DEC RAID Utilities

User's Guide

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Preface

This guide provides a description of the DEC RAID™ Utilities and includes:

- General functional description of the DEC RAID Utilities
- Description of the DEC RAID Stand-Alone Utility (hereafter referred to as the Stand-Alone RAID Manager)
- Description of the DEC RAID NetWare™ (hereafter referred to as the NetWare RAID Manager™)

Intended Audience

This guide is intended for users to understand how to use the DEC RAID Utilities to install, configure, and manage their DEC RAID Subsystem.

Document Structure

This guide contains the following parts and chapters:

Part 1: Introduction

- *Chapter 1: Introduction*, discusses the hardware and software requirements for the DEC RAID Utilities and describes the software kits.

Part 2: Description of the RAID Manager Utility

- *Chapter 2: DEC RAID Manager Utilities*, discusses when and how to run a given utility. It also describes the RAID Manager menus.

Part 3: Array Configuration Editor (ACE)

- *Chapter 3: The Array Configuration Editor*, discusses the configuration utility and its menu.

Part 4: Configuring Logical Units

- *Chapter 4: Configuring Logical Units*, describes how to initially set up your RAID Subsystem.

Part 5: Restoring a Logical Unit

- *Chapter 5: Restoring a Logical Unit*, discusses recovery procedures for logical units of various RAID levels.

Part 6: DEC RAID NetWare Utility

- *Chapter 6: Installation of the DEC RAID NetWare Utility*

- *Chapter 7: Adding Logical Units for NetWare*
- *Chapter 8: Checking/Repairing Array Parity*, describes the automatic and manual check and repair procedure for NetWare.
- *Chapter 9: Array Monitor Daemon*, describes how the Array Monitor Daemon scans and reports errors.

Part 7: DEC RAID SCO™ UNIX™ Utility

- *Chapter 10: Installation of the DEC RAID SCO™ UNIX™ Utility*
- *Chapter 11: Parity Check/Repair Utility*, describes the parity check/repair utility for SCO UNIX.
- *Chapter 12: RAID Monitor*, and how it reports errors.
- *Chapter 13: RAID Status Utility*, and how it displays current status of logical units and drives.

Appendix A: SCSI Status Codes
Appendix B: SCSI Sense Keys and Additional Sense Codes
Appendix C: DPT™ Host Adapter Error Codes
Glossary

Associated Documents

In addition to this guide, the following documentation may be useful to the reader:

- *DEC RAID Subsystem User's Guide*
- *HSZ10-AX Controller Site Preparation Guide*

Conventions

This guide uses the following conventions:

Table 1 Conventions

Esc	Press the Escape key.
Fn	Press a function key (for example, F1).
italics	Used for emphasis.
bold text	Used for user input, new terms, and for emphasis.

Part I

Introduction to the DEC RAID Utilities

This part of the guide contains:

- Chapter 1, Introduction

1
Introduction

The DEC RAID Utilities are a collection of utilities designed to provide RAID configuration and management functionality in the MS–DOS™, NetWare™ and SCO UNIX™ operating system environments. This chapter describes the necessary hardware and software components required for each operating system. It also describes the various DEC RAID Utility Kits and their components.

1.1 Hardware Requirements

The DEC RAID Utilities are designed to run with the following hardware components:

- DEC RAID Subsystem (SZ200) with the HSZ10 disk array controller
- Distributed Processing Technology (DPT) PM2012B EISA to SCSI differential host adapter
- Supported drives: RZ25 and RZ26

Refer to the *RAID Subsystem User's Guide* for further information on the SZ200 RAID Subsystem.

1.2 Software Requirements

The DEC RAID Utilities offer RAID management services in the MS–DOS, NetWare and SCO UNIX environments. The following sections discuss DEC RAID Utility support for each operating system.

1.2.1 MS–DOS

The DEC RAID Stand-Alone Utility (or Stand-Alone RAID Manager) is a MS–DOS-based utility used primarily to configure the RAID array in an MS–DOS and/or SCO UNIX environment. The utility is provided on a MS–DOS Version 5.0 bootable floppy.

1.2.2 NetWare

In addition to the DEC RAID Stand-Alone Utility, the DEC RAID NetWare Utility (or NetWare RAID Manager ™) provides the same level of functionality in the NetWare Version 3.11 operating system environment. Additional features include:

- Array parity check/repair
- Array Monitor Daemon to notify users of drive status changes

1.2.3 SCO UNIX

Configuration in SCO UNIX Version 3.2.4 is accomplished through the DEC RAID Stand-Alone Utility. Additional functionality is provided through a set of SCO UNIX Utilities including:

- Array parity check/repair utility
- RAID Monitor to notify users of changes in logical unit and drive status
- RAID status utility to display current logical unit and drive status

1.3 DEC RAID Utility Kits

Software kits are available for the DEC RAID Utilities for each supported operating system. The following sections describe the kits and the files contained within each kit.

1.3.1 DEC RAID Stand-Alone Utility Kit (MS–DOS based)

The DEC RAID Stand-Alone Utility Kit contains a bootable MS–DOS Version 5.0 diskette with the files listed in Table 1–1. This document is also included as part of that kit.

Table 1–1 DEC RAID Stand-Alone Utility Kit

Files	Description
COMMAND.COM	MS–DOS Version 5.0
DPTDDL.SYS	DPT MS–DOS driver
CONFIG.SYS	Configuration file
RAIDMGR.CWA	RAID Manager overlay C-Worthy file
RAIDMGR.EXE	Stand-Alone RAID Manager
RAIDMGR.MSG	RAID Manager message file
RAIDMGR.HLP	RAID Manager help file
RAIDMGR.CFG	RAID Manager configuration file
ACE.EXE	Array Configuration Editor (ACE)
ACF.EXE	Array Configuration Utility (ACF)
FAD.EXE	Array Diagnostic Utility (FAD)
README.BAT	RAID Manager online introduction
READ.ME	RAID Manager online introduction text
PAGE.EXE	Pagination for online introduction
FDISK.EXE	Fdisk utility
ACEHELP <DIR>	Directory of help files
DOS <DIR>	Directory of DOS utilities

1.3.2 DEC RAID NetWare Utility Kit

The DEC RAID NetWare Utility Kit contains the DEC RAID Stand-Alone Utility Kit as well as a diskette with the files listed in Table 1–2.

Table 1–2 DEC RAID NetWare Utility Kit

Files	Description
RMINST.NLM	Installation file
RAIDMGR.NLM	NetWare RAID Manager
RAIDMGR.CFG	Configuration file
RAIDMGR.DAT	Menu and form definitions for RAID Manager
RAIDMGR.MSG	Message file
RAIDMGR.HLP	Help file
RAIDIF1.NLM	NetWare file
ACE.NLM	Array Configuration Editor (ACE)
APC.NLM	Array Parity Check/Repair Utility (APC)
AMD.NLM	Array Monitor Daemon Utility (AMD)
RELEASE.ID	Release version number
ACEHELP <DIR>	Directory of help files

1.3.3 DEC RAID SCO UNIX Utility Kit

The DEC RAID SCO UNIX Utility Kit contains the DEC RAID Stand-Alone Utility Kit as well as a diskette with the files listed in Table 1–3.

Table 1–3 DEC RAID SCO UNIX Utility Kit

Files	Description
makedpth	Create device files used by utility
help.txt	Help text file
monitor	RAID Monitor executable
monitorsh	Shell script to run RAID Monitor
parity	Parity Check/Repair Utility executable
paritysh	Shell script to run Parity Check/Repair Utility
raidstat	RAID Status Utility executable
raidstatsh	Shell script to run the RAID Status Utility
read.me	Read me file with general information about the kit

Part II

Description of the RAID Manager Utility

This part of the guide contains:

- Chapter 2, DEC RAID Utilities

B

2

DEC RAID Utilities

2.1 What are the DEC RAID Utilities?

The DEC RAID Utilities allow you to configure, monitor, and repair disk arrays. There are two versions of the utilities:

- DEC RAID Stand-Alone Utility—this is a MS–DOS-based program provided on a bootable MS–DOS Version 5.0 floppy.
- DEC RAID NetWare Utility—this is an NLM used for most array purposes in NetWare. It is loaded to your NetWare system during the DEC RAID Utilities installation.

2.1.1 Using the DEC RAID Stand-Alone Utility

Use the DEC RAID Stand-Alone Utility to do the following:

- Configure or reconfigure a logical unit in the MS–DOS or SCO UNIX environment.
- Configure or reconfigure a logical unit in the NetWare environment if that unit contains (or will contain) the operating system.
- To restore the logical unit containing your operating system if drives fail (one or more drives on a RAID 0 logical unit, 2 or more drives with other RAID levels). Note that this involves reformatting the logical unit instead of reconstructing the data on it.
- To download controller firmware to a controller attached to the logical unit containing your operating system.
- To access logical units after system boot, if for some reason you cannot access any of your logical units any other way.

2.1.2 Using the DEC RAID NetWare Utility

Use the DEC RAID NetWare Utility to perform all array tasks that do not involve a logical unit containing the operating system. Specifically, use the DEC RAID NetWare Utility to do the following:

- Configure, reconfigure, and modify logical units that do not contain the operating system.
- Check and repair array parity on logical units.
- Check device statuses for the array devices on your system.
- Change DEC RAID Manager configuration parameters (scheduled parity time, parity file name, and so on).
- Restore a RAID 1 or RAID 5 logical unit after a single disk failure (on any logical unit, even one containing the operating system).

2.2 Starting the DEC RAID Utilities

There are two ways to start DEC RAID Utilities, depending on whether you are running the DEC RAID Stand-Alone Utility from diskette or running the DEC RAID NetWare Utility.

2.2.1 Starting the DEC RAID Stand-Alone Utility

To run DEC RAID Stand-Alone Utility, perform the following steps:

1. Bring down your operating system in an orderly fashion, if necessary.
2. Insert the diskette with the DEC RAID Stand-Alone Utility in Drive A:
3. Reboot your system.
4. Type **raidmgr** and press the Return key.
5. The system starts to load DEC RAID Stand-Alone Utility from the diskette. There is a delay while DEC RAID Manager scans all the SCSI buses on your system, looking for arrays. This delay can take 5-10 seconds per adapter. During this scan, DEC RAID Manager may prompt you if it does not detect any arrays on your system (for example, arrays may not be turned on or are not yet ready).
6. After DEC RAID Stand-Alone Utility has located all the arrays on your system, the opening menu is displayed. See Section 2.4 for a description of the DEC RAID Manager™ menus.

2.2.2 Starting the DEC RAID NetWare Utility

To run the DEC RAID NetWare Utility, perform the following steps:

1. From the system console, type **load raidmgr** and press the Enter key.
2. There is a delay while the DEC RAID Manager scans all the SCSI buses on your system, looking for arrays. This delay can take 5-10 seconds per adapter.
3. After DEC RAID NetWare Utility has located all the arrays on your system, the opening menu is displayed. See Section 2.4 for a description of the DEC RAID Manager menus.

Note

Do not leave DEC RAID Manager or the NetWare Install utility running because AMD will not work.

2.3 Moving Around in the DEC RAID Utilities

Table 2–1 lists how to move around in the DEC RAID Manager menus.

Table 2–1 Moving within the DEC RAID Manager Menus

To:	Press:
Select an option	The up and down arrow keys to highlight the option you want, then press the Enter key.
Return to the previous menu	The Escape key.
Exit the DEC RAID Stand-Alone Utility	The Esc key until a popbox appears asking whether you want to exit DEC RAID Stand-Alone Utility. To exit DEC RAID Manager, select Y. To remain in DEC RAID Manager, select N. To return to the Disk Array Services menu, press the Esc key.

2.4 DEC RAID Utility Menus

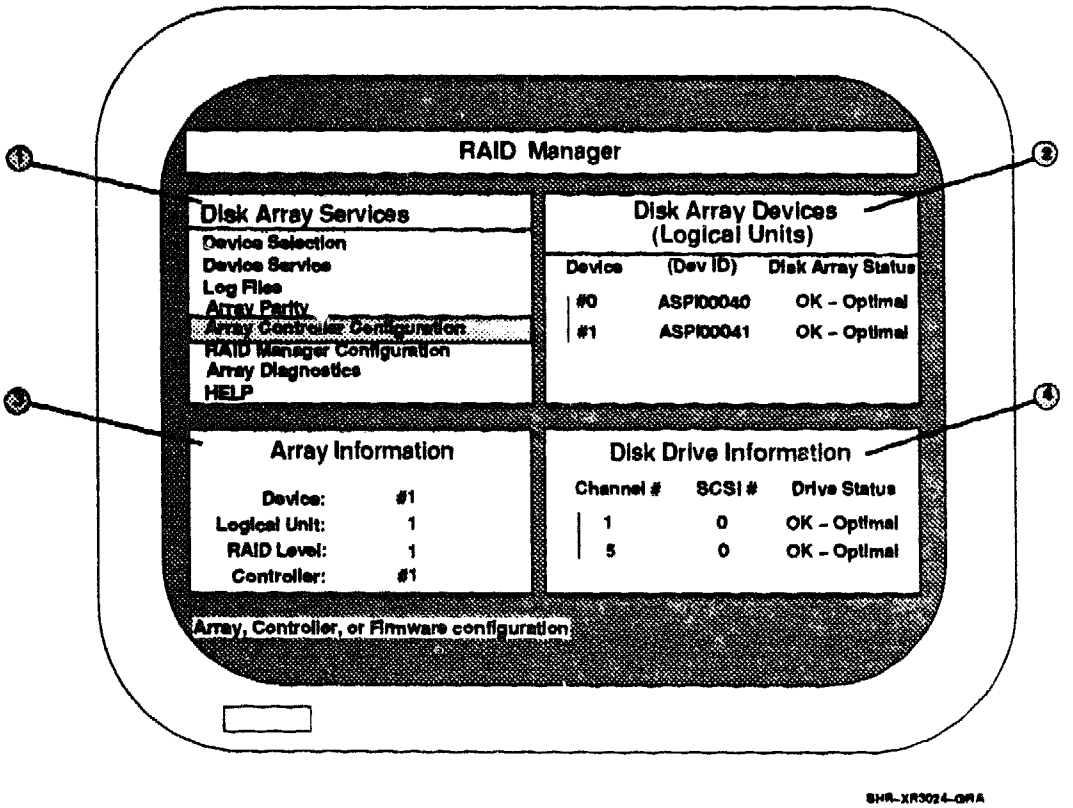
DEC RAID Utilities operations are performed by selecting functions from the various DEC RAID Manager menus. Most of the menus are self-explanatory and use the same basic type of display. The following sections detail the displays used by the DEC RAID Manager and give a map showing what selections you must make from the menus to perform a given function.

Two menus are given, the initial DEC RAID Manager window (Disk Array Services, Figure 2–1) and the Array Controller Configuration, Figure 2–2. The major difference between the two windows is that the Disk Array Services Window shows all the logical units on your system, whereas the Array Controller Configuration Window gives only the logical units attached to a given array controller.

2.4.1 Disk Array Services Window

Figure 2–1 shows the Disk Array Services menu. The following is a brief description of each menu item. Note that some options are available only on the DEC RAID NetWare Utility, while others are accessible by both the NetWare and the DEC RAID Stand-Alone Utility.

Figure 2–1 Disk Array Services Window



SHR-XR3024-GRA

❶ Disk Array Services Window

- Disk Array Services Menu—Lists the functions you can select. Only the highlighted items can be selected on your system.
- Device Selection—Select the logical unit (LUN) you want to access or for which you want to display information. These options will not be highlighted if only a single LUN exists.
- Device Service (NetWare only)—Restore a logical unit after one or more disk failures (see Chapter 5).
- Log Files (NetWare only)—Display the DEC RAID Manager Activity and Error logs (see Chapter 9).
- Array Parity (NetWare only)—Check and Repair array parity (NetWare only, see Chapter 8).
- Array Controller Configuration—Configure logical units (see Chapter 4).
- DEC RAID Manager Configuration (NetWare only)—Set the DEC RAID Manager configuration.
- Array Diagnostics—Run diagnostics on the disk array.
- Help—Display help. Note that you can get online help at any point by pressing the F1 key. Use Esc to exit help.

❷ Disk Array Devices Display—Shows all the disk array devices (logical units) attached to your system.

- Device—The device number of the logical unit. For the DEC RAID Stand-Alone Utility, this number is assigned by the DEC RAID Manager (see Section 2.6.1). In the DEC RAID NetWare Utility, this number is assigned by NetWare and is the same device number used for all NetWare operations (see Section 2.6.2).
- Dev ID—The device ID of the logical unit. For the DEC RAID Stand-Alone Utility, this device ID is assigned by the DEC RAID Manager (see Section 2.6.1). In the DEC RAID NetWare Utility, this is the same device ID used for all NetWare operations (see Section 2.6.2).
- Disk Array Status—The current status of the logical unit. Logical units marked as anything other than *OK - Optimal* need immediate attention (see Section 2.5 for a description of the statuses displayed).

❸ Array Information Display—Gives further information on the logical unit currently highlighted in the Disk Array Devices display.

- Device—The device number of the logical unit (the same device number displayed in the Disk Array Devices display).
- Logical Unit—The logical unit number of the logical unit.
- RAID Level—The RAID level of the logical unit.
- Controller—The DEC RAID Manager-assigned number of the array controller attached to the logical unit. DEC RAID Manager numbers array controllers sequentially, in the order in which they are found.

❹ Disk Drive Information Display—Gives information on the drives contained in the logical unit currently highlighted in the Disk Array Devices display.

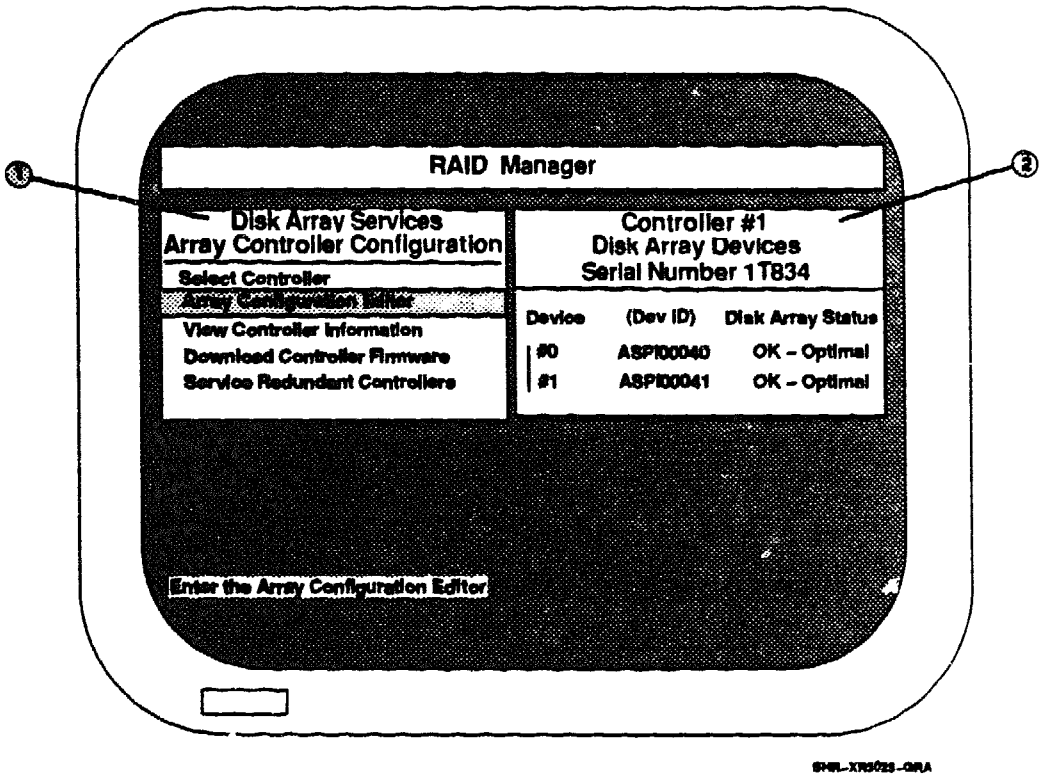
- Channel #—The channel number of the drive.

- SCSI #—The SCSI ID of the drive.
- Drive Status—The current status of the drive. Drives marked as anything other than *OK* - *Optimal* need immediate attention (see Section 2.5 for a description of the statuses displayed).

2.4.2 Array Controller Configuration Window

Figure 2–2 shows the Array Controller Configuration Window. The following is a brief description of each menu item.

Figure 2–2 Array Controller Configuration Window



❶ Array Controller Configuration Menu—Lists the functions you can select. Only the highlighted items can be selected.

- Select Controller—Select the array controller you want to access. In a single controller configuration, you cannot select this option.
- Array Configuration Editor— Configure logical units attached to the highlighted controller (see Chapter 3 and Chapter 4).
- View Controller Information—View information on the highlighted controller.
- Download Controller Firmware—Download new array controller firmware to the highlighted array controller.
- Service Redundant Controllers—Perform redundant path management. This feature is currently not available.

❷ Disk Array Devices Display—Shows the disk array devices (logical units) attached to the currently selected controller. (The controller is identified by controller number and serial number.) To change the currently selected controller, use the *Select Controller* function on the Disk Array Services menu.

- Controller #—The DEC RAID Manager-assigned number of the array controller attached to the logical unit. DEC RAID Manager numbers array controllers sequentially, in the order in which they are found.
- Controller serial number—The serial number of the array controller attached to the logical units displayed.
- Device #—The device number of the logical unit. For the DEC RAID Stand-Alone Utility, this number is assigned by DEC RAID Manager (see Section 2.6.1). In the DEC RAID NetWare Utility, this number is assigned by NetWare and is the same device number used for all NetWare operations (see Section 2.6.2).
- Dev ID—The device ID of the logical unit. For the DEC RAID Stand-Alone Utility, this device ID is assigned by DEC RAID Manager (Section 2.6.1). In the DEC RAID NetWare Utility, this is the same device ID used for all NetWare operations (see Section 2.6.2).
- Disk Array Status—The current status of the logical unit. Logical units marked as anything other than *OK - Optimal* need immediate attention (see Section 2.5 for a description of the statuses displayed).

2.4.3 DEC RAID Utility Road Map

The following table lists the DEC RAID Utilities tasks, the DEC RAID Manager menu selections required from the opening menu to perform the task, and where to look in this guide for more information.

Task	Menu Selections	Chapter(s)
Change Array Monitor Daemon (AMD) parameters (NetWare)	DEC RAID Manager Configuration General Configuration	Chapter 9
Change scheduled parity check time (NetWare)	DEC RAID Manager Configuration General Configuration or Array Parity Change Automatic Parity Time	Chapter 8
Check array parity (NetWare)	Array Parity Check and Repair Parity or Check Parity (no repair)	Chapter 8
Configure a logical unit	Array Controller Configuration Array Configuration Editor	Chapter 3 and 4
Delete a logical unit	Array Controller Configuration Array Configuration Editor	Chapter 3 and 4
Format a logical unit after drive failure (NetWare)	Device Service Format disk array device	Chapter 5
Get help for selected function	Select function, then press the F1 key	
Get help with procedures	Help	
Modify a logical unit	Array Controller Configuration Array Configuration Editor	Chapter 3 and 4
Read activity log (NetWare)	Status Messages View DEC RAID Manager Activity Log	Chapter 9
Read error messages (NetWare)	Status Messages View DEC RAID Manager Error Log	Chapter 9
Read parity report (NetWare)	Array Parity View Parity Report	Chapter 8
Replace a failed drive (NetWare)	Device Service Replace the disk drive	Chapter 5

2.5 DEC RAID Manager Logical Unit And Drive Status

Table 2–2 explains the logical unit status displayed in the Disk Array Devices window.

Table 2–2 Logical Unit Status

Status	Meaning
Degraded	A drive in the logical unit has failed and the logical unit is now in degraded mode (RAID 1 and 5 only). The logical unit is operational in the degraded mode, but the failed drive should be replaced as soon as possible. Select the logical unit and check the Disk Drive Information window to determine the status of the drives.
Degraded—Warning	A drive in the degraded logical unit has been put in warning. Note that this means one drive has failed and a second drive about to fail. In a RAID 1 logical unit, this status indicates the most serious condition possible. Steps must be taken immediately to replace the bad drives to prevent the permanent loss of data.
Drive Failures	More than one drive in a RAID 5 logical unit has failed, and the logical unit is no longer operating. All data on the logical unit has been lost.
Formatting	The logical unit is not available because it is being formatted.
Ok - Optimal	The logical unit is fully operational.
Ok - Reconstructing	The logical unit is functioning in degraded mode and a drive in the unit is being reconstructed. Select the logical unit and check the Disk Drive Information window to determine the status of the drives.
Ok - Warning	The logical unit is still optimal, but one or more drives are in a warning state because of a read or write error. Note that in a RAID 0 logical unit, the logical unit may not be usable. Select the logical unit and check the Disk Drive Information window to determine the status of the drives.
Wait For Format	The logical unit is not accessible because it needs to be formatted. In NetWare, use the *Format disk array device* selection in the *Device Service* menu to format the logical unit. In the DEC RAID Stand-Alone Utility, use the format option in the Array Configuration Editor.
Wrong Drive	The wrong drive was replaced (that is, the drive that was replaced was not a failed drive but was an optimal drive).

Table 2–3 explains the status of drives as displayed in the Disk Drive Information window.

Table 2–3 Drive Status

Status	Meaning
Ok - Optimal	The drive is functioning correctly.
Failed	The drive has failed and is no longer functioning. The drive should be replaced as soon as possible.
Formatting	The drive is currently being formatted.
Newly Replaced	The drive was just replaced.
Reconstructing	The data on the drive is currently being reconstructed.
Warning	The drive has been put into a warning state as the result of a read or write error. The severity of this status depends to some extent on the RAID level of the logical unit. • On all RAID levels, this status could indicate a minor read or write error, in which case the logical unit is still usable. • In RAID level 0, this is the most serious status the array controller assigns to a drive. The logical unit may no longer be accessible. • In RAID 1, this status is assigned if the second drive in a mirrored pair fails after the first drive has failed. The logical unit may no longer be accessible. In all cases, the *Warning* drive should be replaced as soon as possible.

2.6 DEC RAID Manager Device Names

The DEC RAID Manager displays a device number and a device ID for each array logical unit on your system. These names are for reference purposes only, as you do not have to enter them. Both the device numbers and the device IDs are different depending on whether you are running the DEC RAID Stand-Alone Utility or the DEC RAID NetWare Utility.

2.6.1 DEC RAID Stand-Alone Utility Device Names

During the initial SCSI bus scan, DEC RAID Stand-Alone Utility assigns a device number and a device name (Dev ID) to each array logical unit it finds on your system.

- The device number is assigned for reference purposes. You have as many device numbers as you have array logical units attached to your system. Other non-array storage devices are not included in this numbering. DEC RAID Stand-Alone Utility assigns these numbers in the order it detects the logical unit (which depends on the type of host adapter and where it is installed).
- The device name (Dev ID) identifies the hardware location of the logical unit. The device name used by the DEC RAID Stand-Alone Utility has the following format:

```
adapter_type   device_number
For example:
ASPI00040
```

  - adapter_type—This identifies the interface type of the host adapter connected to the controller. The currently supported interface is ASPI™.
  - device_number—This 5-digit number provides the hardware address location of the logical unit. The definition of these digits is shown in the following table.

Digit	Meaning
1	I/O bus number
2	Controller number
3	SCSI bus number
4	Controller SCSI ID
5	Logical unit number

In this example, the I/O bus number is 0, controller number is 0, SCSI bus number is 0, controller SCSI ID is 4, and the logical unit number is 0.

2.6.2 NetWare Device Name

NetWare assigns each logical unit a device number and a device ID.

- The device number is assigned for reference purposes. This number is the same number used by NetWare to refer to the logical unit in other NetWare utilities (such as Install). Logical units are numbered along with the other storage devices on your system.

- The device ID is the NetWare-assigned device ID of the logical unit. This device ID is the same ID used by NetWare to refer to the logical unit in other NetWare utilities (such as Install). The digits in the device ID have the following meanings:
  - The first 2 digits indicate the type of host adapter. These digits are assigned by NetWare. For example, 8B is the DPT PM2012B host adapter.
  - The 3rd digit is the board number assigned to the host adapter by the NetWare system.
  - The 4th digit is the SCSI ID of the array controller.
  - The 5th, or last, digit is the logical unit number.

For example, a device ID of 8B061 identifies the host adapter as a DPT PM2012B, board 0, array controller SCSI ID 6, logical unit 1.

Part III

Description of the Array Configuration Editor

This part of the guide contains:

- Chapter 3, Array Configuration Editor (ACE)

3

Array Configuration Editor (ACE)

3.1 What is ACE?

The Array Configuration Editor (ACE) is used for configuring logical units on your array subsystem. Although your array is shipped pre-configured from the factory, you may want to change that configuration. For example, if your subsystem came with 3 pre-configured, 5-drive, RAID 5 logical units, you may want to change one of those units to a RAID 0 logical unit. Use ACE to change the configuration.

Although ACE allows you to do other functions (such as reconstruct data on a drive), some of these functions can more easily be done using other functions in the DEC RAID Manager. The only operation you must use ACE for is configuring or reconfiguring logical units.

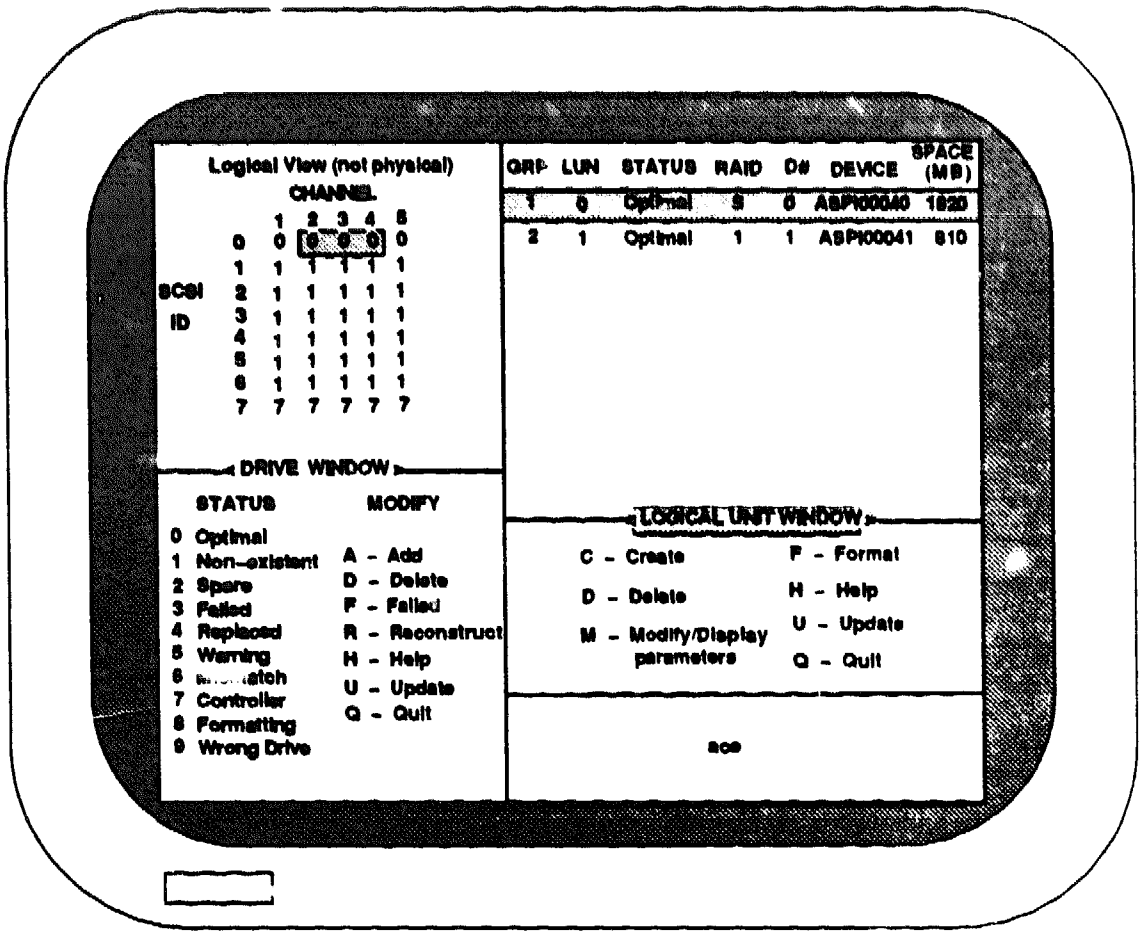
For more information on how to configure or reconfigure logical units, see Chapter 4.

3.2 Starting ACE

ACE is an option on the DEC RAID Manager menus. To start ACE:

1. Start the DEC RAID Manager. See Chapter 2 for information on starting the DEC RAID Manager. Note that you need to use the DEC RAID Stand-Alone Utility in the MS–DOS or SCO UNIX environments, or in NetWare if the logical unit you want to configure contains (or will contain) your operating system.
2. From the *Disk Array Services* menu select the *Array Controller Configuration* option.
3. From the *Array Controller Configuration* menu select the *Array Configuration Editor* option.
4. The ACE screen displays. Refer to Section 3.2.1 for a description of that display. See Section 3.2.2 for a description of how to move around in the screen display.

Figure 3–1 ACE Window



SHR-XR3026-GRA

3.2.1 ACE Screen Window

Figure 3–1 shows the ACE display. The display is made up of two parts: The Drive window (the left half of the screen) and the Logical Unit window (the right half of the screen).

You can tell which window is active by the label (for example, *Drive Window* or *Logical Unit Window*) that is currently highlighted. When you start ACE, you are in the Logical Unit Window.

The active window determines which array devices you can select and what parts of the other window are highlighted.

Table 3–1 Understanding the ACE Window

When the Logical Unit Window Is Active...	
You Select:	Other Window Highlights:
A logical unit (LUN), Drive Group 0, or a row with space remaining to be configured by pressing the arrow keys or the space bar.	The drives contained in the selected logical unit. When you select Drive Group 0, all drives that have a *Spare* status (2) are highlighted.
When the Drive Window Is Active...	
You Select:	Other Window Highlights:
An individual drive by pressing the arrow keys, the space bar, or the Enter key.	The drive group that contains the selected drive.

3.2.2 Navigating in ACE

To navigate or select elements in the ACE, use the keys shown in Table 3–2.

Table 3–2 ACE Navigation Keys

Key For Navigating or Selecting	Description of the Key in the Drive Window	Description of the Key in the Logical Unit Window
TAB key	Moves the cursor to the logical unit window.	Moves the cursor to the drive window.
Space Bar	Moves the cursor to all available drives in the drive matrix.	Moves the cursor down in the logical unit display.
Down Arrow	Moves the cursor down in the drive matrix.	Moves the cursor down in the logical unit display. Moves the cursor to each logical unit that can be changed.
Up Arrow	Moves the cursor up in the drive matrix.	Moves the cursor up in the logical unit display.
Right Arrow	Moves the cursor right in the drive matrix.	N/A
Left Arrow	Moves the cursor left in the drive matrix.	N/A
Enter Key	Moves the cursor to each drive that is configured into a drive group.	Moves the cursor to each logical unit parameter that can be modified. Executes certain actions. For example, when you change the logical unit parameters, you type **Y** and press the Enter key.
Q key	Quits the following:	
	ACE	ACE
	The window for selecting a RAID level	The window for selecting a RAID level.

(continued on next page)

Table 3–2 (Cont.) ACE Navigation Keys

Key For Navigating or Selecting	Description of the Key in the Drive Window	Description of the Key in the Logical Unit Window
	The window for selecting the Channel and ID of drives	The window for selecting the Channel and ID of drives.
	Modify/Display Parameters option	*Modify/Display Parameters* option.
	Help option	*Help* option.

3.2.3 Quitting ACE

Press the Q key to quit ACE when the cursor is in the drive window or the logical unit window, as indicated in Table 3–2.

3.3 Drive Window

The Drive Window is the left half of the ACE utility display (Figure 3–1). You are in the Drive Window when the *Drive Window* label in the middle of the window is highlighted. You switch between this window and the Logical Unit Window with the Tab key.

Use the Drive Window to view:

- The status of all the drives connected to a particular array controller
- The location of the array controller itself
- To modify drive status

The upper half of the Drive Window, the Drive Matrix, displays the current drive status. See Section 3.3.1 for more information about the Drive Matrix. Notice that an abbreviated definition of each drive status is always displayed in the lower left-hand corner of the Drive window, labeled *Status*. For example, the drive with SCSI Channel 1, SCSI ID 0 is an optimal drive—its status is 0, or *optimal*. For descriptions of each drive status, see Section 3.3.2.

The Drive window also shows you the operations you can perform while the Drive Window is active. These operations, or options, are displayed under the *Modify* label.

3.3.1 Drive Matrix

The Drive Matrix is located in the upper half of the Drive Window. The Matrix shows the status of each potential drive position on the array controller you are accessing. See Section 3.3.2 for a description of the drive status displayed in the Drive Matrix.

The Drive Matrix displays the drives according to a logical order, by SCSI ID, not according to the physical location of the ranks.

The Drive Matrix also indicates the location of the array controller, which has the status *controller* (status of 7), as shown in Figure 3–1.

3.3.2 ACE Drive Status

ACE displays the following possible status for drives in the Drive Matrix.

Drive Status	Description
0 - Optimal	The drive is operating at an optimal level.
1 - Non-existent	No drive is physically connected to the array at this position.
2 - Spare	The drive is connected to the array, but not configured into a logical unit.
3 - Failed	The drive was failed by the array controller or by the user and must be replaced.
4 - Replaced	The drive has just been replaced, or is being formatted, or is being reconstructed.
5 - Warning	The drive has been put into a warning state as the result of a read or write error. The severity of this status depends to some extent on the RAID level of the logical unit. • On all RAID levels, this status could indicate a minor read or write error, in which case the logical unit is still usable. • In RAID level 0, this is the most serious status the array controller will assign to a drive. The logical unit may no longer be accessible. • In RAID 1, this status is assigned if the second drive in a mirrored pair fails after the first drive has failed. The logical unit may no longer be accessible. In all cases, the *Warning* drive should be replaced as soon as possible.
6 - Mismatch	The array controller sensed that the drive has either a sector size, capacity, serial number, SCSI Channel, or ID different than what the array controller expected.
7 - Controller	This status is not a drive status—it indicates the location of the array controller in the array.
8 - Formatting	The drive is currently being formatted.
9 - Wrong drive	The wrong drive was replaced.

3.3.3 Drive Window Options

The following options are given in the Drive window. For more information on how to perform drive options, see Section 4.9.

- Add A Drive—Use the *Add* drive option to add a drive that has a status of *Non-existent* (1). After adding the drive, the drive status changes to *Spare* (2).
- Delete A Drive—Use the *Delete* drive option to delete a drive that has a status of *Spare* (2). After physically removing the drive, use this option to change the drive status of the removed drive to *Non-existent* (1).

  It is not necessary to delete the drive because the array controller does not attempt to access the drive if it is not physically in the array. If you reboot the subsystem or server, the status on the removed drive changes to *Non-existent* (1).

- Fail A Drive—Use the *Fail* drive option to fail a drive with a drive status of *Warning* (5) or *Optimal* (0). After failing the drive, the status changes to *Failed* (3).

  Important Note:

  Do not fail a drive in a RAID 0 logical unit because there is no parity. Do not fail a drive in a RAID 1, 3, or 5 logical unit if the logical unit is already degraded.

- Reconstruct Drive Data—Normally, you do not need to initiate drive data reconstruction because the array controller automatically reconstructs a replaced drive. However, if your array does not automatically reconstruct replaced drives, you must use this selection to start reconstruction. You can only reconstruct drive data on a RAID 1 or 5 logical unit with a single-drive failure.
- Update Drive Status (NetWare only)—The ACE display is updated in NetWare every 10 seconds. This option allows you to rescan the devices and update the drive status.
- Help—Help menus for drive options.
- Quit (NetWare only)—Exit the ACE utility when the drive window is selected.

3.4 Logical Unit Window

The Logical Unit Window is the right half of the ACE utility display (see Figure 3–1). You are in the Logical Unit Window when the *Logical Unit Window* label in the middle of the window is highlighted. Switch between this window and the Drive window with the Tab key.

Use the Logical Unit Window to view the logical unit status and the device name of each logical unit. Also use this window to create, delete, or format logical units, and to modify/display the logical unit parameters.

The upper half of the Logical Unit window, the Logical Unit Display, displays information about the drive groups and logical units attached to the controller you are accessing. For more information on the Logical Unit display, see Section 3.4.1.

Also shown in Figure 3–1 are the operations you can perform while the Logical Unit window is active. For more information on the Logical Unit window options, see Section 3.4.3.

3.4.1 Logical Unit Display

The Logical Unit Display is located in the upper half of the Logical Unit window. It shows the following information:

- The logical units (and drive groups) configured on the array controller you are accessing
- The drive groups of the logical units (there may be more than one logical unit per drive group)
- Logical unit status (see Section 3.4.2 for the possible statuses)
- RAID levels of logical units
- NetWare device numbers (NetWare only)

- Logical unit device names
- Logical unit size
- Disk space remaining in spare drives (this is drive group 0)
- Disk space remaining in drive groups with configured logical units

For example, in Figure 3–1, logical unit (LUN) 0 has been configured as RAID level 5. It has an *Optimal* status, the device name of *ASPI00040* and 1620 MB of space. LUN 0 is in drive group 1.

3.4.2 ACE Logical Unit Status

LUN Status means Logical Unit Status (LUN stands for logical unit number and is often abbreviated to *logical unit*). ACE can display five possible statuses.

Table 3–3 lists each LUN status with a description.

Table 3–3 Logical Unit Status

Status	Description
Creating	You are presently creating this logical unit.
Dead	The logical unit is no longer functioning. Either: • You have changed logical unit parameters and have not yet reformatted the unit. • Two or more drives have failed. • The wrong drive was replaced. • Some component connected to the logical unit failed or returned an unexpected value (bad SCSI ID, bad channel number, and so on). Check the status of the logical unit's drives in the Drive Matrix to help determine the cause of the error.
Degraded[1]	The logical unit is operating in degraded mode (that is, it is still functioning, but data must be reconstructed using data and parity from the good drives). Either: • A single drive has failed. • The replaced drive is still being formatted. • Some component connected to the logical unit failed or returned an unexpected value (bad SCSI ID, bad channel number, and so on). Check the status of the logical unit's drives in the Drive Matrix to help determine the cause of the error.
Optimal[2]	The array is operating at an optimal level.
Reconstructing	The array controller is currently reconstructing the logical unit.

[1]If this is a RAID 1 logical unit, it may not be accessible even if the LUN Status is Degraded. To determine if a RAID 1 array has drive problems, check the status of the drives in the logical unit in the Drive Matrix.

[2]If this is a RAID 0 logical unit, it may not be accessible even if the LUN Status is Optimal. To determine if a RAID 0 array has drive problems, check the status of the drives in the logical unit in the Drive Matrix.

NOTE

Not all statuses are displayed for all RAID levels. For example, a RAID 0 logical unit will never have a status of *Degraded*.

3.4.3 Logical Unit Window Options

The following options are given in the Logical Unit Window. For more information on how to perform these options, see Chapter 4.

- Create A Logical Unit—Use the *Create* logical unit option to create a logical unit in two ways: by configuring *Spare* drives, or by configuring available drives in an existing drive group.
- Delete A Logical Unit—Use the *Delete* logical unit option to delete a logical unit to create a new logical unit, or to change the RAID level or drives in an existing logical unit.

CAUTION

Copy the data on a logical unit to back-up media before deleting the logical unit. Once the logical unit is deleted, you can not access the logical unit—the data is lost.

- Modify/Display Logical Unit Parameters—Use the *Modify/Display Logical Unit Parameters* option to modify and display the current values for the following logical unit parameters:
  - Logical Unit Status (display only)
  - Logical Unit Drives (display only)
  - RAID Level (display only)
  - Logical Block Size in bytes (display only)
  - Logical Unit Size in megabytes
  - Segment Size in blocks
  - Segment Zero Size in blocks
  - Reconstruction Delay Interval in tenths of a second
  - Reconstruction Blocks Per Delay Interval

  Note that the first three items are also displayed in the Drive Matrix and Logical Unit Display.

- Format A Logical Unit—Use the *Format* option to format a logical unit and restore it to a working state. Also, use the *Format* option to restore any logical unit with multiple drive failures. Note that the DEC RAID Manager automatically formats any newly-created logical unit.
- Update LUN Status (NetWare only)—The ACE display is updated in NetWare every 10 seconds. This option allows you to rescan the devices and update the LUN status.
- Help—Help menus for LUN options.
- Quit—Exit the ACE utility when the LUN window is selected.

Part IV

Configuring Logical Units

This part of the guide contains:

- Chapter 4, Configuring Logical Units

4

Configuring Logical Units

4.1 Array Configuration Summary

The drives in the DEC RAID Subsystem were pre-configured into logical units at the factory. If this configuration does not meet your needs, you can change that configuration by doing one or more of the following:

- To modify logical unit parameters other than RAID level and Drive Map (segment size, segment 0 size, and so on), see Section 4.4.
- To modify RAID Level/Drive Map parameters, see Section 4.7.
- To create a new logical unit from spare drives, see Section 4.5.
- To create a new logical unit from space on an existing drive group, see Section 4.6.
- To delete a logical unit, see Section 4.8.

In addition, at any time after the initial installation of your array, you may reconfigure. However, any time you reconfigure, you must first back-up any data on the logical unit file-by-file because reconfiguring a logical unit destroys data on the unit.

If your operating system is MS–DOS or SCO UNIX, use the DEC RAID Stand-Alone Utility for configuring your logical units. Refer to Table 4–1 for a summary of the steps involved in configuring your logical unit. In NetWare, use the DEC RAID NetWare Utility (Table 4–2).

The specific steps you must take depend on two factors:

- Whether you want to use the factory-set configuration (if any)
- Whether you want to put the operating system on the logical unit (for NetWare, this refers to whether the logical unit will contain the SYS volume).

If your array is pre-configured, and you want to change the configuration, treat the logical units as being NOT configured when using the tables.

Table 4–1 DEC RAID Stand-Alone Utility Logical Unit Configuration Tasks

Is Logical Unit Configured?[1]	Will Logical Unit Contain The Operating System Volume?	Steps To Complete
Yes[1]	Yes	1. Install the operating system on the logical unit.
Yes [1]	No	1. No action required.
No	Yes	1. If any data is on the logical unit, back-up the data. 2. Boot the DEC RAID Stand-Alone Utility diskette (Chapter 2). 3. Configure or reconfigure the logical unit (See the procedures in this chapter). 4. Install the operating system on the logical unit. 5. If necessary, copy the data from the back-up media to the logical unit.
No	No	1. If any data is on the logical unit, back-up the data. 2. Shut down the system . 3. Boot the DEC RAID Stand-Alone Utility diskette (Chapter 2). 4. Configure or reconfigure the logical unit (See the procedures in this chapter). 5. Reboot the system. 6. If necessary, recopy the data back onto the logical unit.

[1]If the logical unit is already configured, but you want to change that configuration, treat the logical unit as if it is not already configured when using this table.

Table 4–2 DEC RAID NetWare Utility Logical Unit Configuration Tasks

Is Logical Unit Configured?[1]	Will Logical Unit Contain SYS Volume?	Steps To Complete
Yes[1]	Yes	1. Create the SYS volume on the logical unit (Chapter 7). 2. Install the operating system on the logical unit (with the NetWare Server and Install commands). 3. Install RAID Manager (Chapter 6).
Yes [1]	No	1. If necessary, install RAID Manager (Chapter 6). 2. Create partitions and volumes on the logical unit with the NetWare Install command (Chapter 7).
No	Yes	1. If there is any data on the logical unit, back-up the data (using file-by-file back-up). 2. Boot the DEC RAID Stand-Alone Utility diskette (Chapter 2). 3. Configure or reconfigure the logical unit (see the procedures in this chapter) 4. Install the operating system on the logical unit (with the NetWare Server and Install commands). 5. Install RAID Manager (Chapter 6). 6. If necessary, copy the data from the back-up media to the logical unit.
No	No	1. If necessary, install RAID Manager (see Chapter 6). 2. If there is any data on the logical unit, back-up the data (using file-by-file back-up). 3. If any volumes on the logical unit are mounted, dismount them (with the NetWare Dismount command). 4. Configure or reconfigure the logical unit using the DEC RAID NetWare Utility. 5. Create partitions and volumes on the logical unit (Chapter 7). 6. If necessary, recopy the data back to the logical unit.

[1]If the logical unit is already configured, but you want to change that configuration, treat the logical unit as if it is not already configured when using this table.

4.2 Logical Unit Parameters

Each logical unit has a set of parameters that determine how data is stored on it. Each logical unit can have different parameters, with the following exception: All logical units in the same drive group must have the same RAID Level and Drive Map (that is, they must contain the same drives, with no overlap).

The following table summarizes the parameters. Section 4.2.1 to 4.2.8 explain the parameters in more detail.

Table 4–3 Logical Unit Parameters

Parameter	Meaning	Destroys Data When Changed?	See Section:
RAID Level	Determines how data is stored on the logical unit, and if there is data redundancy.	Yes[1]	4.2.1
Drive Map	Determines what drives make up the logical unit.	Yes[1]	4.2.2
Logical Block Size	The logical block size (in bytes) used by this logical unit.	N/A	4.2.3
Logical Unit Size	Sets the size of the logical unit.	Yes	4.2.4
Segment Size	Determines the amount of data written to a single drive in the logical unit before the controller writes data on the next drive.	Yes	4.2.5
Segment Zero Size	Sets the size of the first segment in the array.	Yes	4.2.6
Delay Interval	The amount of time between reconstruction operations.	No	4.2.7
Blocks Per Delay Interval	The number of blocks reconstructed in one reconstruction operation.	No	4.2.8

[1]Changing RAID Level or Drive Map forces you to change those parameters for all the logical units in that drive group.

4.2.1 RAID Level

The RAID level parameter determines how data is stored on the logical unit. Data is striped or mirrored. The RAID level parameter also determines if data redundancy has occurred. RAID levels 1 and 5 offer data redundancy; RAID level 0 does not.

Caution

Changing the RAID level parameter deletes any data on the logical unit. Use this parameter only after doing a file back-up.

The RAID level also determines the number of drives that can be included in the logical unit and the maximum size of that unit. Refer to Table 4–4.

If you want to change the RAID level for an existing logical unit, you will first have to delete the unit and then recreate it. In addition, if there are other logical units in the same drive group, you will have to delete all of them and change their RAID level as well. Similarly, if you want to create a new logical unit from space in an existing drive group, that logical unit must have the same RAID level as the other logical units in the drive group.

The RAID levels offered by RAID Manager are levels 0, 1, and 5. The levels you select depend on your storage and performance needs.

4.2.2 Drive Map

The Drive Map parameter defines the drives included in the logical unit. Individual drives are identified by Channel number and SCSI ID, which is determined by the physical location of the drive in the array subsystem. Each drive rank in an array has the same SCSI ID, and each rank contains channels 1-5.

Caution

Changing the drive map parameter deletes any data on the logical unit. Use this parameter only after doing a file back-up.

In ACE, the drive matrix shows the drives in a logical arrangement, with SCSI ID 0 first, then SCSI ID 1, and so on. This logical arrangement is not the same as the physical arrangement of the drives in the DEC RAID Subsystem. Refer to the *DEC RAID Subsystem User's Guide* for further details about the DEC RAID Subsystem physical configuration.

The RAID level of the logical unit sets some restrictions on drive selection, as shown in Table 4–4:

Table 4–4 RAID Level/Drive Selection

RAID Level	Drive Map Restrictions
0	Number of drives allowed per logical unit = 1 - 10
1	Number of drives allowed per logical unit = 2 - 10
	Must specify an even number of drives
	The mirrored pair is created by grouping the first and second drive you enter, third and fourth, and so forth
	Drives in a mirrored pair can not be on the same channel
5	Number of drives allowed per logical unit = 3 - 5
	Each drive must be on a separate channel

Note

It is recommended that you use the maximum number of drives when you create a logical unit. Remember that a single-rank array has only 5 drives.

From the table, you can see that defining a RAID 5 logical unit as containing drives (5,3), (4,3), (3,3), (2,3), and (2,0) is not legal, as the last two drives are on the same channel (channel 2). Selecting (5,3), (4,3), (3,3), (2,3), and (1,3) is legal, because although the drives have the same SCSI ID, they are on different channels. Similarly, defining a RAID 1 logical unit as (5,3), (5,0), (4,3), and (4,0) is not legal, as the first and second drives entered must be a mirrored pair and mirrored pairs can not be on the same channel. The third and fourth drives have the same problem. Note that entering (5,3), (4,0), (4,3), and (5,0) is legal because, even though it contains the same drives as the previous example, the mirrored pairs are on different channels.

If you want to change the Drive Map for an existing logical unit, you will first have to delete the unit and then recreate it with the new drives. In addition, if there are other logical units on the same drive group, you will have to delete all of them and recreate them as well. Similarly, if you want to create a new logical unit from space in an existing drive group, that logical unit must include the same drives as the other logical unit in the drive group.

Within the restrictions above, the drives you select for a logical unit depend on your storage and performance needs. In general, always use the maximum number of drives in a logical unit.

4.2.3 Logical Block Size

The logical block size parameter defines the block size in bytes as seen by the logical unit. Currently the logical block size is fixed at 512 bytes and cannot be changed.

4.2.4 Logical Unit Size

This parameter sets the size of the logical unit. Size is determined by the RAID level, number of drives, and the amount of space allocated on those drives. Unallocated space on a set of drives (a drive group) can be used to create other logical units. In general, however, you should allocate all available space for a logical unit, and create one logical unit per drive group (multiple logical units per group are useful with operating systems with size restrictions on disk storage).

Note

You may create any size logical unit—NetWare does not have a size limitation. MS–DOS, however, does have a limit. It does not display a logical unit size of greater than 2 GB. This means that if you create a logical unit with a size greater than 2 GB, and then use an MS–DOS command to display the size, MS–DOS will only indicate that you have 2 GB space available.

Caution

Changing the logical unit size parameter deletes any data on the logical unit. Use this parameter only after doing a file back-up.

Assign all available space to the logical unit.

4.2.5 Segment Size

A segment is the amount of data written on a single drive in the logical unit before the controller continues writing the data on the next drive in the logical unit. For example, if the segment size of a RAID 0 logical unit is 64 blocks, the controller will write 64 blocks of data on drive 1, the next 64 blocks of data on drive 2, the next on drive 3, and so on.

Caution

Changing the segment size parameter deletes any data on the logical unit. Use this parameter only after doing a file back-up.

The recommended segment size is 512 blocks. ACE accepts a segment size as small as 3 blocks and as large as 65,535 blocks (however, do not use an odd number of blocks if you want to enhance array performance).

4.2.6 Segment Zero Size

The first segment in a logical unit is segment 0. Segment 0 is reserved for future development. The recommended segment 0 size is 0. Any other value may degrade array performance.

Caution

Changing the segment size parameter deletes any data on the logical unit. Use this parameter only after doing a file-by-file back-up.

4.2.7 Delay Interval

Note

This parameter only applies to RAID 1 and 5 logical units. The data on a RAID 0 array cannot be reconstructed.

During data reconstruction on a RAID 1 or 5 logical unit (after you replace a drive in a degraded logical unit), the array controller divides its time between data reconstruction and regular I/O operations. In this way, you can continue using the logical unit while it is being reconstructed. The Delay Interval is the amount of time, in tenths of a second, between reconstruction operations. During this time, the array controller is able to perform normal I/O operations. As the delay interval increases, system I/O performance also increases, but the longer reconstruction takes.

You can change this parameter during reconstruction to affect the reconstruction rate. The Delay Interval value interacts with the Blocks per Delay Interval value to determine the over-all rate of reconstruction. See Section 5.7 for further information.

4.2.8 Blocks Per Delay Interval

Note

This parameter only applies to RAID 1 and 5 logical units. The data on a RAID 0 array cannot be reconstructed.

The amount of data, in blocks, that the array controller reconstructs at a time. The more blocks, the longer the time necessary to reconstruct them. This is time that cannot be used to perform system I/O. Therefore, the larger the Blocks Per Interval value, the more system performance degradation increases.

You can change the Blocks Per Interval value after reconstruction begins to adjust system performance.

The Blocks Per Delay Interval value is a decimal number between 1 and 32768. However, the value interacts with the Delay Interval value to determine the over-all rate of reconstruction. See Section 5.7 for further information.

4.3 Displaying and Modifying Logical Unit Parameters

This section describes how to display and modify logical unit parameters for an existing logical unit. The logical unit parameters are described in Section 4.2.

Caution

Note that changing any parameter on an existing logical unit except the Reconstruction Rate parameters destroys all data on that unit. Make sure you back-up all data on the logical unit before modifying any parameters other than Delay Interval or Blocks Per Delay Interval.

You need to use the Display/Modify Logical Unit Parameter function when:

- You want to change logical unit parameters on an existing logical unit (except the RAID level and Drive Map parameters, which use a separate procedure—see Section 4.7.)

  Note that changing parameters on an existing logical unit will usually destroy all data on that unit.
- You want to change the Reconstruction Rate parameters (Delay Interval and Blocks Per Delay Interval). Note that you can change these parameters without destroying data on the logical unit.
- You are creating a new logical unit (in which case this function is started automatically during the creation procedure).
- You want to display the values for the Logical Block Size, Segment Size, Segment 0 size, and Reconstruction Rate parameters.

4.4 Modify/Display Procedure

Perform the following steps to display or modify logical unit parameters:

Caution

Changing any logical unit parameter except the Delay Interval or Blocks Per Delay Interval parameters destroys all data in the logical unit. Make sure you back-up your data file-by-file before modifying any of these logical unit parameters.

1. If necessary, back-up any data on the logical unit you want to change by copying it file-by-file to the back-up media.
2. In NetWare, unmount any volumes contained on the logical unit you want to change if any are mounted (if you are changing the Reconstruction Rate parameters, you do not need to dismount any volumes).
3. If you are going to be modifying parameters in MS–DOS or SCO UNIX, or in NetWare if you are going to be modifying parameters on the logical unit that contains any part of your SYS volume, you will have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   raidmgr

   In the DEC RAID NetWare Utility:

   load raidmgr
5. Select the *Array Controller Configuration* option on the *Disk Array Services* menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying the logical unit you want to modify.
6. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). If not, press the Tab key to switch to the Logical Unit window. Use the Arrow keys to highlight the logical unit you want to modify.
7. Press the M key to modify or display the logical unit parameters. The following screen is displayed:

```
LUN 1 Status = Optimal
LUN 1 Drives = (1,2) (2,2) (3,2) (4,2) (5,2)

PARAMETER                                          VALUE

RAID Level                                             5
Logical Block Size (bytes)                           512
Logical Unit Size (MB)                              1600
Segment Size (blocks)                                512
Segment Zero Size (blocks)                             0
Delay Interval (tenths of a second)                    1
Blocks Per Delay Interval                            256

Are the values shown OK (y/n/q)?
```

8.

- To save the current logical unit parameters for this logical unit, press the Y key. The array controller automatically formats the logical unit if you modified the logical unit size, segment size, or segment zero size.
  In NetWare, if you created a very large logical unit, and you press Alt-Esc to do an MS–DOS operation while the format is occurring (for example, you try to load Install), it is possible that the screen will lock up until the array controller completes the format. This situation occurs because of the way the NetWare driver handles outstanding I/O commands. Wait until the array controller completes the format before doing an MS–DOS operation.

Caution

Changing the values for either the logical unit size, segment size or segment zero size forces the array controller to automatically reformat the logical unit. This will delete all data on the logical unit. If you do not want to change the values, press the Q key to quit the function.

Press the C key to continue.

- To modify a value, press the N key. Use the Down-arrow key or the Enter key to select the value you want to change and enter the new value. Remember, you cannot change the RAID level parameter, or the Logical Block Size (to determine the values you may use for the logical unit parameters, see Section 4.2.)

  After you have set all the parameters you want to set, use the Down-arrow key or the Enter key to move to the *Are the values shown OK* prompt, then press:

  - the Y key to save the current logical unit parameter values.
  - the Q key to quit without changing the logical unit parameters.

Caution

Changing the values for either the logical unit size, segment size or segment zero size forces the array controller to automatically reformat the logical unit. This will delete all data on the logical unit. If you do not want to change the values, select the Q key to quit the function.

Press the C key to continue.

- To quit the display without changing the parameters, press the Q key.

9. Press the Q key to quit the Array Configuration Editor. You return to the Array Controller Configuration menu. Press the Esc key to quit DEC RAID Manager. Then press Y and the Enter key.

10. In DEC RAID Stand-Alone Utility, remove the diskette and reboot the system. In DEC RAID NetWare Utility, use the NetWare Install command to create partitions and volumes on the modified logical unit (Chapter 7).

You are done with the Display/Modify Logical Unit Parameter procedure.

4.5 Creating a Logical Unit from Spare Drives

Use the following procedure to create a logical unit from *Spare* drives.

1. If you are going to be creating a logical unit in MS–DOS or SCO UNIX, or in NetWare if you are going to be creating the logical unit that will contain your SYS volume, you will have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
2. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   raidmgr

   In the DEC RAID NetWare Utility:

   load raidmgr
3. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying logical units attached to the controller you want to create the new logical unit on.
4. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). If not, press the Tab key to switch to the Logical Unit window. Use the Arrow keys to highlight Drive Group 0 (the drive group containing the spare drives attached to the current array controller).
5. Press the C key to create a logical unit. When prompted, specify the RAID level choice. Enter the Channel and ID of each drive you want in the logical unit using the guidelines given below. The drives you can configure into a logical unit are marked with the status *2* in the Drive Matrix (see the Drive window). The cursor moves as you enter each selection.

   Refer to Table 4–4 for considerations when assigning drives.
6. Press the Enter key after entering the drive ID number for the last drive in the logical unit. *Is the data OK* prompt will appear. Press the Y key to respond. The following screen is displayed:

```
LUN 1 Status = Optimal

LUN 1 Drives = (1,2) (2,2) (3,2) (4,2) (5,2)

PARAMETER                                    VALUE

RAID Level                                       5
Logical Block Size (bytes)                     512
Logical Unit Size (MB)                        1600
Segment Size (blocks)                          512
Segment Zero Size (blocks)                       0
Delay Interval (tenths of a second)              1
Blocks Per Delay Interval                      256

Are the values shown OK (y/n/q)?
```

7.

   - To save the current logical unit parameters for this logical unit, press the Y key. The array controller automatically formats the new logical unit. The utility will return to the ACE menu when done.

- To modify a value, press the N key. Use the Down-arrow key or the Enter key to select the value you want to change and then enter the new value. Remember, you cannot change the RAID level parameter, or Logical Block Size (to determine the values you may use for the logical unit parameters, see Section 4.2).
  After you have set all the parameters you want to set, use the Down-arrow key or the Enter key to move to the *Are the values shown OK* prompt, then press:
  - the Y key to save the current logical unit parameter values.
  - the Q key to quit without changing the logical unit parameters.

  Press the C key to continue. The array controller automatically formats the new logical unit. The utility will return to the ACE menu when done.
- To quit the display without changing the parameters, press the Q key. This will return you to the ACE menu.

8. Press the Q key to quit the Array Configuration Editor. You return to the Array Controller Configuration menu. Press the Esc key to quit the DEC RAID Manager. Then press Y and the Enter key.
9. In DEC RAID Stand-Alone Utility, remove the diskette and reboot the system. In DEC RAID NetWare Utility, use the NetWare Install command to create partitions and volumes on the modified logical unit (Chapter 7).

   You are done with this procedure.

4.6 Creating a Logical Unit from an Existing Drive Group

Use the following procedure to create a logical unit from space in an existing drive group. Note that the new logical unit must use the same drives and the same RAID level as the other drives in the group.

1. If you are going to be creating a logical unit in MS–DOS or SCO UNIX, or in NetWare if you are going to be creating the logical unit that will contain your SYS volume, you will have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
2. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```
3. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying the logical units in the drive group in which you want to create the new logical unit.
4. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). If not, press the Tab key to switch to the Logical Unit window. Use the arrow keys to highlight the space remaining in the drive group in which you want to create the new logical unit.

   Note that when the desired drive group is highlighted, all the drives that are in that drive group are highlighted in the Drive Matrix, and will automatically be configured into the logical unit you create. The new logical unit will also have the same RAID level as the other logical units in the group.
5. Press the C key to create a logical unit. The following screen (or one like it—parameter values may vary) is displayed:

```
LUN 1 Status = Optimal
LUN 1 Drives = (1,2) (2,2) (3,2) (4,2) (5,2)

PARAMETER                                          VALUE

RAID Level                                             5
Logical Block Size (bytes)                           512
Logical Unit Size (MB)                              1600
Segment Size (blocks)                                512
Segment Zero Size (blocks)                             0
Delay Interval (tenths of a second)                    1
Blocks Per Delay Interval                            256

Are the values shown OK (y/n/q)?
```

6.
   - To save the current logical unit parameters for this logical unit, press the Y key. The array controller automatically formats the new logical unit. The utility will return to the ACE menu when done.

- To modify a value, press the N key. Press the Down-arrow key or the Enter key to select the value you want to change and then enter the new value. Remember, you cannot change the RAID level parameter, or Logical Block Size (to determine the values you may use for the logical unit parameters, see Section 4.2).
  After you have set all the parameters you want to set, use the Down-arrow key or the Enter key to move to the *Are the values shown OK* prompt, then press:
  - the Y key to save the current logical unit parameter values.
  - the Q key to quit without changing the logical unit parameters.
- Press the C key to continue. The array controller automatically formats the new logical unit. The utility will return to the ACE menu when done.
- To quit the display without changing the parameters, press the Q key. This will return you to the ACE menu.

7. Press the Q key to quit the Array Configuration Editor. You return to the Array Controller Configuration menu. Press the Esc key to quit RAID Manager. Then press Y and the Enter key.
8. In the DEC RAID Stand-Alone Utility, remove the diskette and reboot the system. In DEC RAID NetWare Utility, use the NetWare Install command to create partitions and volumes on the modified logical unit (Chapter 7).

   You are done with this procedure.

4.7 Changing RAID Level/Drives on an Existing Logical Unit

If you want to change the RAID level or drive grouping of an existing logical unit, you must first delete the current logical unit and recreate it with a new RAID level or new drives. Note that if the logical unit is part of a drive group, you will have to change the RAID level/drives on all the logical units in that group. This means that you will have to delete all the logical units in the group.

Use the following procedure to change the RAID level or drive group of an existing logical unit.

1. If necessary, back-up the data on all the logical units in the drive group by copying it file-by-file to the back-up media.
2. In NetWare, unmount any volumes contained on the logical units in the drive group you want to change if any are mounted.
3. If you are going to be creating a logical unit in MS–DOS or SCO UNIX, or in NetWare if you are going to be creating the logical unit that will contain your SYS volume, you will have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

5. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying the logical units you want to modify.
6. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). If not, press the Tab key to switch to the Logical Unit window.
7. Use the Arrow keys to highlight the logical unit you want to modify. Press the D key to delete the logical unit.

   Press:

   - the C key to confirm that you want to delete the logical unit.
   - the Q key if you do not want to delete the unit.

   Repeat this step for each logical unit in the drive group. When you have deleted all the logical units in the group, the status of the highlighted drives in the Drive Matrix change to *Spare* (2).
8. Refer to Section 4.6 to create the logical unit(s) you want with the new RAID levels and/or drive groupings.

4.8 Deleting a Logical Unit

You delete a logical unit to complete one of the following tasks:

- Changing the RAID level of the logical unit
- Changing the drive grouping containing a logical unit
- Deleting a drive from the array

The following procedures gives the steps to delete a logical unit. Normally, there is no reason to use the procedure (deleting a logical unit to change RAID level/drive group is described in the procedure in Section 4.7) as there is usually no reason to remove a drive.

1. If necessary, back-up the data on all the logical units in the drive group by copying it file-by-file to the back-up media.
2. In NetWare, unmount any volumes contained on the logical units in the drive group you want to change if any are mounted.
3. If you are going to be creating a logical unit in MS–DOS or SCO UNIX, or in NetWare if you are going to be creating the logical unit that will contain your SYS volume, you have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

5. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying the logical units you want to modify.
6. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). If not, press the Tab key to switch to the Logical Unit window.
7. Use the arrow keys to highlight the logical unit you want to modify. Press the D key to delete the logical unit.
   Press:
   - the C key to confirm that you want to delete the logical unit.
   - the Q key if you do not want to delete the logical unit.
8. Repeat this step for each logical unit in the drive group. When you have deleted all the logical units in the group, the status of the highlighted drives in the Drive Matrix change to *Spare* (2).
9. Press the Q key to quit the Array Configuration Editor. You return to the Array Controller Configuration menu. Press the Esc key to quit RAID Manager. Then press Y and the Enter key.
10. In the DEC RAID Stand-Alone Utility, remove the diskette and reboot the system. You are done with this procedure.

4.9 Modifying and Displaying a Drive Status

You can add, delete, modify, and reconstruct a drive.

4.9.1 Adding a Drive

Adding a drive through software causes the array controller to change the drive status from *Non-existent* (1) to *Spare* (2), thus making the drive available for you to create a logical unit.

Note that the *Add* option in ACE may not be used to revive a drive in a logical unit that has a *Failed* (3) status, but should not have been failed (such as in the circumstance of a multiple-drive failure where the logical unit status is *Dead - replaced wrong drive*).

The following are steps for adding a drive.

1. Start RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

2. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying logical units attached to the controller connected to the drive you want to add. If not, use the *Select Controller* option to select the correct controller.
3. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). Press the Tab key to switch to the Drive window. Use the arrow keys to highlight the drive you want to add.

   Note

   To add a drive, you must first physically connect the drive to the array while it is operating.

4. Press the A key to add the drive. The status of the drive changes from *Non-existent* (1) to *Spare* (2)

You have added a drive.

You may now create a logical unit using the drive (Section 4.5).

4.9.2 Deleting a Drive

Delete a drive when you plan to remove the drive from the DEC RAID Subsystem, and are not planning to replace it or reboot the DEC RAID Subsystem.

Deleting a drive through software causes the array controller to change the drive status from *Spare* (2) to *Non-existent* (1). This means you can never delete a drive that is part of a logical unit.

- First, delete all the logical units contained on the drive (refer to Section 4.8 to delete the logical unit).
- Second, delete the drive.
- Third, physically remove the drive from the subsystem.

Use the following procedure to delete a drive.

1. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

2. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying logical units attached to the controller connected to the drive you want to delete. If not, use the *Select Controller* option to select the correct controller.
3. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). Press the Tab key to switch to the Drive window. Use the Arrow keys to highlight the drive you want to delete.
4. Press the D key to delete the drive. The status of the drive changes from *Spare* (2) to *Non-existent* (1)

You have deleted a drive.

Remove the drive(s) you deleted from the array.

4.9.3 Failing a Drive

Fail a drive when you want to replace a *Warning* and restore a logical unit.

Failing a drive through software causes the array controller to change the drive status from *Warning* (5) to *Failed* (3). Once a drive is failed, the array controller cannot access that drives's data until you reconstruct the drive data.

Important Note

Do NOT fail a drive in a RAID 0 logical unit because there is no parity.

Do NOT fail a drive in a RAID 1 or 5 logical unit if the logical unit is already degraded.

Use the following procedure to fail a drive.

1. Start RAID Manager from the console by entering:

In the DEC RAID Stand-Alone Utility:

```
raidmgr
```

In the DEC RAID NetWare Utility:

```
load raidmgr
```

2. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying the logical units containing the *Warning* drive you want to fail.
3. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). Press the Tab key to switch to the Drive window. Use the Arrow keys to highlight the *Warning* drive you want to fail.
4. Press the F key to fail the drive. The following message is displayed:

```
If you fail a drive, you may lose
data redundancy or data.

Press 'c' to continue.
Press 'q' to quit.
```

Press the C key to confirm that you want to continue with the operation you selected, or press the Q key to quit.

If you press the C key, the status of the failed drive changes from *Warning* (5) to *Failed* (3).

You have failed a drive.

Reconstruct the drive data, or reformat the logical unit.

4.9.4 Reconstructing a Drive

Use this function to reconstruct a drive after you have replaced a failed drive in degraded RAID 1 or 5 logical unit.

Reconstructing data on a drive causes the array controller to do the following, in order:

- Sense that there is a new drive in the array
- Change the drive status to *Replace* (4)
- Copy special array controller files to the new drive
- Recalculate data and parity from the data and parity on the other drives
- Write the recalculated data and parity to the new drive
- Change the drive status to *Optimal* (0)

If you replace a drive while the DEC RAID Subsystem is still operating (called hot swapping), the array controller automatically starts reconstructing the drive data. You need to use this function only if your subsystem does NOT have hot swapping.

Important Note

Remember, a RAID 0 logical unit does not have parity so you cannot recover the data by reconstructing it. You must restore the RAID 0

logical unit by formatting the logical unit, then copying the data from the back-up media file-by-file (Chapter 5 for more information).

If the drive you want to reconstruct contains more than one logical unit, all the logical units are reconstructed.

Use the following procedure to reconstruct a drive.

1. Physically replace the failed drive.
2. Start DEC RAID Manager from the console by entering:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

3. Select the *Array Controller Configuration* option on the menu. Check the Disk Array Devices window on the right of the screen to make sure it is displaying the logical units containing the drive you want to reconstruct.
4. Select the *Array Configuration Editor* option from the menu. Note that you are in the Logical Unit window of the Array Configuration Editor (ACE). Press the Tab key to switch to the Drive window. Check the status of the drive you want to reconstruct. If the status is currently *Replaced* (4) or *Formatting* (8) and the logical unit status is *Reconstructing*, your system has hot swapping and you do not need to continue with this procedure.
5. Use the arrow keys to highlight the *Failed* drive you want to reconstruct.

   Press the R key to start reconstruction.

You have started the reconstruction of drive data.

Part V

Restoring a Logical Unit

This part of the guide contains:

- Chapter 5, Restoring a Logical Unit

5

Restoring a Logical Unit

5.1 Restoring a Logical Unit Task Summary

Restoring a logical unit is the process of returning the logical unit to a working state after one or more drive failures. The tasks involved depend on the RAID level of the logical unit and on how many drives have failed.

Table 5–1 Procedure for Restoring Logical Units

RAID Level	LUN/Drive Status	Recovery Steps:
0	OK - Warning (1 or more drives in warning)	1. *Stop using the logical unit immediately.* 2. Attempt to back-up the logical unit. 3. Fail all warning drives. 4. Replace all failed drives. 5. Reformat the logical unit. 6. In NetWare, recreate the NetWare partitions and volumes on the restored logical unit. 7. Copy backed-up data to the restored logical unit.
1	OK - Warning (1 or more drives in warning)	1. If two or more drives are in warning, *stop using the logical unit immediately and back-up the logical unit before continuing.* 2. *One at a time*, fail each warning drive, replace the failed drive, and reconstruct the data on it.
1	Degraded (1 or more failed drives)	1. Replace the failed drives (all drives can be replaced at the same time). 2. *One at a time*,, reconstruct the data on the replaced drives.

(continued on next page)

Table 5–1 (Cont.) Procedure for Restoring Logical Units

RAID Level	LUN/Drive Status	Recovery Steps:
1	Degraded - Warning (1 or more failed drives *and* 1 or more drives in warning)	1. *Stop using the logical unit immediately.* 2. Attempt to back-up the logical unit. • If the back-up is successful, then *one at a time*, replace and reconstruct each failed drive, then fail, replace, and reconstruct each warning drive. • If the back-up is not successful, then fail all warning drives, replace all failed drives, and reformat the logical unit. In NetWare, recreate the NetWare partitions and volumes. Copy backed-up data back to the restored logical unit.
5	OK - Warning (1 or more drives in warning)	1. If two or more drives are in warning, *stop using the logical unit immediately and back-up the logical unit before continuing.* 2. *One at a time*, fail each warning drive, replace the failed drive, and reconstruct the data on it.
5	Degraded (1 failed drive)	1. Replace the failed drive. 2. Reconstruct the data on the replaced drive.
5	Degraded - Warning (1 failed drive *and* 1 or more drives in warning)	1. *Stop using the logical unit immediately and back-up the logical unit before continuing.* 2. Replace the failed drive and reconstruct the data on it. 3. *One at a time*, fail each warning drive, replace the failed drive, and reconstruct the data on it.
5	Drive Failures (2 or more failed drives *and* any drives in warning)	1. Fail all warning drives. 2. Replace the failed drives. 3. Reformat the logical unit. 4. In NetWare, recreate the NetWare partitions and volumes on the restored logical unit. 5. Copy backed-up data to the restored logical unit.

5.2 When to Replace a Drive

You need to replace a drive when the following occurs:

- For NetWare, the Array Monitor Daemon (AMD) sends a message indicating that a drive has failed or been put in a warning state.
- For SCO UNIX, the Array Monitor sends a message indicating a change in status to *Failed* or *Warning*.
- You see a logical unit status other than *Ok - Optimal* displayed in the DEC RAID Manager Disk Array Devices window.

Table 5–2 shows the logical unit status displayed for the varying degrees of logical unit failures.

Table 5–2 Logical Unit Status

RAID Level	LUN Status	Meaning
0	Ok - Warning	One or more drives in the logical unit has been put in warning because of a read or write error. The array controller never assigns a *Failed* status to a drive in a RAID 0 logical unit, no matter how severe the error, so this is the most serious status possible for a RAID 0 logical unit. Depending on the severity of the error, the logical unit may no longer be accessible, and all data on the unit may be lost. Stop using the logical unit immediately (if it is still accessible), as further errors may result in loss of all data.
1	Ok - Warning	One or more drives in the logical unit has been put in warning because of read or write errors that were not serious enough to fail the drives. The logical unit remains accessible. The warning drives should be replaced as soon as possible. If two or more drives are in warning, stop using the logical unit immediately, as the failure of these drives would result in the loss of data.
1	Degraded	One or more drives in the logical unit have failed, but no two drives in a mirrored pair have failed, so data on the logical unit can be recovered from mirrored disks. The failed drives should be replaced as soon as possible. If they cannot be replaced as soon as possible. If they cannot be replaced immediately, back-up the data on the logical unit to prevent future data loss.

(continued on next page)

Table 5–2 (Cont.) Logical Unit Status

RAID Level	LUN Status	Meaning
1	Degraded - Warning	Either: • One or more drives in the logical unit have failed *and* the mirrored pair of a failed drive has also failed. The array controller never assigns a *Failed* status to the second failed drive in a mirrored pair, no matter how severe the error (it assigns a status of *Warning*), so this is the most serious status possible for RAID 1 logical unit. The logical unit is not longer accessible, and all data on the unit is lost. • One or more drives in the logical unit have failed *and* a minor error has occurred on another disk (the disk may or may not be the mirrored pair of a failed disk). The logical unit remains accessible.
5	Ok-Warning	One or more of the drives in the logical unit have been put in warning because of read or write errors that were not serious enough to fail the drives. The warning drives should be replaced as soon as possible, before they fail. The logical unit remains accessible. If two or more drives are in warning, stop using the logical unit immediately, as the failure of these drives would result in the loss of data.
5	Degraded	A single drive in the logical unit has failed, but the date on that drive can be reconstructed using data and parity from the other drives. The failed drive should be replaced as soon as possible. If they cannot be replaced immediately, back-up the data on the logical unit to prevent future data loss.
5	Degraded - Warning	A single drive in the logical unit has failed, *and* and one or more drives have been put in warning because of minor errors. The logical unit is still accessible. Stop using the logical unit immediately, as the failure of a warning drive will result in data loss.
5	Drive Failures	Two or more drives in the logical unit have been failed and the logical unit is inaccessible. All data in the unit is lost.

Note

Refer to the following sections for a further description of drive failures and RAID levels, and the actions to take when they occur.

5.3 Drive Failures on RAID 0

This section describes drive failures on a RAID 0 logical unit and the logical unit and drive status that result from such failures.

5.3.1 Single Drive Failure on RAID 0

When a single drive in in a RAID 0 logical unit experiences unrecoverable read or write errors, the array controller puts the drive in a *Warning* state and changes the logical unit status to *Ok - Warning*. This occurs even if the drive is completely inaccessible (for example, if power to the drive is lost). All the data on the logical unit may be lost, depending on the severity of the error that generated the warning.

Whenever one or more drives are put in *Warning*, back-up the data on the logical unit file-by-file (if possible), fail the drives, replace the drives, and then reformat the logical unit. For the NetWare environment, you must then add the logical unit to your system by creating partitions and volumes (using the NetWare Install command). Copy data back to the restored logical unit from your back-up media.

5.4 Drive Failures on RAID 1

This section describes drive failures on a RAID 1 logical unit and the logical unit and drive status that result from such failures.

5.4.1 Single Drive Failures on RAID 1

Whenever a single drive in an optimal RAID 1 logical unit experiences read or write errors, the array controller changes the status of the drive to *Warning* if the errors are minor (read errors on a few sectors) or *Failed* if the errors are serious (loss of drive power, drive component failure, and so on). The logical unit status changes to *Ok - Warning* or *Degraded*, depending on whether the drive status is *Warning* or *Failed*. In either case, you can continue to access the logical unit, because the data on the failed drive can be read from its mirrored drive.

Whenever a single drive is marked as *Failed* (or *Warning*), you should replace it as soon as possible. The array controller will then reconstruct the data on the drive automatically. If you cannot replace the drive immediately, back-up the data file-by-file, then replace it when you can.

5.4.2 Multiple Drive Failures on RAID 1

Whenever the second drive in a RAID 1 logical unit experiences read or write errors, the array controller takes the following actions:

- If the drive is the mirrored pair of a drive that is already failed, the drive status changes to *Warning*, even if the drive is completely inaccessible. The logical unit status changes to *Degraded - Warning*, but the logical unit may not be accessible.
- If the drive is not the mirrored pair of a failed drive, the drive status changes to *Warning* or *Failed*, depending on the severity of the error. The logical unit status changes to *Ok - Warning*, *Degraded*, or *Degraded - Warning*, depending on the previous status of the logical unit.

A RAID 1 logical unit can have more than one failed drive and still remain degraded *as long as none of the failed drives are a mirrored pair*. For example, in a six drive RAID 1 logical unit, it is possible for as many as 3 drives to fail while the logical unit remains accessible (in degraded mode). You should not, however, continue to operate a RAID 1 logical unit with any number of failed or warning drives longer than it takes to replace the drives.

The worst status in RAID 1 logical unit can have is *Degraded - Warning*. This status means that either a mirrored pair of drives has failed, and all data on the logical unit has been lost, or that a minor read error has occurred on a drive in an already degraded logical unit. To determine the action to take to restore the unit, you should attempt to back-up the data.

- If the back-up succeeds, the logical unit does not contain a failed mirrored pair. You can probably reconstruct the data on the failed and warning drives.
- If the back-up fails, a mirrored pair has failed and all data has been lost. You will have to restore the logical unit by reformatting it.

5.5 Drive Failures on RAID 5

This section describes drive failures on a RAID 5 logical unit and the logical unit and drive status that result from such failures.

5.5.1 Single Drive Failure on RAID 5

Whenever a single drive in an optimal RAID 5 logical unit experiences read or write errors, the array controller changes the status of the drive to *Warning* if the errors are minor (read errors on a few sectors) or *Failed* if the errors are serious (loss of drive power, drive component failure, and so on). The logical unit status changes to *Ok - Warning*, or *Degraded*, depending on whether the drive status is *Warning* or *Failed*. In either case, you can continue to access the logical unit, as the data on the failed drive can be reconstructed using parity and data on the other drives.

Whenever a drive is marked as *Failed* (or *Warning*), you should replace it as soon as possible. The array controller will then reconstruct the data on the drive automatically. If you cannot replace the drive immediately, back-up the data file-by-file, then replace it when you can.

5.5.2 Multiple Drive Failures on RAID 5

If a second drive in a RAID 5 logical unit experiences read or write errors, the array controller marks the drive as *Warning* or *Failed*, depending on the severity of the error. The logical unit status changes to *Optimal - Warning*, *Degraded - Warning*, or *Drive Failures*, depending on the previous status of the logical unit. If the status changes to *Drive Failures* (because of the failure of a second drive), all data in the logical unit is lost.

If the logical unit status is *Optimal - Warning*, or *Degraded - Warning*, you will probably be able to reconstruct the data on the failed and warning drives by replacing the drives, one by one, beginning with the failed drive. If the logical unit status is *Drive Failures*, you will have to replace the failed drives and reformat the logical unit.

5.6 What Is Reconstruction?

Reconstruction is a process used to restore a degraded RAID 1 or 5 logical unit to its original state after a single drive has been replaced. During reconstruction, the array controller recalculates the data on the drive that was replaced, using data and parity from from the other drives in the logical unit. The controller then writes this data to the replaced drive. Note that although RAID level 1 does not have parity, the array controller can reconstruct data on a RAID 1 logical unit by copying data from the mirrored disk.

Note

Reconstruction only applies to a degraded RAID 1 or 5 logical unit with a single-drive failure.

The array controller automatically initiates the reconstruction process after you replace a drive in a degraded RAID 1 or 5 logical unit. Once reconstruction is initiated the array controller completes the following actions:

- Formats the new drive (if the array controller determines it is necessary)
- Copies special array software files to the new drive
- Recalculates the data and parity from the data and parity on the other logical unit drives
- Writes the recalculated data and parity to the new drive

Reconstruction can take place while the logical unit is in use. You do not need to shut it down. While the utility is formatting the new drive, there is no additional effect on the system I/O performance (the logical unit continues to operate in the degraded mode). Once data reconstruction begins, you can adjust the rate of reconstruction so that it does not interfere significantly with system performance.

If there are multiple-drive failures in a RAID 1 or 5 logical unit (that is, the status is *Degraded - Warning* or *Drive Failures*), you cannot reconstruct the drive data. To restore a RAID 1 or 5 logical unit to a working state in this case, you need to replace the drives and reformat the logical unit. See Section 5.4.2 and Section 5.5.2 for more information.

5.7 Reconstruction Rate

The rate of reconstruction depends on two parameters, the delay interval parameter and the blocks per delay interval parameter.

The delay interval is the time between reconstruction operations. When the array controller reconstructs data on a drive, it divides its time between reconstruction and normal I/O operations. System I/O operations take place during this delay interval. As the delay interval increases, system I/O performance also increases, but so does reconstruction time.

The blocks per delay interval is the number of blocks the array controller reconstructs during each reconstruction operation. The more blocks, the longer the time necessary to reconstruct them. This is time that cannot be used to perform system I/O. Therefore, the larger the reconstruction amount, the more system performance degradation increases.

Note that these parameters control only the rate of data reconstruction, not total reconstruction time. The first step in reconstruction, formatting the replaced drive, can take 12-15 minutes. During this time, however, you can continue to access the array with no decrease in current system performance (the array remains in the degraded mode).

Some suggested rates, as well as sample timings, are given in the table below.

Table 5–3 Reconstruction Rates

Rate (relative)	Reconstruction Frequency *in tenths of a second*	Reconstruction Amount *in blocks*	Time for Completion *in minutes/GB*[1]
Slow	6	250	20
Moderate	1	256	7
Fast	1	1024	3

[1]Timings are approximate and apply only to data reconstruction; formatting time (typically 15-20 minutes) is not included. Times will be slower if other processes are accessing the array during reconstruction

In general, reconstruction times tend to level off after block sizes of 20K. Although higher block sizes (up to 64K) are possible, there is no great reduction in time at the higher levels.

5.8 Restoring a RAID 0 Logical Unit

Restore a RAID 0 logical unit when one or more of the following occurs:

- A drive has a status of *Warning*.
- The logical unit has a status of *Ok - Warning*
- In NetWare, the Array Monitor Daemon (AMD) notifies you of a change in disk or logical unit status or NetWare notifies you that it can no longer access the logical unit.
- In SCO UNIX, the Array Monitor notifies you of a changes in logical unit or drive status.

Use the following procedure to restore a RAID 0 logical unit.

1. Attempt to back up the data on the logical unit, if possible.
2. In NetWare, unmount any volumes on the unit, if they are still mounted.
3. If you modify parameters in MS–DOS or SCO UNIX, or in NetWare and if these parameters are on the logical unit that contains any part of your SYS volume, you will have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager by entering the following command from the console:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

5. From the Disk Array Service menu, select *Device Selection*. Scroll through the Disk Array Devices window until you find a logical unit with a status of *Ok - Warning* This should be the RAID 0 logical unit you need to restore.
6. Select that unit. Examine the Array Information and Disk Drive Information windows at the bottom of the screen to make sure that you have selected the correct logical unit. The selected unit should be a RAID 0 logical unit with one or more drives with a *Warning* status.
7. For the DEC RAID Stand-Alone Utility:
   - Replace the drive with the *Warning* status with a new drive, restart the system, and restart DEC RAID Manager.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the *Disk Array Services* menu select the *Array Controller Configuration* option.
   - From the *Array Controller Configuration* menu select the *Array Controller Editor* option.
   - From the logical unit window, select *Format* to format the logical unit.
   - After the reformat is finished, press the Esc key to quit the DEC RAID Manager. Then, press Y and the Enter key.
   - Remove the diskette and reboot the system.
   - Copy backed-up data back to the logical unit.
8. For the DEC RAID NetWare Utility:
   - From the *Disk Array Services* menu select *Device Service*.
   - From the Service Disk Array Device menu, select *Replace the disk drive*. Follow the instructions given to replace the *Warning* drive or drives. Press the Enter key as you complete each step to check the step off.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the Service Disk Array Device menu, select *Format disk array device*. Answer the prompts to reformat the logical unit.
   - After the reformat is finished, press the Esc key to quit DEC RAID Manager. Then, press Y and the Enter key.
   - In the DEC RAID NetWare Utility, use the NetWare Install command to create partitions and volumes on the restored logical unit. (See Chapter 7)
   - Copy backed-up data back to the logical unit.

You are done with this procedure.

5.9 Restoring a RAID 1 Logical Unit

You need to restore a RAID 1 logical unit when one or more of the following occurs:

- A drive has a status of *Warning* or *Failed*.
- The logical unit has a status of *Ok - Warning*, *Degraded*, or *Degraded - Warning*.
- In NetWare, the Array Monitor Daemon (AMD) notifies you of a change in disk or logical unit status or NetWare notifies you that it can no longer access the logical unit.
- In SCO UNIX, the Array Monitor notifies you of a change in logical unit or disk status.

Use the following procedure to restore a RAID 1 logical unit.

1. If the status of the logical unit is *Degraded - Warning*, see Section 5.10. If the status of the logical unit is *Ok - Warning* or *Degraded*, continue with the next step.
2. If you cannot replace the disk right away, attempt to back up the data on the logical unit, if possible.
3. If you are restoring a logical unit in MS–DOS or SCO UNIX you have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager by entering the following command from the console:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

5. From the Disk Array Service menu, select *Device Selection*. Scroll through the Disk Array Devices window until you find a logical unit with an *Ok - Warning* status or *Degraded* status. This should be the RAID 1 logical unit you need to restore.
6. Select that unit. Examine the Array Information and Disk Drive Information windows at the bottom of the screen to make sure that you have selected the correct logical unit. The selected unit should be a RAID 1 logical unit with one or more drives with a *Failed* status.
7. For the DEC RAID Stand-Alone Utility:
   - Replace the drive with the *Failed* status with a new drive.

   Caution

   You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the *Disk Array Services* menu select the *Array Controller Configuration* option.

- From the *Array Controller Configuration* menu select the *Array Configuration Editor* option.
- From the logical unit window, select *Reconstruct* to initiate reconstruction of the logical unit.
- After the reconstruction is finished, press the Esc key to quit DEC RAID Manager. Press the Y key and the Enter key.
- Remove the diskette and reboot the system.

8. For the DEC RAID NetWare Utility:
   - From the *Disk Array Services* menu select *Device Service*.
   - Check the Disk Drive Information window. The drive marked *Failed* should be highlighted. If it is not, select *Select Disk Drive* and select the *Failed* drive. If there is more than one drive in *Failed* drive, highlight the first one. If there are *Failed* and *Warning* drives, select a *Failed* one first.
   - From the Service Disk Array Device menu, select *Replace the disk drive*.
   - Follow the instructions given to replace the *Failed* drives. Replace the highlighted drive, not all the *Failed* or *Warning* drives. Press the Enter key as you complete each step to check the step off.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - After you have checked off all the tasks, watch the status of the logical unit you just restored. It should change to *Reconstructing*.

     If the status does not change to *Reconstructing*, make sure the drive you just replaced is highlighted, then select *Reconstruct disk drive* from the *Service Disk Array Device* menu to start data reconstruction.
   - Wait for the reconstruction to finish. After it is finished, if you have any *Failed* or *Warning* drives, repeat these steps to replace and reconstruct them.
   - After the logical unit status changes to *Ok - Optimal*, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key.

5.10 Restoring RAID 1 Logical Units after Multiple Failures

After a multiple drive failure, RAID 1 logical unit has a status of *Degraded - Warning*, at least one *Failed* drive, and a mirrored pair of a *Failed* drive with a status of *Warning*. Depending on the severity of the error that caused the *Warning*, the logical unit may not be accessible and all the data in it may be lost.

Use the following procedure to restore a RAID 1 logical unit after a multiple drive failure.

1. Stop using the logical unit immediately if it is still working. Continuing to access the logical may result in complete loss of data.

2. Attempt to back-up the data on the logical unit.
   - If the backup was successful, you may be able to reconstruct the data in the logical unit. Go to Section 5.9, and complete the procedure. You will need to replace the failed drive first, reconstruct it, and then replace the *Warning* drive. If the reconstruction operation fails, continue with this procedure to restore the logical unit.
   - If the backup was not successful, continue with this procedure to restore the logical unit.
3. If you are restoring a logical unit in MS–DOS or SCO, or in NetWare and if the logical unit contains any part of your SYS volume, you will have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager by entering the following command from the console:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```
5. From the Disk Array Service menu, select *Device Selection*. Scroll through the Disk Array Devices window until you find a logical unit with a status of *Degraded - Warning*. This should be the RAID 1 logical unit you need to restore. Select that unit. Examine the Array Information and Disk Drive Information windows at the bottom of the screen to make sure that you have selected the correct logical unit. The selected unit should be a RAID 1 logical unit with one or more drives with a *Failed* or *Warning* status.
6. For the DEC RAID Stand-Alone Utility:
   - Replace the drive with the *Failed* or *Warning* status with a new drive, restart the system, and restart DEC RAID Manager.

   Caution

   You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the *Disk Array Services* menu select the *Array Controller Configuration* option.
   - From the *Array Controller Configuration* menu select the *Array Configuration Editor* option.
   - From the logical unit window, select *Format* to initiate reconstruction of the logical unit.
   - After the reformat is finished, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key.
   - Remove the diskette and reboot the system.

     Copy backed-up data back to the logical unit.

7. For the DEC RAID NetWare Utility:
   - From the *Disk Array Services* menu select *Device Service*.
   - Check the Disk Drive Information window. The drive marked *Warning* should be highlighted. If it is not, select *Select Disk Drive* and select the *Warning* drive. If there is more than one drive in *Warning*, highlight the first one.
   - From the Service Disk Array Device menu, select *Replace the disk drive*.
   - Follow the instructions given to replace the *Warning* drive or drives. Press the Enter key as you complete each step to check the step off.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the Service Disk Array Device menu, select *Format disk array device*. Answer the prompts to reformat the logical unit.
   - After the reformat is finished, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key.
   - Use the NetWare Install command to create partitions and volumes on the restored logical unit (see Chapter 7).

     Copy backed-up data back to the logical unit.

   You are done with this procedure.

5.11 Restoring a RAID 5 Logical Unit

Restore a RAID 5 logical unit when one or more of the following occurs:

- A drive has a status of *Warning* or *Failed*.
- The logical unit has a status of *Ok - Warning*, *Degraded*, or *Degraded - Warning*.
- In NetWare, the Array Monitor Daemon (AMD) notifies you of a change in disk or logical unit status or NetWare notifies you that it can no longer access the logical unit.
- In SCO UNIX, the Array Monitor notifies you of a change in logical unit or drive status.

Use the following procedure to restore a RAID 5 logical unit.

1. If the status of the logical unit is *Degraded - Warning*, see Section 5.12. If the status of the logical unit is *Ok - Warning* or *Degraded*, continue with the next step.
2. If you cannot replace the disk right away, attempt to back up the data on the logical unit, if possible.
3. If you are restoring a logical unit in MS–DOS or SCO UNIX you have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
4. Start DEC RAID Manager by entering the following command from the console:

In the DEC RAID Stand-Alone Utility:

```
raidmgr
```

In the DEC RAID NetWare Utility:

```
load raidmgr
```

5. From the Disk Array Service menu, select *Device Selection*. Scroll through the Disk Array Devices window until you find a logical unit with an *Ok - Warning* status, *Degraded* or *Degraded - Warning*. This should be the RAID 5 logical unit you need to restore.
6. Select that unit. Examine the Array Information and Disk Drive Information windows at the bottom of the screen to make sure that you have selected the correct logical unit. The selected unit should be a RAID 5 logical unit with one *Failed* drive and/or one or more drives with a *Warning* status.
7. For the DEC RAID Stand-Alone Utility:
   - Replace the drive with the *Warning* status with a new drive.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the *Disk Array Services* menu select the *Array Controller Configuration* option.
   - From the *Array Controller Configuration* menu select the *Array Configuration Editor* option.
   - From the logical unit window, select *Reconstruct* to initiate reconstruction of the logical unit.
   - After the reconstruction is finished, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key.
   - Remove the diskette and reboot the system.
8. For the DEC RAID NetWare Utility:
   - From the *Disk Array Services* menu select *Device Service*.
   - Check the Disk Drive Information window. The drive marked *Failed* should be highlighted. If it is not, select *Select Disk Drive* and select the *Failed* drive. If there is more than one drive in *Failed* drive, highlight the first one. If there are *Failed* and *Warning* drives, select a *Failed* one first.
   - From the Service Disk Array Device menu, select *Replace the disk drive*.
   - Follow the instructions given to replace the *Failed* drives. Replace the highlighted drive, not all the *Failed* or *Warning* drives. Press the Enter key as you complete each step to check the step off.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

- After you have checked off all the tasks, watch the status of the logical unit you just restored. It should change to *Reconstructing*

  If the status does not change to *Reconstructing*, make sure the drive you just replaced is highlighted, then select *Reconstruct disk drive* from the *Service Disk Array Device* menu to start data reconstruction

- Wait for the reconstruction to finish. After it is finished, if you have any *Failed* or *Warning* drives, repeat these steps to replace and reconstruct them.

- After the logical unit status changes to *Ok - Optimal*, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key

5.12 Restoring RAID 5 Logical Units after Multiple Failures

After a multiple drive failure, a RAID 5 logical unit has a status of *Drive Failures* and at least two *Failed* drives. The logical unit is not accessible and all the data in it has been lost.

Use the following procedure to restore a RAID 5 logical unit after a multiple drive failure.

1. If you are restoring a logical unit on MS–DOS or SCO, or in NetWare and the logical unit contains any part of your SYS volume, you have to use the DEC RAID Stand-Alone Utility. Reboot the system using the DEC RAID Stand-Alone Utility diskette and continue with this procedure.
2. Start DEC RAID Manager by entering the following command from the console:

   In the DEC RAID Stand-Alone Utility:

   ```
   raidmgr
   ```

   In the DEC RAID NetWare Utility:

   ```
   load raidmgr
   ```

3. From the Disk Array Service menu, select *Device Selection*. Scroll through the Disk Array Devices window until you find a logical unit with a status of *Degraded - Warning* or *Drive Failures*. This should be the logical unit you need to restore.
4. Select that unit. Examine the Array Information and Disk Drive Information windows at the bottom of the screen to make sure that you have selected the correct logical unit. The selected unit should be a RAID 5 logical unit with two or more drives with a *Failed* status.
5. For the DEC RAID Stand-Alone Utility:

   - Replace the drives with *Failed* status with new drives.

   Caution

   You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the *Disk Array Services* menu select the *Array Controller Configuration* option.

- From the *Array Controller Configuration* menu select the *Array Configuration Editor* option.
- From the logical unit window, select *Format* to initiate reconstruction of the logical unit.
- After the reformat is finished, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key.
- Remove the diskette and reboot the system.

  Copy backed-up data back to the logical unit.

6. For the DEC RAID NetWare Utility:
   - From the *Disk Array Services* menu select *Device Service*.
   - Check the Disk Drive Information window. The drive marked *Failed* should be highlighted. If it is not, select *Select Disk Drive* and select the first *Failed* drive.
   - From the Service Disk Array Device menu, select *Replace the disk drive*.
   - Follow the instructions given to replace all the *Failed* drives. Press the Enter key as you complete each step to check the step off.

Caution

You must wait 10 seconds from the time you take out a drive, to the time that you reinsert a new one for the bus to recognize the drive change.

   - From the Service Disk Array Device menu, select *Format disk array device*. Answer the prompts to reformat the logical unit.
   - After the reformat is finished, press the Esc key to quit DEC RAID Manager. Then, press the Y key and the Enter key.
   - Use the NetWare Install command to create partitions and volumes on the restored logical unit (see Chapter 7).

     Copy backed-up data back to the logical unit.

You are done with this procedure.

Part VI

DEC RAID NetWare Utility

This part of the guide contains:

- Chapter 6, Installation of the DEC RAID NetWare Utility
- Chapter 7, Adding Logical Units to NetWare
- Chapter 8, Checking/Repairing Array Parity
- Chapter 9, The Array Monitor Daemon

F

6

Installation of the DEC RAID NetWare Utility

6.1 About Installation

The DEC RAID NetWare Utility is installed into the NetWare file server system by the installation program called RMINST.NLM. You do not need to remove an old version of the DEC RAID NetWare Utility since the installation program copies the new version into a different directory than the old version.

RMINST.NLM performs the following task when it installs the DEC RAID NetWare Utility:

- Creates the following directories
  - sys:/system/raidmgr
  - sys:/system/raidmgr/acehelp
- Copies the program and data files from the distribution diskette containing DEC RAID Manager into the raidmgr subdirectory
- Copies the online help file (raidmgr.nfo) into the sys:/public directory
- Copies the Array Configuration Editor help files into the sys:/system/raidmgr/acehelp subdirectory
- Determines which drivers are in resident memory using the list of supported disk drivers in the raidmgr.cfg file (located in the sys:/system/raidmgr subdirectory)
- Loads the amd utility if the driver is ASPI and loaded into memory
- Reports any errors it encounters while copying files, checking drivers, or loading the amd utilities.

6.1.1 DEC RAID Manager Files

When you install the DEC RAID NetWare Utility, the installation program copies the files listed in Table 6–1 onto the file server:

Table 6–1 Files Copied to the File Server in NetWare

File	Description
raidmgr.nlm	User shell
raidif1.nlm	NetWare file
ace.nlm	Array Configuration Editor
amd.nlm	Array Monitor Daemon

(continued on next page)

Table 6–1 (Cont.) Files Copied to the File Server in NetWare

File	Description
apc.nlm	Automatic parity check/repair
raidmgr.cfg	Configuration file
raidmgr.dat	Menu and form definitions for RAID Manager
raidmgr.msg	Messages displayed by RAID Manager
raidmgr.hlp	Online help for RAID Manager
release.id	Release version
acehelp <dir>	Online help files for the Array Configuration Editor

6.2 When to Install the DEC RAID Manager

Install the DEC RAID Manager after you have installed your array subsystem and host adapter, if necessary.

6.3 Before You Install the DEC RAID Manager

- If necessary, install the host adapter, using the instructions accompanying the host adapter kit.
- Install all the required drivers you need. Refer to Chapter 1 to determine which drivers your system needs.

6.4 Running the Installation Program

There are two ways to install DEC RAID Manager.

If you have an MS–DOS partition on your file server, refer to Section 6.4.1 to run the installation program using MS–DOS.

If you do not have an MS–DOS partition on your file server, refer to Section 6.4.2 to run the installation program without using MS–DOS.

6.4.1 Using an MS–DOS Partition

Perform the following steps to run the installation program using a MS–DOS partition.

1. Make sure you have read Section 6.3, Before You Install the DEC RAID Manager.
2. Insert the DEC RAID Manager distribution diskette in drive A:.
3. Type the following at the NetWare file server console, then press the Enter key:
   load a:rminst

The following screen is displayed:

```
NetWare RAID Manager Installation

Enter DOS drive identifier (default A:):
```

4. Press the Enter key twice.
   The installation program reads the release.id file from the device, and displays the contents on the screen. This file contains DEC RAID Manager-specific information.
5. Press the Y key and the Enter key to continue with the installation.
   The installation program does the following:
   - Creates the sys:/system/raidmgr and sys:/system/raidmgr/acehelp directories,
   - Copies files into the directories from the distribution diskette,
   - Copies the online help files into the sys:/public directory.

6. Note when the following message (indicating that installation is complete) is displayed.

```
AUTOEXEC.NCF setup complete
Disk Array Monitor started

NetWare RAID Manager Installation complete
```

7. If the Disk Array Monitor is not automatically started, unload the DEC RAID Manager, load amd, then load the DEC RAID Manager.

You have successfully completed the installation.

Go to Chapter 7 to configure the logical units.

6.4.2 Without Using an MS–DOS Partition

Perform the following steps to run the installation program without using a MS–DOS partition.

NOTE

You can not use MS–DOS if you have made it inaccessible on the file server.

1. Make sure you have read Section 6.3, Before You Install the DEC RAID Manager.
2. Make sure you are using a client workstation that has MS–DOS running and the network software loaded.
3. Log in to the file server from the PC with security privileges equivalent to supervisor.
   For example, if the file server name is SERVER1, type the following on the workstation, and then press the Enter key:
   login SERVER1/supervisor
4. Map a virtual volume to the SYS volume.
   For example, if the file server name is SERVER1, type the following on the workstation, and then press the Enter key:

```
map s:=SERVER1/SYS:
```

5. Insert the DEC RAID Manager distribution diskette in drive A:.
6. If necessary, change the default path to the SYS volume path by typing the following, and then press the Enter key:

```
s:
```

7. Change the directory to system by typing the following, and then press the Enter key:

```
cd \system
```

8. Delete the following existing DEC RAID Manager files by typing the following and pressing the Enter key after each line:

```
del acf.nlm

del apr.nlm

del apc.nlm

del arc.nlm

del amd.nlm

del raidmgr.ini
```

Note

If the file is not found, an error message is displayed after you try to delete it. Ignore the error message and continue deleting files.

9. Change the directory to public by typing the following, and then press the Enter key:

```
cd \public
```

10. Delete the following old RAID Manager file by typing the following, and then press the Enter key:

```
del nwdutil.nfo
```

11. Change the directory to system by typing the following, and then press the Enter key:

```
cd \system
```

12. Create the following directories, if they do not already exist, by typing the following and pressing the Enter key after each line:

```
mkdir raidmgr

mkdir raidmgr\acehelp
```

13. Copy the following files from the distribution diskette to the directories by typing the following and pressing the Enter key after each line:

```
copy a:\*.* raidmgr

copy  a:\acehelp\*.* raidmgr\acehelp
```

It takes a few moments to copy the files.

14. Delete any occurrences of lines which contain the following commands in the autoexec.ncf file (located in the system directory) using a text editor.

```
load amd
```

15. Add the following commands to the end of the autoexec.ncf file to load amd:

```
load raidmgr\amd
search add sys:\system\raidmgr
```

16. Log off the file server.
17. Reboot the server.

You have successfully installed the DEC RAID Manager.

6.5 Installation Error Messages

Table 6–2 describes installation error messages and probably causes during installation of the DEC RAID NetWare Utility.

Table 6–2 Installation Error Messages

Message	Probable Cause	Action To Take
ERROR Unable to create RAIDMGR and/or RAIDMGR ACEHELP directory.	SYS volume is not mounted, or NetWare is unable to create a directory, or software problem	**First Option:** Mount the SYS volume if it is not mounted. **Second Option:** Try to install again.
ERROR in copying files. Re-run RMINST.	Media error.	**First Option:** Try to install again. **Second Option:** Obtain a new copy of the DEC RAID Manager, and try to install again.
ERRORS occurred in help copy file. Files not copied: <filenames>	SYS volume is not mounted, or there is a media error.	**First Option:** Mount the SYS volume if it is not mounted. **Second Option:** Try to install again. **Third Option:** Obtain a new copy of DEC RAID Manager, and try to install again.
ERROR DOS is not loaded:	RMINST procedure has failed.	**First Option:** Load the utilities manually by copying them from a workstation over the network. **Second Option:** Reboot the server without performing REMOVE DOS, and reinstall RAID Manager.
ERROR AUTOEXEC.NCF not updated. No space for temporary file.	There is not enough disk space. The temporary file requires 10-12 Kbytes.	**First Option:** Remove some files to allow for the temporary file to be created.
ERROR AUTOEXEC.NCF not updated. File not found.	There is no autoexec.ncf file available.	**First Option:** Create an autoexec.ncf and reinstall the DEC RAID Manager. **Second Option:** Ignore the error and continue with the installation.

(continued on next page)

Table 6–2 (Cont.) Installation Error Messages

Message	Probable Cause	Action To Take
ERROR AUTOEXEC.NCF not updated. File could not be written.	There is a write-protect flag on the autoexec.ncf file or the autoexec.ncf file is damaged.	**First Option:** Check the permissions on the autoexec.ncf file and remove any write-protects. **Second Option:** Obtain a new copy of autoexec.ncf file.
WARNING Array monitor not started. Cause: Disk driver not loaded.	One of the recognized drivers that DEC RAID Manager supports needs to be loaded.	**First Option:** Load one of the supported drivers.
WARNING An old version of Array Monitor is running. Complete this installation, then enter "unload AMD" and "load RAIDMGR\AMD".	A file called amd.nlm has already been loaded and you cannot load an nlm file with the same name twice.	**First Option:** Unload AMD and load RAIDMGR\AMD.
ERROR Array Monitor not started. Cause: AMD.NLM not found.	There is a media error.	**First Option:** Obtain a new set of diskettes, and repeat the installation procedure.
ERROR RAID Manager Software not found.	The wrong location for the diskette was specified, or there is a media error.	**First Option:** Specify the diskette location again. **Second Option:** Obtain a new set of diskettes, and repeat the installation procedure.

7

Adding Logical Units to NetWare

7.1 Using the Install Command

After you configure a logical unit, you use the NetWare Install command to create partitions and volumes so that your system can access it. You use this command in the same way you would use it on a standard hard disk, using the instructions given in the NetWare documentation. For best results, select 32K or 64K as the block size of any volumes on the logical unit.

7.2 Adding Logical Units to Existing Volumes

You can add an array logical unit to an existing volume just as you can add any other disk storage device. However, you should remember that the data reliability of a combined volume is only as great as the reliability of its weakest part.

That is, if you combine a RAID 5 logical unit and a RAID 0 logical unit into the same volume, the resulting volume has the data redundancy protection of a RAID 0 logical unit (that is, none). Even though the RAID 5 portion of the volume has data redundancy, if the RAID 0 portion fails, the whole volume may become usable and all data on the volume lost. A RAID 1 and a RAID 5 volume would, however, offer data redundancy.

In general you should not combine redundant and non-redundant disk storage systems in the same volume.

7.3 Performance Notes

Array performance depends on many different factors, including RAID level, block size, I/O block size, and so on. Here are a few suggestions that may improve performance on your array.

- Make your segment size at least the same size as your average I/O size. For example, if your average I/O size is 16 Kbytes (32 blocks), change your segment size (using the Configuration utility) to 32 blocks as well.
- Always use a segment 0 size of 0.
- If data redundancy is not important, try using RAID 0 instead of RAID 1 or 5. In some circumstances this improves performance. However, all data is lost if a single drive fails.

8

Checking/Repairing Array Parity

8.1 What is Parity Check/Repair?

Note

Parity check/repair applies only to RAID 1 and 5. RAID 0 does not have array parity, and therefore cannot be checked and repaired. RAID 1 does not really have "parity" either, but parity check compares data on the mirrored drives. In addition, you cannot run parity check/repair on a degraded RAID 1 or 5 logical unit (a logical unit with a status of *Degraded*).

Parity Check/Repair performs the following functions:

- Scans the logical unit and checks the array parity for each block in the logical unit. On a RAID 1 logical unit, parity check compares the data on each mirrored pair, block by block.
- Repairs any array parity errors found during the parity check. On a RAID 1 logical unit, the array controller changes the date on the mirror disk to make it match the data on the data disk. On a RAID 5 logical unit, the controller changes the parity segment so that it is consistent with the data segments.

  Note that if the array parity errors resulted from corrupted data, the data is not repaired, only the array parity. Also, note that you may still lose some data as a result of the power failure or abnormal shutdown, especially if you do not have an uninterruptible power supply (UPS). Data cached in buffers are lost and cannot be reconstructed if you do not have a UPS. This is one of the reasons you should always maintain back-up files, even with a redundant array.

8.1.1 When to Run Parity Check/Repair

Run parity check/repair at the following times:

- Automatically at a time determined during the DEC RAID Manager installation (Section 8.2). Automatic parity check/repair helps guarantee the data integrity of the logical unit so that you can reconstruct the data on the array if a drive fails.
- Manually after an abnormal server or array shutdown (Section 8.3). As the result of such a shutdown, required array parity may not have been updated, resulting in potential data corruption. You must run parity check/repair on the logical unit after you run the NetWare VRepair command to repair any volumes on the unit.

8.2 How Automatic Parity Check/Repair Works

This section describes how the automatic parity check/repair works. See Section 8.3 for information on manual operation.

During the DEC RAID Manager installation, you specify when you want the parity check/repair utilities to run automatically. Automatic parity check /repair insures the data integrity of your array, which allows you to accurately reconstruct data on the array after a device fails.

8.2.1 Automatic Parity Check/Repair Operation

- During the DEC RAID Manager installation, you specify a time to run automatic parity check/repair. You can also specify a parity check without repairing any errors found.
- At the specified time of day, the system starts the parity check operation. A new screen is created on the system console for the parity check operation.
- Parity check writes messages to this screen. If any errors are found, they are also written to a parity error log file.
- The log file is named device-ID.chk, where device-ID is the device ID of the logical unit checked (for example, 8B001.chk is the name of the parity error log file for device 8B001). The file is in the SYS/raidmgr directory. A separate log file is created for each logical unit.
- If parity errors are found, and you specified automatic parity repair, the system repairs the parity errors.

  If you did not specify automatic parity repair, you have to check the parity error log files to see if any errors are recorded, and then run parity check /repair manually. There is no reason not to specify automatic parity repair.
- Automatic parity check/repair is performed on each logical unit in turn.
- After the automatic parity check/repair process, the parity error log file contains one of the following:

  If no errors were found, the file contains only the date and time automatic parity check/repair was run.

  If errors where found, the file contains a list of the bad blocks found and repaired (if parity repair was run).
- If desired, you can change the scheduled automatic parity check/repair time see Section 8.4.
- You can check the current settings for automatic parity check/repair by selecting *RAID Manager Configuration* from the *Disk Array Services* menu, then selecting *General Configuration* to view DEC RAID Manager configuration parameters.

8.3 How to Run Manual Parity Check/Repair

This section describes how to run parity check/repair utilities manually. See Section 8.2 for information on automatic operation.

You run parity check/repair manually after an abnormal shutdown (power failure, system crash, and so on). Note that you may still lose some data as a result of the power failure or abnormal shutdown, especially if you do not have an uninterruptible power supply (UPS). Data cached in buffers are lost and cannot be reconstructed if you do not have a UPS. This is one of the reasons you should always maintain back-up files, even with a RAID 5 array.

You need to run parity check/repair after you run VRepair on the affected volumes.

8.3.1 Manual Parity Check/Repair Operation

- Manual parity check/repair is run from the DEC RAID Manager. You should run manual parity check after you have run VRepair on any affected volumes.
- You can run parity check without repairing parity (although normally there is no reason not to repair parity).
- An entry is made in the activity log showing the parity check operation.
- Parity check creates a file to store parity errors found and repaired. This file is named device-ID.chk, where device-ID is the device ID of the logical unit checked (for example, 8B001.chk is the name of the parity error log file for device 8B001). The file is in the SYS/raidmgr directory.
- You can temporarily change the name of the parity error log file using the *Change Parity Report File Name* option in the *Disk Array Parity* menu. This change applies only to this logical unit, and only for the next run of parity check. If you leave the DEC RAID Manager without running parity check, the change no longer applies.
- After you run manual parity check/repair, the parity error log report is automatically displayed, without your having to enter the file name of the file.
- You must run parity check/repair on each logical unit separately.

8.3.2 Running the Check

Use the following procedure to check and repair parity manually.

1. If you are running parity check/repair after an abnormal system shutdown, first run VRepair on all affected volumes before checking parity.
2. Start the DEC RAID Manager by entering the following command from the console:

   ```
   load raidmgr
   ```

3. Use the *Device Selection* option in the *Disk Array Services* menu to select the logical unit you want to check.
4. After you have selected the logical unit you want to check, select *Array Parity* from the *Disk Array Services* menu. The following menu is displayed:

5. From the *Disk Array Parity* menu, you can select the following options:
   - Check and Repair Parity—use this option to check and repair parity on the selected logical unit. The parity error log file contains a list of the errors found and repaired.
   - Check Parity (no repair)—use this option to check parity on the selected logical unit without repairing any errors found. The parity error log file contains a list of the errors found.
   - Change Parity Report File Name—use this option to change the name of the parity error log file for the current logical unit before you run parity check/repair. This change applies only to this logical unit, and only for the next run of parity check.
   - View Parity Report—use this option to view the parity report file for any logical unit.
   - Change Automatic Parity Time—use this option to change the scheduled time for au omatic parity check. You can not change the automatic parity repair parameter here.
6. If you want to write the parity error report to a file other than the default file, select the *Change Parity Report File Name* option and enter the new name. Any new name applies only to this logical unit and only for this run of parity check/repair.
7. Select either *Check and Repair Parity* or *Check Parity (no repair)* to start parity check.
8. A prompt is displayed to confirm that you want to check parity. Press Yes and the Enter key to start the selected operation.
9. A popbox is displayed as parity check is performed showing the percentage of the check completed. When the operation is completed, press the Enter key.
10. The parity error report for the logical unit you just checked is displayed.
    - If you selected parity check/repair, this is a list of the parity errors found and repaired. If no errors were found the report indicates this.
    - If you selected parity check without repair, this is a list of the parity errors found. To repair these errors, you have to run parity check with repair. If no errors were found the report indicates this.
11. After viewing the report, press the Esc key to return to the *Disk Array Parity* menu.
12. If you want to check more logical units, press the Esc key to return to the *Disk Array Services* menu, then use the *Device Selection* option to select another logical unit. Then go back to Step 4 and repeat this procedure.
13. Press the Esc key until you get the DEC RAID Manager exit prompt, then exit the DEC RAID Manager.

8.4 Changing Parity Check Scheduling

Use the following procedure to change the scheduled time for automatic parity check/repair.

Note

You can also change the scheduled time (but not the parity repair option) by selecting *Change Automatic Parity Time* from the *Disk Array Parity* menu.

1. Start the DEC RAID Manager by entering the following command from the console:

   ```
   load raidmgr
   ```

2. From the *Disk Array Services* menu, select *RAID Manager Configuration*.
3. From the *RAID Manager Configuration* menu, select *General Configuration*.
4. Use the Down-arrow key to highlight the *Parity Check Start Time* parameter on the General Configuration display.
5. Enter the new time for automatic parity check. Enter the time as a 24-hour value (that is, 1:00 PM is entered as 13:00).

Important

While the parity check/repair utility is running, workstations connected to the server may slow considerably until the check function is completed. During the utility's daily run, try and choose a time when this slowdown does not affect your operations.

6. After you enter the new time, press the Enter key The cursor automatically moves down one to highlight the *Automatic Parity Repair* option.
7. If you want to change the current value, press any key except the space bar or the Enter key to toggle to the other value (*yes* or *no*). There is normally no reason not to specify automatic parity repair.
8. After you have specified the parity repair parameter, press the Enter key to save the new value. The cursor automatically highlights the next parameter.
9. Press the Enter key to exit the *General Configuration* menu.
10. You are then prompted to determine whether you want to leave the menu with the current changes, leave without the changes, or return to the *General Configuration* menu to make more changes.
11. After you select *Yes*, you return to the *RAID Manager Configuration* menu.
12. Press the Esc key until you get the DEC RAID Manager exit prompt, then exit the DEC RAID Manager.

9

The Array Monitor Daemon

9.1 Array Monitor Daemon

The Array Monitor Daemon scans for non-optimal status on your array devices and notifies you when one is found. While these status changes are also written to the system error log and on the console screen, the Array Monitor Daemon notifies you immediately of the changes in status, and displays a message on the console terminal, regardless of which screen you happen to be in.

9.1.1 How the Array Monitor Daemon Works

The Array Monitor Daemon operates as follows:

1. At an specified interval (determined by the delay parameter value), the daemon polls the array devices (both logical units and individual drives) for their status.
2. If a status other then *Ok - Optimal* is returned (for any array component), the daemon *takes over* the console screen and displays the other status on the console screen for a specified period (determined by the persistence parameter value).
3. If at the end of the persistence interval you have not acknowledged the message, the daemon releases the screen. It displays the status again after the specified delay interval.
4. To acknowledge the message, press any key except the Enter key. The message then remains on the screen until you press the Enter key. After you press the Enter key, the delay interval begins again.

The Array Monitor Daemon continued to display the same status until you correct the condition that caused the status.

Important Note

The Array Monitor Daemon (AMD) does not poll array devices if DEC RAID Manager, the NetWare Install utility, or the NetWare VRepair utility is currently loaded.

9.1.2 What to do When an Error is Displayed

When the Array Monitor Daemon displays an error status on the console, you should take the following steps:

1. When the message first appears, press any key except the Enter key to hold the message on the screen (pressing the Enter key clears the screen—if that happens, you have to wait for the message to be displayed again).
2. Read the message, taking note of the array device named in the message (see the AMD message format Section 9.3).

3. Change to the console screen (by pressing the Alt-Esc key) to see if any messages are displayed there (they may have scrolled off the screen).
4. Start the DEC RAID Manager and check the logical unit status and drive status of the devices named in the error message.
5. Determine the nature of the error. See Section 2.5 for a list of logical unit status and drive status.
6. Read the system error log to see if there are any associated messages in the log that might further explain the error and its consequences. Frequently, there are also standard NetWare error messages associated with the error.
7. Take whatever action is required to restore your array (Chapter 5 of this manual).

9.1.3 Error Log Example

This section gives an example of Array Monitor Daemon operations on a RAID 5 logical unit. The example represents one set of error messages you might see if a single drive fails on a RAID 5 logical unit. It is not necessarily the only sequence (the circumstances which caused the drive to fail may result in different error messages being displayed).

1. You are using the logical unit when the following message appears on the console terminal screen (which is not current set to the system console) at 1:40 PM:

```
Disk Array Monitor
Version xx.xx.xx

Device #7 (8B001) Degraded: Drive Failure
Array Drive Error: Channel 1, ID 0: Drive Failure

Press the Enter key to clear screen, any key to hold screen.
```

2. You press any key except the Enter key to keep the message on the screen so that you can read it.
3. From this message, you can see that a drive has failed in a RAID 1 or RAID 5 logical unit, leaving the logical unit in the degraded mode. The logical unit involved is Device #7.
4. After you have read the message, press the Enter key to clear the error message from the screen.
5. Press the Alt-Esc key to switch to the console screen and see the following messages:

```
7/29/92 1:39 PM: 0.0.0 Array Monitor Daemon: Array Device Error:
Device #7 (8B001) Status: Degraded: Drive Failure

7/29/92 1:39 PM: 0.0.0 Array Monitor Daemon: Array Component Disk Error:
Channel 1 ID 0, Status: Failed: Drive Failure
```

6. Next, start the DEC RAID Manager and use the *Device Selection* option to select Device #7. You can see from the display that Device #7 is a RAID 5 logical unit and that one of the drives in the array has failed.
7. Check your system error log until you find the corresponding messages (from the *Disk Array Services* menu, select *System Messages*, then *System Error Log*). In this case, you see the following messages:

```
7/29/92 1:39 PM Severity = 3
0.0.0 Array Monitor Daemon: Array Device Error:
Device #7 (8B001) Status: Degraded: Drive Failure

7/29/92 1:39 PM Severity = 3
0.0.0 Array Monitor Daemon: Array Component Disk Error:
Channel 1 ID 0, Status: Failed: Drive Failure
```

8. Check any messages preceding and following to see if they clarify the reasons for the drive failure. In this case, there are no further messages.

   Note you could see standard NetWare error messages relating to the array error messages. For example, for an error more serious than the one in this example you might see:

```
9/27/91 10:57:38 am  Severity = 4.
1.1.10 Device #1 (8B001) *** NCR ADP-92/01 0100 deactivated due to drive failure.

9/27/91 10:57:38 am  Severity = 4.
1.1.86 Volume ARRAY dismounted due to drive deactivation
```

   These messages, from NetWare, indicate that the array device has been deactivated as the result of a drive failure, and that the volume ARRAY (contained on the deactivated device), has been dismounted. These messages would follow array-specific messages indicating drive or logical unit failure.

9. Search through the rest of the error log to make sure there are no errors affecting other logical units or other errors affecting this unit.
10. Given the error indicated, you would then go to Chapter 5 for the steps required to restore a RAID 5 array. (In this case, you would replace the failed drive and reconstruct the data on it.)
11. Clear the error log (copy it to a file first so that you can refer to it later if necessary).

9.2 Error Message Types

The DEC RAID Manager and the disk array software generate three basic types of error messages:

- Array-specific error messages, which are displayed only for the disk array. These messages are displayed by AMD on the current screen, the console screen, and in the system error log (see Section 9.4).
- Standard NetWare error messages. These messages are displayed on the console and written to the system error log. These messages are also used for devices other than the disk array. See your NetWare System Messages documentation for an explanation of these messages. These messages are not displayed by the Array Monitor Daemon.
- Error messages that occur while you are running the DEC RAID Manager. These messages are displayed on the console as soon as they occur. They are not written to the system error log (Section 9.5).

9.3 AMD Error Message Format

There are three kinds of AMD messages:

- AMD messages that appear in the pop-up screen.
- AMD messages displayed on the system console.
- AMD messages written in the system error log.

9.3.1 AMD Pop-Up Message Format

AMD pop-up messages are displayed periodically on the console terminal, regardless of which screen is currently displayed, until you acknowledge the message. They have the following format:

```
                Disk Array Monitor
                 Version xx.xx.xx

Device #n (devID) lun-status
Array Drive Error: Channel x, ID y: drive-status
```

- n is the device number of the logical unit affected by the status change.
- devID is the device ID of the logical unit affected by the status change. Device IDs have the following format:

  The first 2 digits indicate the type of host adapter. These digits are assigned by NetWare. For example, 8B is the DPT PM2012B differential host adapter.

  The 3rd digit is the board number assigned to the host adapter by the NetWare system.

  The 4th digit is the SCSI ID of the array controller.

  The 5th, or last, digit is the logical unit number.
- lun_status is the current status of the affected logical unit.
- x is the channel number of the drive affected by the status change.
- y is the SCSI ID of the drive affected by the status change.
- drive_status is the current status of the affected drive.

9.3.2 AMD Console Message Format

AMD console messages are displayed on the system console once when the status change is detected. AMD console messages have the following format (the first message given is for a logical unit; the second message is for an array drive):

```
mm/dd/yy hh:mm : 0.0.0 Array Monitor Daemon: Array Device Error:
Device #n (devID) Status: lun-status

mm/dd/yy hh:mm : 0.0.0 Array Monitor Daemon: Array Component Disk Error:
Channel x ID y, Status: drive-status
```

- mm/dd/yy hh:mm is the time the status change was detected.
- n is the device number of the logical unit affected by the status change.
- devID is the device ID of the logical unit affected by the status change. Device IDs have the following format:

  The first 2 digits indicate the type of host adapter. These digits are assigned by NetWare. For example, 8B is the DPT PM2012B differential host adapter.

  The 3rd digit is board number assigned to the host adapter by the NetWare system.

  The 4th digit is the SCSI ID of the array controller.

  The 5th, or last, digit is the logical unit number.
- lun_status is the current status of the affected logical unit.
- x is the channel number of the drive affected by the status change.
- y is the SCSI ID of the drive affected by the status change.
- drive_status is the current status of the affected drive.

9.3.3 AMD Error Log Message Format

AMD error log messages are written into the system error log when the status change is first detected. They have the following format (note that this is a standard NetWare error log format):

```
dd/mm/yy hh:mm Severity = z
0.0.0 Array Monitor Daemon: Array Device Error:
Device #n (devID) Status: lun-status

dd/mm/yy hh:mm Severity = z
0.0.0 Array Monitor Daemon: Array Component Disk Error:
Channel x ID y, Status: drive-status
```

- mm/dd/yy hh:mm is the time the status change was detected.
- z—the severity of the error:

  0 = Informational

  1 = Warning

  3 = Critical

  4 = Fatal
- n is the device number of the logical unit affected by the status change.
- devID is the device ID of the logical unit affected by the status change. Device IDs have the following format:

  The first 2 digits indicate the type of host adapter. These digits are assigned by NetWare. For example, 8B is the DPT PM2012B differential host adapter.

The 3rd digit is board number assigned to the host adapter by the NetWare system.

The 4th digit is the SCSI ID of the array controller.

The 5th, or last, digit is the logical unit number.

- lun_status is the current status of the affected logical unit.
- x is the channel number of the drive affected by the status change.
- y is the SCSI ID of the drive affected by the status change.
- drive_status is the current status of the affected drive.

9.4 AMD Error Messages

The following messages are AMD messages, and appear on you system console if AMD detects a status change in the array.

9.4.1 Array Component Errors

These errors have the following format:

```
Array Monitor Daemon: Array Component Error
<drive name > Status: Array Formatting
```

where <drive name > is the device ID of the drive.

Note

The errors in the following tables are all Array Component Errors, so the words *Array Monitor Daemon: Array Component Error* are not displayed in the following tables.

Table 9–1 Array Component Errors

Message	Probable Cause	Action To Take
<drive name> Status: Array Formatting	The array controller is formatting a drive.	No action.
<drive name> Status: Bad Channel	You have installed a drive that has a different channel than the drive that was originally in its place.	Replace the drive with a drive having the correct channel.
<drive name> Status: Drive Not Ready	The drive failed the Test Unit Ready (that occurs during a logical unit format) after the drive was hot swapped, added, or after the subsystem was started.	Replace the drive, and make sure that the data is restored to the logical unit containing it.
<drive name> Status: Failed	The drive failed during a write to the logical unit, or failed the initialization process.	Replace the drive, and make sure that the data is restored to the logical unit containing it.

(continued on next page)

Table 9–1 (Cont.) Array Component Errors

Message	Probable Cause	Action To Take
<drive name> Status: Failed by User	The drive was failed through ACE.	Replace the drive, and make sure that the data is restored to the logical unit containing it.
<drive name> Status: Format Failed	The SCSI format issued to the drive failed. This format was issued through ACE as a logical unit format or drive format before reconstruction.	Try to format the logical unit again. If it fails again, replace the drive and make sure that the data is restored to the logical unit containing it.
<drive name> Status: Illogical SCSI ID	You have installed a drive that has a different ID than the drive that was originally in its place.	Replace the drive with a drive of the correct ID.
<drive name> Status: Newly Replaced	The drive has just been replaced.	No action.
<drive name> Status: Status: OK - Warning Condition	The drive has experienced errors while read operations were occurring.	Backup (if possible) and restore the logical unit.
<drive name> Status: Status: OK - Warning Condition	The drive is part of a RAID 0 logical unit and has experienced errors while reading or writing.	Backup (if possible) and restore the logical unit.
<drive name> Status: Reconstructing	The drive data is being reconstructed by the array controller.	No action.
<drive name> Status: Start of Day Failure	At system boot-up, the drive failed because it did not accept writes from the array controller.	Backup (if possible) and restore the logical unit.
<drive name> Status: Write Failed	The drive failed when the array controller was initializing it for array parity.	Backup (if possible) and restore the logical unit.
<drive name> Status: Wrong Capacity	The drive is incompatible with the other drives in the logical unit because its capacity is different.	Remove the drive and replace it with a certified drive.
<drive name> Status: Wrong Ctrl Serial No.	The drive that was just installed was originally connected to a different array controller and was formatted with special information about that array controller, AND it replaced a drive that was optimal, spare, or warning.	Fail the drive using ACE, and restore the logical unit.
<drive name> Status: Wrong Parameters	The drive is incompatible with the other drives in the logical unit because it is a different size.	Remove one drive and replace it with a drive that is the same size as the other drives.

(continued on next page)

Table 9–1 (Cont.) Array Component Errors

Message	Probable Cause	Action To Take
<drive name> Status: Wrong Replacement Disk	An optimal or warning drive in a degraded logical unit was replaced, or an optimal or spare drive or a drive that is being formatted was replaced and then the subsystem was shutdown.	Replace the drive that was mistakenly removed from the subsystem, turn on the subsystem, and remove the drive that you had intended to remove. CAUTION: DO NOT send I/O to the logical unit until you have completed all the steps above.
<drive name> Status: Wrong Sector Size	The drive is incompatible with the other drives in the logical unit because its sector size is different.	Remove the drive and replace it with a certified drive.

9.4.2 Array Device Errors

These errors have the following format:

```
Array Monitor Daemon: Array Device Error
<LUN name > Status:  Bad Channel
```

where <LUN name> is the device name of the logical unit.

Note

The errors in the following tables are all Array Device Errors, so the words *Array Monitor Daemon: Array Device Error* are not displayed in the following tables.

Table 9–2 Array Device Errors

Message	Probable Cause	Action To Take
<LUN name> Status: Bad Channel	The logical unit is dead because a drive that has a different channel than the drive that was originally in its place was installed.	Replace the drive with the wrong channel with a drive of the correct channel.
<LUN name> Status: Bad Identifier	The logical unit is dead because a drive has a different ID than the drive that was originally in its place was installed.	Replace the drive with the wrong channel with a drive of the correct ID.
<LUN name> Status: Bad Parameters	The logical unit is dead because a drive that has a different capacity from the other drives in the logical unit has been installed.	Replace the drive with the wrong capacity with a certified drive.

(continued on next page)

Table 9–2 (Cont.) Array Device Errors

Message	Probable Cause	Action To Take
<LUN name> Status: Component Failure	Two drives were removed from a RAID 5 logical unit, and then the multi- rank subsystem was shutdown.	Shutdown the subsystem, replace the drives in their original positions, and restart the subsystem. CAUTION: DO NOT send I/O to the logical unit until you have completed the steps above.
<LUN name> Status: Degraded - Drive Failure	A drive has failed in the logical unit.	The drive needs to be replaced as soon as possible. The logical unit remains degraded until the drive is replaced.
<LUN name> Status: Degraded - Drive Formatting	The logical unit is degraded and the drive that was just replaced is being formatted by the array controller.	No action.
<LUN name> Status: Drive Failures	Multiple drives are failed in the logical unit.	The drives need to be replaced. Then the logical unit needs to be formatted and the data copied from the back-up media to the logical unit.
<LUN name> Status: Formatting	The logical unit is being formatted by the array controller.	No action.
<LUN name> Status: OK - Reconstructing	The array controller is reconstructing the data on the newly-replaced drive.	No action.
<LUN name> Status: Waiting for Format	The logical unit is dead and must be formatted.	Format the logical unit using ACE.

(continued on next page)

Table 9–2 (Cont.) Array Device Errors

Message	Probable Cause	Action To Take
<LUN name> Status: Wrong Drive.	The logical unit is dead because a drive that was either optimal or in warning was replaced.	**First Option:** If no writes are sent to the logical unit, do the following: • Remove the new drive. • Replace the original drive. • Either, install the new drive in the correct location if the wrong drive was replaced, or fail the warning drive using ACE and replace it. **Second Option:** If writes are sent to the logical unit, reformat the logical unit and copy the data from the backup media to the logical unit.

9.4.3 Other Status Change Errors

Table 9–3 Other Status Change Errors

Message	Probable Cause	Action To Take
Automatic Disk Array Parity Check Complete	Displayed once daily when the automatic parity check utility completes.	No action.
Automatic Disk Array Parity Check Started	Displayed once daily when the automatic parity check utility starts.	No action.
Array Monitor Daemon: <LUN 0 name> Obsolete Downloadable Controller Firmware [Version xx.yy.zz]	An old version of firmware is on the array drives.	Download new firmware.
Array Monitor Daemon: Power Supply #x Failure	A power supply failed.	Replace the failed power supply.
Array Monitor Daemon: Subsystem Unique Device #x failure	A subsystem component failed (for example, a fan).	Replace the failed component.
Disk Array Parity Check: Device #n (DevID)	The automatic parity check started for this device.	No action.

9.5 DEC RAID Manager Messages

Table 9–4 lists the error message explanations given in the DEC RAID Manager messages. These explanations may appear whenever you are using a DEC RAID Manager function or option.

Table 9–4 DEC RAID Manager Messages

Explanation	Probable Cause	Action To Take
ABORT: Insufficient Memory	Software problem.	Call your Customer Services Representative.
ABORT: Invalid option <option> in the command line.	The incorrect option was typed.	Type the command again using the correct option.
ABORT: No message text for confirmation header <#>, <message>	Software problem.	Call your Customer Services Representative.
ABORT: Unable to create confirmation menu	Software problem.	Call your Customer Services Representative.
ABORT: Unable to locate the DEC RAID Manager Data File	The file is deleted, or it was never installed properly.	Remove the DEC RAID Manager and reinstall it.
ABORT: Unable to locate the DEC RAID Manager Help File	The file is deleted, or it was never installed properly.	Remove the DEC RAID Manager and reinstall it.
ABORT: Unable to locate the DEC RAID Manager Message File	The file is deleted, or it was never installed properly.	Remove the DEC RAID Manager and reinstall it.
Error encountered during disk array parity checking.	The array controller was unable to complete the array parity operation due to an array controller software error.	Call your Customer Services Representative.
Error encountered during disk array parity repair. The array device may be require other servicing.	The array controller was unable to complete the array parity operation due to an array controller software error.	Call your Customer Services Representative.
File <file> on path <path> cannot be created or opened for writing.	There is a problem with the file, or there is a DEC RAID Manager software problem.	Try the operation again. If it fails again, call your Customer Service Representative.
File <file> on path <path> cannot be opened for reading.	There is a problem with the file, or there is a DEC RAID Manager software problem.	Try the operation again. If it fails again, call your Customer Service Representative.
Firmware data file <file> is not present in path <path>.	the DEC RAID Manager cannot find the file in the path you selected.	Try the operation again using the correct path name. If the problem occurs again, call your Customer Services Representative.

(continued on next page)

Table 9–4 (Cont.) DEC RAID Manager Messages

Explanation	Probable Cause	Action To Take
Incomplete download file or invalid download record format.	There is a problem with the diskette or with the file.	Try to download the firmware again. If the problem occurs again, call your Customer Services Representative.
the DEC RAID Manager Help file <file> is corrupt.	Software problem.	Remove the DEC RAID Manager utilities and reinstall them. If the problem occurs again, call your Customer Services Representative.
Unable to get exclusive access to the array device. A volume on the device may be mounted, or another process may have the device locked.	A volume may be mounted, or there is another process that is presently accessing the logical unit (for example, the Install utility, or another NetWare NLM).	**First Option:** Unmount the volume if it is mounted, then try the operation again. **Second Option:** Try to terminate the other process accessing the logical unit, then try the operation again.
Unable to complete the operation because an error occurred during a SCSI command. For detailed information, examine the DEC RAID Manager Activity Log.	There is a software problem or a host adapter problem.	Read the DEC RAID Manager Activity Log to determine the exact problem that occurred.
Unable to copy download file from disk. File may not be present, or SYS volume is full.	SYS volume is out of space, or there is a problem with the DOS copy.	**First Option:** Check the SYS volume to determine if it is full, and make some space on the disk if it is out of space. **Second Option:** Fix the DOS copy problem.
Unable to copy file form flexible disk. DOS must be present to perform the copy.	DOS is not available and must be for the firmware download.	• Reboot your system. • At the DOS prompt, enter *server -na*, then press the Enter key. • Download the firmware again.

Part VII

DEC RAID SCO UNIX Utility

This part of the guide contains:

- Chapter 10, Installation of the DEC RAID SCO UNIX Utility
- Chapter 11, Array Parity Check/Repair
- Chapter 12, RAID Monitor Utility

10

Installation of the DEC RAID SCO UNIX Utility

The DEC RAID SCO UNIX Utility provides additional functions in the SCO UNIX environment which are not present using the DEC RAID Stand-Alone Utility. These include a RAID Monitor for notification of changes in logical unit status or drive status, a RAID status utility for displaying current logical unit status and drive status, and a parity check/repair utility for checking and repairing parity on the disk array.

Chapter 2 describes the DEC RAID Stand-Alone Utility, its installation and functionality. This chapter discusses installation of the DEC RAID SCO UNIX utilities. Chapter 11 discusses the parity check/repair utility. Chapter 12 describes the array monitor utility, and Chapter 13 the RAID status utility.

10.1 About Installation

The DEC RAID SCO UNIX Utility kit is a floppy containing executables, shell scripts, and an SCO UNIX Sdsk driver. Table 10–1 describes the contents of the kit.

Table 10–1 DEC RAID SCO UNIX Utility Kit

File Name	Description
makedpth	Shell script to create device files /dev/dptH0 and /dev /dptH1 used by the utilities
monitor	RAID Monitor executable
monitorsh	Shell script to run the RAID Monitor
parity	RAID parity check/repair executable
paritysh	Shell script to run the parity check/repair utility
raidstat	RAID status utility executable
raidstatsh	Shell script to run the RAID status utility
read.me	Informational file for the user to read describing each of these files
help.txt	Text file for help messages

The next sections describe installation procedures for each of these utilities. Chapter 11, Chapter 12, and Chapter 13 provide further details on each of the utilities, their options, and their error messages.

10.1.1 Installing the RAID Manager Parity Check/Repair Utility

Installation of the RAID Manager parity check/repair utility involves the following steps:

1. Copy the following files from floppy to any directory of choice:
   - parity
   - paritysh
   - makedpth
   - help.txt
2. Change to superuser mode.
3. Set the PATH variable to point to the directory where the files reside.
   - **PATH=$PATH/directory_name**
4. Type **makedpth** to create the device files in /dev required by the utilities.
5. At this point, the RAID parity check/repair utility can be run. Chapter 11 describes running the RAID parity check/repair utility and its options.

10.1.2 Installing the RAID Monitor Utility

Installation of the RAID Monitor utility involves the following steps:

1. Copy the following files from floppy to any directory of choice:
   - monitor
   - monitorsh
   - makedpth
   - help.txt
2. Change to superuser mode.
3. Set the PATH variable to point to the directory where the files reside.
   - **PATH=$PATH/directory_name**
4. Type **makedpth** to create the device files in /dev required by the utilities.
5. At this point, the RAID Monitor can be started. Chapter 12 describes running the RAID Monitor and its options.

10.1.3 RAID Status Utility

Installation of the RAID status utility involves the following steps:

1. Copy the following files from floppy to any directory of choice:
   - raidstat
   - raidstatsh
   - makedpth
   - help.txt
2. Change to superuser mode.

3. Set the PATH variable to point to the directory where the files reside.
   - **PATH=$PATH/directory_name**
4. Type **makedpth** to create the device files in /dev required by the utilities.
5. At this point, the RAID status utility can be run. Chapter 13 describes running the RAID status utility and its options.

11

Array Parity Check/Repair

11.1 RAID Parity Check/Repair Utility

Parity check/repair performs the following functions:

The RAID parity check/repair utility runs a parity check and/or repair on a given LUN. Parity check/repair applies only to RAID 1 and RAID 5. RAID 0 does not have array parity. Parity check on a RAID 1 configuration simply compares the data on the mirrored drives. Parity check/repair cannot be run on a degraded RAID 1 or RAID 5 LUN. See the discussion at the beginning of Chapter 8 for further definition of parity check and repair.

11.1.1 Getting Started

The RAID parity check/repair can be invoked in one of two ways: through the shell script or by invoking the executable directly. The shell script method prompts you for options and invokes the monitor executable. The executable requires switch options to be specified, and is provided in the event that you would prefer to include in customized shell scripts.

11.1.1.1 Using the Shell Script

The RAID parity/repair utility can be invoked by typing *paritysh* at the system prompt. The following output will appear:

```
Parity Check/Repair Utility Shell Script  (C) Digital Equipment Corporation 1992
Version XX.X

Enter values for the following parameters or hit <CR>
for default value:

Enter SCSI ID [0]:
```

The format of the input prompt line shows the parameter to enter, followed by square brackets containing the default value of that parameter. Press the Return key or the Enter key to select the default value, or enter some other value for that parameter.

A full help menu which describes the options is available by typing *paritysh -h* at the system prompt. If help information for a specific parameter, enter *h* when that parameter is prompted for, and a description will be displayed.

Once all the parameters have been specified, the shell script invokes the parity executable, redirecting the output to a specified log file, and piping the execution statement to the SCO UNIX *at* utility. This schedules the parity check/repair to occur at the specified time.

The parity check/repair runs as a background process. The first phase reads each block on the LUN and verifies that the parity is *good*. It creates a unique file in /tmp which lists the blocks which had *bad* parity. If a repair is to be done, this file is opened, and the parity of the blocks in that file is repaired.

11.1.1.2 Invoking the Executable

The RAID Monitor can also be started by invoking the executable directly. Enter *parity [options]* to start execution. The *-h* option prints out a help menu with a description of the various switches.

11.1.2 Options

The options available to both the shell script and executable are outlined the Table 11–1.

Table 11–1 Parity Check/Repair Utility Options

Options	Symbol	Description
SCSI ID	-iID	The SCSI ID of the DEC RAID Subystem. The value must be from 0 to 7, with a default value of 0.
SCSI LUN	-iLUN	The SCSI LUN. This value is not used at this time and should be set to the default value of 0.
Device File	-dFILENAME	The device file name for access to the DPT Host Adapter. • For the shell script, the default is *0*, for /dev /dptH0 which is the device file for the DPT controller as a primary controller. Enter *1* for /dev/dptH1 which is the secondary controller. • Invoking the executable, this option does not need to be specified for the default value of 0. If the secondary controller is required, either *-d/dev/dptH1* or *-1* can be specified.
Check only	-c	Select parity check option only (no repair).
Time	n/a	Time of day to run the parity/check utility. Used by the paritysh only. If no time is specified, then the utility will be run within the next few minutes. Invoking the executable will cause the Parity check /repair to run in the foreground immediately, unless piped to *at* or some other scheduling utility.
Log File Name	n/a	Name of the log file to write errors. Used by the paritysh only. The user must manually redirect the output to a file if the executable is invoked.

11.1.3 Output

The output goes to the screen or to a log file depending on how the utility is run. The output is shown below.

```
Parity Check/Repair Utility  (c) Digital Equipment Corporation 1992
Version X.XX

Parity Check begun timestamp

Comparing block 0 H to FFFF H
      .
      .
      .

Parity Check completed timestamp

Number of blocks with bad parity: 0

Parity Repair begun timestamp

Parity Repair completed timestamp

Number of repaired blocks: 0
```

The output lists the range of blocks whose parity is checked. If at any time a block with bad parity is found, the following message appears:

```
*** Bad parity found at block a ****
```

The total number of blocks with bad parity will be displayed after the check is complete. The repair portion of the display will show any blocks repaired with the following message:

```
Repairing parity at block a
```

A final count of all blocks repaired is given at the end of the display.

11.1.4 Error Messages

The error messages returned by the parity check/repair utility use the following format:

- For general error messages:

```
PARITY: message
```

Generically, if an error occurs during a command to the controller which results in either a DPT Host Adapter error, or a SCSI status other than *good*, that information will be presented to the user in the following format:

- SCSI Check Condition Status (2 H)

```
SCSI Check Condition
SCSI Sense Key: 6 H  ASC: 29 H  ASCQ: 0 H
```

In this example, the SCSI status is a Check Condition (2 H), the Sense Key is 6 H, the Additional Sense Code (ASC) is 29 H, and the Additional Sense Code Qualifier (ASCQ) is 0 H indicating a power on, reset or bus device reset occurred. Appendix A lists all the ASC's, ASCQ's and Sense Keys valid for the array controller. Note that these values are given in hexadecimal notation.

- Host Adapter error or SCSI Status (other than *Check Condition*)

```
SCSI Status: 0 H
Host Adapter Status: 7 H
```

In this example, the SCSI status is 0 H and the Host Adapter Status is 7 H indicating a bus parity error. Appendix A lists all the SCSI status codes for the array controller as well as the host adapter error codes.

The following list describes the general error messages returned from the utility.

Error Opening Controller Device File x—Results from problems opening /dev /dptH0 or /dev/dptH1. Verify that those device file exist.

Error issuing read capacity to device—Array controller was unable to respond to the request sense command.

Error issuing verify command to device—Array controller was unable to respond to the verify command.

Error repairing parity on device—An error occurred while repairing the parity blocks.

Illegal switch - x—An illegal option was specified.

Error Opening Bad Parity Blocks File—An error occurred while attempting to open the bad parity blocks file in /tmp.

Error Reading Bad Parity Blocks File—An error occurred during the repair phase trying to open the bad parity blocks file in /tmp.

12

RAID Monitor Utility

12.1 RAID Monitor

The RAID Monitor performs the following functions: The RAID Monitor notifies the user of any change of status in the Logical Units (LUN) or devices in the array. Messages can appear on /dev/console and/or in a file depending on option selection.

12.1.1 Getting Started

The RAID Monitor can be invoked in one of two ways: through the shell script or by invoking the executable directly. The shell script method prompts the user for options and invokes the monitor executable. The executable requires switch options to be specified, and is provided in the event that the user would prefer to include it in customized shell scripts.

12.1.1.1 Using the Shell Script

The RAID Monitor can be invoked by typing *monitorsh* at the system prompt. The following output appears:

```
RAID Monitor Utility Shell Script      (C) Digital Equipment Corporation 1992
Version XX.X

Enter values for the following parameters or hit <CR>
for default value:

Enter SCSI ID [0]:
```

The format of the input prompt line shows the parameter to enter, followed by square brackets containing the default value of that parameter. Press the Return key or the Enter key to select the default value, or enter some other value for that parameter.

A full help menu which describes the options is available by typing *monitorsh -h* at the system prompt. If help information is needed for a specific parameter, enter *h* when that parameter is prompted for, and a description is displayed.

Once all the parameters have been specified, the shell script invokes the monitor executable, redirecting information output to /dev/console, and error information to a logfile.

The monitor runs as a background process in the system. When the monitor is started, a status of the logical units and drives is displayed. This information is similar to the information display when the RAID status utility the screen.

12.1.1.2 Invoking the Executable

The RAID Monitor can also be started by invoking the executable directly. Enter *monitor [options]* to start execution. The *-h* option prints out a help menu with a description of the various switches. It is the user's responsibility to redirect standard output and standard error if necessary.

12.1.2 Options

The options available to both the shell script and executable are outlined the Table 12–1.

Table 12–1 RAID Monitor Options

Options	Symbol	Description
SCSI ID	-iID	The SCSI ID of the DEC RAID Subystem. The value must be from 0 to 7, with a default value of 0.
SCSI LUN	-lLUN	The SCSI LUN. This value is not used at this time and should be set to the default value of 0.
Device File	-dFILENAME	The device file name for access to the DPT Host Adapter. • For the shell script, the default is *0*, for /dev/dptH0 which is the device file for the DPT controller as a primary controller. Enter *1* for /dev/dptH1 which is the secondary controller. • If the executable is invoked, this option does not need to be specified for the default value of 0. If the secondary controller is required, either *-d/dev/dptH1* or *-1* can be specified.
Time	-tTIME	Interval of time to update status. This time is specified in minutes.
Log File Name	n/a	Name of the log file where errors are written. Used by the monitorsh only. The user must manually redirect the output to a file if the executable is invoked.

12.1.3 Error Messages

The error messages returned by the RAID Monitor use the following format:

- For general error messages:

```
MONITOR: message
```

- For a change in LUN status:

```
MONITOR: Lun 0 Status Changed Thu Oct 15 13:11:19 EDT 1992
MONITOR: Drives: (1,2) (3,4)
MONITOR: Previous status: Optimal
MONITOR: New status     : Degraded
```

The LUN is identified in the first message with a timestamp of when the change was displayed. The next line shows the drives associated with that LUN referenced by channel and SCSI ID of the drive. In the above example, 2 drives are associated with LUN 0, a drive in channel 1 and at SCSI ID 2, and at channel 3, and SCSI ID 4. Finally a description of the previous status and new status is displayed.

- For a change in drive status:

```
MONITOR: Drive Channel 1 ID 2 Status Changed Thu Oct 15 13:11:19 EDT 1992
MONITOR: Previous status: Optimal
MONITOR: New status      : Degraded: Drive failure
```

The drive is identified by channel and SCSI ID with a timestamp of when the change was displayed. This is followed by a description of the previous status, and now the new status.

Generically, if an error occurs during a command to the controller which results in either a DPT Host Adapter error, or a SCSI status other than *good*, that information is presented in the following format:

- SCSI Check Condition Status (2 H)

```
SCSI Check Condition
SCSI Sense Key: 6 H  ASC: 29 H  ASCQ: 0 H
```

In this example, the SCSI status is a Check Condition (2 H), the Sense Key is 6 H, the Additional Sense Code (ASC) is 29 H, and the Additional Sense Code Qualifier (ASCQ) is 0 H indicating a power on, reset, or bus device reset occurred. Appendix B lists all the ASC's, ASCQ's and Sense Keys valid for the array controller. Note that these values are given in hexadecimal notation.

- Host Adapter error or SCSI Status (other than *Check Condition*)

```
SCSI Status: 0 H
Host Adapter Status: 7 H
```

In this example, the SCSI status is 0 H and the host adapter status is 7 H indicating a bus parity error. Appendix A lists all the SCSI status codes for the array controller. Appendix C lists all the DPT host adapter error codes.

The following list describes the general error messages returned from the utility.

Error Opening Controller Device File x Monitor process terminating—Results from problems opening /dev/dptH0 or /dev/dptH1. Verify that those device file exist.

Error issuing inquiry command to device Monitor process terminating—Array controller was unable to respond to the inquiry command. Verify that the array controller is booted and the drives are spun up.

Lun x Status Changed Not Configured—LUN originally was configured, but no longer responds as configured.

Lun x Status Changed Configured—LUN originally was not configured, but now responds as if configured.

Error issuing mode sense command to logical array page Monitor process terminating—Unable to successfully issue a mode sense command to the array controller, and are terminating the monitor process.

Error issuing mode sense command to physical array page Monitor process terminating—Unable to successfully issue a mode sense command to the array controller, and are terminating the monitor process.

Illegal switch - x Monitor process terminating—An illegal option was specified.

13

RAID Status Utility

13.1 RAID Status Utility

The RAID status utility displays the current Logical Unit (LUN) status and device status.

13.1.1 Getting Started

The RAID status utility can be invoked in one of two ways: through the shell script or by invoking the executable directly. The shell script method prompts the user for options and invokes the monitor executable. The executable requires switch options to be specified, and is provided in the event that the user would prefer to include in customized shell scripts.

13.1.1.1 Using the Shell Script

The RAID status utility can be invoked by typing *raidstatsh* at the system prompt. The following banner appears:

```
RAID Status Utility Shell Script      (C) Digital Equipment Corporation 1992
Version XX.X

Enter values for the following parameters or hit <CR> for
default value:

Enter SCSI ID [0]:
```

The format of the messages include the parameter to enter, followed by square brackets containing the default value of that parameter. Press the Return key or the Enter key to select the default value, or enter some other value for that parameter.

A full help menu which describes the options is available by typing *raidstatsh -h* at the system prompt. If help information for a specific parameter, enter *h* when that parameter is prompted for, and a description is displayed.

Once all the parameters have been specified, the shell script invokes the raidstat executable, displaying all status information to the screen.

13.1.1.2 Invoking the Executable

The RAID status utility can also be started by invoking the executable directly. Enter *raidstat [options]* to start execution. The *-h* option prints out a help menu with a description of the various switches.

13.1.2 Options

The options available to both the shell script and executable are outlined the Table 13–1.

Table 13–1 RAID Status Utility Options

Options	Symbol	Description
SCSI ID	-iID	The SCSI ID of the DEC RAID Subystem. The value must be from 0 to 7, with a default value of 0.
SCSI LUN	-lLUN	The SCSI LUN. This value is not used at this time and should be set to the default value of 0.
Device File	-dFILENAME	The device file name for access to the DPT Host Adapter. • For the shell script, the default is 0, for /dev/dptH0 which is the device file for the DPT controller as a primary controller. Enter 1 for /dev /dptH1 which is the secondary controller. • Invoking the executable, this option does not need to be specified for the default value of 0. If the secondary controller is required, either *-d /dev /dptH1* or *-1* can be specified.

13.1.3 Output

The status information displayed by the RAID status utility is shown below.

```
RAID Status Utility   Version X.XX  (C) Digital Equipment Corporation 1992
LUN STATUS

Lun   RAID    Status                          Drives (Chan,ID)        Size  Type
-------------------------------------------------------------------------------
0     RAID 5  Optimal                    (2,0)  (3,0)  (4,0)     3318041  Reg
1     RAID 1  Optimal                           (1,0)  (5,0)     1658880  Sub

DRIVE STATUS

ID    Channel
      1     2     3     4     5

0     0     0     0     0     0
1     1     1     1     1     1
2     1     1     1     1     1
3     1     1     1     1     1
4     1     1     1     1     1
5     1     1     1     1     1
6     1     1     1     1     1
7     7     7     7     7     7
0-opt 1-no-exist 2-spare 3-fail 4-repl 5-warn 6-mismtch 7-ctrl 8-fmt 9-wrong
```

The LUN status is displayed first. Each LUN is listed, followed by its RAID number, and status. The drives associated with the LUN are listed next as (x,y) where x is the channel number, and y is the SCSI ID of the drive. The size is display as the number of blocks in this LUN. The LUN type is either regular or sublun.

The drive status shows the status of each drive referenced in the matrix by channel and SCSI ID. The definition of the statuses is listed in the last line of the display (See Section 3.3.2 for an explanation of the drive statuses).

13.1.4 Error Messages

The error messages returned by the RAID status utility use the following format:

- For general error messages:

```
RAIDSTAT: message
```

Generically, if an error occurs during a command to the controller which results in either a DPT Host Adapter error, or a SCSI status other than *good*, that information are presented in the following format:

- SCSI Check Condition Status (2 H)

```
SCSI Check Condition
SCSI Sense Key: 6 H  ASC: 29 H  ASCQ: 0 H
```

In this example, the SCSI status is a Check Condition (2 H), the Sense Key is 6 H, the Additional Sense Code (ASC) is 29 H, and the Additional Sense Code Qualifier (ASCQ) is 0 H indicating a power on, reset or bus device reset occurred. Appendix A lists all the ASC's, ASCQ's and Sense Keys valid for the array controller. Note that these values are given in hexadecimal notation.

- Host Adapter error or SCSI Status (other than *Check Condition*)

```
SCSI Status: 0 H
Host Adapter Status: 7 H
```

In this example, the SCSI status is 0 H and the Host Adapter Status is 7 H indicating a bus parity error. Appendix A lists all the SCSI status codes for the array controller as well as the host adapter error codes.

The following list describes the general error messages returned from the utility.

Error Opening Controller Device File x—Results from problems opening /dev /dptH0 or /dev/dptH1. Verify that those device file exist.

Error issuing inquiry command to device—Array controller was unable to respond to the inquiry command. Verify that the array controller is booted and the drives are spun up.

Lun x Status Changed Not Configured—LUN originally was configured, but no longer responds as configured.

Lun x Status Changed Configured—LUN originally was not configured, but now responds as if configured.

Error issuing mode sense command to logical array page—Unable to successfully issue a mode sense command to the array controller.

Error issuing mode sense command to physical array page—Unable to successfully issue a mode sense command to the array controller.

Illegal switch - x—An illegal option was specified.

A

SCSI-2 Status Codes

This appendix lists the supported SCSI-2 status codes for the array controller. Refer to Table A–1 below.

Table A–1 SCSI-2 Status Codes for the Array Controller

Status Description	Code
Good	00 H
Check Condition	02 H
Busy	08 H
Reservation Conflict	18 H
Queue Full	28 H

B

SCSI Sense Keys and Additional Sense Codes

This appendix lists the SCSI sense keys, additional sense code (ASC), and additional sense code qualifier (ASCQ) values that the controller returns in the sense data. SCSI-2-defined codes are used when possible. Array-specific error codes are used when necessary and are assigned SCSI-2 vendor-unique codes 80-FFH.

Some errors that could be mapped into SCSI-2-defined ASC bytes are assigned vendor-unique codes to provide more error information than the SCSI-2 defined ASCQ bytes. In these cases, the SCSI-2-defined byte is returned in the ASC field and the more detailed error information byte is returned in the ASCQ field as a vendor-unique qualifier of the standard ASC. These ASCQ bytes have values 80-FFH.

Table B–1 below defines SCSI sense keys.

Table B–1 SCSI Sense Keys

Sense Key	Description
0x00	No Sense
0x01	Recovered Error
0x02	Not Ready
0x03	Medium Error
0x04	Hardware Error
0x05	Illegal Request
0x06	Unit Attention
0x07	Data Protect (returned only if the drive returns this sense key)
0x08	Blank Check (not used)
0x09	Vendor-Specific (not used)
0x0A	Copy Aborted (not used)
0x0B	Aborted Command
0x0C	Equal (not used)
0x0D	Volume Overflow (not used)
0x0E	Miscompare (not used)
0x0F	Reserved (not used)

Table B–2 defines the additional sense codes (ASC) and additional sense code qualifiers (ASCQ) affiliated with a given sense key.

Table B–2 SCSI Error Codes

ASC	ASCQ	Sense Key	Description
00	00	0	No Additional Sense Information
00	06	0	I/O Process Terminated
01	00	1,4	No Index/Sector Signal
02	00	1,4	No Seek Complete
03	00	1,4	Peripheral Device Write Fault
04	00	1,2	Logical Unit Not Ready, Cause Not Reportable
04	01	1,2	Logical Unit Is In Process Of Becoming Ready
04	02	1,2	Logical Unit Not Ready, Initializing Command Required
			Start Unit command required
04	03	1,2	Logical Unit Not Ready, Manual Intervention Required
04	04	1,2	Logical Unit Not Ready, Format In Progress
04	80	2	Logical Unit Not Ready, ROM Installed Does Not Support Redundant Controller Configuration
05	00	1,2	Logical Unit Does Not Respond To Selection
06	00	1,3,4	No Reference Position Found
07	00	1,4	Multiple Peripheral Devices Selected
08	00	1,4	Logical Unit Communication Failure
08	01	1,4	Logical Unit Communication Timeout
08	02	1,4	Logical Unit Communication Parity Error
09	00	1,4	Track Following Error
0A	00	1,6	Error Log Overflow
0C	01	1	Write Error Recovered With Auto Reallocation
0C	02	1,3,4	Write Error—Auto Reallocation Failed
10	00	1,3,4	ID CRC or ECC Error
11	00	1,3,4	Unrecovered Read Error
			The description of this error as being unrecovered may be misleading because a drive-reported Unrecovered Read Error can be recovered by the array using parity. The sense key for this case is Recovered and the Recovery Actions field in the sense indicates that parity was used.
11	01	1,3,4	Read Retries Exhausted
11	02	1,3,4	Error Too Long To Correct
11	04	1,3,4	Unrecovered Read Error—Auto Reallocate Failed
11	0A	1,4	Miscorrected Error

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
11	0B	1,3	Unrecovered Read Error—Recommend Reassignment
11	0C	1,3	Unrecovered Read Error—Recommend Rewrite The Data
12	00	1,3	Address Mark Not Found For ID Field
13	00	1,3	Address Mark Not Found For Data Field
14	00	1,3	Recorded Entity Not Found
14	01	1,3	Record Not Found
15	00	1,3,4	Random Positioning Error
15	01	1,4	Mechanical Positioning Error
15	02	1,3,4	Positioning Error Detected By Read Of Medium
16	00	1,3,4	Data Synchronization Mark Error
17	00	1	Recovered Data With No Error Correction Applied
17	01	1	Recovered Data With Ret ies
17	02	1	Recovered Data With Positive Head Offset
17	03	1	Recovered Data With Negative Head Offset
17	05	1	Recovered Data Using Previous Sector ID
17	06	1	Recovered Data Without ECC—Data Auto-Reallocated
17	07	1	Recovered Data Without ECC—Recommend Reassignment
18	00	1	Recovered Data With Error Correction Applied
18	01	1	Recovered Data With Error Correction And Retries Applied
18	02	1	Recovered Data—Data Auto-Reallocated
18	05	1	Recovered Data—Recommend Reassignment
19	00	1,3	Defect List Error
19	01	1,3	Defect List Not Available
19	02	1,3	Defect List Error In Primary List
19	03	1,3	Defect List Error In Grown List
1A	00	1,5	Parameter List Length Error
1B	00[2]	1,4	Synchronous Data Transfer Error
1C	00	0,1,3	Defect List Not Found
1C	01	0,1,3	Primary Defect List Not Found
1C	02	0,1,3	Grown Defect List Not Found
1D	00	1,E	Miscompare During Verify Operation
1E	00	1	Recovered ID With ECC Correction
20	00	1,5	Invalid Command Operation Code
21	00	1,5	Logical Block Address Out Of Range
22	00	1,5	Illegal Function

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
24	00	1,5	Invalid Field In CDB
25	00	1,5	Logical Unit Not Supported
26	00	5	Invalid Field In Parameter List
26	01	5	Parameter Not Supported
26	02	5	Parameter Value Invalid
26	03	5	Threshold Parameters Not Supported
27	00	1,7	Write Protected
28	00	6	Not Ready To Ready Transition (Medium May Have Changed)
29	00[2]	6	Power On, Reset, Or Bus Device Reset Occurred
2A	00	6	Parameters Changed
2A	01	6	Mode Parameters Changed
2A	02	6	Log Parameters Changed
2C	00[2]	1,4	Command Sequence Error
2F	00	6	Commands Cleared By Another Initiator
30	00	1,3	Incompatible Medium Installed
30	01	1,3	Cannot Read Medium - Unknown Format
30	02	1,3	Cannot Read Medium - Incompatible Format
31	00	1,3	Medium Format Corrupted
31	01	3,4	Format Command Failed
31	80	5	Format Command Cannot Execute Because Of Multiple LUN Assignments Per Physical Drive
32	00	3,4	No Defect Spare Location Available
32	01	3,4	Defect List Update Failure
37	00	1	Rounded Parameter
39	00	5	Saving Parameters Not Supported
3A	00	1,2	Medium Not Present
3D	00[2]	1,5	Invalid Bits In Identify Message
3E	00	1,2	Logical Unit Has Not Self-Configured Yet
3F	00	6	Target Operating Conditions Have Changed
3F	01	6	Microcode Has Been Changed Returned when new drive microcode has been downloaded.
3F	02	6	Changed Operating Definition
3F	03	6	Inquiry Data Has Changed

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
3F	80[3]	(6)[1]	Drive Failed Because Of A Failed Write Operation This is the result of an error that prevents access to user data on this drive or that may result in erroneous data being read/written (for example, an Unrecovered Write Error).
3F	81[3]	(6)[1]	Drive Failed- Automatic Reallocation Failed Either reassign block or recovery of data on the reassigned sector failed.
3F	82[3]	(6)[1]	Drive Failed—Reconstruction Failed (Error On Drive Being Reconstructed) The reconstruction operation can not complete because of an unrecoverable Write error or a failed drive format (before reconstruction starts) on the drive being reconstructed. It must be replaced (again) before the reconstruction can be retried.
3F	83[3]	(6)[1]	Drive Failed—Reconstruction Failed (Error On Drive Required For Reconstruction) The reconstruction operation can not complete because of an unrecoverable Read error on one of the drives needed for reconstruction. You can still run the array in degraded mode, but if user data is stored at the address in error, you can not read it. You should attempt a back up of the array to recover the remaining data. To bring the LUN to an optimal state, replace the failed drive, format the array, and restore the data from a back-up copy (the one just made or a previous successful back-up copy).
3F	84[3]	(6)[1]	Drive Failed Due To A Hardware Component Diagnostics Failure
3F	85[3]	(6)[1]	Drive Failed Because It Failed A Test Unit Ready Command (during start-of-day) Or Read Capacity Command (during start-of-day or during a format or reconstruction operation)
3F	86[3]	(6)[1]	Drive Failed Because It Failed A Format Unit Command
3F	87[3]	(6)[1]	Drive Failed By A Host Mode Select Command
3F	88[3]	(6)[1]	Drive Failed Because Of Deferred Error Reported By The Drive
3F	89[3]	(6)[1]	Drive Failed By Start-of-Day Application Code Because Of A Drive Replacement Error
3F	90	(6)[1]	Unrecovered Read/Write Error Unrecovered Read errors always generate this condition.

[1]The Unit Attention sense key in parentheses (6) indicates that this code depends on the Sense Key for Drive Failures field in the EEPROM data.

[3]These conditions (3F 8x) require that the drive be replaced as soon as possible. User data is still available by using parity, but a second failure at this time (when a drive has been downed) results in the loss of user data for the entire LUN (RAID 5) or results in an unrecoverable error (other RAID levels).

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
			Unrecovered Write errors cause this condition if the state of the LUN or the RAID level guarantees that data at the other addresses will not be affected by the failed operation and continued access to this drive.
			A second drive failure or warning condition on another drive can prevent reconstruction of this drive.
3F	91	(6)[1]	Drive Reported Deferred Error Caused Drive To Be Placed In Warning
3F	AX	(6)[1]	Single Drive Array Assurance Error
			* X = 0—Drive ECC Test Failed
			* X = Other—Not Currently Implemented
3F	B0[4]	(6)[1]	Excessive Media Error Rate
3F	B1[4]	(6)[1]	Excessive Seek Error Rate
3F	B2[4]	(6)[1]	Excessive Grown Defects
3F	C0[5]	(6)[1]	No Response From One Or More Drives
3F	C1[5]	(6)[1]	Communication Errors
3F	C2[5]	(6)[1]	Firmware Indicates No Drive Is Present Although Information Stored On Disk Indicates Drive Should Be Present
3F	C7	(6)[1]	Subsystem Component Failure
			FRU code and qualifiers identify the failed component.
3F	C8	(6)[1]	AC Power Is Lost, DC Power Is Being Supplied By A Hold-Over Battery
3F	C9	(6)[1]	AC Power Is Lost, DC Power Supplied For A Maximum Of Two Minutes
			The host should start its shutdown procedure.
3F	CA	(6)[1]	AC Power Is Lost, DC Power Is Exhausted
			The controller will complete currently executing drive commands to maintain data integrity.
3F	CB	(6)[1]	AC Power Was Lost, But Is Now Restored
3F	D0[6]	(6)[1]	>75% Of Transfer Delays Caused By One Drive
3F	D1[6]	(6)[1]	>75% Of Non-Aligned Reselections Caused By One Drive
3F	D2[6]	(6)[1]	Synchronous Transfer Value Differences Between Drives
3F	D3[6]	(6)[1]	Software Measured Performance Degradation

[1]The Unit Attention sense key in parentheses (6) indicates that this code depends on the Sense Key for Drive Failures field in the EEPROM data.

[4]These errors are warnings to allow early drive replacement (drive still being used until a failed Write of user data—3F 80).

[5]These errors are warnings to check installation (drive still being used until a failed Write operation—3F 80).

[6]These errors are indications of potential performance degradation (drive still being used).

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
3F	D4[6]	(6)[1]	Mode Parameter Differences Between Drives May Cause Performance Degradation
3F	E0[7]	(6)[1]	LUN Downed
3F	E1[7]	4	Multiple Drives Have Been Downed
3F	E2[7]	4	Mode Parameters For Drives In LUN Don't Match
3F	E3[7]	4	Drive Channel Verification Failed
3F	E4[7]	4	SCSI ID Verification Failed
3F	E5[7]	4	Wrong Drive Was Replaced
3F	E6[7]	4	Component Failure Affecting Multiple Channels
3F	F0[8]	(6)[1]	EEPROM Error
3F	F1[8]	(6)[1]	EEPROM Hard Checksum Error
3F	F2[8]	(6)[1]	Maximum EEPROM Write Count Exceeded
3F	F8	(6)[1]	Application Software Copy To More Than One Drive Failed. Another download is required if the drive with the current application code failed.
40	00	4	RAM Failure
40	NN	4	Diagnostic Failure On Component NN (80H-FFH) In this release of the software, this ASC and ASCQ are only returned if reported by a drive. FRU codes will distinguish between failures on components of the array controller and components of the drive controllers.
41	00[2]	1,4	Data Path Failure, Carryover From CCS (same as 40 NN)
42	00	4	Power-On Or Self-Test Failure, Carryover From CCS (same as 40 NN)
43	00[2]	1,4	Message Error
44	00	1,4	Internal Target Failure
45	00[2]	1,4	Select/Reselect Failure
46	00[2]	4	Unsuccessful Soft Reset
47	00[2]	1,B	SCSI Parity Error
48	00	1,4	Initiator Detected Error Message Received
49	00[2]	1,4	Invalid Message Error

[1]The Unit Attention sense key in parentheses (6) indicates that this code depends on the Sense Key for Drive Failures field in the EEPROM data.

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

[6]These errors are indications of potential performance degradation (drive still being used).

[7]Subsequent media access commands to this LUN do not execute and return an ASC of Command Cannot Execute Because The LUN Has Been Downed with an ASCQ that indicates why the LUN is down.

[8]The configuration change (drive being marked failed/warning) could not be saved to EEPROM, but the update of the RAM information on the board and the DACSTORE information on the disk were successful. The new configuration information is used until a board power-up/reset. At that time, a diagnostic failure is detected that prevents the board from being used.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
4A	00[2]	1,4	Command Phase Error
4B	00[2]	4	Data Phase Error
4B	80	4	Data Overrun/Underrun
4C	00	1,4	Logical Unit Failed Self-Configuration
4E	00	1,B	Overlapped Commands Attempted
5A	00	6	Operator Request Or State Change Input (Unspecified)
5A	02	1,7	Operator Selected Write Protect
5A	03	6	Operator Selected Write Permit
5B	00	1,6	Log Exception
5B	01	1,6	Threshold Condition Met
5B	02	1,6	Log Counter At Maximum
5B	03	1,6	Log List Codes Exhausted
5C	00	1,6	RPL Status Change
5C	01	1,6	Spindles Synchronized
5C	02	1,6	Spindles Not Synchronized
80	00	4	Error Manager Detected Error
80	01	4	The Error Manager Was Invoked Without Any EM_ Code(s) Loaded
80	02[2]	4	The Error Manager Was Passed An Out-Of-Range Code
80	03[2]	4	The Error Manager Was Passed A Code By The SCSI Driver, But No Error Handler Exists
80	04	4	Fatal Null Pointer
80	05	(6)[1]	No AEN Code Or An Invalid AEN Code Was Loaded By The Application Software This error is detected when the AEN condition is requested by the command handler (either when the next command for this host/LUN is received or when a polled Request Sense is received), not when the AEN condition was detected. The illegal AEN code is loaded into the Error-Specific Information field in the sense data.
80	06	4	Maximum # Of Errors For This I/O Exceeded
80	07	4	Drive Reported Recovered Error Without Transferring All Of Data
81	00	4	Reconstruction Setup Failed
82	00	B	Out Of Heap
82	01	B	No Command Control Structures Available
82	02	B	No DAC Application Control Blocks Available

[1]The Unit Attention sense key in parentheses (6) indicates that this code depends on the Sense Key for Drive Failures field in the EEPROM data.

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
83	00	B	Reservation Conflict
84	00	4	Command Cannot Execute Because The LUN Has Been Downed
84	01[2,9]	4	Multiple Drives Have Been Downed
84	02[2,9]	4	Mode Parameters For Drives in LUN Do Not Match
84	03[9]	4	Drive Channel Verification Failed
84	04[9]	4	SCSI ID Verification Failed
84	05[9]	4	Format In Progress
84	06[9]	4	Awaiting Format Command
84	08[9]	4	Wrong Drive Was Replaced
84	09[9]	4	Component Failure Affecting Multiple Channels
85	00	4	General Application Code Command Handler Error
85	01[10]	4	Drive Error
85	02[10]	4	Host Error
85	03[10]	4	Drive Type Mismatch Within LUN
85	04[10]	4	Operation Not Allowed During Reconstruction
85	05[10]	4	Data Returned By Drive Is Invalid
85	06[10]	4	Non-Failed Drive Unavailable For Operations
85	07[10]	4	Insufficient Rank Structures Available
85	08[10]	4	Full Format Required, But Not Allowed (Sub LUNs)
85	09[10]	4	Drive Cannot Be Mode Selected To Meet LUN Parameters
85	0A[10]	4	Data Recovery After Re-Assign Block Command Failed
85	0B	4	Drive Not Returning Required Mode Sense Page(s) Drives must support Mode Sense pages 3 and 4.
86	00	4	Command Cannot Execute Because The LUN Is In Degraded Mode
87	00	4	Code Download/Upload Error
87	01	4	Partial Download (Missing Application Code Segment)
87	02	(6)[1]	Downloaded Code Cannot Be Saved To Disk Old application code will be uploaded on next power-up/reset.
87	03	4	Code CRC Failure Check is performed on the disk read after the new code is saved to disk.

[1]The Unit Attention sense key in parentheses (6) indicates that this code depends on the Sense Key for Drive Failures field in the EEPROM data.

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

[9]These errors (84 XX) are returned on every media access command to the downed LUN until the error is corrected.

[10]The original CDB field in the array sense data shows the failing command. Debug information is shown in the Error Detection Point sense field.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
87	04	(6)[1]	Upload Of Latest Version Of Code Failed
			An older version of code has been uploaded successfully.
87	05	4	No Package Verification Partition Downloaded
87	06	4	ROM Partitions Required For Download Of Code Missing
87	07	4	Incomplete RAM Partitions
87	08	4	Incompatible Board Type For The Code Downloaded
87	09	4	Incompatible ROM Version For Support Of The Downloaded Code
87	0A	1	Download Of Microcode To A Failed Disk Completed Successfully
			The drive is still unusable until it is marked as replaced and has been reconstructed.
88	00	4	EEPROM Command Error
88	02	4	EEPROM Not Responding
			(There is an EEPROM on the board.)
88	03	4	EEPROM Not "Formatted" (certain key fields have not been set.)
88	04	4	Invalid EEPROM Offset (a Write to the write-protected maintenance area causes this error.)
88	05	4	EEPROM Soft Checksum Error (indicates that an update was interrupted)
88	06	4	EEPROM Hard Checksum Error (indicates a component may be going bad)
88	07	4	Maximum Write Count Exceeded
88	09	4	EEPROM Not Initialized
89	00	4	Error On Request Sense Command To A Drive
8A	00	5	Illegal Command For Pass-Through Mode
			The original CDB field in the array sense data shows the failing command.
8A	01	5	Illegal Command For Current RAID Level
8B	00	B	Write Buffer Command (For Code Download) Was Attempted While Another Command Was Active
8B	01	5	Write Buffer Command (For Drive Microcode Download) Attempted But The Enable Bit In The EEPROM Was Not On
8C	00	4	Destination Transfer State Machine Error
8C	01	4	Invalid Transfer Release Requester
8C	02	4	Invalid Transfer Requester
8C	03	4	Data Stripe/Parity Generation ASIC Configuration Error

[1]The Unit Attention sense key in parentheses (6) indicates that this code depends on the Sense Key for Drive Failures field in the EEPROM data.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
8C	04	4	Data Transfer Request Error
8C	05	4	Invalid Transfer Pad Requester
8D	00	B,4	Destination Driver Data Transfer Did Not Complete
8E	00	B	Data Stripe/Parity Generation ASIC Error
8E	01	E	Parity/Data Mismatch
8E	02	B	Data Underrun
8F	00	B	Premature Completion Of A Drive Command (expected Data Transfer and received Good Status instead)
90	XX	4	DACSTORE Errors
			DACSTORE Error Bit Definitions
			Bits 0—3 = DACSTORE Identifier
			* Value of 0 = DACSTORE directory
			* Value of 1 = Disk store
			* Value of 2 = LUN store
			* Value of 3 = Controller store
			* Value of 4 = Log store
			* Value of 5 = High ID controller serial # store
			* Value of 6 = Low ID controller serial # store
			* Value of 7 = Redundant controller common store
			* Value of 8 = Boot block EEPROM store
			Bits 4—6 = Error Type
			* Value of 0 = Setup error
			* Value of 1 = Invalid directory data
			* Value of 2 = Drive error
			* Value of 3 = Invalid store data
			Bit 7 = Operation Type
			* Value of 0 = Read
			* Value of 1 = Write
91	00	5	Mode Select Errors
91	01	5	LUN Already Exists; Cannot Do "Add LUN" Function "80"
91	02	5	LUN Does Not Exist; Cannot Do "Replace LUN" Function "83" Or Any Logical Function
91	03	5	Drive Already Exists; Cannot Do "Add Drive" Function "80"
91	04	5	Drive Does Not Exist; Cannot Do Requested Action For It
91	05	5	Drive Can't Be Deleted; It Is Part Of A LUN
91	06	5	Drive Can't Be Failed; It Is Formatting

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
91	07	5	Drive Can't Be Replaced; It Is Not Marked As Failed Or Replaced
91	08	5	Invalid Action To Take
91	09	5	Invalid Action With Multiple Sub LUNs Defined (probably an attempt to change page 3—Format Device page)
91	0A	5	Invalid Reconstruction Amount
91	0B	5	Invalid Reconstruction Frequency
91	0C	5	Invalid LUN Block Size
91	0D	5	Invalid LUN Type
91	0E	5	Invalid Segment Size
91	0F	5	Invalid Segment 0 Size
91	10	5	Invalid Number Of Drives In LUN
91	11	5	Invalid Number Of LUN Blocks
91	12	5	Invalid RAID Level
91	13	5	Invalid Drive Sector Size
91	14	5	Invalid LUN Block Size/Drive Sector Size Modulo
91	15	5	No Disks Defined For LUN
91	16	5	Insufficient Rank Structures Available To Define LUN
91	17	5	Disk Defined Multiple Times For LUN
91	18	5	Sub LUN Drives Not The Same As Those Used By Other Sub LUNs On These Drives
91	19	5	Sub LUN RAID Level Mismatch
91	1A	5	First Sub LUN Defined For These Drives Has Not Yet Been Formatted; Second Sub LUN Is Illegal
91	1B	5	Non-Sub LUN Drive Already Owned By Another LUN
91	1C	5	Sub LUN Drive Already Owned By a Non-Sub LUN
91	1D	5	Drive Type Does Not Match The Drive Type Of The Other Drives In The LUN
91	1E	5	Drive Cannot Be Included In Rank Because Rank Is Full
91	1F	5	Ranks Have Different Number Of Disks Defined
91	20	5	Multiple Disks On Same Channel Within Same Rank
91	21	5	Mirrored Disks On The Same Channel
91	22	5	No Parity Disk Defined
91	23	5	No Data Disks Defined
91	24	5	Too Many Disks Defined
91	25	5	No Space Available For LUN—Sub LUN Cannot Be Defined
91	26	5	Drive Status Can Not Be Changed To Good (drive can not be revived through Mode Select)

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
91	27	5	Error In Processing A Subsystem Mode Page
91	28	5	Drive Inquiry Data Mismatch Between Drives In The LUN
91	29	5	Drive Capacity Mismatch Between Drives In The LUN
91	2A	5	Drive Block Size Mismatch Between Drives In The LUN
91	2B	5	Support Of TTD/CIOP Messages Is Not The Same For All Drives In The LUN
91	2C	5	Firmware Does Not Support Redundant Controller Options Selected
92	00	B	BUSY Status From Drives Could Not Be Cleared By Array Controller
93	00	4	Drive Vendor Unique Sense Data Returned See the drive sense area of the array sense for the drive ASC/ASCQ and sense key. Also refer to the drive documentation for further description.
94	00	5	Invalid Request Of A Controller In Redundant Controller Mode.
95	00	1,B	A Drive Channel Was Reset Probable cause is the removal or replacement of a drive during a hot swap operation
95	01	1,B	An Extended Drive Channel Reset Has Been Detected Probable cause is a drive left partially removed or inserted
96	00	6	Redundant Controller Not Supported By Current Firmware
96	01	4	Alternate Controller Not Supported By Current Firmware (however, the alternate controller has been detected)
B0	00	B	Command Timeout
B0	01	B	Watchdog Timer Timeout
B0	02	B	Software Loop Timeout
D0	00[2]	4	SCSI Driver Timeout
D0	01[2]	4	Disconnect Timeout
D0	02[2]	4	Chip Command Timeout
D0	03[2]	4	Byte Transfer Timeout
D1	00[2]	4	Bus Errors
D1	01[2]	4	CDB Transfer Incomplete
D1	02[2]	4	Unexpected Bus Phase
D1	03[2]	4	Disconnect Expected
D1	04[2]	4	ID Message Not Sent

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

(continued on next page)

Table B–2 (Cont.) SCSI Error Codes

ASC	ASCQ	Sense Key	Description
D1	05[2]	4	Synchronous Negotiation Error
D1	06[2]	4	Target Transfer Disable (TTD) Negotiation Conflict
D1	07[2]	4	Unexpected Disconnect
D1	08[2]	4	Unexpected Message
D1	09[2]	4	Unexpected Tag Message
D1	0A[2]	4	Channel Busy
D2	00[2]	4	Miscellaneous SCSI Driver Error
D2	01[2]	4	Illegal C96 Chip Command
D2	02[2]	4	Uncoded Execution Path
D3	00[2]	4	Drive SCSI Chip Reported Gross Error
D4	00[2]	4	Non-SCSI Bus Parity Error
D5	00[2]	4	Miscellaneous Host-Related Errors
D5	01[2]	4	Maximum Messages Received
D5	02[2]	4	Message Reject Received on a Valid Message
D6	00[2]	4	Source Driver Chip-Related Error
D7	00[2]	4	Source Driver Programming Error
D8	00	4	An Error Was Encountered That Required The Data Pointers To Be Restored But The Host Is Non-Disconnecting And Does Not Support The Restore Pointers Message (indicated by an EEPROM option control bit or by host selection without sending the identify message)

[2]The FRU code in byte 14 of the sense data indicates where the error was detected.

C

DPT Host Adapter Error Codes

This appendix lists the error codes for the DPT Host Adapter. Controller errors have priority over SCSI errors. Refer to Table C–1 below.

Table C–1 SCSI Status Codes for the DPT Host Adapter

Error Description	Code
No error	00 H
Selection timeout	01 H
Command timeout	02 H
SCSI bus reset	03 H
Initial controller power-up	04 H
Unexpected bus phase	05 H
Unexpected bus free	06 H
Bus parity error	07 H
SCSI bus hung	08 H
Unexpected message reject	09 H
Reset stuck	0A H
Auto request sense failed	0B H
Controller RAM parity error	0C H
Abort message processed	0D H
Reset message processes	0E H

Glossary

ac distribution

The method of controlling ac power in a cabinet.

adapter

(1.) A connecting device that permits the attachment of accessories or provides the capability to mount or link units.
(2.) The device that connects an 8-bit differential SCSI bus to an 8-bit single-ended SCSI bus.

array

An array is a set of multiple disk drives and a specialized controller, *an array controller*, which keeps track of how the data is distributed across the drives.

array channels

Array channels are the SCSI-2 compliant buses on which the disk drives are located. Each array channel is independent SCSI bus.

array controller

A device that exercises control over the SCSI bus (for example, an HSZ10–AX disk array controller).

BA35X–VA

A collective reference to all versions of the vertical mounting kits—single and double.

CI

A Digital trademark for the Digital Computer Interconnect bus.

cold-swapping

A method of device replacement that requires that power be removed from *all* shelves in a cabinet. This method is used when conditions preclude the use of a warm-swapping or hot-swapping method.

See also *warm-swapping* and *hot-swapping*.

controller

A hardware line device that manages communications over a line. Controllers can be point-to-point, multipoint, or multiple line controllers.

dc power system

The method for providing dc power in a cabinet.

DECstor/me

The mnemonic for the Digital Storage/Modular Enclosure, a modular set of enclosure products that allows customers to design their own storage array. Components include power, packaging, and interconnections in a modular storage shelf into which SBBs and array controller modules are integrated to form modular storage arrays. System-level enclosures to house the arrays and standard mounting devices for SBBs are also included.

double stand

A BA35X–VA vertical mounting kit composed of two single stands clipped together. This configuration can support one BA350–EA shelf.

See also *single stand*.

drive group

A drive group is a set of from 1 to 10 drives that have been configured into one or more logical units. A logical unit can be contained in only one drive group, and all the logical units in a drive group must have the same RAID level and be of the same drive type.

drive rank

Drive ranks represent a numbering scheme providing information on the maximum number of drives on every array channel. A one rank system indicates that there is a maximum of one drive per disk channel. A two rank array indicates that there is a maximum of two drives per disk array channel. However, any channel can have zero for its maximum number.

DSSI

Digital Storage System Interconnect.

FD SCSI

The fast, differential SCSI bus with an 8-bit data transfer rate of 10 Mb/s.

See also *FWD SCSI* and *SCSI*.

FWD SCSI

The fast, wide, differential SCSI bus with a 16-bit data transfer rate of 20 Mb/s.

See also *FD SCSI* and *SCSI*.

H981x

A collective reference to the H9810 (short), H9811 (medium), and H9812 (tall) towers.

Heartbeat LED

The bottom most LED on the HSZ10-AX controller. Beats once per second.

host

The primary or controlling computer in a multiple computer network.

hot-swapping

A method of device replacement whereby the complete system remains online and active during device removal or insertion. The device being removed or inserted is the only device that cannot perform operations during this process

See also *cold-swapping* and *warm-swapping*.

LUNs (logical units)

A *logical unit* is a grouping of drives which has its own device SCSI ID and number. Each logical unit has its own array parameters (RAID level, segment size, and so on). For most purposes, a logical unit is equivalent to an array.

mirrored

A copy of data on a disk or a set of disks. Refer to the description of RAID 1.

parity check/repair

The process of verifying and repairing parity information so that data can be maintained and reconstructed in the event of a drive failure. Parity Check/Repair functionality is provided by the DEC RAID utilities.

RAID

A redundant array of inexpensive disks.

rank

A set of drives (1 per channel). See also *drive rank*.

redundancy

Also *data redundancy*. Data stored on another physical disk that can be used to recover data if the physical disk containing the data cannot be accessed.

SBB

System building block. A modular carrier plus the individual mechanical and electromechanical interface required to mount it into a standard shelf. Any device conforming to shelf mechanical and electrical standards is considered an SBB.

SCSI

Small Computer System Interface. This interface defines the physical and electrical parameters of a parallel I/O bus used to connect computers and a maximum of seven SBBs. The DECstor/me modular storage system implementation uses SCSI–2, which permits the synchronous transfer of 8-bit data at rates of up to 10 MB/s.

segment

A group of blocks that is continuous data which can be stored on a disk drive.

shelf array

A modular storage shelf that provides power, cooling, interconnects, and mounting for SBBs. Specific shelves are denoted by the prefix BA350 (that is, BA350–RA, BA350–SA, and so on). Shelves may be mounted in kits, towers, or cabinets.

single stand

A reference to the basic BA35X–VA vertical mounting kit with a capacity of one BA350–SA shelf.

See also *double stand*.

Small Computer System Interface

See *SCSI*.

stands

A collective reference to all versions of the vertical mounting kits—both single and double.

static storage device (SSD)

An electronic storage device such as the EZ51R–VA.

striped

See the description of RAID 0.

system building block

See *SBB*.

towers

A collective reference to the H9810 (short), H9811 (medium), and H9812 (tall) towers.

warm-swapping

A method of device replacement whereby the complete system remains online during device removal or insertion. The system bus may be halted for a brief period of time, during device insertion or removal. No booting or loading of code is permitted except on the device being inserted.

See also *cold-swapping* and *hot-swapping*.

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