serial matches a mask set up by the operator through the Library Manager console. Cleaner volumes without the character *J* on the seventh position of the external volume label are assigned to this category. The hosts do not have a record of volumes in the cleaner volume category. Volumes in this category are not reported in inventory data in response to a request from the host.
FFFF	All except DFSMS/MVS	Indicates a private volume. Set by the control program. Any tape mount request to this category must be for a specific volume serial, not based on the category only.

Appendix B. SMF Record Type 94 Format

This appendix shows the format of SMF record type 94.

B.1 Record Type 94 (5E). IBM Tape Library Dataserver Statistics

The ATL accumulates statistics over the period of one hour. These statistics represent the activity of the IBM Tape Library Dataserver that results from all hosts attached to the library.

At the end of the hour, the system calculates composite statistics about the activity of all devices in the library and writes an SMF type 94 record.

The information in the SMF type 94 record represents:

- Current Information

  Represents the value of the statistic at the point the record is written.

- Summary of the Last Hour Information

  Represents statistics over the most recent hour for which composite statistics have been calculated.

B.1.1 Record Mapping

B.1.1.1 Header/Self-defining Section
This section contains the common SMF record headers fields and the triplet fields (offset/length/number), if applicable, that locate the other sections on the record. The mapping macro resides in SYS1.MACLIB.

Offsets		Name	Length	Format	Description
0	0	SMF94LEN	2	binary	Record length. This field and the next field (total of four bytes) form the RDW (record descriptor word).
2	2	SMF94SEG	2	binary	Segment descriptor (see record length field).
4	4	SMF94FLG	1	binary	System indicator: **Bit** **Meaning When Set** 0-2 Reserved 3-6 Version indicators* 7 Reserved.
5	5	SMF94RTY	1	binary	Record type 94 (X′5E′).
6	6	SMF94TME	4	binary	Time since midnight, in hundredths of a second, when the record was moved into the SMF buffer.
10	A	SMF94DTE	4	packed	Date when the record was moved into the SMF buffer, in the form 0*cyydddF*.
14	E	SMF94SID	4	EBCDIC	System identification (from SMFPRMxx parmlib member).
18	12	SMF94WID	4	EBCDIC	Subsystem identification, worktype indicator.
22	16	SMF94STP	2	binary	Record subtype '01' — 34xx library statistics.

B.1.1.2 Self-Defining/Tiplet Section

Offsets		Name	Length	Format	Description
24	18	SMF94SDL	4	binary	Self-defining section length.
28	1C	SMF94POF	4	binary	Offset to product section from start of record, including record descriptor word (RDW).
32	20	SMF94PLN	2	binary	Length of product section.
34	22	SMF94PON	2	binary	Number of product sections.
36	24	SMF94HOF	4	binary	Offset to format section from start of record, including record descriptor word (RDW).
40	28	SMF94HLN	2	binary	Length of format section.
42	2A	SMF94HON	2	binary	Number of format sections.
44	2C	SMF94SOF	4	binary	Offset to self-description information section from start of record, including record descriptor word (RDW).
48	30	SMF94SLN	2	binary	Length of self-description information section.
50	32	SMF94SON	2	binary	Number of self-description information sections.
52	34	SMF94LOF	4	binary	Offset to ATL statistics section from start of record, including record descriptor word (RDW).
56	38	SMF94LLN	2	binary	Length of ATL statistics section.
58	3A	SMF94LON	2	binary	Number of ATL statistics sections.
60	3C	SMF94MOF	4	binary	Offset to mount statistics section from start of record, including record descriptor word (RDW).
64	40	SMF94MLN	2	binary	Length of mount statistics section.
66	42	SMF94MON	2	binary	Number of mount statistics sections.
68	44	SMF94DOF	4	binary	Offset to demount statistics section from start of record, including record descriptor word (RDW).
72	48	SMF94DLN	2	binary	Length of demount statistics section.
74	4A	SMF94DON	2	binary	Number of demount statistics sections.
76	4C	SMF94EOF	4	binary	Offset to eject statistics section from start of record, including record descriptor word (RDW).
80	50	SMF94ELN	2	binary	Length of eject statistics section.
82	52	SMF94EON	2	binary	Number of eject statistics sections.
84	54	SMF94AOF	4	binary	Offset to audit statistics section from start of record, including record descriptor word (RDW).
88	58	SMF94ALN	2	binary	Length of audit statistics section.
90	5A	SMF94AON	2	binary	Number of audit statistics sections.
92	5C	SMF94IOF	4	binary	Offset to insert statistics section from start of record, including record descriptor word (RDW).
96	60	SMF94ILN	2	binary	Length of insert statistics section.
98	62	SMF94ION	2	binary	Number of insert statistics sections.
100	64	SMF94VOF	4	binary	Offset to VTS statistics
104	68	SMF94VLN	2	binary	Length of VTS statistics
106	6A	SMF94VON	2	binary	Number of VTS statistics
108	6C	SMF94XOF	4	binary	Offset to import/export statistics
112	70	SMF94XLN	2	binary	Length of import/export statistics
114	72	SMF94XON	2	binary	Number of import/export statistics
116	74	SMF942OF	4	binary	Offset to VTS enhanced library statistics
120	78	SMF942LN	2	binary	Length of VTS enhanced library statistics
122	7A	SMF942ON	2	binary	Number of VTS enhanced library statistics

B.1.1.3 Product Section

Offsets		Name	Length	Format	Description
0	0	SMF94TYP	2	binary	Subtype for type 94 record.
2	2	SMF94RVN	2	EBCDIC	Record version number C′01′.
4	4	SMF94PNM	8	EBCDIC	Product name ′JDZ1110 ′.
12	C	SMF94MVS	8	EBCDIC	MVS operating system name.

B.1.1.4 Format Section

Offsets		Name	Length	Format	Description
0	0	SMF94HSF	1	binary	Statistics format. Always equals zero.
1	1	SMF94HHI	2	binary	Hour index. Incremented every hour. Value ranges from 0 to 23.

B.1.1.5 Self-Description Information

Offsets		Name	Length	Format	Description
0	0	SMF94SLT	6	EBCDIC	System-managed tape library type number. For example, '003495' represents the 3495 Tape Library Dataserver.
6	6	SMF94SLM	3	EBCDIC	System-managed tape library model number. For example, 'L30' represents model L30.
9	9	SMF94SMA	3	EBCDIC	System-managed tape library manufacturer. Always equals 'IBM'.
12	C	SMF94SPL	2	EBCDIC	System-managed tape library plant of manufacture. For example, '13' represents San Jose, California, and '77' represents Valencia, Spain.
14	E	SMF94SNO	12	EBCDIC	System-managed tape library sequence number. Uniquely identifies a ATL.
26	1A		1		Reserved.

B.1.1.6 Self-Managed Tape Library Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94LID	2	binary	Number of drives currently installed in a ATL.
2	2	SMF94LMD	2	binary	Number of drives currently mounted in a ATL.
4	4	SMF94LM1	2	binary	Maximum number of drives mounted during the last hour.
6	6	SMF94LM2	2	binary	Minimum number of drives mounted during the last hour.
8	8	SMF94LM3	2	binary	Average number of drives mounted during the last hour.
10	A	SMF94LT1	2	binary	Maximum amount of time, in seconds, that a tape volume was mounted on a drive during the last hour. The mount time of a volume is the time when the system completed mounting a volume on a drive until the time when the ATL receives an order from the host to demount the volume.

Offsets		Name	Length	Format	Description
12	C	SMF94LT2	2	binary	Minimum amount of time, in seconds, that a tape volume was mounted on a drive during the last hour. The mount time of a volume is the time when the system completed mounting a volume on a drive until the time when the ATL receives an order from the host to demount the volume.
14	E	SMF94LT3	2	binary	Average amount of time, in seconds, that all tape volumes were mounted on drives during the last hour. The mount time of a volume is the time when the system completed mounting a volume on a drive until the time when the ATL receives an order from the host to demount the volume.

B.1.1.7 Mount Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94MPR	2	binary	The total number of mount requests currently pending.
2	2	SMF94MP1	2	binary	Maximum number of mount requests pending during the last hour.
4	4	SMF94MP2	2	binary	Minimum number of mount requests pending during the last hour.
6	6	SMF94MP3	2	binary	Average number of mount requests pending during the last hour.
8	8	SMF94MTO	2	binary	Total number of mounts during the last hour.
10	A	SMF94MIN	2	binary	Index mounts during the last hour. An index mount is a mount accomplished using the automatic cartridge loader of a 3490 tape drive.
12	C	SMF94MPM	2	binary	Pre-mounts during last hour. A single pre-mount operation causes a volume to be added to the automatic cartridge loader of a 3490 tape drive.
14	E	SMF94MT1	2	binary	Maximum amount of time, in seconds, required to perform any single mount operation during the last hour.
16	10	SMF94MT2	2	binary	Minimum amount of time, in seconds, required to perform any single mount operation during the last hour.
18	12	SMF94MT3	2	binary	Average amount of time, in seconds, required to perform a single mount operation during the last hour.

B.1.1.8 Demount Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94DPR	2	binary	The total number of demount requests currently pending.
2	2	SMF94DP1	2	binary	Maximum number of demount requests pending during the last hour.
4	4	SMF94DP2	2	binary	Minimum number of demount requests pending during the last hour.
6	6	SMF94DP3	2	binary	Average number of demount requests pending during the last hour.
8	8	SMF94DTO	2	binary	Total number of demounts during the last hour.

Offsets		Name	Length	Format	Description
10	A	SMF94DIN	2	binary	Index demounts during the last hour. An index demount moves a volume from the feed station to the output stack of the automatic cartridge loader of a 3490 tape drive.
12	C	SMF94DPM	2	binary	Post-demounts during the last hour. A post-demount operation moves a volume from the output stack of the automatic cartridge loader of a 3490 tape drive.
14	E	SMF94DT1	2	binary	Maximum amount of time, in seconds, required to perform any single demount operation during the last hour.
16	10	SMF94DT2	2	binary	Minimum amount of time, in seconds, required to perform any single demount operation during the last hour.
18	12	SMF94DT3	2	binary	Average amount of time, in seconds, required to perform a single demount operation during the last hour.

B.1.1.9 Eject Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94EPR	2	binary	The total number of eject requests currently pending. An eject operation moves one volume from the ATL to an output station for an operator to remove.
2	2	SMF94EP1	2	binary	Maximum number of eject requests pending during the last hour.
4	4	SMF94EP2	2	binary	Minimum number of eject requests pending during the last hour.
6	6	SMF94EP3	2	binary	Average number of eject requests pending during the last hour.
8	8	SMF94ETO	2	binary	Totals number of ejects during the last hour.
10	A	SMF94ET1	2	binary	Maximum amount of time, in seconds, required to perform any single eject operation during the last hour.
12	C	SMF94ET2	2	binary	Minimum amount of time, in seconds, required to perform any single eject operation during the last hour.
14	E	SMF94ET3	2	binary	Average amount of time, in seconds, required to perform a single eject operation during the last hour.

B.1.1.10 Audit Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94APR	2	binary	The total number of audit requests currently pending. When the host requests an audit operation, the accessor moves to a shelf location and ensures that a volume is present.
2	2	SMF94AP1	2	binary	Maximum number of audit requests pending during the last hour.
4	4	SMF94AP2	2	binary	Minimum number of audit requests pending during the last hour.
6	6	SMF94AP3	2	binary	Average number of audit requests pending during the last hour.
8	8	SMF94ATO	2	binary	Total number of audits during the last hour.

Offsets		Name	Length	Format	Description
10	A	SMF94AT1	2	binary	Maximum amount of time, in seconds, required to perform any single audit operation during the last hour.
12	C	SMF94AT2	2	binary	Minimum amount of time, in seconds, required to perform any single audit operation during the last hour.
14	E	SMF94AT3	2	binary	Average amount of time, in seconds, required to perform a single audit operation during the last hour.

B.1.1.11 Insert Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94INS	2	binary	Number of insert stores during last hour. This number is the number of volumes moved from an input station to a location inside the ATL.

B.1.1.12 VTS Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94VNO	1	binary	Reserved, Set to X'00'.
1	1	SMF94VLS	5	EBCDIC	Library sequence number for the library segment for which VTS statistics are being reported.
6	6	SMF94VTI	1	binary	Number of underlying physical tape devices currently installed in the VTS subsystem.
7	7	SMF94VTA	1	binary	Number of underlying physical tape devices currently available for use by the VTS subsystem.
8	8	SMF94VTX	1	binary	Maximum number of underlying physical tape devices mounted concurrently in this VTS during last hour.
9	9	SMF94VTN	1	binary	Minimum number of underlying physical tape devices mounted concurrently in this VTS during last hour.
10	A	SMF94VTV	1	binary	Average number of underlying physical tape devices mounted concurrently in this VTS during last hour. Value is determined by summing number of concurrently mounted physical devices every 10 seconds, and dividing resultant sum by 360 during hourly statistics generation.
11	B	SMF94VR2	1	binary	Reserved, set to X'00'
12	C	SMF94VMX	2	binary	Maximum time in seconds used by the library to perform a mount request of a physical drive in the VTS in the last hour. Time is accrued from time mount request is accepted until it is completed. Mount time is accredited to the hour that mount is completed.
14	E	SMF94VMN	2	binary	Minimum time in seconds used by the library to perform a mount request for a physical drive in the VTS in the last hour. Time is accrued from time mount request is accepted until it is completed. Mount time is accredited to the hour that mount is completed.
16	10	SMF94VMV	2	binary	Average time in seconds used by the library to perform a mount request for a physical drive in the VTS in the last hour. Time is accrued from time mount request is accepted until it is completed. Mount time is accredited to the hour that mount is completed.

Offsets		Name	Length	Format	Description
18	12	SMF94VPS	2	binary	The number of physical mount requests completed in last hour to satisfy recall mounts.
20	14	SMF94VPM	2	binary	The number of physical mount requests completed in last hour to satisfy copy requests.
22	16	SMF94VPR	2	binary	The number of physical mount requests completed in last hour to satisfy reclamation mounts.
24	18	SMF94VDC	1	binary	The number of virtual devices configured in this VTS at the time request for statistics was received (current).
26	19	SMF94VDX	1	binary	The maximum number of virtual drives that were concurrently mounted in this VTS during the last hour.
26	1A	SMF94VDN	1	binary	The minimum number of virtual drives that were concurrently mounted in this VTS during the last hour.
27	1B	SMF94VDA	1	binary	The average number of virtual drives that were concurrently mounted in this VTS during the last hour. Value is determined by summing number of concurrently mounted virtual devices every 10 seconds, and dividing resultant sum by 360 during hourly statistics generation.
28	1C	SMF94VVX	2	binary	Maximum time in seconds that a virtual drive was mounted in this VTS during the last hour. Time is accrued from completion of mount until a demount is issued. Mount time is accredited to the hour that demount is issued.
30	1E	SMF94VVN	2	binary	Minimum time in seconds that a virtual drive was mounted in this VTS during the last hour. Time is accrued from completion of mount until a demount is issued. Mount time is accredited to the hour that demount is issued.
32	20	SMF94VVA	2	binary	Average time in seconds that a virtual drive was mounted in this VTS during the last hour. Time is accrued from completion of mount until a demount is issued. Mount time is accredited to the hour that demount is issued.
34	22	SMF94VRX	2	binary	Maximum time in seconds used to complete a mount request on a virtual drive in the last hour. Time is accrued from time mount request is accepted until it is completed. Mount time is accredited to the hour that the mount is completed.
36	24	SMF94VRN	2	binary	Minimum time in seconds used to complete a mount request on a virtual drive in the last hour. Time is accrued from time it is completed. Mount time is accredited to the hour that the mount is completed.
38	26	SMF94VRA	2	binary	Average time in seconds used to complete a mount request on a virtual drive in the last hour. Time is accrued from time mount request is accepted until it is completed. Mount time is accredited to the hour that the mount is completed.
40	28	SMF94VFR	2	binary	The number of virtual mounts in last hour using VTS Fast-Ready facility. Fast-Ready is used for mount-from-category request for which the specified category has the Fast-Ready attribute set, or for specific volume requests for which the specified volume is, at the time the mount request is received, assigned to a category that has the Fast-Ready attribute set.
42	2A	SMF94VMH	2	binary	The number of virtual mounts in the last hour that were completed for specific requested volume found resident in Tape Volume Cache (specific mount hits).

Offsets		Name	Length	Format	Description
44	2C	SMF94VMS	2	binary	The number of virtual mounts in last hour that were completed with specific requested logic volume recalled from a physical tape back into Tape Volume Cache.
46	2E	SMF94VMP	2	binary	The number of virtual volumes for which a copy operation was completed in the last hour.
48	30	SMF94VBW	4	binary	The total number of bytes written successfully through host channels to virtual volumes in an integral multiple of 4096 bytes during the last hour. If number of bytes written is not an integer multiple of 4096, the number is rounded up.
52	34	SMF94VBR	4	binary	The total number of bytes read successfully through host channels from virtual volumes in an integral multiple of 4096 bytes during the last hour. If number of bytes read is not an integer multiple of 4096, the number is rounded up.
56	38	SMF94VTW	4	binary	The total number of bytes written successfully by VTS to its attached physical drives in an integral multiple of 4096 bytes during the last hour. If number of bytes written is not an integer multiple of 4096, the number is rounded up. Bytes are accredited to the hour in which the underlying premigrates of virtual volumes complete.
60	3C	SMF94VTR	4	binary	The total number of bytes read successfully by VTS from its attached physical drives in an integral multiple of 4096 bytes during the last hour. If the number of bytes read is not an integer multiple of 4096, the number is rounded up. Bytes are accredited to the hour in which the underlying stage requests complete.
64	40	SMF94VCA	2	binary	The average, in minutes, of the times of last reference of the virtual volumes in the Tape Volume Cache as determined at the end of the reported hour.
66	42	SMF94VCZ	2	binary	The average number of megabytes of data on a logical volume for the active logical volumes which are on VTS stacked volumes at the end of the reported hour. This is a calculated field (SMF94VBA divided by SMF94VLA) and represents the average size of a logical volume copied from the Tape Volume Cache.
68	44	SMF94VNM	2	binary	The number of virtual volumes in Tape Volume Cache at the end of reported hour.
70	46	SMF94VR3	2	binary	Reserved, set to X'00'
72	48	SMF94VBA	4	binary	The total number of megabytes of data on the active logical volumes which are on VTS stacked volumes at the end of the reported hour. The number is the integral multiple of 1,048,576 bytes. This is the number of megabytes copied from the Tape Volume Cache to the stacked volumes and may include multiple versions of logical volumes. The obsolete versions will become inactive during the next reconciliation process.
76	4C	SMF94VLA	4	binary	The total number of active logical volumes which are on VTS stacked volumes at the end of the reported hour. This number may include multiple versions of logical volumes; therefore, may exceed the number of defined logical volumes. The obsolete versions will become inactive during the next reconciliation process.

Offsets		Name	Length	Format	Description
80	50	SMF94VEC	4	binary	The total estimated storage capacity of the empty 3590 cartridges managed by the VTS in an integral multiple of 1,048,576 bytes (1 MB) at the end of the reported hour. Partially filled stacked volumes are not included in this calculation. The number of empty stacked volumes is multiplied by the estimated amount of data that can be stored on one of these volumes.
					For a 3494 Model B18 without EHPO, this amount is 20 GB for the 3590-B1A tape drives and 40 GB for the 3590-E1A tape drives which is obtained by assuming a 2:1 compression ratio.
					For a 3494 Model B16 this amount is 20 GB for the 3590-B1A tape drives.
					The 3494 Model B18 VTS with enhanced ESCON host attachments provides compression into the TVC; therefore, further compression when writing to the stacked volume is unlikely, and the estimated amount of data copied from the TVC to a stacked volume is 10 GB for 3590-B1A tape drives and 20 GB for 3590-E1A tape drives.

B.1.1.13 Import/Export Statistics

Offsets		Name	Length	Format	Description
0	0	SMF94IM1	2	binary	count of physical volumes processed during import operations that completed in the last hour.
2	2	SMF94EX1	2	binary	count of physical volumes that contain the successfully exported logical volumes exported during the last hour.
4	4	SMF94IM2	4	binary	count of the number of logical volumes successfully imported during import operations that completed during the last hour.
8	8	SMF94EX2	4	binary	count of the number of logical volumes successfully exported for export operations that completed during the last hour.
12	C	SMF94IM3	4	binary	megabytes of data imported for import operations that completed in the last hour.
16	10	SMF94EX3	4	binary	megabytes of data exported during export operations that completed in the last hour.
20	14	SMF94IM4	4	binary	megabytes of data that was moved from one physical stacked volume to another as part of the import operations that completed in the last hour.
24	18	SMF94EX4	4	binary	megabytes moved from one physical stacked volume to another as part of the export operations completed in the last hour.
28	1C		8	binary	Reserved, set to X′00′
36	24	SMF94ACA	2	binary	Accessor A mounts. The count of the number of mount operations accessor A completed during the last hour.
38	26	SMF94ACB	2	binary	Accessor B mounts. The count of the number of mount operations accessor B completed during the last hour.
40	28		4	binary	Reserved, set to X′00′

B.2 Notes and Comments

We add a few notes in this section about some of the numbers presented above. They should lead to a better understanding of the way that these numbers are obtained from the VTS.

B.2.1 SMF94VBW SMF94VBR SMF94VTW and SMF94VTR for 3494-B18 with EHPO.

The MBytes written and read fields (SMF94VBW and SMF94VBR) reported by the VTS are from the channels perspective meaning that they are a count of the bytes prior to compression (on writes) or after decompression (on reads). They do provide an accurate view of the throughput of the box from the MVS point of view. The MBytes written and read to physical tape include the effects of compression (SMF94VTW and SMF94VTR), this is the VTS internal view. You cannot directly determine the compression ratio of data by comparing the MVS view with the VTS view.

B.2.2 SMF94VEC

This fields provides the estimated amount of data that can be written to the available (FF03 category) stacked volumes and uses a compression factor of data from the TVC to the stacked volume.

You can obtain the number of scratch stacked volumes by using the command **D SMS,lib(libname),detail**

B.2.3 SMF94LID SMF94LMD SMF94LM1 SMF94LM2 SMF94LM3

This is the count of native drives existing in the library, excluding the drives owned by the VTS(s)

B.2.4 Timing Fields SMF94LT1 SMF94LT2 SMF94LT3

The indicated times applies to all drives of the library including the drives owned by the VTS(s)

B.2.5 SMF94VLA

This fields contains the number of virtual volumes managed by the VTS. These volumes have been used at least once. Volumes which have only been created but not used are not accounted. Multiple (duplicate) versions of the same logical volume exist from the time a scratch volume is reused until the next reconciliation.
The daily **minimum** value of this field should be observed.
Virtual volumes that have never been used are not accounted: this implies that the daily minimum will continuously increases until it reaches the exact number of defined volumes.

B.2.6 SMF94VBA

This fields contains the sum of the **compressed** megabytes accumulated on the SMF94VLA logical volumes. The daily **minimum** should be observed due to the reconciliation process.

B.2.7 SMF94VCZ

This fields contains the average size in **compressed** megabytes of virtual volumes managed by the VTS. It does not include any volumes that are in cache. It is a calculated field, (SMF94VBA dived by SMF94VLA).

Note: The fields labeled SMF94VLA and SMF94VBA in the SMF record type 94 indicate the number of logical volumes and the number of *compressed* megabytes managed by VTS.

This actually includes all the logical volumes that have ever been used by the VTS, PLUS every instance of every volume that has been used by the VTS since the VTS has last done what is called a *reconciliation*. A reconciliation is that period of activity by the VTS when the most recent instance of a volume is determined as the active one, and all other instances of that volume are deleted from active volume list.

Therefore, once all the volumes have been used at least once, SMF94VLA value should be at least as large as the total number of logical volumes defined. The difference between SMF94VLA and the total number of defined logical volumes is the number of instances that logical volumes have been used since the last reconciliation. Similarly, the field SMF94VBA will increase after reconciliation took place. Thus, the numbers would show an increase as logical volumes are being used until the next reconciliation.

A reconciliation normally occurs sometime during a 24 hour period. It can occur more often if it is forced by a Reclamation process. A reconciliation would occur before every Reclamation process.

The minimum observed value for SMF94VLA should be equal or slightly higher, to the number of virtual volumes managed by the library manager in this VTS, and also be equal or slightly higher to the number of virtual volumes managed by all the tape management systems connected to this VTS.

Appendix C. Using a VTS without Tape Management System

A few MVS customers do not have a tape management system to control tape operations. Rather the JCL contains the volume serial numbers where each output data set is to be written. In such environment all tape mounts are specific.

The JCL scheme can be divided into two categories:

1. The output data set is cataloged and it is opened for output while the disposition is old.
2. The volume list is explicitly coded in the DD statement.

When the output data set grows beyond the capacity of the defined volumes a non-specific mount is requested by Open/Close/EOV and the data set extends on the new volume gotten from the scratch volume list and requested via a non-specific request. If the data set is recataloged, the catalog reflects the supplementary volume, while the JCL volume list will not be automatically extended.

When the data set shrinks, the unused volumes are not automatically removed, neither from the catalog, nor from the JCL DD statement.

The two previous concerns become more important when the tape media capacity evolves greatly, due to technological changes, such as a migration to Magstar or a migration to a Virtual Tape Server.

When migrating to a Virtual Tape Server, there is an added performance concern as the output tapes' volumes are not put in the fast-ready category. The objective of this section is to indicate circumventions to avoid unnecessary staging of output tapes.

C.1 General Concepts

There are a few items which must be understood before we describe a viable solution. They apply to the entire architecture, software and hardware, of the support of the IBM libraries in an MVS and DFSMS environment.

1. Specific mount request

   The host specifies the volume to be mounted. The specific mount request, generally, is used to access an existing data set residing on the target tape.

2. Non-specific mount request

   The host does not specify the volume to be mounted. The selection of the volume to be mounted is delegated to another component of the architecture. In our case, the library manager will select a volume in the scratch category associated to this specific host.

   The interference of the tape management system is limited to accept or reject the proposed volume.

3. Return to scratch

   It is the function of the tape management system to refill the stack of scratch volumes when the data set on volumes have expired. This function can be run daily or only when the stack of scratch volumes goes below a threshold.

4. Scratch and private volume status

   A scratch volume is a volume that does not contain a valid data set. On private volumes, there is at least one data set which has not expired. The status of the volume is retained in the tape management data base.

5. Scratch and private volume category

   The categories belong to the vocabulary of the Library Manager. Every connected host uses a set of categories associated to the various status and nature of the volumes owned and managed by the host.

   Under control of the tape management system, when a volume returns to the scratch status, the category of the volume is updated in the library manager data base.

6. Tape Configuration Data Base (TCDB)

   The TCDB reflects the contents of all the volumes managed by the host and, logically, in one of the libraries of the system.

   The status of the volume (scratch or private) is recorded in the TCDB, as well as the library name where the volume resides, and the fact of the physical presence of the volume in the library.

   To preserve the confidentiality of the volume's contents, you cannot issue a specific mount for a volume which is in the scratch status in the TCDB.

7. Fast-ready Category

   In a VTS, no volume data is staged in the TVC when the volume is in the fast ready category. Also, an attempt to read any data beyond the VOL1 and HDR1 to HDR8 will end with an I/O error.

   The fast ready category is associated to the scratch categories of all the connected hosts.

   A volume selected to receive output data set does not need to be staged in the tape volume cache. From the software point of view, this particular use of the volume is formulated in the mount request as a non specific request commonly designated as scratch mount.

8. Return to Private category

   Once the data have been written to the volume(s), the volume(s) must be removed from the fast ready category, in order to be usable.

C.2 Mounting Rules

From the above list we can draw the following rules for the VTS operations without tape management system:

1. When a specific mount is used for the output data set, the requested volumes must be put in the fast-ready category prior to mounting, to avoid unnecessary staging.

   This can be achieved by executing the CBRSPLCS program which is in SYS1.SAMPLIB.

2. When a specific mount is used for the output data set, the requested volumes must be put in the private status in the TCDB.

   This can be achieved by executing an ALTER IDCAMS command against the target volume.

```
ALTER  Vserial VOLUMEENTRY USEATTRIBUT(PRIVATE) +
       STORAGEGROUP('sssssss')
```

3. Once the data has been written to the volumes, they must be put into the private category.

   This can be achieved by executing CBRSPLCS program which is in SYS1.SAMPLIB.

This can be achieved by adding the execution of a preparation procedure, specific to each job and each output tape data set. This preparation procedure will put the volume in the fast ready category in the LM and in private status in the TCDB.

When JES3 is controlling the tape allocations, the disposition NEW or OLD must be considered to determine where, in the job flow, the preparation procedure must be invoked.

The rerun of the job should also be examined for proper positioning of the change category step.

Dynamic allocation of the virtual volume should be reviewed to include the function described above.

C.3 Conclusion

It is possible to drive a VTS without tape management system, but this requires specific changes for each and every data set. This approach must be avoided and, if not avoidable, be limited to a transition phase toward managed tapes.

Appendix D. Migration of IBM 3494 Model B16 to Model B18

In this chapter we review a variety of migration scenarios and give you the information you need to migrate to the IBM 3494-B18 VTS. Scenarios are presented to assist you in migrating from a currently installed VTS model B16 to the VTS model B18.

All upgrade options with the Performance Accelerator Feature, Extended High Performance Option, and the Extended Performance ESCON Channels based on a VTS Model B18 with standard ESCON Channels or with the old ESCON High Performance Option and Enhanced ESCON Channels are described in: 4.2.7, "Upgrade Scenarios" on page 106 of Chapter 4, "VTS Performance Accelerator" on page 99.

Here we describe the enhancements which are available since August 1998 with the IBM 3494-B18 VTS subsystem and discuss general considerations. We discuss the migration scenarios in detail and describe the installation tasks you must perform to implement the IBM Magstar VTS in your installation when you already have a VTS subsystem.

For upgrading your existing Magstar 3494 Tape Library with an VTS, refer to Chapter 2, "Preinstallation Planning and Sizing" on page 17 through Chapter 6, "Using the IBM Magstar VTS" on page 123. For additional information about operating the VTS, see Chapter 7, "Operating the VTS" on page 165.

The scenarios for migration of an existing VTS B16 to a B18 VTS are:

- You can attach the existing Magstar tape drives installed in the IBM 3494-D12 frame to the IBM 3494-B18 frame, move the control information from the IBM 3494-B16 controller to the IBM 3494-B18 controller, and start immediately using the VTS for your tape processing. To complete the MES conversion, the IBM 3494-B16 frame is converted to an additional storage unit frame, to a drive unit frame that can be attached to a second IBM 3494-B18 VTS in the same Magstar 3494 Tape Library, to a SCSI drive unit frame, or to an ESCON drive unit frame. This migration scenario is more of a B16-to-B18 conversion MES than an actual migration.

  We call this scenario *in place migration*. For details refer to D.3, "In Place Migration" on page 334.

- You can add an additional IBM 3494-D12 and a IBM 3494-B18 frame to your existing IBM Magstar 3494 Tape Library that contains the IBM 3494-B16 frame. During the migration, both VTS subsystems are used in parallel, where new logical volumes are written to the IBM 3494-B18 VTS and logical volumes existing in the IBM 3494-B16 VTS are processed from there. After data migration is complete, the IBM 3494-B16 frame is either kept as it is or converted later to a B18.

  We call this scenario *parallel operation within one library*. For details refer to D.4, "Migration Using Parallel Operation within One Library" on page 340.

- You can install an additional IBM Magstar 3494 Tape Library with an IBM 3494-B18 VTS subsystem. Both libraries are used in parallel until migration is complete.

  We call this scenario *parallel operation with two libraries*. For details refer to D.5, "Migration Using Parallel Operation with Two Libraries" on page 345.

Variations of each of these migration scenarios are summarized at the end of the sections that describe the scenarios.

Figure 119 lists the advantages and drawbacks of the three migration scenarios.

	Advantages	Drawbacks
Scenario 1 In Place Migration	✓ No customer involvement ✓ No data movement ✓ No transition harware to be installed ✓ No additional SW definitions needed (HCD,DFSMS)	✓ Outage time ✓ Little testing possible ✓ Limited fallback possibilities
Scenario 2 Parallel Operation within one Library	✓ No transition hardware to be installed ✓ Outage time ✓ Testing possible ✓ Good fallback ✓ Preferable solution if D12 for 2nd VTS is already installed	✓ Customer involvement ✓ Data movement ✓ Additional SW definitions needed (HCD, DFSMS)
Scenario 3 Parallel Operation with two Libraries	✓ Outage time ✓ Extended testing possible ✓ Excellent fallback possible	✓ Transition hardware to be installed / de-installed ✓ Customer involvement ✓ Data movement ✓ Additional SW definitions needed (HCD, DFSMS)

Figure 119. Migration Scenarios: Comparison

Your target configuration and the outage time that you allow for determine the migration scenarios that you can follow. Scenario 1 requires longer outage times, but it allows you to migrate with no or only limited changes to your software definitions. It may also be the most cost effective solution, if your target configuration contains a single IBM 3494-B18 VTS subsystem. Scenario 2 requires less outage time, but it requires more changes to your software definitions. You might want to choose Scenario 2 if you plan for two VTS subsystems in a single IBM Magstar 3494 Tape Library. Scenario 3 requires the installation of an additional IBM Magstar 3494 Tape Library. You might want to choose this scenario if you plan for an additional IBM 3494. If your installation does not allow any downtime, you can migrate as described in scenario 3.

D.1 VTS Enhancements for Model B18

Here we describe the enhancements which are available since August 1998 with the IBM 3494-B18 VTS subsystem and discuss general considerations.

D.1.1 Monitoring the IBM 3494 with SNMP

Because there are different attachment methods of hosts to the Library Manager, the IBM 3494 now provides SNMP to send alerts over a TCP/IP LAN network to one or more SNMP monitoring stations. These monitoring stations along with other customer-supplied software can be used to alert operations staff of possible problems or operator interventions that occur in the library.

For details on SNMP, see Chapter 7, "Operating the VTS" on page 165.

D.1.2 IBM 3494-B18 Frame

The IBM 3494-B18 frame is a stand-alone frame that can be installed up to 14 m from the IBM Magstar 3494 Tape Library that contains the physical Magstar tape drives of the VTS subsystem. Installation outside the IBM Magstar 3494 Tape Library allows for concurrent maintenance of the VTS while the IBM 3494 itself can continue to operate with native tape drives or with another VTS subsystem.

The IBM 3494-B18 frame contains the VTS controller and the TVC. Attachment to the hosts is through the IBM 3494-B18 frame, using standard channels, Extended Performance ESCON Channels, or SCSI.

D.1.2.1 VTS Controller

In contrast to the IBM 3494-B16, which attaches to the Library Manager through one RS-232 and two RS-422 connections, the VTS controller in the IBM 3494-B18 frame attaches to the Library Manager through a LAN connection. This change frees up 3 of the 16 Library Manager connection ports that are available.

D.1.2.2 Tape Volume Cache

The TVC of the IBM 3494-B18 is available in four sizes: 216 GB, 432 GB, 648 GB, or 864 GB, assuming a 3:1 compression ratio. The actual usable size varies depending on the compression ratio that you achieve in your environment. Without the EHPO feature these sizes are respectively 72 GB, 144 GB, 216 GB or 288 GB. When you upgrade an IBM 3494-B16 to an IBM 3494-B18, the EHPO (EHPO) feature is required. With EHPO, data is compressed at the channel interface and before it is written to the TVC.

D.1.2.3 Host Attachment

Like the IBM 3494-B16, the IBM 3494-B18 attaches to the hosts through two standard ESCON channels like the IBM 3494-B16 does, or through two or four Extended Performance ESCON Channels. The Extended Performance ESCON Channels in conjunction with EHPO provide compression of the tape data in the TVC. The data is compressed by the extended performance ESCON adapter of the IBM 3494-B18.

When upgrading from a B16 to a B18, you must install the EHPO feature, which provides the microcode (LIC) for data compression and you must install at least two Extended Performance ESCON Channels (one FC 3412). You cannot upgrade an IBM 3494-B16 to an IBM 3494-B18 with standard ESCON channels. You can, however, upgrade the standard ESCON channels of an IBM 3494-B18 to Extended Performance ESCON Channels.

For availability or performance reasons, you can install two additional Extended Performance ESCON Channels. The number of ESCON channels installed does not impact any other configuration option. Four Extended Performance ESCON Channels may be desirable in an environment with heavy write throughput requirements during certain peak hours or if you like to position the VTS for the Performance Accelerator Feature.

D.1.2.4 Library Configuration

A single IBM Magstar 3494 Tape Library can contain up to two VTS subsystems: one IBM 3494-B18 and one IBM 3494-B16 subsystem, or two IBM 3494-B18 subsystems. Each VTS subsystem in the library has its own library sequence number, which is also called *library id*, and is defined as a separate logical library.

D.1.3 Physical Tape Drives

The configuration options for Magstar tape drives in the IBM 3494-D12 frame remain the same when attaching to the IBM 3494-B18 controller. You can install three to six drives attached to the same VTS controller.

The attachment of the Magstar tape drives to the Library Manager has changed though. The drives no longer connect to the Library Manager through an RS-422 connection. Connection is solely through the LAN connection of the IBM 3494-B18 frame to the library manager. This gives you the possibility to use six additional Library Manager connections to add native tape drives to the same IBM Magstar 3494 Tape Library, for example, Magstar tape drives directly attached to the hosts through ESCON channels using the 3590 Model A60 tape controller or directly attached through SCSI.

Note that the Import/Export function requires four active Magstar tape drives in an VTS subsystem. If you are planning to use this function, you must install at least four IBM 3590 tape drives.

D.1.4 Virtual Tape Drives

The IBM 3494-B16 VTS provides 32 virtual drives per subsystem independent of the number of physical drives in the VTS configuration. With the IBM 3494-B18 VTS, the number of virtual drives is 64, if the VTS has at least 432 GB of TVC,assuming a 3:1 compression ratio, and if EHPO with Extended Performance ESCON Channels are installed. With standard ESCON channels or if less than 432 GB of tape volume cache, assuming a 3:1 compression ratio, is installed, the VTS is limited to 32 virtual drives per subsystem.

D.1.5 Virtual Volumes

If you install one IBM 3494-B18 in an IBM Magstar 3494 Tape Library, you can define up to 150,000 logical volumes for this single VTS. If you install two IBM 3494-B18s in a single IBM Magstar 3494 Tape Library, you can define up to 300,000 logical volumes for both VTS subsystems.

Virtual volumes that were created in an IBM 3494-B16 VTS which has been upgraded to a model B18 can be read and appended in the IBM 3494-B18 VTS. Compression is performed on a record level as the appended data is sent to the TVC. Therefore a single virtual volume can contain compressed and uncompressed records and allows you to use the DISP=MOD to process a virtual volume.

Because of the compression, the data stored on a virtual volume is now comparable to the data stored on a physical 3490 cartridge. If you are copying data out of the VTS onto native 3490 tape drives, you will no longer lose space on the physical cartridges.

D.1.6 Performance Considerations

Compressing the data before it is written to the TVC enhances the throughput because less data is transferred through the TVC to the Magstar cartridges. In addition, larger cache sizes and compression allow you to keep more data in the TVC and increase the number of virtual volumes available for fast access by a cache hit without requiring a physical Magstar cartridge to be mounted for recall of a logical volume.

When writing data to a virtual volume, the host compression definition is now honored. If you define a virtual volume to be written uncompressed using the JCL parameter TRTCH, the data class compaction definition, or the definition in the DEVSUPxx parmlib member, you can create uncompressed virtual volumes in the TVC. To achieve the optimum throughput, we strongly recommend that you check your definitions to make sure that you specify compaction when writing data to the IBM 3494-B18 VTS with the EHPO feature and Extended Performance ESCON Channels.

The management of the TVC content has been modified to improve the multi-hour sustained write data rate. During times of high host write activity, more virtual volumes, which are ready to be copied to tape, are retained in the TVC. When free space is required in the TVC for new write operations, those virtual volumes that have been copied are migrated by fragmenting them. Copying increases as the write operations from the host decrease. Write operations are given priority until the amount of logical volumes and data ready for copying becomes too large. Thus, the VTS allows for longer periods of peak throughput.

With regard to the overall throughput of your VTS, it may be advisable to add more stacked cartridges instead of increasing the reclamation threshold. Increasing the reclamation threshold causes more tape mounts and more data transfer within the VTS. It also requires two Magstar tape drives for the entire reclamation period.

D.2 Planning for B16 to B18 Migration

In this section we describe general migration considerations. For detailed information specific to each scenario see D.3, "In Place Migration" on page 334 through D.6, "Upgrade the IBM 3494-B18 with EHPO" on page 349.

D.2.1 Hardware Configuration

Table 36 on page 330 summarizes the different upgrade options when migrating to an IBM 3494-B18.

Table 36. Upgrade Options		
From	**to B18 Standard**	**to B18 EHPO + new Channels**
B16	n/a	• 2 or 4 Extended Performance ESCON Channels • 216 GB TVC,assuming a 3:1 compression ratio, and 32 Virtual Drives • 432/648/864 GB TVC,assuming a 3:1 compression ratio, and 64 Virtual Drives • Up to 6 Magstar Drives • Advanced Function Feature • Open Systems Attachment
B18 Standard	• 144/216/288 GB TVC • Up to 6 Magstar Drives	• 2 or 4 Extended Performance ESCON Channels • 432/648/864 GB TVC,assuming a 3:1 compression ratio, and 64 Virtual Drives • Up to 6 Magstar Drives • Advanced Function Feature • Open Systems Attachment
B18 EHPO, 2 Channels	n/a	• two additional Extended Performance ESCON Channels • 432/648/864 GB TVC,assuming a 3:1 compression ratio, and 64 Virtual Drives • Up to 6 Magstar Drives • Advanced Function Feature • Open Systems Attachment

You cannot upgrade an IBM 3494-B16 to an IBM 3494-B18 with standard ESCON channels. The model upgrade requires for the EHPO and two Extended Performance ESCON Channels at a minimum. You can, however, install an IBM 3494-B18 with standard ESCON channels and upgrade the two standard ESCON channels later to two or four Extended Performance ESCON Channels. You cannot install a combination of standard and Extended Performance ESCON Channels with a single IBM 3494-B18 frame.

D.2.1.1 Ordering Support

Depending on the migration scenario that you select, different considerations apply. To convert an existing IBM 3494-B16 into an IBM 3494-B18, an MES must be ordered for the model conversion. To install the IBM 3494-B18 into an existing library in addition to an IBM 3494-B16, you need to order an MES including the additional frames to be installed and some additional features on the IBM 3494-L1x frame. If you install a completely new library including the IBM 3494-B18, see 2.8, "Ordering Support" on page 36 for details.

We describe ordering support related to the three migration scenarios in D.3, "In Place Migration" on page 334 through D.6, "Upgrade the IBM 3494-B18 with EHPO" on page 349.

You can upgrade the size of your TVC during migration of the IBM 3494-B16 to the IBM 3494-B18.

Part of the B16 to B18 migration is the upgrade of the Library Manager LIC. The Library Manager must be at E/C level F23225 or higher. The Library Manager LIC level to support the IBM 3494-B18 must be 523 or higher. If the IBM 3494-B18 frame is to be installed in an existing IBM Magstar 3494 Tape Library, that does not already have the Enhanced Library Manager feature (FC 5045) or the IBM 3494-HA1 frames installed, the new Library Manager hardware is automatically provided as part of the B16 to B18 MES.

After the conversion of an IBM 3494-B16 to an IBM 3494-B18 is completed, the TVC and the VTS controller are removed from the IBM 3494-B16 frame and returned to IBM. The empty B16 frame must be converted to one of the following frames:

- **Additional Storage Unit Frame**

  This frame contains up to 400 cartridge storage cells as the IBM 3494-B16 frame did before. You need to order feature code 5500 on the IBM 3494-L1x frame for this conversion. If you later plan to install an additional IBM 3494-B18 VTS subsystem in the same IBM Magstar 3494 Tape Library, you can convert feature code 5500 to feature code 5502, Drive Unit for B18 frame, or to feature code 5503 or 5504.

- **Drive Unit for B18 Frame**

  This frame contains up to 290 cartridge storage cells and up to six Magstar tape drives. It cannot be used like a IBM 3494-D12 frame for Magstar tape drives attached through SCSI to its hosts; it can be attached to an IBM 3494-B18 frame only. You need to order feature code 5502 on the IBM 3494-L1x frame for this conversion. The necessary hardware to install three or four Magstar tape drives is included with feature code 5502. If you need to install five or six Magstar tape drives, you need to order RPQ 8B3167 in addition. You can convert FC 5502 to FC 5503 or FC 5504.

- **SCSI Drive Unit Frame** The SCSI drive unit frame contains additional cartridge storage (up to 290 cartridges) and provides the necessary hardware for installation of three or four IBM Magstar 3590 tape drives that will be attached to host system SCSI adapters. You need to order feature code 5503 on the IBM 3494-L1x frame for this conversion. If you need to install five or six Magstar tape drives, you need to order RPQ 8B3167 in addition.

- **ESCON Drive Unit Frame** The ESCON drive unit frame contains additional cartridge storage (up to 345 cartridges) and provides the necessary hardware for installation of one or two IBM Magstar 3590 tape drives and one 3590 Model Ax0 Controller that will be attached to host system ESCON adapters. You need to order feature code 5504 on the IBM 3494-L1x frame for this conversion. If you need to install the third or fourth tape drive, you need to order RPQ 8B3168 in addition.

For more details on the different feature codes, see 2.8, "Ordering Support" on page 36.

D.2.2 Software Implementation

Migration from an IBM 3494-B16 to an IBM 3494-B18 does not necessarily require much software implementation effort. However, you should consider these topics:

- **64 instead of 32 virtual devices**

  If you have at least 432 GB of TVC (equals 144 GB of uncompressed data and EHPO), the IBM 3494-B18 VTS provides 64 virtual devices. Therefore, you need to update your HCD definitions to define the additional devices to the subsystem. These changes can be done in advance of the hardware migration. For details, see 3.3, "Hardware I/O Configuration Definition" on page 60.

  In addition, when you are using the LIBRARY-ID and LIBPORT-ID parameters in the HCD definition as described in 3.3.4, "HCD Support for Library and Port IDs" on page 67, you need to define two additional LIBPORT-IDs.

  If you are using JES3, you need to update the JES3 definitions to add the new devices. This change can be done in advance and be activated during a planned IPL.

- **Two additional Extended Performance ESCON Channels (optional)**

  With the IBM 3494-B18, you have the option of attaching the VTS to its hosts through four Extended Performance ESCON Channels. If you add two additional ESCON channels, you need to update the HCD definitions, which you can do in advance of the hardware migration.

- **Compression**

  To benefit from the compression of the data in the TVC, make sure that the SMS data classes that you assign to tape data sets written to the VTS have defined COMPRESSION=YES. If you define COMPRESSION=NO, you switch off compression when data is written in the TVC. This wastes space in the TVC and may decrease the overall VTS performance.

- **Library ID and library name**

  One physical IBM Magstar 3494 Tape Library can consist of up to three logical libraries: one logical library per VTS subsystem and one library for all native tape drives in the IBM Magstar 3494 Tape Library. Each of these logical libraries has its own library sequence number or library ID, which the IBM service representative defines during hardware installation. Usually, the last five characters of the machine serial number are used.

  The library ID is used when defining the system-managed library in the ISMF Library Define panel. When you convert the IBM 3494-B16 VTS to an IBM 3494-B18 VTS, the library ID remains the same. Therefore no software changes are required for migration in place as in migration scenario 1.

  When you add the IBM 3494-B18 VTS to an existing library or when you install an additional IBM Magstar 3494 Tape Library including the IBM 3494-B18 VTS, the new VTS logical library will have a new library ID. You need to define a new logical library through ISMF. You also need to update your SMS constructs.

- **Advanced Function Feature**

  If you want to implement the Import/Export function, software updates are required. You must install PTFs that provide the support for the new functions. To implement Import/Export, additional definitions are required in

your tape management system. We describe planning and implementation information for the Import/Export function in Chapter 9, "IBM Magstar VTS Advanced Function" on page 245.

- **Open Systems Attachment**

  If you plan to attach open systems hosts to the VTS (FC 3422), refer to 3.6, "IBM Magstar VTS SCSI Attachment" on page 90.

D.2.3 Volume and Data Migration

There is absolutely no requirement to move any data that has been created on logical volumes in the IBM 3494-B16 VTS or logical volumes themselves. With the IBM 3494-B18 VTS, you can immediately continue your normal processing as you did before using the IBM 3494-B16 VTS. The only difference now is that new volumes are compressed in the TVC, so the size of the volumes effectively increases from 400 MB for MEDIA1 or 800 MB for MEDIA2 to up to 1.2 GB or 2.4 GB depending on the compression ratio achieved.

Figure 120 outlines the way compression works with logical volumes previously written to the IBM 3494-B16 VTS and how it works with the IBM 3494-B18 with EHPO.
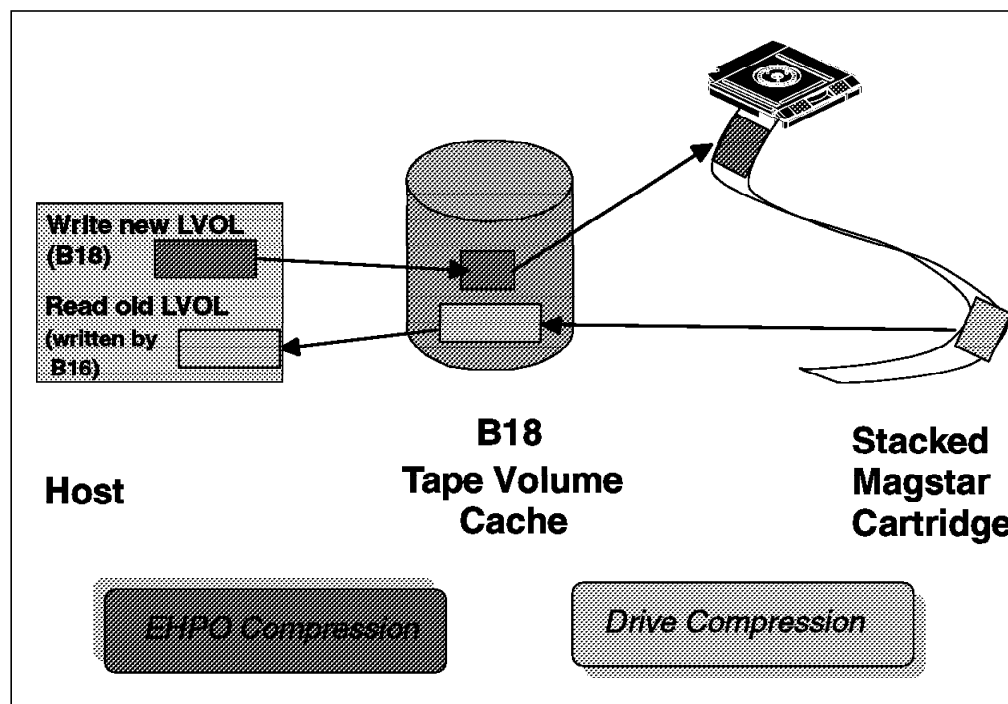
Figure 120. VTS Compression

In Figure 120, two data sets are processed by the host using an IBM 3494-B18 VTS:

- The first data set is newly created and written to the TVC. It is compressed when it is written into the TVC in the ESCON attachment.

- The second data set has been created in the IBM 3494-B16 VTS before and is now read by the host. Because it was compressed using Magstar drive compression before being written to the stacked cartridge, it is now uncompressed when it is written into the TVC.

Compression in the TVC takes place when the data is transferred to the VTS from the host via the channel attachment. Compression takes place by the EHPO feature regardless if it is a write from ESCON attached or SCSI attached host.

Although there is no need to read the old B16 versions to the host and write them back to the IBM 3494-B18 EHPO to achieve compression, you might want to do so for the following reasons:

- To reduce the number of logical volumes

  If you need more than 150,000 logical volumes per VTS with your current implementation and have many multivolume files inside your VTS subsystem, it may be helpful to rewrite these multivolume files to the IBM 3494-B18 VTS to free up some volsers of logical volumes.

- To use the TVC more effectively

  If you keep large files in the TVC that are often read only, you might consider copying these logical volumes to new logical volumes to allow data compression to take place into the TVC.

Note: A second effect imposed by this fact is, that stacked cartridges, written on a IBM 3494-B18 EHPO cannot be recovered on a IBM 3494-B16 or B18 standard. The recall of logical volumes from a stacked cartridge created on the IBM 3494-B18 EHPO results in logical volume entries on the TVC in compressed format which are not recoverable on an IBM 3494-B16 or B18 which does not have and Extended Performance ESCON Channels.

Note: The number of stacked volumes required in a VTS for storage of logical volumes may be greater for a Model B18 with EHPO than for the Model B16 or Model B18 without EHPO:
Depending upon the nature of the data patterns, the compression achieved by the EHPO channel attachment and the 3590 tape drives will not be the same.

D.3 In Place Migration

Figure 121 on page 335 shows the source and the target configuration for in place migration.
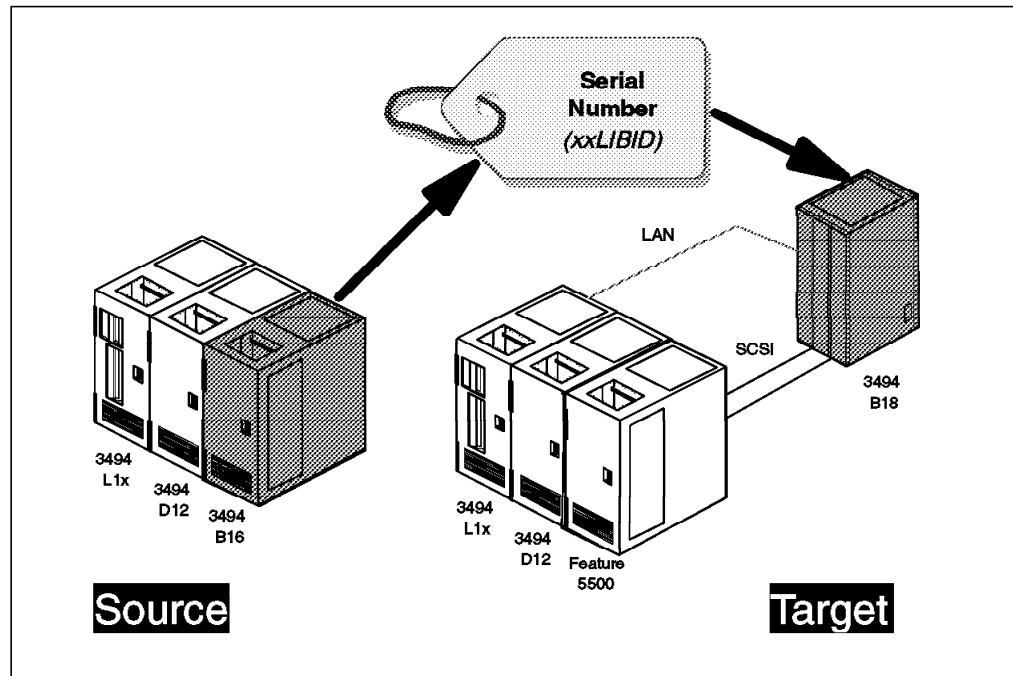
Figure 121. Migration Scenario 1: In Place Migration

As indicated in Figure 121, the serial number of the IBM 3494-B16 is removed from the IBM 3494-B16 frame and is assigned to the IBM 3494-B18 frame. The serial number is retained because it is a conversion of an existing asset rather than the installation of an additional machine.

The IBM 3494-B16 is no longer a separate IBM 3494 model but is converted to a feature of the IBM 3494-L1x frame. If the IBM 3494-B16 is converted to an IBM 3494-S10-like frame, it becomes feature number 5500. If it is converted to an IBM 3494-D12-like frame for later use together with another IBM 3494-B18 in the same IBM Magstar 3494 Tape Library, it becomes feature number 5502. If it is converted to a SCSI unit frame, it becomes feature number 5503 and if it is converted to an ESCON unit frame, it becomes feature number 5504.

Transferring the serial number to the IBM 3494-B18 also helps in minimizing the implications on host software definitions, because the last five characters of the machine serial number are usually used as the library ID or library sequence number when defining the library to the host through ISMF and JES3. You do not have to update the SMS library definition in the TCDB through ISMF. If you are using JES3, you do not have to change the JES3 SETNAME and HWSNAME definitions for the library-specific library name and for the library-specific device name. You must only specify the additional 32 device addresses in the DEVICE statements.

D.3.1 Preparing for Migration

In place migration is basically performed by the IBM hardware CEs. You do not have to change any software definitions, because the library ID will remain the same. Because in place migration involves physical replacement of essential parts of your IBM Magstar 3494 Tape Library and VTS subsystem, you must plan for the appropriate outage of your tape library and the VTS.

The only software changes that are required can be prepared and activated in advance:

- If your VTS configuration allows for 64 logical devices, you should do the HCD definitions for additional 32 drives in advance, which also includes adding two additional LIBPORT-IDs as described in 3.3.4, "HCD Support for Library and Port IDs" on page 67. You can activate these changes through the ACTIVATE IODF command or an IPL.

- If you need to update the JES3 definitions as well, we recommend that you update the JES3 DEVICE statements in advance so that they can be activated during a planned IPL in advance of the hardware installation.

You need to perform the complete hardware installation either during one session or in three different steps on three different dates. Which way you choose will largely depend on the continuous downtime that your installation allows for.

D.3.2 Migration Steps

In this section, we describe in detail all of the migration steps for an in place migration. The steps are grouped according to three different actions, which must be performed sequentially but not necessarily on the same date.

D.3.2.1 Upgrade of the Library Manager

If the Library Manager is not at the appropriate EC level, it is replaced as part of the B16 to B18 migration. If you already have an enhanced Library Manager installed, the Library Manager LIC must be updated. The following steps are required:

- **Vary the VTS and the library offline**

  The IBM Magstar 3494 Tape Library and the VTS subsystem have to be shut down before the Library Manager or the Library Manager LIC can be replaced. Therefore you should first terminate all processing on library drives and thereafter vary offline all logical libraries inside this IBM Magstar 3494 Tape Library. After completion, the IBM service representative can shut down the VTS subsystem and the Library Manager.

- **Replace the Library Manager or upgrade the Library Manager LIC**

  Either the complete Library Manager hardware including the latest preinstalled level of LIC is provided, or the appropriate Library Manager LIC level has to be installed on the Library Manager. This task is performed by the CE.

- **Vary the IBM Magstar VTS and the library online**

  After completion of the Library Manager upgrade, you can vary the libraries online again.

Plan for a two hour outage for this part of the migration if you decide to have it done upfront. However, we recommend doing the library manager upgrade during the model upgrade to minimize overall effort.

D.3.2.2 Install Model Upgrade B16 to B18

This is the main part of the migration during which the the IBM 3494-B18 frame is installed and cabled to the IBM Magstar 3494 Tape Library. The VTS database and the file fragments are moved to the IBM 3494-B18 controller. On completion of this part, you will be able to use the IBM 3494-B18 VTS and have access to all the data contents copied over from the IBM 3494-B16.

- **Complete all host jobs and vary the VTS logical library offline**

To accelerate the subsequent Force Migrate operation, the IBM service representative has the possibility to activate a background job which finds resident virtual volumes and copies them to stacked volumes.

When the library is offline to all attached hosts, the IBM service representative places it in PAUSE mode and checks for any cartridges left in the VTS- owned 3590 tape drives.

- **Force migrate to copy all logical volumes to tape**

  After setting the library back to AUTO-Online, the IBM service representative initiates a force migrate operation of the VTS subsystem. Force migrate causes all virtual volumes that have not yet been copied to tape to be copied and all virtual volumes that are still residing in the TVC to be migrated. When force migrate is active, you do not have access to your data in the VTS subsystem. If native tape drives are available in the IBM Magstar 3494 Tape Library, they can be used.

  Note that the force migrate operation can require from 1.5 to 7.5 hr depending on the size of the TVC and the number of virtual volumes that have to be migrated. To shorten the time required, consider starting the B16 to B18 migration after some period of low activity in the VTS.

- **Copy VTS database and cache resident file fragments to tape**

  After the Force Migrate operation has completed, the IBM service representative initiates the backup of the VTS database and of all file fragments in the TVC. During this step, you have access to native drives in the IBM Magstar 3494 Tape Library but not to the VTS subsystem.

- **Install the IBM 3494-B18 frame and attach it to the IBM Magstar 3494 Tape Library**

  During installation of the IBM 3494-B18 frame, the IBM service representative performs these activities:

  – Installs the SCSI extenders in the IBM 3494-D12 frame

  – Installs the IBM 3494-B18 frame and cables it to the SCSI extender.

  – Installs the attachment concentrator and cables the IBM 3494-B18 frame to the IBM 3494-L1x frame

  During these activities, you have access to native drives in the IBM Magstar 3494 Tape Library but not to the VTS subsystem. Part of this installation steps can be done concurrently during the preparation process.

- **Disconnect the IBM 3494-B16 and the drives in the IBM 3494-D12 frame from the Library Manager**

  The library now must be varied offline to all attached hosts. The IBM service representative then sets the library to PAUSE mode and disconnects the Library Manager from the IBM 3494-B16 frame and from the drives in the IBM 3494-D12 frame. You do not have access to the IBM Magstar 3494 Tape Library until the IBM 3494-B18 has been installed.

- **Teach the new configuration**

  The IBM service representative performs a TEACH CURRENT operation of the library and a subsequent Inventory and tests the IBM 3494-B18 VTS.

- **Restore the VTS database and cache resident file fragments**

  The library now is placed into AUTO-Online mode, and the IBM 3494-B18 VTS is online. The virtual drives are still not available to the hosts, but you can

use native drives in the IBM Magstar 3494 Tape Library while the IBM service representative initiates a restore of the file fragments to the TVC and of the IBM 3494-B18 VTS database. On completion of the restore, the IBM service representative performs a cleanup of the IBM 3494-B16 and removes the serial number tag from the IBM 3494-B16 frame.

- **Vary the VTS online**

  You can now vary the virtual drives back online to the hosts and start using the IBM 3494-B18 VTS.

Plan for 7 to 14.5 hr of downtime for this part of the migration. Because the duration largely depends on the time required to empty the TVC through a Force Migrate command, we strongly recommend that you start off with as many virtual volumes copied to tape as possible. This is usually after a period of low activity in the VTS subsystem.

D.3.2.3 Convert the IBM 3494-B16 Frame to a Storage Frame

During this conversion, the obsolete parts of the IBM 3494-B16 frame are removed to be returned to IBM. We assume that you convert the IBM 3494-B16 frame to an additional storage unit frame, which takes 3 hr of IBM service representative time. However, during this conversion, the IBM 3494-B18 VTS and the IBM Magstar 3494 Tape Library are available for tape processing.

This part of the migration can be performed during the installation of the B16 to B18 model upgrade or subsequently to the actual model upgrade. The IBM service representative performs the following tasks:

- Erase cache contents.

- Removes the cache and the controller from the IBM 3494-B16 frame

- Returns the parts to IBM

We recommend that you not convert the IBM 3494-B16 frame to a Drive Unit for B18 frame unless you plan to install a second IBM 3494-B18 in the near future. The conversion of the IBM 3494-B16 frame to a Drive Unit for B18 frame takes an additional 12 hr without installing the Magstar tape drives. You can upgrade the additional storage unit frame to a Drive Unit for B18 frame any time later.

D.3.3 Migration Summary

Table 37 on page 339 summarizes the migration steps described above. We assume that the Library Manager upgrade is done as part of the IBM 3494-B18 installation rather than upfront.

Table 37. Migration Tasks with Scenario 1		
Task	**VTS Accessibility**	**3494 Accessibility**
Preparation		
Update HCD	Yes	Yes
Update JES3 definitions	Yes	Yes
IPL / activate IODF	n/a	n/a
Migration Part 1		
Vary B16 virtual drives offline	No	Yes
Force migrate TVC	No	Yes
Copy VTS DB and file fragments	No	Yes
Vary the VTS and LM offline	No	No
Back up LM database	No	No
Install new LM in L1x	No	No
Restore LM database to new LM	No	No
Install attachment concentrator in L1x	Yes	Yes
Install SCSI extenders in D12	Yes	Yes
Cable 3590s in D12 to SCSI extenders	No	Yes
Install B18 and cable to D12 (SCSI) and L1x	No	No
Disconnect B16	No	Yes
3494 Teach Current	No	No
Restore VTS DB and file fragments	No	Yes
Attach host ESCON cables to B18	No	Yes
Vary VTS online	No	Yes
Migration Part 2		
Convert B16 to 5500 or 5502	Yes	Yes
Erase B16 cache	Yes	Yes
Note:		
Accessibility indicators are given based on lab procedures. Individual customer environments may require different procedures.		

Note:

> The total installation time for migration in place is 12 to 14.5 hr including the Library Manager update. During the installation, the IBM Magstar 3494 Tape Library is unavailable for 3.5 to 6.0 hr, and the VTS subsystem is unavailable for 8 to 10 hr.

If you are installing additional native tape drives and/or additional frames during the migration, check with your IBM representative on additional installation considerations and outage times.

If you are planning to install a second IBM 3494-B18 VTS subsystem in the same IBM Magstar 3494 Tape Library after migration is complete, you can use the

former IBM 3494-B16 frame as the drive unit frame for the second IBM 3494-B18 VTS. To convert FC 5500 (Additional Storage Unit frame) to FC 5502 (Drive Unit for B18 frame) requires an installation time of 5 to 8 hours, depending on the number of Magstar tape drives to be installed. During most of this time, the IBM Magstar 3494 Tape Library and the first IBM 3494-B18 will be accessible by the hosts.

The implementation of the second IBM 3494-B18 frame itself is the same as if your were initially installing an IBM 3494-B18 VTS. For the information you may need for installation and implementation, in See Chapter 2, "Preinstallation Planning and Sizing" on page 17 and Chapter 3, "Installing the Virtual Tape Server" on page 53.

D.4 Migration Using Parallel Operation within One Library

Figure 122 shows the source and target configuration when you migrate to an IBM 3494-B18 using a parallel operation within one IBM Magstar 3494 Tape Library.
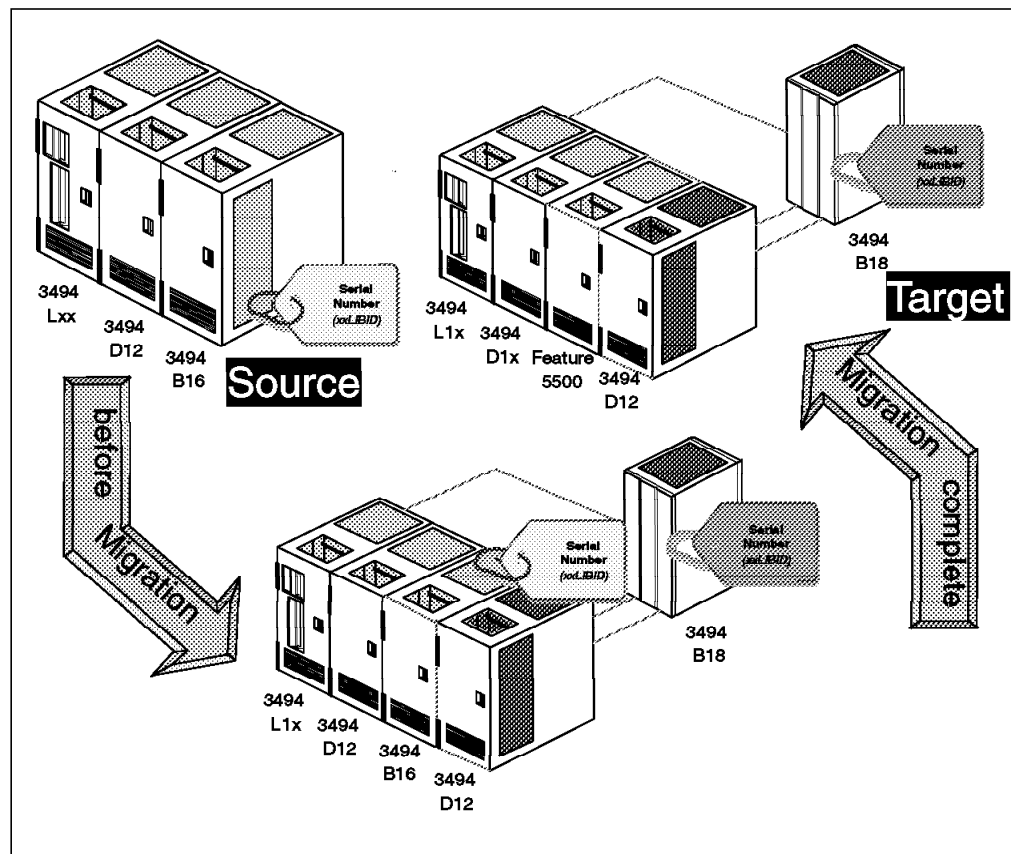
Figure 122. Migration Scenario 2: Parallel Operation within One Library

In migration scenario 2, you add an additional IBM 3494-B18 VTS to the IBM 3493-B16 VTS in the same IBM Magstar 3494 Tape Library. Because you create a new logical library within the same physical tape library, the software implementation steps are the same as if you were installing a complete new library. After installation of the IBM 3494-B18 VTS, you start moving your data

from the IBM 3494-B16 VTS into the IBM 3494-B18 VTS, by either copying the data from the IBM 3494-B16 subsystem to the IBM 3494-B18 VTS subsystem, writing new data to the IBM 3494-B18 subsystem and waiting until the data in the IBM 3494-B16 VTS subsystem has expired, or using a combination of both.

After you have completely migrated your data to the IBM 3494-B18 VTS, it is your choice what to do with the IBM 3494-B16 VTS, because this migration scenario does not include a model conversion from an IBM 3494-B16 to an IBM 3494-B18. Therefore we recommend this migration scenario if you are planning to add a second VTS subsystem to the same IBM Magstar 3494 Tape Library that you already have installed. You may upgrade the IBM 3494-B16 VTS to an IBM 3494-B18 VTS any time later, if your throughput and processing requirements require it.

You may want to use the IBM 3494-B16 VTS for other workload, for example, for the attachment to a test LPAR, or you may want to move workload to the IBM 3494-B16 VTS that does not benefit from the EHPO compression, for example, data sets that are already host compressed.

D.4.1 Preparing for Migration

In preparing for the IBM 3494-B18 VTS hardware installation, you should plan for hardware and software changes.

D.4.1.1 Hardware Installation

Perform the following tasks before the hardware installation:

1. Decide on the configuration of the IBM 3494-B18 VTS subsystem regarding number of Magstar tape drives, number and type of host channel attachments and size of the TVC. In addition, plan for a sufficient number of storage cells to store the stacked Magstar cartridges required.

2. Prepare and complete the physical installation planning, including the floor plan.

3. Decide on the volser range for logical volumes for use in the IBM 3494-B18 VTS subsystem.

4. Order additional cartridges and labels.

During migration, additional stacked cartridges might be required to hold the logical volumes of the additional VTS. You may want to use a volser range adjacent to the one you are using for the IBM 3494-B16 VTS.

For additional information about hardware planning and preparation, see Chapter 2, "Preinstallation Planning and Sizing" on page 17.

D.4.1.2 Software-Related Considerations

To the host, the implementation of a second VTS subsystem appears as if a new library were being added, because every VTS subsystem represents a logical library. Therefore, there is no difference in the software implementation when you install a completely new IBM Magstar 3494 Tape Library including the VTS subsystem, or when you add a VTS subsystem to an existing IBM Magstar 3494 Tape Library. We summarize the steps required for implementation in an OS/390 environment and refer you to the appropriate sections in Chapter 3, "Installing the Virtual Tape Server" on page 53 and Chapter 6, "Using the IBM Magstar VTS" on page 123 for details. For implementation in a VM/ESA or VSE/ESA environment, refer to 3.5.4, "VM/ESA" on page 89.

- Define the hardware configuration.

  See 3.3, "Hardware I/O Configuration Definition" on page 60 for details of HCD definitions for a new library and for PARMLIB updates such as setting the MIH value for the new virtual tape drives.

- If applicable, update the JES3 definitions.

  See 3.5.3.1, "JES3 Sample Initialization Deck Definition" on page 86 for a sample JES3 initialization deck definition.

- Identify the data to be moved to the IBM 3494-B18 VTS.

  If you are planning to move all workload to the IBM 3494-B18 VTS subsystem, you just need to change the ACS routines to direct the complete VTS workload to the IBM 3494-B18. You may, however, want to leave part of the workload in the IBM 3494-B16 VTS, for example, if tape data is already compressed on the host. Identify the tape workload that you want to move from the IBM 3494-B16 VTS and from native tape drives to the IBM 3494-B18 VTS subsystem.

- Define a data migration plan.

  You can either copy your tape data to the IBM 3494-B18 VTS subsystem, or you can write new data to the B18 and use the B16 to read existing data, or you can use a mixture of both strategies. For details on the methods to move data, see:

  - 6.6, "Moving Data into and out of VTS" on page 146
  - 6.6.1, "Moving Data into the VTS: Phased Method" on page 147
  - 6.6.2, "Moving Data into the VTS: Quick Method" on page 148
  - 6.6.5, "Combining Methods to Move Data into the VTS" on page 153

  Develop a data migration plan depending on the method you have selected and on the time you can spend on moving the data.

- Prepare the SMS definitions:

  - Defining the new library through ISMF.

  - Defining new data classes, if required. Make sure that the compression parameter in the data class definition is set to YES for data to be written to the IBM 3494-B18 VTS. You can also use existing data class definitions that have been used for the IBM 3494-B16 VTS.

  - Defining a new storage class, if required. Because the storage class in a system-managed tape environment is used only to determine whether the tape volume is to be system-managed or not, you can assign any storage class you want. If you use the storage class name for further filtering in the ACS routines, you may want to define a new one.

  - Define or update one or more storage group related to the new library. Because the storage group is used to direct allocations to a specific SMS-managed tape library, you should define at least one storage group that is connected only to the new IBM 3494-B18 library.

  - Preparing the update of the ACS routines. You have to update the ACS routines to direct tape allocations to the new IBM 3494-B18 library. Depending on the test plan and data migration plan, you have to update the ACS routines more than once. Be sure that the new ACS routines are activated only after the IBM 3494-B18 VTS is online, otherwise tape allocations to this new library will be unsuccessful.

- Update your tape management system.

Define the logical volser range to your tape management system as scratch volumes. Although you do not have to predefine scratch volumes with DFSMSrmm, we recommend predefining the volsers. If the volsers are predefined, INSERT processing on the host will be performed much faster after the logical volser range has been defined on the Library Manager.

- Define a test plan.

  Before moving workload to the IBM 3494-B18 VTS, you may want to test it in your environment. Set up a test plan including typical processing in your environment. If you are planning to move additional workload from native tape drives to the VTS subsystem, you should also include this in your test plan.

Plan for having these steps completed before the hardware installation of the IBM 3494-B18 VTS. We recommend that you perform all updates in advance. If you prefer, you can also perform the updates after the hardware has been installed.

D.4.2 Migration Steps

We summarize the migration steps for hardware installation and software implementation of the IBM 3494-B18 logical library.

D.4.2.1 Upgrade the Library Manager

See D.3.2, "Migration Steps" on page 336 for details on this Library Manager Upgrade tasks.

D.4.2.2 Install the IBM 3494-B18 VTS Subsystem

An additional IBM 3494-D12 frame has to be added to your existing IBM Magstar 3494 Tape Library, or an existing IBM 3494-D12 frame can be used for attachment of the IBM 3494-B18 frame. Model conversions are available from an existing IBM 3494-D10 or IBM 3494-D14 frame to an IBM 3494-D12 frame. During the installation of the IBM 3494-D12 frame, the IBM Magstar 3494 Tape Library and the IBM 3494-B16 VTS are unavailable for the hosts.

During installation of the IBM 3494-B18 frame, the IBM service representative performs these activities:

- Installs the SCSI extender in the IBM 3494-D12 frame

  If a new IBM 3494-D12 frame is added to your configuration, the SCSI extender will be preinstalled.

- Installs the IBM 3494-B18 frame and cables it to the SCSI extender.

- Installs the attachment concentrator and cables the IBM 3494-B18 frame to the IBM 3494-L1x frame.

- Teaches as the new configuration

  The IBM service representative performs a TEACH CURRENT operation and a subsequent inventory and tests the IBM 3494-B18 VTS.

During these activities, you have access to native drives in the IBM Magstar 3494 Tape Library but not to the VTS subsystem.

D.4.2.3 Setup of the New VTS Subsystem

After completing the hardware installation, you have to set up the new VTS subsystem. On the Library Manager console, you:

- Define an additional volser range for stacked volumes.
- Define and insert the volser range for logical volumes.
- Define the VTS management policy.
- Set the VTS category attributes.

See 3.4, "VTS Definition from the Library Manager" on page 70 for details on these implementation tasks. On completion of the Library Manager definitions, you should:

- Insert additional stacked Magstar cartridges.

- Reinventory the IBM Magstar 3494 Tape Library.

- Vary online the IBM 3494-B18 logical library and, if required, the logical drives

- Activate the ACS routines that allow you to direct test allocations to the IBM 3494-B18 logical library.

- Start testing the IBM 3494-B18 VTS.

D.4.2.4 Migrate the Tape Workload

On completion of your testing of the IBM 3494-B18, start migrating the target workload into the new VTS subsystem. To do so, you just need to change the ACS routines:

- For a phased migration, use existing filter lists and change the storage group assignment in the storage group ACS routine per group of data sets or per application at the pace you want to migrate your tape data to the IBM 3494-B18 VTS subsystem.

- For a quick migration, change all storage group assignments for VTS candidates to point to the IBM 3494-B18 VTS subsystem. Use the tools described in 6.6.3, "Products to Simplify the Task" on page 151 to copy logical volumes residing in the IBM 3494-B16 VTS.

- For a partial migration to balance the tape workload between both VTS subsystems, redirect tape allocations as described before for the data sets identified in your migration plan, and copy tape data as required.

After you have completed your migration, you may have obsolete logical volumes in the IBM 3494-B16 VTS. To free up space on the stacked Magstar cartridges, consider ejecting logical volumes from the IBM 3494-B16 VTS. For details on ejecting logical volumes, see 7.12, "Ejecting Logical Volumes from the VTS" on page 188. Eventually, you may want to reassign stacked volume ranges to the new IBM 3494-B18 VTS as data is transferred away from the IBM 3494-B16.

D.4.3 Migration Summary

Table 38 on page 345 summarizes the installation tasks of migration scenario 2. Note that these tasks may vary depending on the actual configuration.

Table 38. Migration Tasks with Scenario 2		
Task	**VTS Accessibility**	**3494 Accessibility**
Upgrade Library Manager	No (Yes with HA1)	No (Yes with HA1)
Add D12 frame	No	No
Install B18 frame and cable to D12 SCSI) and L1x.	Yes	Yes
Note:		
Accessibility indicators are given based on lab procedures. Individual customer environments may require different procedures.		

Note:

> The total outage time for migration using parallel operation within one library is 6 to 10 hours including the Library Manager update.

If you plan to convert the IBM 3494-B16 VTS to another IBM 3494-B18 later, you can do so. The conversion does not require another update of the Library Manager. For further details refer to D.3.2, "Migration Steps" on page 336.

D.5 Migration Using Parallel Operation with Two Libraries

When you install an additional IBM Magstar 3494 Tape Library including the IBM 3494-B18 VTS, you do not experience downtime during the hardware installation. As outlined in Figure 123 on page 346, the target configuration can include completely removing the IBM Magstar 3494 Tape Library with the IBM 3494-B16 VTS, or keeping it for other workload. You may also want to upgrade the IBM 3494-B16 VTS to an IBM 3494-B18 VTS after you have completed migration to the IBM 3494-B18 VTS.

Figure 123 on page 346 shows the source and target configuration when you migrate to a IBM 3494-B18 using a parallel operation with two IBM Magstar 3494 tape libraries.
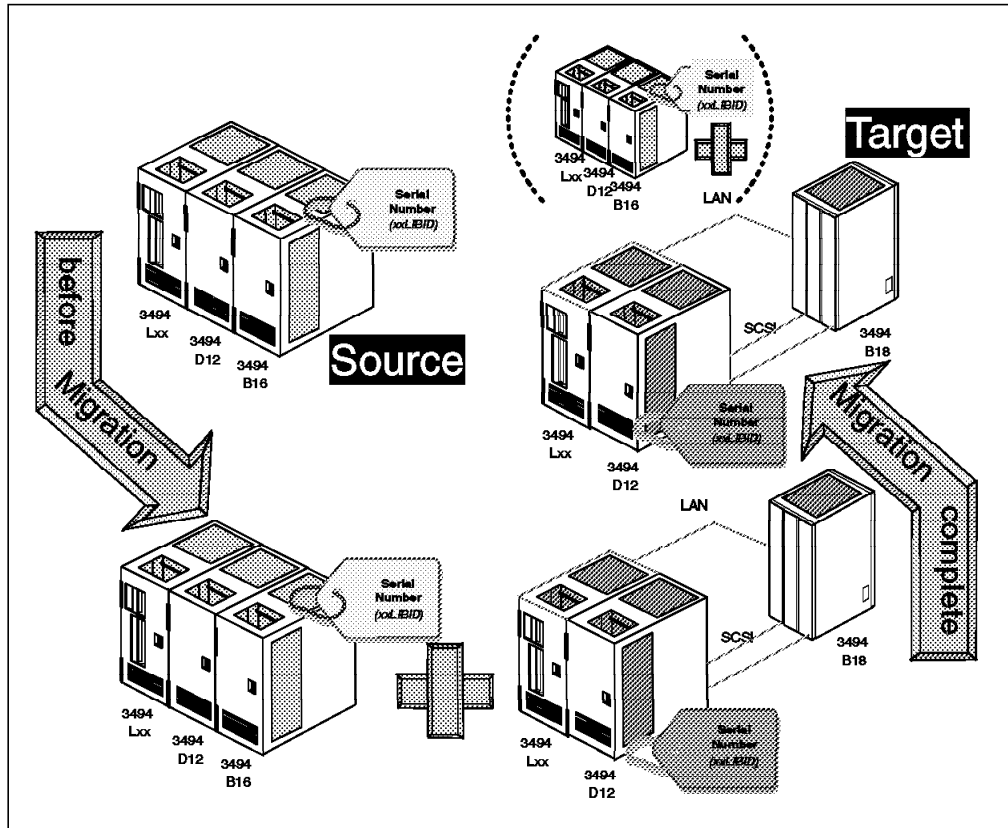
Figure 123. Migration Scenario 3: Parallel Operation with Two Libraries

In Chapter 2 Chapter 2, "Preinstallation Planning and Sizing" on page 17 and Chapter 3, "Installing the Virtual Tape Server" on page 53 we describe in detail the tasks related to the hardware installation and the setup of the new IBM Magstar 3494 Tape Library. Please use those chapters to install and implement the new IBM Magstar 3494 Tape Library including the IBM 3494-B18 VTS.

Depending on your target configuration, you can choose among different ways of migrating your workload to the IBM 3494-B18 VTS subsystem:

• **Host controlled data migration**

   This migration method is comparable to the migration method described in D.4, "Migration Using Parallel Operation within One Library" on page 340 and is not disruptive to your tape processing. It requires that the target IBM Magstar 3494 Tape Library contain additional stacked Magstar cartridges, because you cannot use the physical cartridges in the IBM 3494-B16 VTS at the same time as the IBM 3494-B18 uses them. Host controlled data migration can be used independently of the physical configuration of your source and target libraries, and independently of whether you plan to keep both VTS subsystem or plan to de-install it.

   The method of moving your data under the control of the hosts from one VTS subsystem to another VTS subsystem is the same for two VTS subsystems in the same IBM Magstar 3494 Tape Library and for two VTS subsystems in two different IBM Magstar 3494 Tape Libraries. therefore we do not repeat the data migration steps in this section. See D.4.1.2, "Software-Related Considerations" on page 341 and D.4.2.3, "Setup of the New VTS Subsystem" on page 344 for details.

• **Controlled disaster recovery**

This migration method is disruptive to your tape processing because it involves moving the source library containing the IBM 3494-B16 VTS to the target library containing the IBM 3494-B18 VTS. The Library Manager database of the target library is built based on the information created during setup of the target library and during inventory processing. We describe this migration method in D.5.1, "Migration Steps Using Controlled Disaster Recovery."

- **Physical cartridge movement**

   This migration method is disruptive to your tape processing and is largely performed by the CE. The stacked Magstar cartridges are removed from the IBM Magstar 3494 Tape Library containing the IBM 3494-B16 VTS and placed in the IBM Magstar 3494 Tape Library containing the IBM 3494-B18 VTS. A backup of the source Library Manager's database is restored on the Library Manager of the target library. The IBM 3494-B16 VTS database and file fragments in the TVC are restored on the IBM 3494-B18 VTS. This procedure is not generally applicable because the physical configuration of source and target IBM Magstar 3494 Tape Library may vary. You need to check with your IBM representative to determine whether you can use this method.

   For details see D.5.2, "Migration Steps for Physical Cartridge Movement" on page 348.

D.5.1 Migration Steps Using Controlled Disaster Recovery

The basic steps at the source IBM Magstar 3494 Tape Library containing the IBM 3494-B16 are:

1. Vary the logical library and the virtual drives offline.

2. FORCE MIGRATE.

3. Remove stacked cartridges and take them to the target library.

4. IBM service representative clears the content of the IBM 3494-B16 database and cache.

5. Reinventory the complete system, including deletion of the logical volumes, if you want to continue to use the IBM Magstar 3494 Tape Library because it contains native drives or because you want to use the IBM 3494-B16 VTS for other workload.

6. If you want to continue to use the IBM 3494-B16 VTS, skip the reinventory in the previous step and proceed as follows:

   - Define a stacked volser range for the IBM 3494-B16.

   - Add a new volser range of logical volumes to your tape management system.

   - Define and insert a logical volser range for the IBM 3494-B16.

   - Insert stacked cartridges.

   - Reinventory the source IBM Magstar 3494 Tape Library.

7. Vary the logical library and the virtual drives back online.

Perform these tasks at the target IBM Magstar 3494 Tape Library containing the IBM 3494-B18 VTS:

1. Update location information in the tape management catalog to reflect the new IBM Magstar 3494 Tape Library as the home location, otherwise your

tape management system may reject INSERT processing of the logical volumes in the target VTS subsystem.

2. Invoke the Disaster Recovery Process from the Library Manager.

3. Place the stacked Magstar cartridges for the recovery in the target library.

4. Vary the logical library online.

5. Reinsert the logical volumes.

   The logical volume fragments will not be recreated during this process and you might expect slightly increased mount times after resuming operation due to the fact that the fragments have to rebuilt.

6. Wait until insert processing has completed on the host.

7. Vary the virtual drives online.

For details see 10.3, "Disaster Recovery at Another Site" on page 297.

D.5.2 Migration Steps for Physical Cartridge Movement

Figure 124 shows the source and target configuration when you migrate to an IBM 3494-B18 using physical cartridge movement.
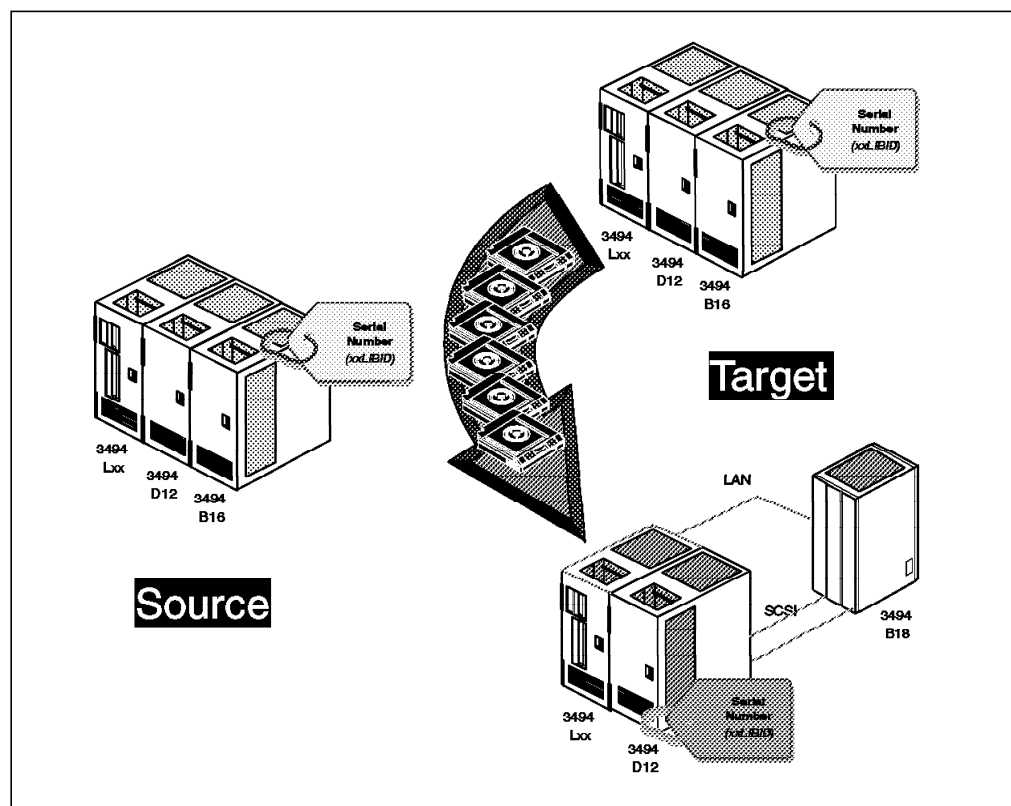
Figure 124. Migration Scenario 3: Physical Cartridge Movement

- Install an additional IBM Magstar 3494 Tape Library

  - At least one IBM 3494-L1x, one IBM 3494-D12, and one IBM 3494-B18 frame

  - Define the HCD definitions for the new library

  - Define the new library through ISMF

- Define or update SMS constructs for the new library, especially storage groups
  - Prepare ACS routine changes
  - If applicable, update JES3 definitions
  - Vary the new IBM 3494-B18 VTS online

The subsequent tasks are done by the IBM service representative using specialized tools.

- Move the content of the IBM 3494-B16 to the IBM 3494-B18 library

  - Initialize concurrent force migrate to drain the TVC
  - Vary IBM 3494-B16 offline
  - Copy all TVC resident logical volumes to stacked cartridges using Force Migrate function.
  - Copy TVC fragments and VTS database to service cartridge (3590)
  - Copy Library Manager database to diskette
  - Move stacked cartridges to IBM 3494-B18

    This might involve physical transportation of data if the new VTS is in a different location. The duration and difficulty of this step should not be underestimated.

  - Make sure receiving IBM 3494-B18 is empty and load stacked cartridges
  - Update Library Manager database with entries from originating IBM 3494-B16
  - Restore VTS database and TVC fragments
  - Reinventory the library for physical cartridges, keeping the logical volumes
  - Vary IBM 3494-B18 online
  - Update TCDB and tape management system CDS regarding location of the logical volumes if needed.

- Redirect the workload to the IBM 3494-B18 library, using nondisruptive adjustments in the DFSMS ACS routines and constructs
- Complete the model upgrade process
- Vary the IBM 3494-B16 library offline
- Dispose of the IBM 3494-B16 library or use it for other workload or upgrade to a IBM 3494-B18 library.

Note:

   The total outage time for this scenario is 6 to 9 hours.

D.6 Upgrade the IBM 3494-B18 with EHPO

If you upgrade the standard ESCON channels of an IBM 3494-B18 with EHPO and Extended Performance ESCON Channels the upgrade allows for:

- Compression in the TVC

- 64 virtual drives, if the size of the TVC is at least 432 GB assuming a 3:1 compression ratio

- Using the Import/Export function

- Upgrade the VTS with the Performance Accelerator Feature

A detailed description of this upgrade is described in: 4.2.7, "Upgrade Scenarios" on page 106 of Chapter 4, "VTS Performance Accelerator" on page 99.

The upgrade is performed by the IBM service representative who replaces the ESCON adapter cards in the IBM 3494-B18. During the upgrade you do not have access to the IBM 3494-B18 VTS. You can, however, access native drives and data outside the VTS subsystem in the same IBM Magstar 3494 Tape Library.

From a host software point of view, the upgrade is comparable to migrating from the IBM 3494-B16 to the IBM 3494-B18 VTS as described. For details on the changes to your host software, refer to D.3.1, "Preparing for Migration" on page 335. Considerations related to the introduction of compression in the TVC are described in D.2.3, "Volume and Data Migration" on page 333.

Appendix E. Special Notices

This publication is intended to help storage systems technical professionals in customers, Business Partners and IBM to plan, size, configure order and implement the IBM Magstar Virtual Tape Servers. The information in this publication is not intended as the specification of any programming interfaces that are provided by the Magstar 3494 Tape Libraries or the supporting host software.

See the PUBLICATIONS section of the IBM Programming Announcement for the Magstar 3494 Virtual Tape Server for more information about what publications are considered to be product documentation.

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Appendix F. Related Publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

F.1 International Technical Support Organization Publications

For information on ordering these ITSO publications see "How to get IBM Redbooks" on page 357.

- *IBM Magstar Tape Products Family: A Practical Guide*, SG24-4632

- *Guide to Sharing and Partitioning IBM Automated Tape Library Dataservers*, SG24-4409

- *DFSMShsm Primer*, SG24-5272

- *DFSMS/MVS V1R5 Technical Guide*, SG24-4892

- *Tivoli Storage Manager Version 3.7: Technical Guide*, SG24-5477

F.2 IBM Redbooks collections

Redbooks are also available on the following CD-ROMs. Click the CD-ROMs button at `http://www.redbooks.ibm.com/` for information about all the CD-ROMs offered, updates and formats.

CD-ROM Title	Collection Kit Number
System/390 Redbooks Collection	SK2T-2177
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IBM Enterprise Storage and Systems Management Solutions	SK3T-3694

F.3 Other Publications

These publications are also relevant as further information sources:

- *DFSMS/MVS Storage Administration Reference for DFSMSdfp*, SC26-4920

- *DFSMS/MVS OAM Planning Guide for Tape Libraries*, SC26-3051

- *DFSMS/MVS Implementing System Managed Storage*, SC26-3123

- *DFSMS/MVS DFSMShsm Implementation and Customization Guide*, SH21-1078

- *DFSMS/MVS DFSMSrmm Guide and Reference*, SC26-4931

- *DFSMS/MVS DFSMSrmm Implementation and Customization Guide*, SC26-4932

- *DFSMS/MVS Using the Volume Mount Analyzer*, SC26-4925

- *OS/390 MVS Recovery and Reconfiguration Guide*, GC28-1777

- *Data Facility Data Set Services Version 2 Release 5 and DFSMS/MVS Version 1 Stand-Alone Services Overview*, SC26-0185

- *DFSMS/MVS OAM Planning Guide for Object Support*, SC26-4918

- *IBM 3494 Tape Library Introduction and Planning Guide*, GA32-0279

- *Magstar 3494 Tape Library Operator Guide*, GA32-0280

- *IBM Magstar 3590 Introduction and Planning Guide*, GA32-0329

- *IBM Magstar 3590 Operator's Guide*, GA32-0330

- *IBM Magstar 3590 Tape Subsystem Hardware Reference*, GA32-0331

- *3490E Installation Planning and Operator's Guide*, GA32-0378

- *IOCP User's Guide*, GC38-0401

- *HCD User's Guide*, SC28-1848

- *Ditto User's Guide and Reference*, SH19-8221-02

- *Basic Tape Library Support User's Guide and Reference*, SC26-7016

- *VM/ESA DFSMS/VM Removable Media Services User's Guide and Reference*, SC35-0141

- *3494 Tape Library Dataserver User's Guide: Library Control Device Driver for VSE/ESA*, GC35-0176

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