



## Summary Report of ISO/IEC 10995 Test Program Performed by Millenniata on M-DISC™ DVD

### 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 commitment to provide permanent data storage solutions to our customers, we have completed the full ISO/IEC 10995 Standard Test Program to determine the expected data retention lifetime of the M-DISC Technology in the DVD format. We are pleased to present the following test report.

In short, all results confirm the M-DISC has an expected average lifetime of 1,332 years when stored at normal conditions of 25°C and 50% Relative Humidity (RH). Not only is this consistent with our performance claims, the test results also demonstrate the M-DISC performs over 100 times better than the next best digital data storage solution available.

### Description of Results and Predicted Lifetime

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

PIE Sum 8 Max is a measure of the data read error rate for a DVD disc. The maximum value specified in the test is 280. While the typical DVD player will successfully read a disc with several times this error rate, this value is specified in the ISO/IEC 10995 Standard and is used as the failure specification in this test.

To determine the expected lifetime of the M-DISC, the PIE Sum 8 Max values for all discs experiencing a particular test condition are analyzed and compared against the elapsed time in the test. Performing this analysis for all four different test conditions (see the above table) enables a scientific estimation of the disc lifetime at normal storage conditions (25 °C and 50% RH).

The M-DISC test results displayed below in Figure 1 help demonstrate the significant lifetime advantage of the M-DISC. The M-DISC advantage in maintaining an acceptable error rate becomes very obvious at the lower temperature conditions specified in the ISO/IEC 10995 Standard. This is exactly what should be expected if the M-DISC has a very long lifetime.

Figure 2 below highlights another of the significant lifetime advantages of the M-DISC. The jitter is a direct measure of the accuracy of the data recording process on the disc. As the disc ages, jitter will typically increase. These four charts show the change in jitter from the initial or starting value as the disc ages during the test, meaning a value of 0 would indicate there was no change. It is obvious that the recorded data marks are stable and accurate on the M-DISC under extreme conditions. This stability is key to the exceptional data retention lifetime of the M-DISC.

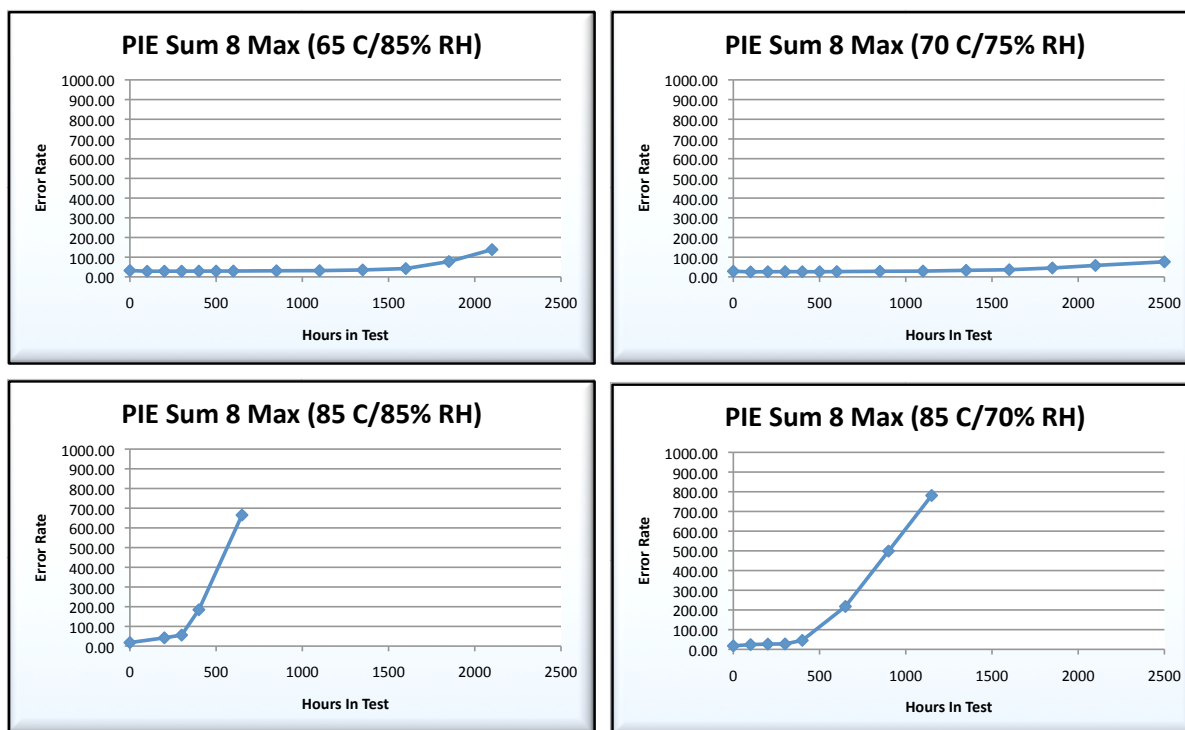


Figure 1. M-DISC PIE Sum 8 Maximum Error Rates By Test Condition

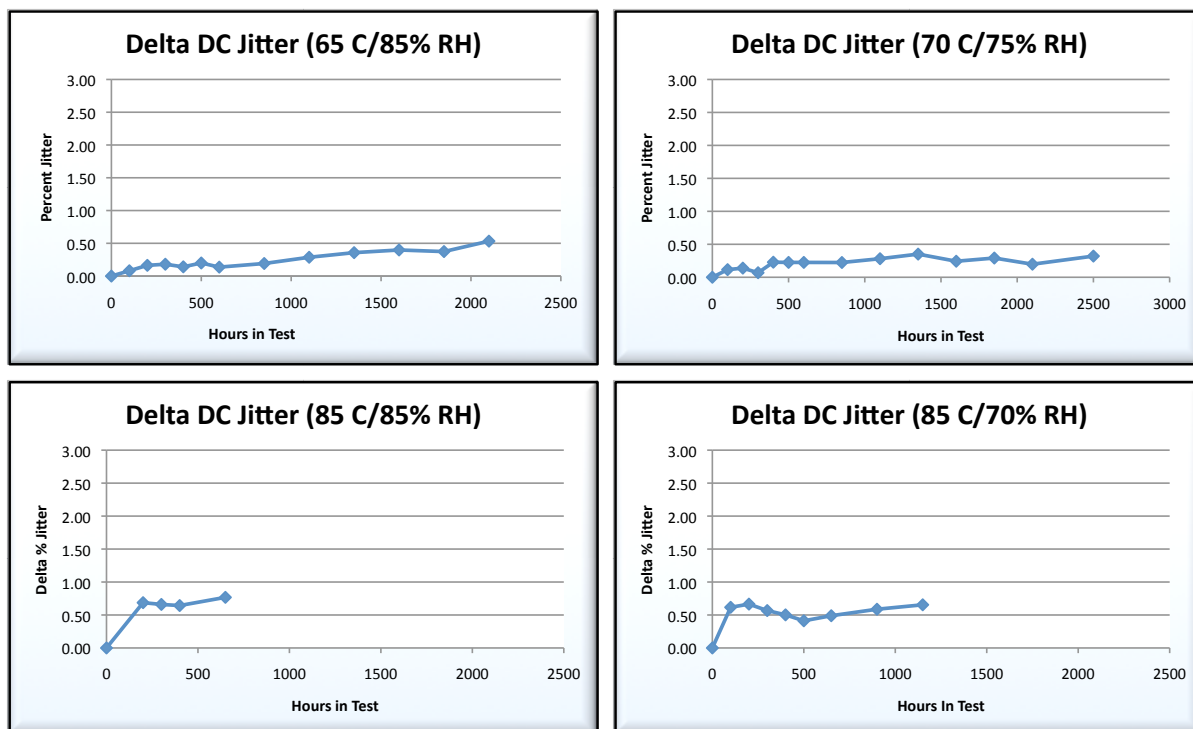


Figure 2. M-DISC Data-to-Clock (DC) Jitter by Test Condition

Figure 1 and Figure 2 are only representative average values for the set of M-DISCs exposed to each of the individual test conditions. The curves in these figures represent a large number of data points. Following the mathematical analysis procedures specified in the ISO/IEC 10995 Standard, the entire collection of data points 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 results are shown in Table 2 for various storage conditions.

	15 °C	20°C	25 °C	30 °C	35°C	40 °C
30% RH	16969	6880	2875	1237	547	248
50% RH	7865	3189	1332	573	253	115
70% RH	3646	1478	618	266	117	53

Table 2. M-DISC DVD Expected Mean Lifetime in Years Under Selected Storage Conditions