



Percept Technology Labs

PRODUCT TEST AND COMPLIANCE EXPERTS



RDX REMOVABLE DISK ARCHIVABILITY STUDY TEST REPORT

JULY 2007

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INTRODUCTION

Disk drives have long been integral to data storage. The latest generation of removable disk-based storage technology incorporates the ability to remove and store your data, making it extremely portable and convenient. However, one relative unknown regarding this type of technology is the archivability of removable disks. Archivability refers to how long a removable disk can be stored under ideal conditions and the data can still be retrieved. There are few, if any public studies that show how long a removable disk can be stored while retaining the ability to read the data.

RDX Technology

ProStor Systems' RDX removable disk product is one of the industry's first disk-to-removable disk backup and archive systems. It offers enterprise-class data protection and performance to servers, networks and professional workstations at an affordable price. ProStor chose the 2½ inch hard drive which was originally designed for portability – notebooks rather than desktops. RDX technology utilizes the additional ruggedized features to ensure performance under varying conditions. The ruggedized feature set includes three times more resistance to shock/vibration, wider temperature tolerances, and a new methodology (ramp load) to control damage to the heads and media when not in use. Other benefits of the 2.5 inch drive include low power consumption and full disk encryption. The larger 3.5 inch drive, while offering higher capacity, is designed for the stable desktop environment and lacks the feature set required for portability.

Percept Technology Labs, Inc., an independent test and consulting company, worked in conjunction with ProStor Systems to determine the life expectancy of the RDX removable cartridge in a typical storage environment. Percept conducted an accelerated archival test on a sample group of RDX removable cartridges to predict the probability of retrieving data after extended storage periods.

ARCHIVABILITY TESTING

The standardized life expectancy of a device is defined as the minimum lifespan that can be expected for which 99% of the products will continue to operate normally when stored at 20° C (68° F) and 30% RH. What Percept set out to achieve with this testing was to determine just how long an RDX removable disk could be placed in storage and retain its ability to read the data. Percept used onsite environmental chambers and set the temperature and humidity levels much higher than accepted normal storage conditions in order to accelerate the life and determine the lifespan of the RDX removable disk cartridges.

Configuration

A total sample size of 80 RDX removable disk cartridges were used in the testing. The samples were separated into five groups at varying group sizes. Using a drive read/write fixture, Percept wrote data to each drive, completely utilizing the available removable disk capacity of 160GB and then verified the data by comparing it to what was originally written recording any errors. This process established a baseline for the removable disk's performance.

Figure 1: Read/Write Test Fixture



Test Method

In order to simulate the accelerated temperature and humidity conditions, five environmental chambers were set at specific temperature and humidity levels well above normal storage conditions. Following is a table detailing each cartridge group, including the sample size, the temperature, the humidity level, the total duration of testing and how often the group was monitored for failures.

Table 1: Cartridge Group Details

GROUP	SAMPLE SIZE	TEMP (F/C)	HUMIDITY (RH)	TOTAL DURATION	MONITORING FREQUENCY
Group A	10	176°F / 80°C	85%	4000 hours	336 hours
Group B	10	176°F / 80°C	55%	2000 hours	500 hours
Group C	15	176°F / 80°C	10%	3500 hours	500 hours
Group D	15	158°F / 70°C	85%	3000 hours	750 hours
Group E	30	140°F / 60°C	85%	4000 hours	1000 hours
Group F (3.5" disk)	5	176°F / 80°C	85%	4000 hours	336 hours

NOTE: Group F, with the 500GB 3.5 inch disks, was used as a comparison to the RDX removable disk drives.

Each cartridge was labeled and recorded in a cartridge tracking database. Once labeled and recorded, each cartridge was placed into the respective chambers and closely monitored at set intervals for failures. During the course of testing, environmental conditions in the chambers were continuously monitored to ensure operation at specified levels. For the duration of testing, failure was defined as an un-recoverable read error while reading any data from the disk. Once a cartridge experienced an un-recoverable read error, it was removed from the test. Each cartridge was monitored until either failure or test completion. The chambers were programmed to operate 24 hours per day.

The following steps were executed for each test interval:

1. The cartridges were placed in the environmental chamber according to the stated sample size and environmental settings.
2. The chamber was ramped to the desired temperature and humidity levels over a period of 4 to 5 hours and the temperature and humidity levels were maintained at the desired levels for the specified interval duration.

3. At the completion of the interval duration, the humidity was reduced to 10% and the temperature was maintained at the elevated level for 44 hours before being ramped to 20° C over a period of 4 to 5 hours.
4. The cartridges were removed from the chamber, placed in the read/write fixture and all data sectors were read while checking for errors.
5. All cartridges that did accurately read the data were returned to the chamber and the interval cycle was repeated until the desired total duration was achieved.

The environmental chambers used for this study are Tenney chambers – Model TH27, T20RS and THJR. Following is a picture of the test setup in one of the chambers.

Figure 2: Test Setup in Chamber



Results

At the conclusion of testing, the results suggest that temperature has a greater effect on archivability than does humidity. Group A was subjected to the harshest conditions at 176°F / 80°C and 85%RH, and after 4,000 hours, had a 30% failure rate. Group E, having the lowest temperature of 140°F / 60°C, also had the lowest rate of failure at 3%. The duration of Group E's testing was also 4,000 hours.

Notably, the 3.5 inch hard drives in Group F performed poorly under the same harsh conditions as the 2.5 inch hard drives in Group A. 100% of these drives experienced failure by 4,000 hours.

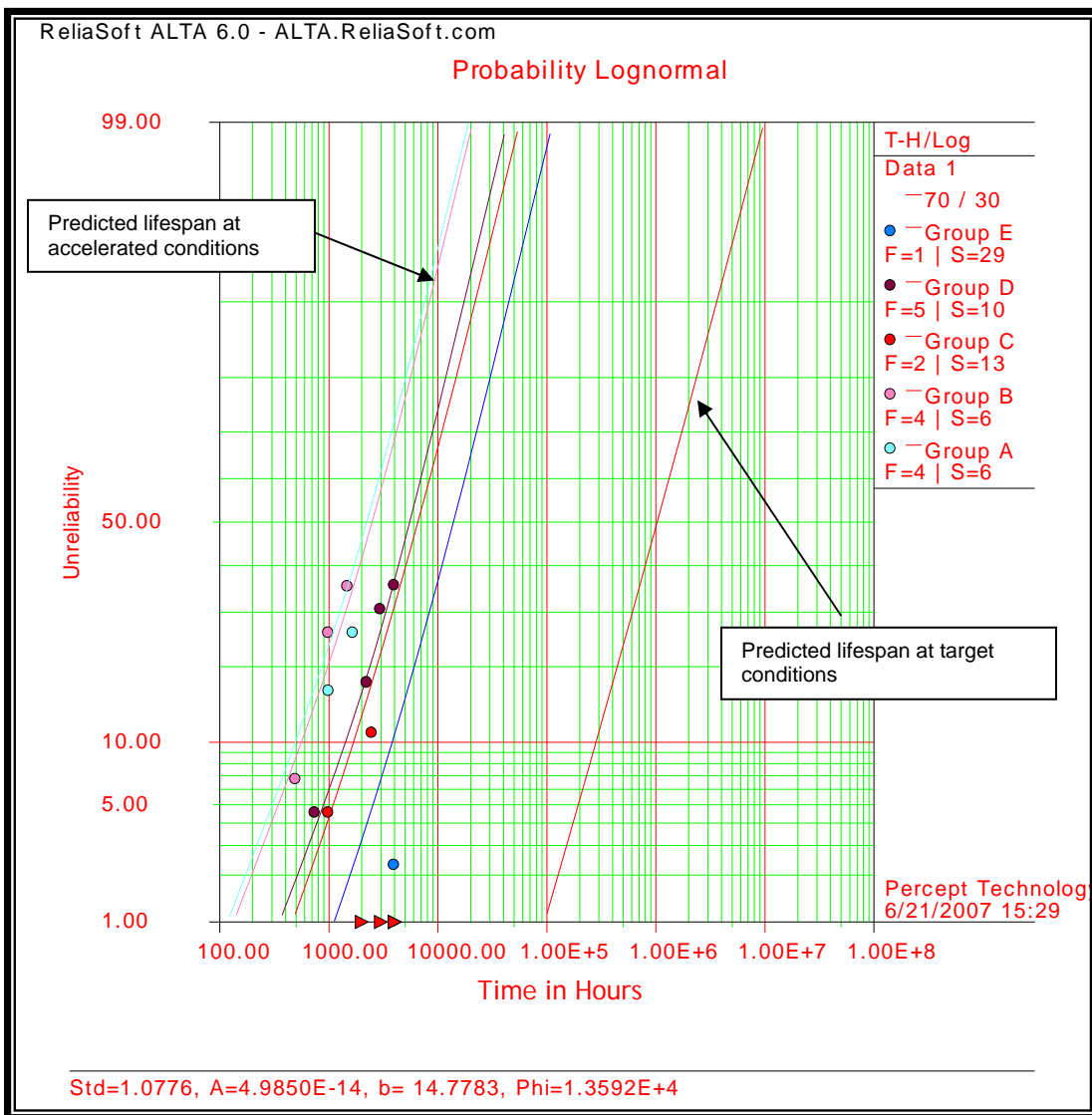
Table 2: Archivability Test Results

Group	Temperature (F/C)	Humidity (RH)	Final Duration	Total # of Failures out of Initial Population
A	176°F / 80°C	85%	4000hrs	4 out of 10
B	176°F / 80°C	55%	2000hrs	4 out of 10
C	176°F / 80°C	10%	3500hrs	2 out of 15
D	158°F / 70°C	85%	3000hrs	5 out of 15
E	140°F / 60°C	85%	4000hrs	1 out of 30
F	176°F / 80°C	85%	4000hrs	5 out of 5

RELIABILITY ANALYSIS

Once Percept obtained the results of the archivability testing, those results were plotted into ReliaSoft's ALTA reliability software to extract a prediction of the lifespan for RDX disk drives. The failure data was coded into ALTA the distribution wizard was used to determine the best statistical fit distribution model. Lognormal was chosen as the best fit for the data. Next the Temperature-Humidity accelerated life model was chosen because of its applicability to the stresses used in the archive test. Environmental usage conditions are next set as 20°C / 68°F at 30% RH. Following is the output graph of this data.

Figure 3: ReliaSoft Results



Using the results obtained with ReliaSoft, Percept calculated the B(X) life of the disk drive for three different time spans – 20 years, 25 years and 30 years. The B(X) calculation yields time based on the given stress level and probability of failure. Replacing the X with a 1 (B1) represents the time by which 1% of the units in a population will fail. For example, if the disk drive has a B1 life of 2000 hours, 1% of the population will have failed by 2000 hours of operation.

As expected, the higher the temperature in the storage environment, the lower the humidity has to be in order to get the maximum length of storage time and vice versa. Using ReliaSoft ALTA software to determine what temperature and humidity settings yield 20, 25 and 30 years of storage life, Percept built the following charts.

Figure 4: Archival Environmental Limits

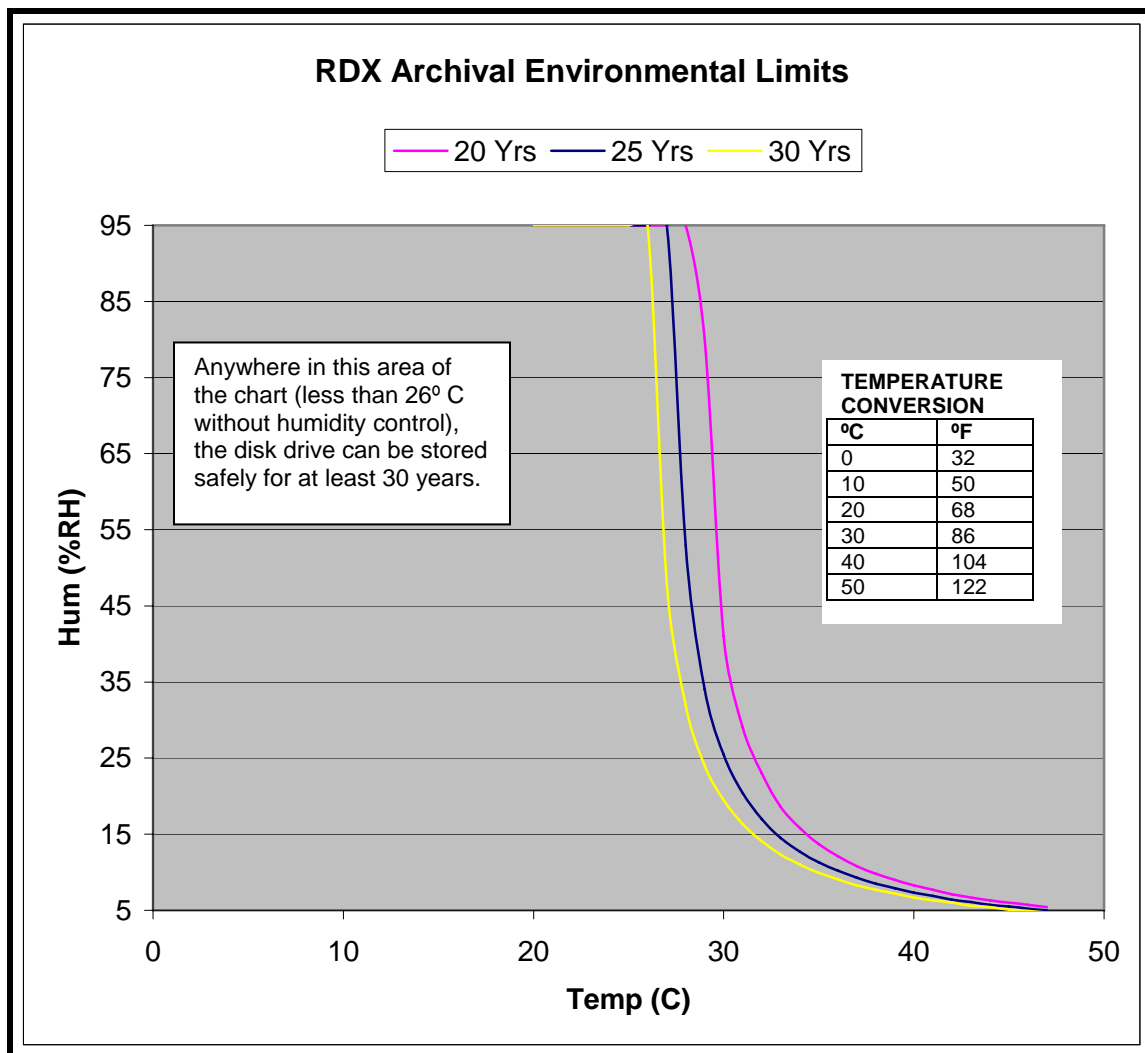
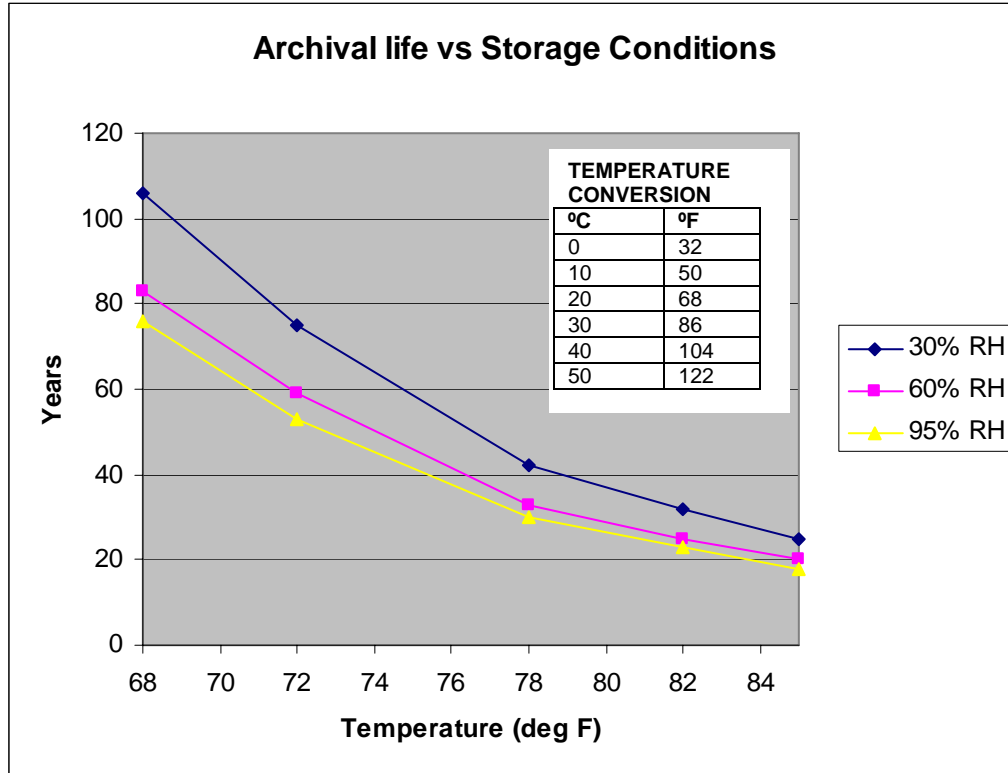
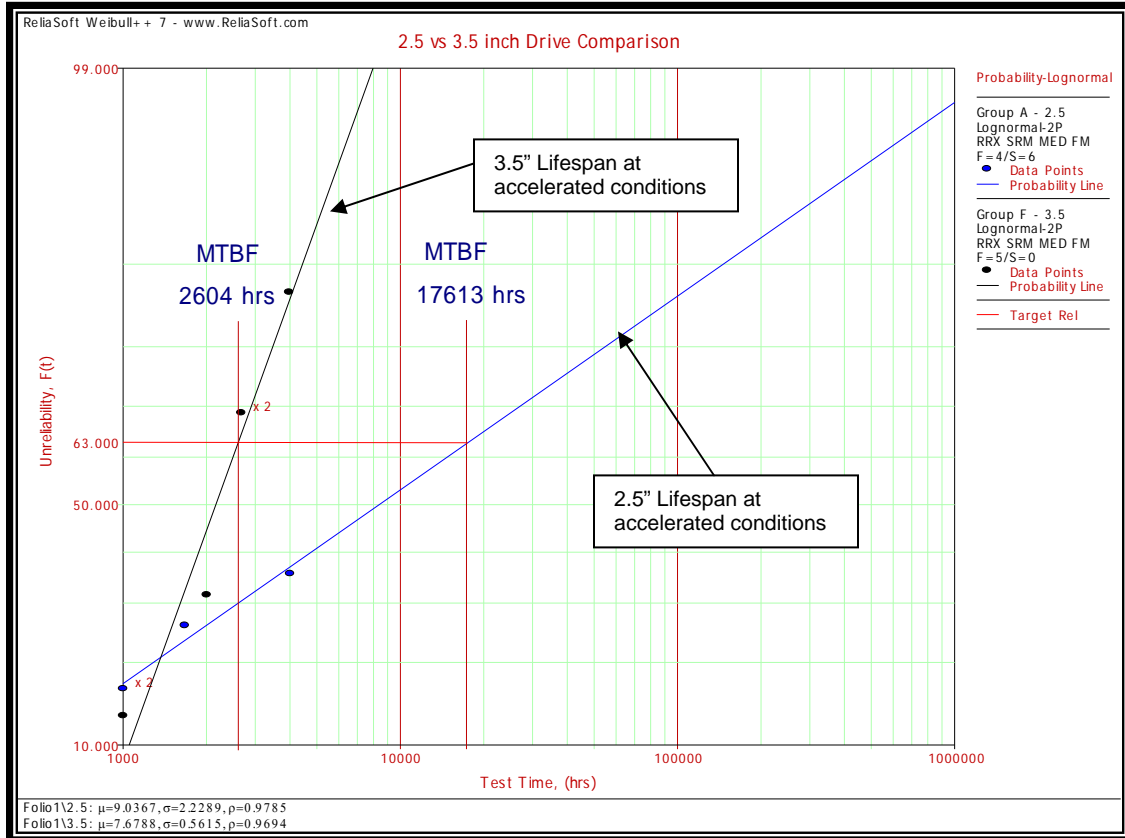


Figure 5: Archival Environmental Limits



According to our results, Percept found that the RDX 2.5" drives were more reliable than the 3.5" drives for groups stored at the same conditions of 80°C / 85% RH. This difference was greater than 6 times when the Mean Time Before Failure (MTBF) of the two samples are compared. Following is a Weibull chart displaying the average MTBF differences between the drive types.

Figure 6: Life Comparison of 2.5" & 3.5"



CONCLUSION

The data predicts that the RDX removable disks are archivable and will be able to read the data contained on them after a long storage period. The results indicate that with proper care and a climate-controlled environment, the RDX removable disk drives from ProStor can safely archive data for an extended period of time. Statistically speaking, here are the results found by Percept.

Storage Conditions		Total Years of Safe Storage
Temperature	Humidity	
Up to 68° F	5 - 30%	100 plus years
Up to 78° F	5 - 95%	30 years
Up to 82° F	5 - 60%	25 years
Up to 85° F	5 - 60%	20 years

About Percept Technology Labs

Percept Technology Labs, Inc. is an established, independent product and consulting company with a proven track record of helping customers test and improve their products since 1996. Percept specializes in data storage, ITE and consumer electronic products. To learn about Percept's full line of testing and consulting services, please visit www.percept.com or call 303-444-7480.