Grade Measurement Test

National Institute of Standards and Technology (NIST)

Information Technology Laboratory
Information Access Division

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What is the National Institute of Standards and Technology (NIST)?
NIST

Advanced Technology Program

Co-funding of private sector R&D to develop broadly beneficial new technologies

Measurements and Standards Laboratories

Nation’s ultimate reference point for measurements and standards to support industry, science, health care, safety, and the environment.

Manufacturing Extension Partnership

Nationwide network of extension centers assisting the Nation’s 385,000 smaller manufacturers in all 50 states and Puerto Rico.

Baldrige National Quality Program

Annual Baldrige awards in manufacturing, service, small business, education, and health care promote business excellence

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NIST → Measurements and Standards Laboratories

- Strengthen the U.S. economy and improve the quality of life by working with industry to develop and apply technology, measurements, and standards

- Enhance US industrial competitiveness and economic growth through critically needed standards, measurements, and data
Information Technology Laboratory (ITL)
6 Divisions

- Mathematics and Computational Science Division
- Statistical Engineering Division
- Computer Security Division
- Networking Research Division
- Software Testing Division

Information Access Division

- Human Language Technology
- Biometrics Technology
- Interactive Systems Technology
- Digital- and Multi-Media Technology
- Pervasive Computing
- Data Preservation
Grade Measurement Test

• A measurement to indicate disc grade
• A test that can be performed in a reasonable time
• An indicator to consumers about quality
• Provide number that consumers can use for planning
Topics

✓ Consumer Perception
✓ LE Test Issues
✓ Alternatives
✓ Benefits
Consumer Perception

Manufacturers vs. Headlines

LE Best Case
-Manufacturers
  - ~ 100 – 300 years CD-Rs
  - ~ 100 years DVD-Rs

LE Worst Case
-Headlines
  - CDs fail in short time frame
  - 2 -10 years failure
  - “CD Rot”
Most Commonly Asked Question
How long will my (recordable) disc last?

Answer: It depends 😊

• Disc construction
  – Materials
  – Manufacturing process

• Initial recording quality
  – Quality of burn (depends on disc and burner)
  – Condition of disc before recording

• Care and handling
  – Physical handling
  – Environmental influences
Consumer Perception

Why

• Variation in life expectancy among discs
  – Quality differences between brands
  – Quality differences within brands
• General claims of up to 100 years LE (DVD±R)
  – Actual could be as low as 30 years in normal ambient room conditions
  – Anecdotal stories conflicting with general claims
• User confidence/uncertainty/awareness
  – Consumer expectations - uncertain or unrealistic
  – Planning under uncertainty – sampling and migration
Archive Quality Labeled Discs

“Archive” quality discs available from some manufacturers

- What does it mean?
  - How are they different from regular discs?
  - How many years will they last? Longer LE?
  - How does archive quality disc from manufacturer A compare to archive quality disc from manufacturer B?
  - How are they determined to be longer lasting?
Consumer Perception

Consumer Indecision - More Questions

• Should I trust my digital content to optical discs?
• Which disc should I buy?
• How long will it last?
• What is the minimum number of years I can expect?
• Does price make a difference?
• What should I look for, in a disc?
Consumer Perception

DVD-R Accelerated Aging Comparison Examples

PIE from High T and RH

DVD discs

Aged in high temperature and humidity conditions

PIE from Metal-Halide Light

DVD discs

Aged in Metal-Halide light

D1
D2
D3

PI error

0 100 200 300 400 500

Hours

0 1000 2000

PI error

0 500 1000 1500

Hours

0 200 400 600 800
Consumer Perception

Metal-Halide Light Test

Jitter from Metal-Halide Light

POE from Metal-Halide Light
LE Issues

Life Expectancy (LE) Test Standards

Existing LE Test Method Standards
• CD-ROM
• CD-R
LE Testing Issues

- **Time duration**
  - Typically one to two years
  - Time to market

- **Capability**
  - Equipment
  - Space
  - Expertise

- **Cost**
  - Labor
  - Contract out

- **Existing LE Test Followed?**

- **No Standard DVD Test**
  - No Standard LE Test for DVD yet
  - NIST is developing a proposed procedure

- **No Standard “archive quality” test methodology**
  - NIST proposal
LE - Accelerated Aging Times

<table>
<thead>
<tr>
<th>Stress Test-Set</th>
<th>Stressed at (T&lt;sub&gt;inc&lt;/sub&gt;, RH&lt;sub&gt;inc&lt;/sub&gt;)</th>
<th>Incubation duration</th>
<th>Minimum total time</th>
<th>Specimen quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80 °C, 85 %</td>
<td>500 h</td>
<td>2000 h</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>80 °C, 70 %</td>
<td>500 h</td>
<td>2000 h</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>80 °C, 55 %</td>
<td>500 h</td>
<td>2000 h</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>70 °C, 85 %</td>
<td>750 h</td>
<td>3000 h</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>60 °C, 85 %</td>
<td>1000 h</td>
<td>4000 h</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13,000 h total</td>
<td>80 total</td>
</tr>
</tbody>
</table>

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### Incubation + Testing Time

<table>
<thead>
<tr>
<th>No. of Chambers</th>
<th>Incubation time</th>
<th>No. of weeks</th>
<th>Testing time (2 analyzers)</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13,000 hrs</td>
<td>78 wks</td>
<td>6 wks</td>
<td>84 wks</td>
</tr>
<tr>
<td>2</td>
<td>7,000 hrs</td>
<td>42 wks</td>
<td>6 wks</td>
<td>48 wks</td>
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<tr>
<td>3</td>
<td>5,000 hrs</td>
<td>30 wks</td>
<td>6 wks</td>
<td>36 wks</td>
</tr>
<tr>
<td>4</td>
<td>4,000 hrs</td>
<td>24 wks</td>
<td>6 wks</td>
<td>30 wks</td>
</tr>
</tbody>
</table>
First Stress Test Set
500 hour intervals x 4

80°C, 85%RH

LE Issues
LE Issues

Second Stress Test Set
500 hour intervals x 4

80°C, 70%RH
LE Issues

Third Stress Test Set
500 hour intervals x 4

80°C, 55%RH
LE Issues

Fourth Stress Test Set
750 hour intervals x 4

70°C, 85%RH
Fifth Stress Test Set
1000 hour intervals x 4

60°C, 85%RH
Alternatives

Alternatives to Existing LE Test
(to save time and cost)

• Shorter LE Test
  – Less expensive
  – Less accurate

• Initial Error Rate Test
  – Measures initial quality of data on disc
  – Does not account for disc degradation rate
  – Does not indicate life expectancy

• Target Test - “Archival”, or “Longevity” or “Grade”
  – Longevity specific, i.e.: minimum number of years expected
  – Not a test to determine total disc LE
One Approach

- Shorten the LE test
  - Creates higher uncertainty for total disc LE measurement
  - But
  - Uncertainty level is still good for lower limit or hurdle
- Consider error increase rate
  - \( > x = \text{fail} \)
- Consider initial error rate?
  - \( > x = \text{not acceptable} \)
Another Approach

\( T_s \text{ with } RH_s \text{ for } (x)hrs = Y_n \) (other values remain constant)

Set \( Y_n = "\text{Grade}" \) (examples: 30, 50, 75)

For given “Grade” (example: 50), determine hrs, for \( T_s \) and \( RH_s \)

At determined \( T_s \), \( RH_s \), hrs (correlating to a given “Grade”), if error rate is:

- \( > \) BLER max (CD), PIE max (DVD) \( \rightarrow \) Fail
- \( < \) BLER max (CD), PIE max (DVD) \( \rightarrow \) Pass

Also consider error increase rate through interval testing.
Targeted Time Period Test

• A test for targeted time period for longevity
  – 50 year example
  – Discs are expected to have less than BLER-max or PIE-max at 50 yrs
  – Error rate increases less than an established maximum acceptability
  – Total disc LE is unknown (not necessary)

• Can have more than one target or establish only one target.
  – > 30 yrs
  – > 50 yrs
  – > 75 yrs
  – > 100 yrs
Benefits

Consumer/Industry Benefits

• Consumer
  – Consumer uncertainty reduced
  – More informed choice for consumer
  – Increase consumer confidence
  – More realistic consumer expectation
  – Consumer purchasing can be based on needs or migration plans

• Industry
  – Industry standard test
  – Self-test or third party
  – Time to market
  – Testing cost (compared to LE testing)
  – Pricing
Thank you!

NIST
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Information Technology Laboratory
Digital Data Preservation
Fred Byers, Oliver Slattery, Jian Zheng
http://www.itl.nist.gov/div895/preservation/
Care and Handling Guide
http://www.itl.nist.gov/div895/carefordisc/
Other ideas

• Early warning indicator
• RFID
Early Warning Indicator

- Could also be called:
  - Error Alert
  - Check Disc
- A warning about error rates that are approaching BLER max or PIE max.
  - May also consider Burst errors
- Just a light as an indicator or a pop-up window