WHITE PAPER

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Compaq Computer Corporation

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Tape Drives, Media, and the Importance of Cleaning

The main objective of this paper is to detail why tape drives must be cleaned periodically and the cleaning requirements for each tape technology. In addition, several other topics are addressed including:

- *Overview of magnetic recording*
- *Overview of cleaning and dropouts*
- *Media life and tape streaming*
- *Supported tape technologies and recommended cleaning intervals*
- *Tape drive cleaning procedures*
- *Recommended tape data and cleaning cartridges*

EXECUTIVE OVERVIEW

Tape drive cleaning is an essential part of tape drive maintenance and is required for optimum performance and reliability. If a tape drive is not cleaned regularly, particle buildup will interfere with operation of the read/write head. Buildup on read/write heads slows down tape drive operation, increases dropouts, wastes storage capacity, increases the chance of data errors, and may cause tape drive errors.

Listed below are some of the more common errors and results that may occur if tape drives are not properly cleaned and maintained:

- Media errors
- Write errors
- Read errors
- Reduced tape capacity
- Reduced backup performance

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Tape Drives, Media, and the Importance of Cleaning
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OVERVIEW OF MAGNETIC RECORDING

Tape drives operate by passing a thin piece of plastic tape covered with magnetic particles (the tape media) across a read/write head. As the tape media passes over the head, wear occurs on both the tape and the read/write head causing small amounts of magnetic particles from the tape media to collect on the head. Additionally, since tape drives are not hermetically sealed, dust and other particles get inside the drive mechanism and can also build up on the head. If the drive is not cleaned as recommended, particle buildup will interfere with the operation of the tape drive.

OVERVIEW OF CLEANING AND DROPOUTS

Dropouts occur when the signal strength from the read/write head is below a predetermined minimum threshold value. When this occurs, the drive detects a "bad spot" on the tape media and rewrites the data to the next "good spot." These "bad spots," or unused sections of tape media, are referred to as *dropouts*. Dropouts are caused by three primary factors: imperfections in the magnetic coating on the tape media, worn read/write heads, and dirty read/write heads. Regular cleaning reduces the occurrence of *dropouts* that result in reduced tape capacity and backup performance.

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MEDIA LIFE AND TAPE STREAMING

Typically tape media manufacturers specify media life in terms of passes not the number of backups for a tape. The life of the media in terms of full backups can be approximated by dividing the media specification for the number of passes by the number of tracks on a tape. For example on the 525 ACA drive there are 30 tracks on the tape cartridge which is rated for 5000 passes. This equates to approximately 5000 passes/30 tracks=167 full backups. Note: This calculation assumes that the drive is *streaming* and does not apply to DAT drives.

The actual life of a tape cartridge is determined by such factors as the design of the tape path and head, the number of passes (or tracks) a drive requires for one complete backup, humidity and temperature, and whether there is a header at the beginning of the tape that is read and updated frequently causing additional passes

A *pass* is defined as any forward or reverse motion of the tape media across the read/write head. The actual life of a tape cartridge is determined by such factors as the design of the tape path and head, the number of passes (or tracks) a drive requires for one complete backup, humidity and temperature, and whether there is a header at the beginning of the tape that is read and updated frequently causing additional passes.

Another important factor that affects media and head life is tape streaming. Tape drives and backup software are designed to *stream* the tape drive because *nonstreaming* significantly reduces media life, increases head wear, and lowers backup performance. *Streaming* is defined as a continuous forward motion of the tape media across the read/write head during a backup. *Nonstreaming* is defined as a non-continuous back-and-forth motion of the tape across the read/write head.

A tape drive will stream the tape cartridge when the following conditions are met:

- The disk drive/disk drive array can supply data as fast or faster than the tape drive can accept data.
- The software configuration of the operating system and backup software is optimized correctly to support streaming.
- The CPU has sufficient available processing power to handle the overhead of tracking the backup progress and the processing required to stream the tape drive while accessing the disk drive/disk drive array.

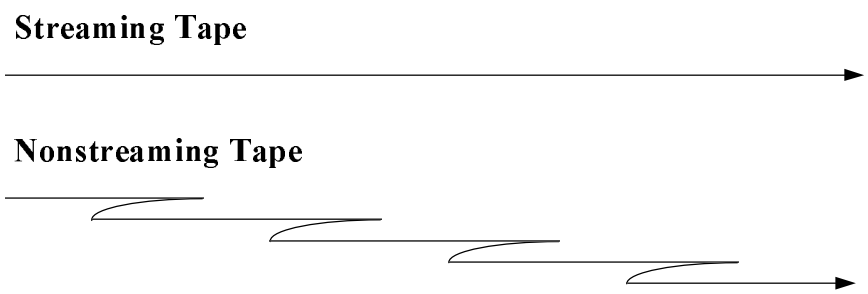

Figure 1: Backup performance is best and head wear is minimized when the tape media streams past the head in smooth, continuous motion. The place in the nonstreaming diagram where the tape motion overlaps is considered three passes.

SUPPORTED TAPE TECHNOLOGIES AND RECOMMENDED CLEANING

Current approved Compaq tape drive technologies:

- Quarter inch cartridge (QIC) drives
- Digital audio tape (DAT) drives
- Digital linear tape (DLT) drives

QIC Drive Overview

Tape drives that record data on quarter-inch tape media are referred to as QIC (quarter inch cartridge) drives and employ what is referred to as serpentine recording. As the tape media passes over a stationary read/write head, a single track is recorded from the beginning of the tape media to the end. The read/write head then moves up or down to the next track recording data in the opposite direction. QIC drives handle dropouts by means of read-after-write error checking and automatic rewrite algorithms.

Compaq offers three QIC drive options:

- The 340/680-Megabyte Tape Drive
- The 525-Megabyte Advanced Circuit Architecture (ACA) Tape Drive
- The 1.2-Gigabyte Advanced Circuit Architecture (ACA) Tape Drive

QIC Cleaning

QIC drives are somewhat sensitive to head particle buildup and require regular cleaning.

QIC drives are somewhat sensitive to head particle buildup and require regular cleaning. Manufacturers of QIC drives recommend cleaning the drive every 8 hours of operation (see Table 1). QIC drives can be cleaned either with swabs and an isopropyl alcohol solution or with a cleaning cartridge.

DAT Drive Overview

Digital audio tape (DAT) drives provide fast backup performance on 4 mm tape DDS (digital data storage) media. To ensure 100 percent data integrity, DAT drives use three levels of error correction with 32-bit cyclical redundancy check (CRC) detection and support hardware data compression. DAT drives employ what is referred to as helical recording similar to what is used in VCRs. The read/write head on a DAT drive sits at a 6-degree angle to the tape media (see Figure 2). It records data in diagonal stripes using a rotating drum head.

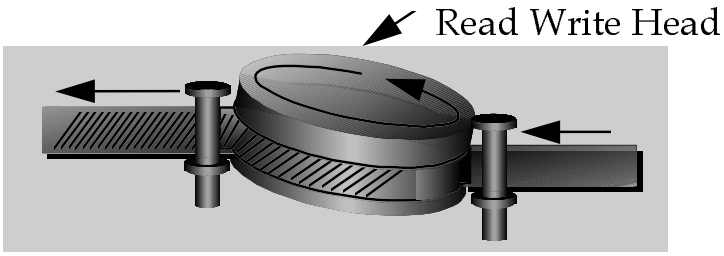

Figure 2: DAT drives record data by means of helical scanning. This technology requires that the tape media be wrapped around the drum head. Thie higher level of tension on the tape media contributes to wear.

Compaq offers three DAT drive options:

- The 2/8-Gigabyte DAT Drive.
- The 4/16-Gigabyte TurboDAT Drive.
- The TurboDAT Autoloader combines a 4/16-Gigabyte TurboDAT Drive with either a 4-tape or a 12-tape cartridge magazine.

DAT Cleaning

Among the tape drives available today, DAT drives are one of the most susceptible to particle buildup. If a DAT drive is not kept clean, increased dropouts will occur. It is conceivable to loose 20 percent of backup capacity and performance if the recommended head cleaning schedule is not followed.

Among the tape drives available today, DAT drives are one of the most susceptible to particle buildup. If a DAT drive is not kept clean, increased dropouts will occur. It is conceivable to loose 20 percent of backup capacity and performance if the recommended head cleaning schedule is not followed. DAT drives monitor when the total number of dropouts reach a predetermined threshold and will slowly flash the green LED indicating the tape drive needs cleaning.

To optimize DAT performance the following additional recommendations for cleaning should be followed:

- When using new tape media for backups, DAT drives NEED to be cleaned after each 8 hours of read/write operation until the entire data cartridge(s) has been used 5 times.
- When using data cartridges that have already been used 5 times, clean DAT drives after each 25 hours of read/write operation.

Clean DAT drives before doing a complete server backup.

- Clean DAT drives before doing a complete server backup.
- When using a TurboDAT Autoloader, keep a *cleaning* cartridge in the last slot. Refer to your software user manual for instructions on how to schedule and perform cleaning operations using the software application.

When using a TurboDAT Autoloader, keep a cleaning cartridge in the last slot.

- DAT cleaning cartridges typically last about 30 passes.

DAT cartridges should include a label to track the number of backups a tape has been used for. Writing this information on the label provides a convenient record of how many times a cartridge has been used.

Occasionally a single cleaning cycle will not fully clean read/write heads on a DAT drive. If backup software reports errors, clean the drive to eliminate the possibility that dirty heads are causing the error. Sometimes as many as four or more cycles are needed to complete the cleaning because DAT drives perform only a minimum cleaning cycle to reduce head wear.

The magazine guide path of a TurboDAT Autoloader also becomes dirty. The cartridge rollers and magazine rollers should be cleaned every 2 weeks. The *Compaq TurboDAT Autoloader User*

Guide (Compaq part number 199432-003) contains instructions for cleaning them using a cotton swab moistened with isopropyl alcohol.

No alcohol or cleaning solution should be used to clean DAT drive read/write heads.

> ***CAUTION:*** *No alcohol or cleaning solution should be used to clean DAT drive read/write heads. To avoid damaging a DAT drive, DO NOT clean read/write heads with a cotton swab. Fibers from a cotton swab can cause permanent damage to the head. Use the cleaning cartridge.*

DLT Drive Overview

Digital Linear Tape (DLT) drives were developed for a minicomputer environment and use advanced linear recording technology, a highly accurate tape guide system, and an adaptive control mechanism. This provides high-capacity, high-duty-cycle backups unlike DAT and QIC technology.

DLT cartridges are specified to last 500,000 passes over a read/write head. Under optimum environmental conditions, this specification equates to 7,812 backups using the entire tape capacity. This long media life is the result of the reduced head to media interface, and advanced tape path dynamic adjustment technologies used in the DLT.

DLT Cleaning

DLT drives are not highly susceptible to particle buildup; therefore, they do not require frequent cleaning.

DLT drives are not highly susceptible to particle buildup; therefore, they do not require frequent cleaning. A DLT drive monitors the total number of hours it is used. After a predetermined number of hours, the yellow "Use Cleaning Tape" indicator on the front panel of the DLT drive illuminates automatically to signal that the drive needs cleaning. A DLT drive should be cleaned when this indicator illuminates. A DLT cleaning cartridge only uses a small section for each cleaning. The cleaning cartridge lasts until it reaches the end of the cleaning medium.

> *NOTE: One cleaning cycle is sufficient to clean a DLT drive. DO NOT perform multiple cleaning cycles on a DLT drive.*

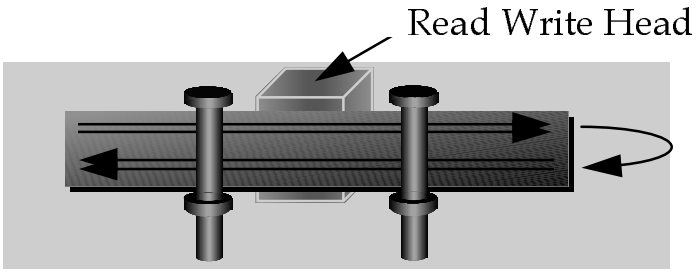

Figure 2: DLT drives record data using two parallel tracks in a serpentine fashion. DLT drives feature a state-of-the-art curved tape path that reduces tension on the tape media and increases the life of read/write heads.

CLEANING TAPE DRIVE PROCEDURE

Cleaning a tape drive is a simple procedure, typically requiring only that an appropriate cleaning cartridge be inserted in the tape drive and be allowed to cycle. Depending upon the type of tape drive, a cleaning cycle typically lasts approximately one minute. For the appropriate procedure and supplies needed to clean a Compaq tape drive, refer to the user documentation provided with each tape drive. Cleaning cartridges are typically packaged with instructions on their use.

CLEANING FREQUENCY

When a tape drive is cleaned according to a regular schedule, problems associated with dirty heads will be minimized

Regular cleaning of a tape drive minimizes particle buildup on the read/write head. When a tape drive is cleaned according to a regular schedule, problems associated with dirty heads will be minimized. When designing a schedule for data backup, it is important to include regular cleaning of tape drives as part of the backup plan.

Table 1 identifies part numbers for appropriate cleaning cartridges and the recommended cleaning frequency for each Compaq tape drive. Recommended cleaning frequency is based upon drive vendor specifications. Actual cleaning frequency may vary depending on temperature, humidity, and the tape cartridge manufacturer.

Compaq offers cleaning cartridges for DAT and DLT tape drives. Customers worldwide may contact their Compaq sales representatives to obtain appropriate supplies for proper tape drive maintenance. Cleaning supplies for QIC drives may be obtained from local computer supply stores.

TABLE 1: RECOMMENDED CLEANING FREQUENCY FOR COMPAQ TAPE DRIVES

TAPE DRIVE		CLEANING CARTRIDGE	RECOMMENDED CLEANING FREQUENCY	
Model	Option Kit		New Data Cartridges	Used Data Cartridges
340/680 MB	197082-001	third party	after 8 hr. read/write	
525 MB ACA	142030-001	third party	after 8 hr. read/write	
1.2 GB ACA	199574-001	third party	after 8 hr. read/write	
2/8 GB DAT	142019-001	131194-001	after 8 hr. read/write	after 25 hr. read/write
4/16 GB TurboDAT	142181-001	131194-001	after 8 hr. read/write	after 25 hr. read/write
TurboDAT Autoloader (internal)	142183-001	131194-001	after 8 hr. read/write	after 25 hr. read/write
TurboDAT Autoloader (external)	142187-001	131194-001	after 8 hr. read/write	after 25 hr. read/write
10/20 GB DLT (internal, rack only)	199742-001	199704-001	when "Use Cleaning Tape" LED turns on	
10/20 GB DLT (external)	199675-001	199704-001	when "Use Cleaning Tape" LED turns on	

Note to Table 1

In this context, the term *new data cartridge* refers to a new, unused tape cartridge and to a tape cartridge that has previously been used in its entirety for five times or fewer. The term *used data cartridge* refers to a tape cartridge that has been used—in its entirety—for backup more than five times.

Compaq recommends tape cartridges that have been testeo with the matching tape drive

The use of unapproved tape cartridges is discouraged because they may not be compatible with Compaq tape drives.

RECOMMENDED TAPE CARTRIDGES

Compaq recommends tape cartridges that have been tested with the matching tape drive. Before Compaq makes a recommendation, the tape cartridge it is evaluated to determine the quality and reliability of the magnetic media and the cartridge. The use of unapproved tape cartridges is discouraged because they may not be compatible with Compaq tape drives. Table 2 lists the data cartridges approved for use in Compaq tape drives.

Table 2 lists currently available Compaq tape drives, the type of data cartridge used with each, and approved data cartridges for use with each.

TABLE 2: COMPAQ TAPE DRIVES

Model	Tape Drive** Option Kit	Type of Data Cartridge	Media Life*			Backups
			Type of Interface	Media Width	Passes	
340/680 MB	197082-001	QIC MC3000XL	Floppy	1/4 inch	5,000	125
525 MB ACA	142030-001	QIC DC6000	SCSI	1/4 inch	5,000	167
1.2 GB ACA	199574-001	QIC DC6000	SCSI	1/4 inch	5000	167
2/8 GB DAT	142019-001	DAT DDS1	SCSI	4 mm	2,000	300
4/16 GB TurboDAT	142181-001	DAT DDS2	SCSI	4 mm	2,000	300
TurboDAT Autoloader (internal)	142183-001	DAT DDS2	SCSI	4 mm	2,000	300
TurboDAT Autoloader (external)	142187-001	DAT DDS2	SCSI	4 mm	2,000	300
10/20 GB DLT (internal, rack only)	199742-001	DLT	SCSI	1/2 inch	500,000	7,812
10/20 GB DLT (external)	199675-001	DLT	SCSI	1/2 inch	500,000	7,812

Notes to Table 2

1. Under optimum environmental conditions of 50 percent relative humidity and 22 degrees C. Assumes that drive is streaming and that entire tape capacity is used for each backup.
2. The expected number of backups listed in the Media life column are approximate. The tape media may last longer than the number of full backups listed above or it may last less.

Table 3 lists currently available Compaq tape drives and approved data cartridges for use with each.

TABLE 3: COMPAQ TAPE DRIVES AND APPROVED DATA CARTRIDGES

Tape Drive		Type of Data Cartridge	Brand	Approved Data Cartridges Part No.
Model	Option Kit			
340/680 MB	197082-001	QIC MC3000XL	3M	197413-001
525 MB ACA	142030-001	QIC DC6000	3M 6525 3M 6320 3M 6250	116571-001 116570-001 115298-001
1.2 GB ACA	199574-001	QIC DC6000	3M Magnus 1.0 3M Magnus 1.2 3M 6525 3M 6320 3M 6250	 199575-001 116571-001 116570-001 115298-001
2/8 GB DAT	142019-001	DAT DDS1	Sony 60M Sony 90M, Fuji 90M, Maxell 90M	131107-001 131107-002
4/16 GB TurboDAT	142181-001	DAT DDS2	Sony 120M, Maxell 120M, Sony 90M, Fuji 90M, Maxell 90M	137611-001 131107-002
TurboDAT Autoloader (internal)	142183-001	DAT DDS2	Sony 120M, Maxell 120M, Sony 90M, Fuji 90M, Maxell 90M	137611-001 131107-002
TurboDAT Autoloader (external)	142187-001	DAT DDS2	Sony 120M, Maxell 120M, Sony 90M, Fuji 90M, Maxell 90M	137611-001 131107-002
10/20 GB DLT (internal, rack only)	199742-001	DLT	Compac Tape (2.6 GB) Compac Tape II (6.0 GB) Compac Tape III (10.0 GB)	 199702-001
10/20 GB DLT (external)	199675-001	DLT	Compac Tape (2.6 GB) Compac Tape II (6.0 GB) Compac Tape III (10.0 GB)	 199702-001

Note

If approved cartridges do not have a part number, that approved cartridge is not available through Compaq.