

# Summary Report of ISO/IEC 10995 Test Program Performed by Millenniata™ on Two Brands of Archival DVD-R

## Introduction

Millenniata has established a new standard in digital data storage with the introduction of the M-DISC family of inorganic archival optical media. As part of our on-going program to confirm the longevity performance of the DVD and other optical media, Millenniata performed a series of tests conforming to the ISO/IEC 10995 Standard Test Program. This test report will summarize the results obtained on two organic archival media brands.

## Media Tested

The discs used in this test were DVD-R media selected with particular attention to the historical manufacturing quality of the brands, the cost of the media (assuming that higher cost equates to higher quality), and the data lifetime claims of the manufacturer. The first DVD (Brand A) is an archival gold disc with a claimed data lifetime of 100 years and a suggested retail price of about \$2.60 per disc. The second DVD (Brand B) is an archival disc with a claimed data lifetime of 30 years and a suggested retail price of about \$2.85 per disc. (Prices are in U.S. dollars.)

## Test Setup

The test conducted at Millenniata followed strict guidelines and standards that are set by the ISO/IEC 10995 Test Specification. The test conditions are summarized in table 1 below.

Test Number	Test Stress Condition		Number of Specimens	Incubation Duration	Time Completed
	Temp °C	% RH		Hours	Hours
1	85	85	20	100 - 250	650
2	85	70	20	100 - 250	1150
3	65	85	30	100 - 250	2100
4	70	75	20	100 - 250	2500

Table 1: ISO/IEC 10995 Test Condition Summary

## Results of the Testing

Key values measured on the DVDs tested included Normalized Modulation, DC Jitter, and PIE Sum 8 Maximum. Each of these values were measured multiple times for each specimen under each of the identified stress conditions.

Normalized Modulation is a measure derived from the reflectivity of the DVD in the written area. It is a measure of the difference in light reflected from the data marks and the area between the marks. A value of 60% is required to be within the standard DVD-R specification. As this value drops below 60%, the ability of a typical drive to read the disc may become impaired.

DC Jitter is a measure of variation in the beginning and end positions of marks made by the laser on a written disc. The specified upper limit to this value on a newly written disc is 9%. While not a direct measure for the loss of data, as the DC Jitter increases, the ability of a drive to correctly recognize the edges of the data marks is degraded and digital errors will increase.

PIE Sum 8 Maximum is a measure of the data read error rate for a DVD. The limit value specified in the test is 280. All DVDs have a measurable error rate in playback that is automatically corrected by the drive. While the typical DVD player will successfully read a disc with several times the 280 error rate, this value is specified in the ISO/IEC 10995 Standard and is used as the failure specification in this test.

The test results below are only representative average values for the sets of DVDs exposed to each of the individual test conditions. The curves in these figures represent a large number of discrete data points.

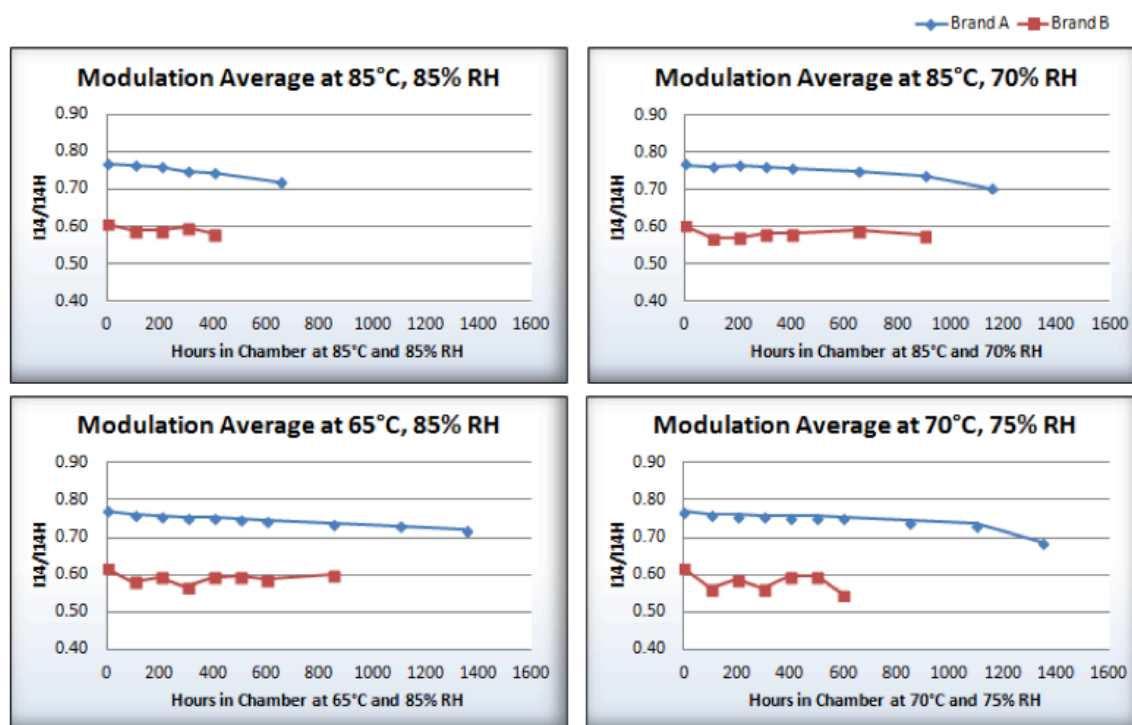


Figure 1: Normalized Modulation Average

Normalized Modulation for Brand A was easily within specification for the duration of the test procedure. Brand B however quickly fell to just below the specified limit, and stayed below for the remainder of the test.

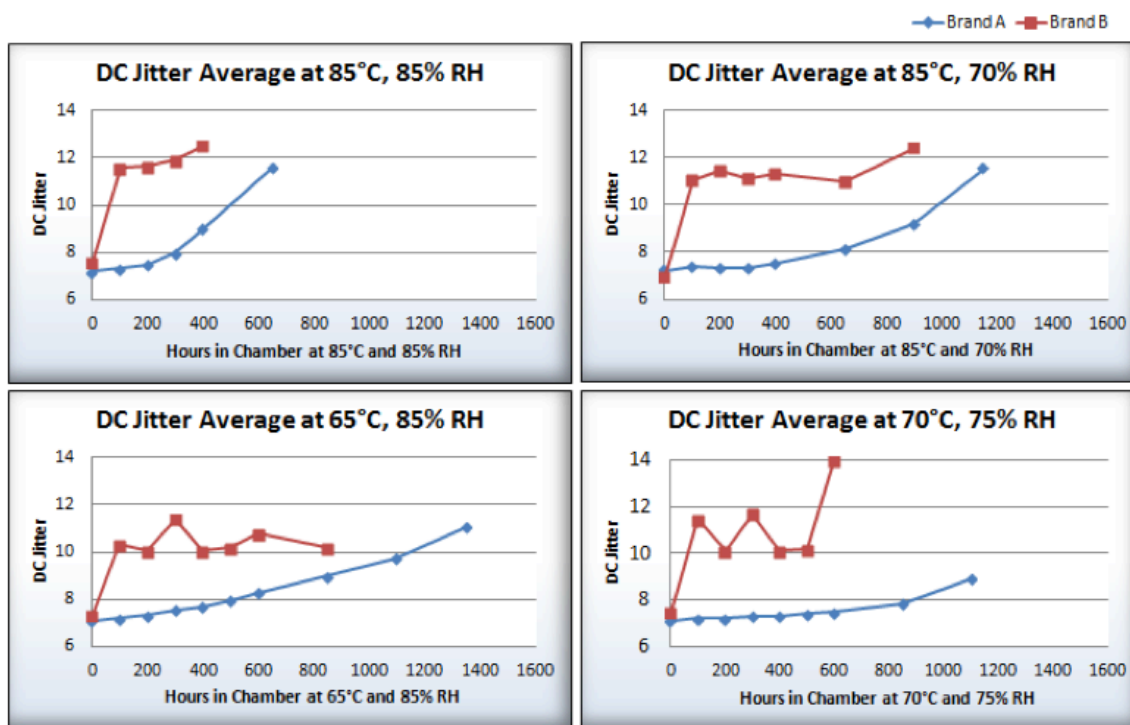


Figure 2: DC Jitter Average

As can be seen above, Brand A shows a steady increase in DC Jitter on all of the test conditions. This is not desirable, as eventually the ability of the drive to determine the length of the marks will decrease to the point that significant errors will occur. Brand B shows a sudden increase in DC Jitter at the beginning of each test, and significant variability thereafter. This is a much less desirable condition, as it indicates a quick and unpredictable failure mode for the discs.

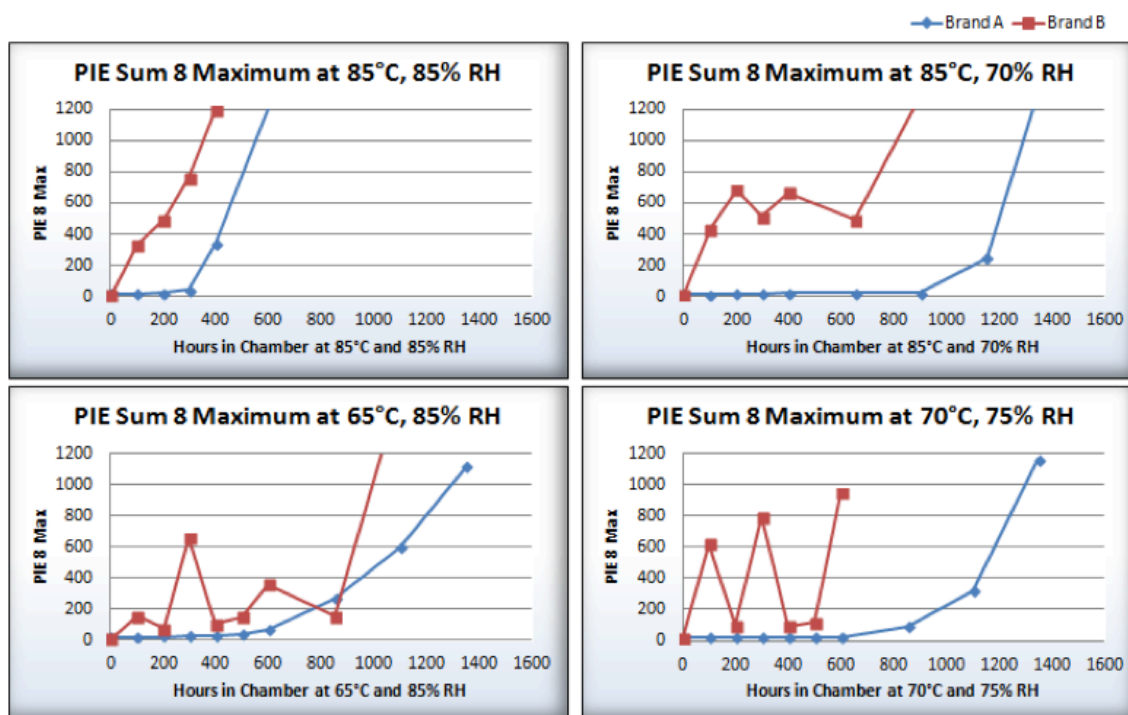


Figure 3 PIE Sum 8 Maximum

The PIE Sum 8 Maximum values for Brand A show a regular predictable increase in value as time is spent at high stress conditions. It is easy to determine a predicted performance over time. Brand B shows much more variability in the measurement.

To determine the expected lifetime of the discs, the PIE Sum 8 Maximum values for all discs experiencing a particular test condition are analyzed and compared against the elapsed time in the test. Performing this analysis for the four different test conditions (see table 1) enables a scientifically rigorous estimation of the lifetime of the disc under various storage conditions.

The PIE Sum 8 Maximum test results displayed above demonstrate the significant lifetime concerns of the organic archival DVDs tested. These values predict a significantly shorter lifetime than claimed for both brands of discs tested. Following the mathematical analysis procedures specified in the ISO/IEC 10995 Standard, the entire collection of data taken in the test can be processed and reduced to a lifetime estimate for any specified set of storage conditions (combinations of storage temperature and relative humidity). While this mathematical analysis is too extensive and laborious to be described in this summary report, the predicted lifetime results are shown in Table 2 for various storage conditions. The typical values of 25°C and 50% RH are highlighted.

		15 °C	20 °C	25 °C	30 °C	35 °C	40 °C
<b>Brand A</b>	30% RH	14.2	11.5	9.4	7.7	6.3	5.2
	50% RH	4.6	3.7	3.0	2.5	2.0	1.7
	70% RH	1.5	1.2	1.0	0.8	0.7	0.6
<b>Brand B</b>	30% RH	7.8	4.9	3.1	2.0	1.3	0.9
	50% RH	6.8	4.3	2.7	1.7	1.1	0.8
	70% RH	5.9	3.7	2.3	1.5	1.0	0.7

Table 2: Average Predicted Data Lifetime in years (25°C and 50% RH is considered typical)