



Hewlett Packard
Enterprise

Extreme tape media reliability for Hybrid IT archive data

How the HPE LTO Ultrium media brand specification and testing ensures the highest levels of quality and reliability

Contents

- Overview.....3
 - The HPE LTO Ultrium media brand specification.....3
- Real life testing for Hybrid IT data protection.....3
- Error rate: the ultimate measure of storage supplies quality.....4
- HPE LTO Ultrium media brand specification tests in detail.....5
- Ongoing commitment.....5
 - Green Tape Test (GTT).....5
 - Full Volume Life (FVL) test.....6
 - Rigorous environment interchange testing.....6
 - Tough drop testing.....6
 - Extensive testing of load/unload.....6
 - Locate/rewind/append testing.....7
 - Shipping and storage testing.....7
 - Shoeshine testing for high duty cycle automation.....7
- Testing for archival stability.....8
 - Built to last.....8
 - Real time archiving using LTO-1.....8
- Conclusion.....9

Overview

IDC forecasts that by 2025 the global datasphere will grow to 163 zettabytes, ten times the 16.1 ZB of data generated in 2016¹, whilst independent studies² show that the fully loaded cost of a tape storage solution is dramatically cheaper than using primary or secondary storage. Although Hybrid IT cloud and scale out object storage systems provide customers with more archiving options, especially for the longer retention of backup data, using the cloud exclusively for archiving can become expensive, especially when retrieval costs are factored in³. Based on a survey conducted by Solutions North Consulting⁴, an average of 10-15% of archived, long-term retention of secondary copy data is retrieved monthly by users or administrators. Yet the tiered pricing models typically used by CSP's mean that the costs of retrieving data from the cloud can soon dwarf the cost of the storage.

So once data has reached the end of its operational usefulness – remembering, 80% of all data is never accessed 90 days after creation – then it makes sense to migrate it to a secure, scalable and cost-effective medium like HPE Linear Tape Open (LTO) Ultrium tape.

Additionally, tape is seeing a resurgence in its use as an added layer of protection against cybercrime and ransomware attacks. By providing an 'airlock' barrier for data, tape helps lower data centre risk with reliable offline and off-premises data protection.

HPE LTO Ultrium solutions, featuring the newest 30 TB LTO-8 technology, allow customers to offload primary storage and cold data to tape, for long-term retention, while reducing their overall risk and increasing resiliency against downtime or disruption.

The HPE LTO Ultrium media brand specification

Because HPE offers a comprehensive data protection portfolio for Hybrid IT (traditional IT, private and public clouds), it understands the requirements for current and next generation LTO Ultrium tape solutions. In particular, HPE understands the importance of media reliability in providing a long-term home for archive data, as well as a final safeguard against natural disasters, network or power outages, human error, or malicious acts.

This is why HPE has a unique set of demanding quality standards for HPE LTO Ultrium cartridges. Unlike LTO logo tests, the HPE brand specification measures how tape performs in 'real world', automated, Hybrid IT infrastructures, a foundation that underpins and supports other HPE storage solutions.

Hewlett Packard Enterprise branded LTO Ultrium cartridges are designed, manufactured and tested to provide outstanding reliability for backing up, archiving and restoring your data.

Using real life conditions and both Hewlett Packard Enterprise and non-HPE devices, we supplement extensive in-process QA parametric testing with ongoing, drive based scrutiny, to make sure performance is excellent for any combination of device, duty cycle and environment.

Because Hewlett Packard Enterprise is a drive manufacturer as well as the leading supplier of LTO Ultrium storage supplies, we have the ability to re-create many different scenarios mirroring how customers use their cartridges.

The goal of this white paper is to describe our media testing in detail and demonstrate how this constant commitment to quality makes Hewlett Packard Enterprise LTO Ultrium storage supplies the safest choice for keeping your business data secure.

Real life testing for Hybrid IT data protection: Hewlett Packard Enterprise vs. LTO logo or 'industry standards'

The major point is that Hewlett Packard Enterprise's real life testing program for LTO Ultrium storage supplies goes far beyond the lab tests that ensure compliance with the specification for the Ultrium format.

Although important, the scope and purpose of the LTO format requirements are often misunderstood. The LTO format is not a quality standard; it is simply intended to specify how an LTO Ultrium cartridge should function. This is to ensure that any new cartridge will work in any new drive.

But a consistent quality standard is the intrinsic purpose of the HPE brand specification for LTO Ultrium storage supplies.

¹ 'Data Age 2025' White Paper, IDC 2017 sponsored by Seagate. 1 ZB = 1 Trillion GB.

² <http://bit.ly/2zFX0Te>

^{3&4} <https://www.lto.org/resources/tcotool/>

HPE's strict charter measures the most important variable parameters of the manufacturing process. Compared to the logo test, it has tighter, more controlled specifications in key areas like environmental interchange and load/ unload. HPE also has stringent process controls like regular ongoing Full Volume Life and 'Green Tape' Testing (GTT), in addition to a lengthy list of multiple lot specifications. All of these enable us to pinpoint with incredible degrees of accuracy how well your tape drive and media will perform across a range of applications and environments.

Ultimately, the best possible microscope to test tape cartridges is a tape drive, or rather thousands of tape drives, performing the same backup and restore tasks as end users. As a leader in hardware and storage supplies for all of the mainstream tape technologies, Hewlett Packard Enterprise has established comprehensive R&D and manufacturing programs to scrutinise the performance of tape backup solutions under every conceivable kind of stress.

Whilst no one can predict the future, the breadth and depth of Hewlett Packard Enterprise LTO Ultrium tape cartridge testing gives us more confidence that your data will be safe on HPE tapes, no matter which brand of hardware you own.

Error rate: the ultimate measure of storage supplies quality

How does Hewlett Packard Enterprise ensure its LTO Ultrium data cartridges are so reliable?

Simply by performing the most comprehensive study of error rates, capacity and transfer rates that technology can deliver.

Bit Error Rate (BER) is a critical measure of how well your tape drive and data cartridges are performing together. It indicates the reliability of the write (backup) and read (restore) processes, together with the associated 'margin' for each process.

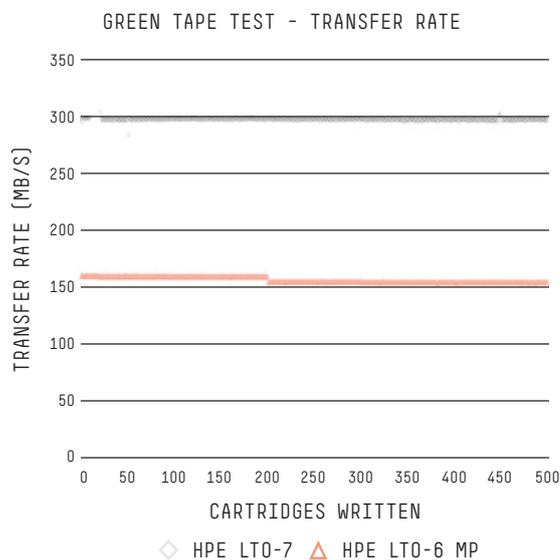
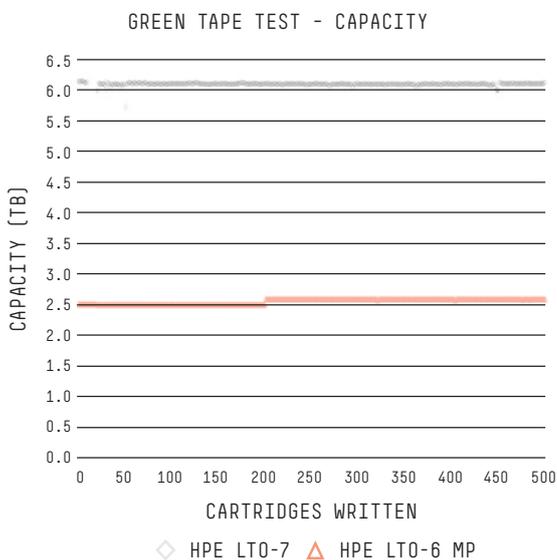
High BER indicates that the backup or restore operation may be slow or even fail, whereas low consistent error rate indicates an optimum data transfer process with excellent performance.

High BER can be caused by several factors, including poor manufacture, tape edge damage or debris on the tape head. Regardless of the source, however, it means more attempts are required to successfully write and validate the data on the tape. This pulls more tape through the drive, reducing the overall capacity and, in the worst-case scenario, leading to corruption or backup failure.

Capacity and transfer measurements are real life metrics that you may observe for yourself if a tape is performing badly. Reduced capacity means more tapes are needed to back up the same amount of data. Slower transfer speeds mean longer backups or backup windows being exceeded, which leads to inconvenience and disruption.

In both cases, the hidden cost of even a minor deviation in performance can soon become a significant expense.

For example, the capacity and transfer rate of multiple LTO-6 MP and LTO-7 cartridges used during Hewlett Packard Enterprise LTO-7 drive Green Tape Testing is shown in the two charts below. In these examples, all cartridges deliver full capacity thanks to the very low error rate of HPE branded LTO media.



HPE LTO Ultrium media brand specification tests in detail

The influence of Hewlett Packard Enterprise over data cartridge quality begins in the formative stages of R&D. HPE collaborates with leading manufacturers to define the parameters for recording media in its drives, such as physical characteristics (for example, tape thickness), recording density (for example, number of bits/inch) and signal performance (for example error rate).

The Hewlett Packard Enterprise brand qualification program addresses the four main areas of concern that you and other end users are likely to have:

<p>Restore</p> <p>Will I get my data back whenever I need to restore from the tape?</p>	<p>Archival life</p> <p>Will the tape meet and even surpass regulatory and corporate requirements for data retention?</p>	<p>Compatibility</p> <p>Not just “Will it work with...?” but “Will it work to the level I expect from my tape device, regardless of who makes it?”</p>	<p>Daily experience</p> <p>Will it survive the rigours of everyday use in a busy and challenging environment?</p>
--	--	---	--

Ongoing commitment

Compared to the current LTO specification, which requires testing a limited quantity of cartridges for initial LTO-1 through LTO-8 format compliance tests (with re-evaluation taking place every 12 months), Hewlett Packard Enterprise tests a minimum of 500 data cartridges taken from at least two separate manufacturing batches.

Other LTO certified media are guaranteed to interchange between HPE and non-HPE drives as well, but the LTO logo does not guarantee a minimum, consistent level of quality.

Green Tape Test

One of the things that distinguishes Hewlett Packard Enterprise is our awareness of the importance of Green Tape Tests (GTT). This specialised test supports the ever-increasing number of customers using brand new cartridges for each and every backup and restore operation – e.g. in archival activities.

Hewlett Packard Enterprise performs monthly Green Tape Tests of HPE LTO Ultrium cartridges at manufacturing facilities, and further procedures at HPE laboratories. To provide full test coverage, and to make sure differences in drive design do not affect the performance of HPE tapes, such tests incorporate the use of HPE and non-HPE drives. Key metrics such as user capacity and transfer rates are monitored throughout the tests to ensure good performance is maintained.

These metrics continue to grow, as conducting regular GTT is an important aspect of Hewlett Packard Enterprise’s commitment to ongoing media quality and the evolving role of tape in archiving. For example, GTT was a vital aspect of testing during LTO-7 R&D so that even before launch:

- Over 1,000 LTO-7 cartridges underwent GTT
- Over 750 million metres of LTO-7 tape were pulled – 462,000 miles

This commitment was maintained during development of LTO-8 with extensive testing conducted by HPE engineers:

- Over 1,000 LTO-8 cartridges tested (including GTT)
- Over 1,250 million metres of LTO-8 tape were pulled – 776,000 miles

And this is on top of the ongoing quality controls for prior generations of Hewlett Packard Enterprise LTO Ultrium storage supplies. Each month, a series of Green Tape Tests are conducted using multiple cartridges (taken directly from production) using HPE and non-HPE drives.

Since the beginning of 2016, over 8,500 cartridges have been tested in HPE’s demanding GTT protocol. Almost 950 million metres (590,302 miles) of media have been pulled. And almost 55 million gigabytes of data have been written. All of these ongoing tests are intended to make sure that you receive the most reliable tape media possible.

Full Volume Life (FVL) test

This requires no capacity loss or significant error rate degradation when multiple full volume write/read operations are conducted using a single cartridge. FVL is used by Hewlett Packard Enterprise to verify sustained product performance if you are using the same cartridge for each and every backup and restore operation.

Rigorous environmental interchange testing

In contrast to limited interchange using a single data cartridge, on a single drive under one or more test conditions, Hewlett Packard Enterprise thoroughly checks its storage supplies for full interchange between multiple tapes on multiple drives in all of the following conditions:

- 50°F/10°C and 80% R.H. cold and wet
- 50°F/10°C and 20% R.H. cold and dry
- 104°F/40°C and 20% R.H. hot and dry
- 104°F/40°C and 35% R.H. hot and ambient
- 84°F/29°C and 80% R.H. hot and wet

During full volume write and read operations, the error rate must remain within stringent performance levels that have been determined by HPE engineers. Data is continuously written to, and read from the tapes for 24 hours at each environment. The benefit to you is that the drive and cartridge are robust enough to withstand sustained use in all conditions, not just in controlled environments such as an IT data centre. The HPE environmental interchange tests also examine a wide range of performance by using several drives and several cartridges to ensure complete consistency of results, as opposed to a narrower, customised test involving a single data cartridge.

Tough drop testing

In the LTO format specifications there are no cartridge drop test requirements. However, Hewlett Packard Enterprise testing evaluates HPE branded LTO Ultrium data cartridges against a minimum standard of fragility, and verifies that there shall be no irreversible loss of function to a data cartridge following a 0.75 metre drop onto a concrete floor. This requirement shall be met when 20 data cartridges are dropped successively on their top and bottom faces, and edges. In separate tests, this requirement shall apply when the data cartridges are dropped by themselves, in their library cases, or any packaging configurations.

The benefit to you is that the data cartridges are robust enough to withstand daily use and transportation (for example, to an off-site storage solution) without being damaged or causing data loss.

Extensive testing of load/unload operations

In the LTO Ultrium format specifications, there are no loading or unloading requirements. However, Hewlett Packard Enterprise has led the development of LTO technology in this area and proposed several format changes that increase the reliability of the leader pin assembly, a core component of the load/unload operation.

This test uses an automated mechanism cycle of load, grab Leader Pin Assembly (LPA), thread (with a few metres of tape wound onto a take-up reel), unthread, park LPA, and unload. Each cycle is repeated a minimum of 20,000 times.

In Hybrid IT deployments, the vast majority of HPE LTO Ultrium drives will be integrated into automation systems like HPE StoreEver MSL, T950 and TFinity. As a result, the load/unload performance of HPE branded data cartridges is actually assessed in three different drive orientations – horizontal, tape path up, and tape path down – rather than just a single horizontal orientation. This is to replicate how the drive and tapes are used in real working environments.

The benefit to you of the HPE load/unload tests is that the cartridge leader mechanism is robust enough to perform effectively throughout its expected use and will not break, causing damage and disruption to the drive. This in turn prevents a backup having to be repeated, or costly downtime whilst the drive is repaired. In addition, the cartridge will load successfully into a drive without the risk of a poorly seated cartridge introducing further downtime (even after the cartridge has experienced several thousand load operations).

Locate/rewind/append testing

This test measures the ability of a section of the tape to withstand repeated stress (e.g. file locate, retrieve and append operations) in a highly demanding customer environment (84°F/29°C, 80% R.H.). The benefit to you is that the data cartridge performs under the most extreme daily conditions, reducing the number of failed backups and restores and minimising the risk of disruption to the network.

Shipping and storage testing

This test is performed using a single data cartridge and a single drive.

The Hewlett Packard Enterprise qualification plan ensures that HPE branded LTO Ultrium storage supplies can be shipped and used repeatedly. The test is performed using multiple cartridges in an environmental chamber under the following environments:

- Store the test data cartridges for two days at 50°F/10°C, 10% R.H.
- Store the test data cartridges for two days at 120°F/49°C, 15% R.H.
- Store the test data cartridges for two days at 84°F/29°C, 80% R.H.

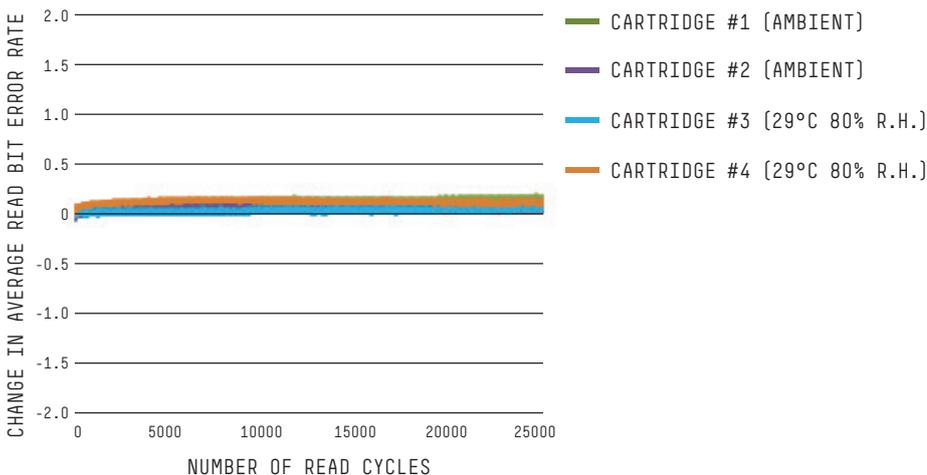
A full volume write operation is conducted prior to the cartridges entering the environmental chamber. After storage, a full volume read operation is performed.

Shoeshine testing for high duty cycle automation

In the LTO compliance procedures, there are no shoeshine tests. The HPE testing procedure measures the ability of the media to withstand repeated passes over the tape head by simulating excessive repositioning or error recovery on a short length of tape.

Data is written to a short section of tape. The tape is rewind, the data is read and error rate checked. This 'rewind-read-error check' procedure is repeated up to 20,000 times and at the end of the test, there should be no loss of performance.

The benefit to you is that the tape withstands very intensive use even if it is restricted to a small part of the tape. This is especially relevant if you are a library customer who may be using named tapes for specific applications and who only fills the same part of the tape each time data is written.



Testing for archival stability

If you place a tape into an archive and a legal officer, sales manager, publisher or newsroom asks you to produce the data ten years from now, how certain can you be that it has been preserved, complete and good as new?

Ultimately, this is the primary objective for any archival storage technology in a Hybrid IT infrastructure.

The extreme conditions in which we can test our tapes enable HPE to say with confidence that its data cartridges will last for at least their 30-year warranty life.

Built to last

Particulate media like LTO Ultrium incorporates a binder system to hold the magnetic particles in place and bond them to the substrate. Early binder systems could suffer from hydrolysis (e.g. the binder could absorb moisture and eventually degrade leading to debris). However, today's advanced binder systems used in HPE MP and BaFe media products are far more tolerant to high humidity conditions and, as such, binder hydrolysis no longer poses any significant risk.

Signal degradation is another factor that could affect the archival properties of a tape. Historically, signal loss would occur due to oxidation of the magnetic particles (e.g. a chemical reaction would reduce the magnetic strength of each particle and as a result, the read back signal strength would diminish).

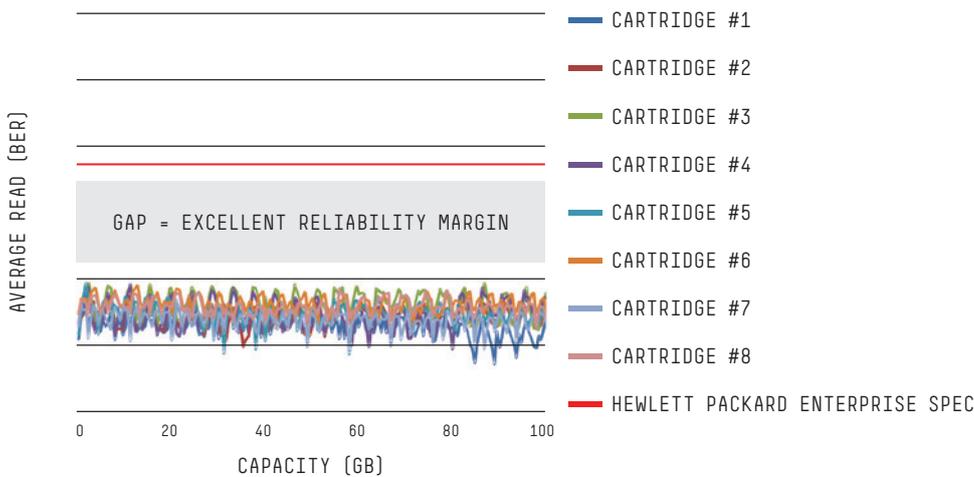
However, there have been several improvements to metal particle technology in recent years and the magnetic particles used in all HPE LTO Ultrium tapes incorporate an extremely effective 'armour coating'. This passivation layer, as it is termed, surrounds and protects the magnetic particles, effectively eliminating the oxidation process completely. Hence, there is no significant signal reduction during the read back (restore) process, even after prolonged periods of storage. The later generation Barium Ferrite particles are oxides that are inherently more stable, and hence do not require a passivation layer. Hewlett Packard Enterprise LTO Ultrium data cartridges also utilise high coercivity particles and hence such media is far less susceptible to stray magnetic fields (again helping to ensure ongoing data integrity and restore reliability).

Any significant loss of magnetisation would result in a lower SNR signal, and hence higher BER. This could ultimately compromise the integrity of the data backup. Thus, for archiving, it is essential that tapes are designed to resist the effects of both particle oxidation and binder hydrolysis. In order to demonstrate archive life, it is necessary to conduct accelerated ageing tests. Such tests give an indication of how the magnetisation will degrade over an extended period of time, and whether hydrolysis is likely to occur.

Real time archiving using LTO-1

Given the maturity of LTO technology, it is now possible to highlight real time archive performance, rather than relying solely on accelerated laboratory tests. Since the early days of LTO technology, HPE has been tracking the performance of 8 x Hewlett Packard LTO-1 cartridges that have been kept in archival storage. These cartridges were all manufactured in June 2003, and a full capacity (100 GB) backup of data was performed in July 2003, using a HP LTO-1 drive.

The cartridges have been stored in recommended archival conditions for 14 years, and recently, the original data on those tapes was restored using a HP LTO-2 drive. The results were truly impressive, as illustrated on the next page.



Conclusion

A typical enterprise customer may have tens or even hundreds of tape drives in their organisation. But this number is still dwarfed by the quantity of devices that are used in HPE testing. Unlike even advanced end users, HPE has the resources and expertise to forensically examine every aspect of the media manufacturing process, a complex, multi-stage process requiring mastery of production and materials.

Examples of precise detail obtained by HPE include servo quality, error rate performance and even the tape’s abrasivity characteristics. None of this is directly visible on the production line or in a data centre.

HPE not only listens, we learn from your experience and that of hundreds of thousands of HPE tape customers. Many features that you see on our products are a direct result of customer feedback, including pre-labelled media, anti-static shells, better leader pin design to prevent drive damage, robust cartridges to withstand impacts, and the introduction of differently coloured cartridges to make sure you never load the wrong media into your drives. Ultimately, tape drives are the best form of microscope to examine the quality of a data cartridge.

Your data is unique. It’s the DNA of your business and we do everything we can to help you reduce risk, reduce cost and manage your data growth. When you entrust your data to a HPE LTO Ultrium tape, we want you to feel it’s as safe as it would be in your own hands.

Learn more at
hpe.com/storage/storagemedia