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Preservation Metrics

In the mid-1990's IPI began work on computer modeling and the development of algorithms to measure the effects of the storage environment on collections. This research led to the introduction of the general quantitative model of chemical decay in organic materials called the time-weighted preservation index (TWPI), published in *New Tools for Preservation: Assessing Long-Term Environmental Effects on Library and Archives Collections* [2]. Based on this concept, IPI developed the Preservation Environment Monitor® datalogger and Climate Notebook® software. During field trials of these tools, IPI developed additional metrics for environmentally induced mechanical damage, biological decay, and metal corrosion. These metrics were incorporated into the analysis performed by Climate Notebook and the PEMdata.com [3] website.

IPI's Preservation Metrics are described briefly below. Environments are rated as Good, OK, or Risk based on evaluation of temperature and relative humidity using the metrics. For an in-depth explanation, download [Understanding Preservation Metrics \(PDF\)](#)

[4].

Type of Decay: Chemical Change

Metrics Used:

Time Weighted Preservation Index (TWPI)

TWPI Value (years)

≥75

Interpretation

Good

45-75

OK

Interpretation:

Higher the TWPI, the better

≤45

RISK

Measures:

The rate of chemical decay as determined by the rate of spontaneous chemical change in organic materials.

- TWPI integrates the T and RH values as they change over time into a single estimate of the cumulative effects of the environment on the rate of chemical decay.
- TWPI is helpful as a quantitative comparison of the preservation quality of different storage locations or environments.

Applies to:

All Organic Materials (paper, textiles, plastics, dyes, leather, fur, etc)

Type of Decay: Mechanical Damage

Metrics Used:

Minimum % Equilibrium Moisture Content (min % EMC) Maximum % Equilibrium Moisture

% Min EMC, % Max EMC and % DC

Interpretation

Min EMC > 5.0 AND Max EMC < 12.5 AND DC < 0.5

Good

Min EMC > 5.0 AND Max EMC < 12.5 AND DC < 1.5

OK

Min EMC < 5.0 OR Max EMC > 12.5 OR DC > 1.5

RISK

Content
(max % EMC)
% Dimensional
Change (% DC)

Interpretation:

Moderate % EMC is best ==> % EMC between 5% and 12 % maintains appropriate levels of moisture

The lower % DC, the better ==> fewer, smaller fluctuations between maximum EMC and minimum EMC

Measures:

Three aspects of moisture content that promote mechanical or physical damage:

- **Max % EMC:**
Is it too damp? Will paper curl? Will emulsions soften? Will wood warp?
- **Min % EMC:**
Is it too dry? Will paper become brittle? Will emulsions crack? Will wood chip?
- **% DC:**
How great are the fluctuations between the most damp and the most dry? Has expansion and contraction - from absorption/desorption of water - put physical stress on the collection materials?

Applies to:

All organic or hygroscopic materials (paper, textiles, plastics, dyes, leather, fur)

Most Important for:

Rare books, paintings, furniture, textiles; any bound or composite object

Type of Decay: Mold Risk

Metrics Used:

Mold Risk Factor (MRF)

Mold Risk Factor

≤ 0.5

Interpretation

Good

Measures:

The risk for growth of the xerophilic mold species on collection objects or in collection areas.

> 0.5

RISK

Interpretation:

Lower the MRF, the better

- MRF greater than 0.5 indicates that mold spores are half way to germination, meaning half way to a vegetative mold state.
- MRF greater than 1.0 indicates that mold spores have germinated, entering a vegetative mold state and visible mold could be actively growing.

*Note: There is no "OK" rating for mold growth. At a MRF of 0.5, conditions are appropriate for germination of spores. By alerting RISK of mold growth at germination, the user is aware of the potential of mold growth before any visible or vegetative mold will appear. This allows for time to react and prevent formation of vegetative mold.

Applies to:

All organic materials (paper, textiles, plastics, dyes, leather, fur) or inorganic materials with organic films

Type of Decay: Metal Corrosion

Metrics Used:

Maximum Equilibrium Moisture
Content (% EMC max)

% EMC (max)

≤ 7.0

≥ 7.1 and ≤ 10.5

≥ 10.6

Interpretation

Good

OK

RISK

Interpretation:

Lower % EMC is better

Measures:

The effect of the environment on metal corrosion. The % EMC max represents the maximum amount of moisture that was present in hygroscopic collection materials. Because metallic corrosion is dependent on available moisture, the Max % EMC gives us an idea whether or not metallic objects (mainly ferrous metals) would corrode in such an environment.

Applies to:

Metals or materials with metal components

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[1] <https://www.imagepermanenceinstitute.org/category/sections/environmental-management>

[2] <https://www.imagepermanenceinstitute.org/store/publications/new-tools-preservation>

[3] <http://www.pemdata.org>

[4] https://www.imagepermanenceinstitute.org/webfm_send/536