Storage Environments: Monitoring & Control

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Storage Environments

- The following environmental parameters in a store room affect the long-term stability of collections:
  - Pollutants
  - Light
  - Pests
  - Temperature
  - Humidity

Pollutants – the problem

- Common types of pollutants are:
  - Corrosive gases such as:
    - Organic solvents or acids used to treat objects
    - Industrial atmospheric pollution (e.g. Sulfur)
    - Emissions from objects (e.g., most woods emit volatile organic acids)
    - Emissions from packing materials (acidic paper and cardboard emit volatile organic acids)
  - Particulates such as:
    - Dust, soot, etc.

Pollutants – the solution

- To reduce corrosive gases:
  - Identify and monitor
    - Use active or passive sampling devices to detect, identify, and measure the concentration of volatile chemicals
    - Use pH testing pens to identify acidic packaging materials
  - Reduce and protect
    - Use only non-off-gassing or non-acidic storage materials
    - Use chemical absorbent materials like activated charcoal papers
    - Use barrier protective packaging like Corrosion Intercept™
- To reduce particulates:
  - Use internal environmental systems to filter air
  - Keep storage areas clean and dust-free
  - Bag and cover your collections

Active sampler


Passive sampler

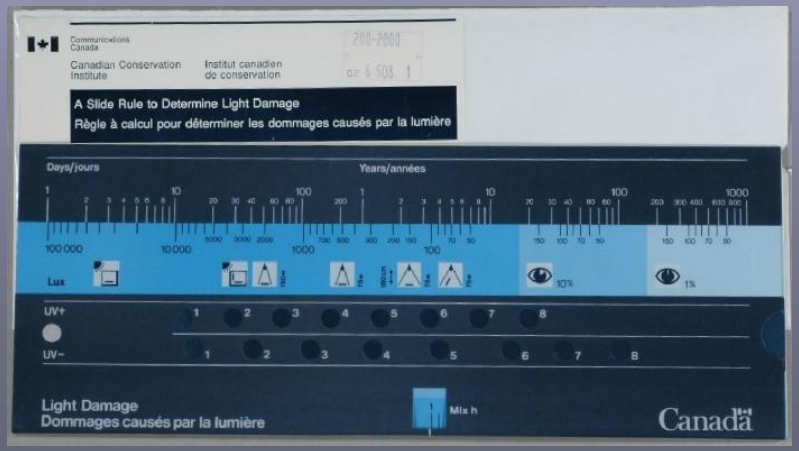
Light – the problem

- Light is measured in Lux or Lumens
- Light accelerates some chemical reactions
  - Fading of dies and other colors
  - polymer degradation, both natural (fibers) and synthetics (plastic containers, bags, labels)
- Light supports biological activity
- Light damage is less critical in storage, more of a display problem.

Light Damage – the solution

- To control light damage:
  - Monitor existing light levels with a light meter or fade card
  - Calculate annual exposure levels, and compare to management standards for different materials
  - Alter your lighting to meet the standards:
    - Reduce the amount of time the lights are on,
    - Use fewer lighting fixtures, or focus lights only where needed,
    - Use lighting fixtures with lower Ultra-violet component.

Light Monitor



Light Damage Slide-Rule Calculator

Pests – the problem

- The two common types of pest affecting collections are:
  - Micro-biological
    - mold, mildew, fungi, bacteria
      - They come from the external environment, and are ofent inherent in objects (especially from excavations)
      - Damage is directly to the object as a result of biological activity: microbes feed on the objects and leave behind metabolic products that are staining or chemically reactive.
  - Macro-biological
    - insects, rodents
      - Damage can be direct (insects feeding on cellulose), or indirect (urine, feces)

Pests – the solution

Monitoring station

- To control microbiological growth:
  - Practice good house-keeping to keep areas clean,
  - Use environmental controls to reduce temperature, moisture, and light that encourages growth
- To control macro-biological pests:
  - Integrated Pest Management (IPM) – a program of monitoring, cleaning, and pest control
    - Establish and enforce housekeeping rules such as regular cleaning schedules, and no food or drink in storage or work areas to attract pests,
    - Inspect and clean collections before putting them in storage,
    - Monitor and identify – use sticky traps at ingress points to capture and identify pests in your building,
    - Identify and blocks points of ingress,
    - Tailor pest eradication to the pests you know you have.

Most Critical: Temperature & Humidity

- Most object instability problems can be traced to problems with temperature and humidity
- These are the most straight-forward to understand, monitor, and control
- They are inter-related (Relative Humidity is directly related to Temperature)

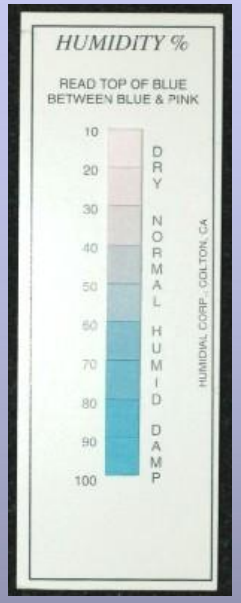
Temperature – the problem

- High temperatures result in:
  - Physical distortion (expansion & contraction),
  - Chemical changes (heat accelerates chemical reactions like oxidation)
  - Enhanced biological decay (microbiology likes it warm)
- Low temperatures result in:
  - Physical distortion (expansion & contraction)
- Fluctuation of temperatures result in:
  - Cycles of dimensional instability
  - Unequal changes, cracking

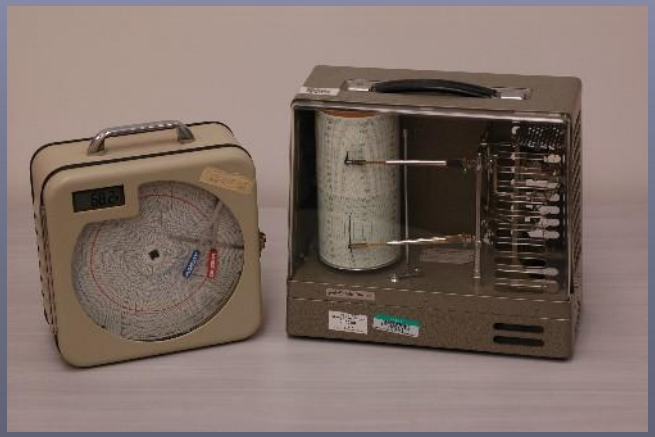
Humidity – the problem

- Humidity is measured as either:
  - Absolute Humidity - the total amount of moisture in a closed system.
  - Relative Humidity - the amount of water vapor that the atmosphere can support at a given temperature
    - warm air can hold more moisture than cold air
    - condensation occurs when Temperature drops below the point where RH exceeds 100%
- High humidity results in:
  - Condensation
  - Enhanced biological activity
  - Physical distortion (organic materials absorb water and swell)
  - Chemical activity (moisture is a catalyst to metal oxidation and glass decay)
- Low humidity results in:
  - Physical distortion (organic materials release moisture and shrink & crack)
  - Efflorescence of soluble salts on porous surfaces
- Fluctuations result in:
  - Cycles of distortion & physical damage
  - Cycles of salt absorption and efflorescence, leading to loss of porous surfaces

Temperature and Humidity – understanding the problem



- Mechanical methods
  - Thermometers,
  - Humidity indicators – moisture sensitive chemicals change color with humidity (not very accurate),
  - Thermo-hygrographs – mechanically measure and record changes in T & RH, but they require frequent chart-changes and recalibration,



Temperature and Humidity – understanding the problem

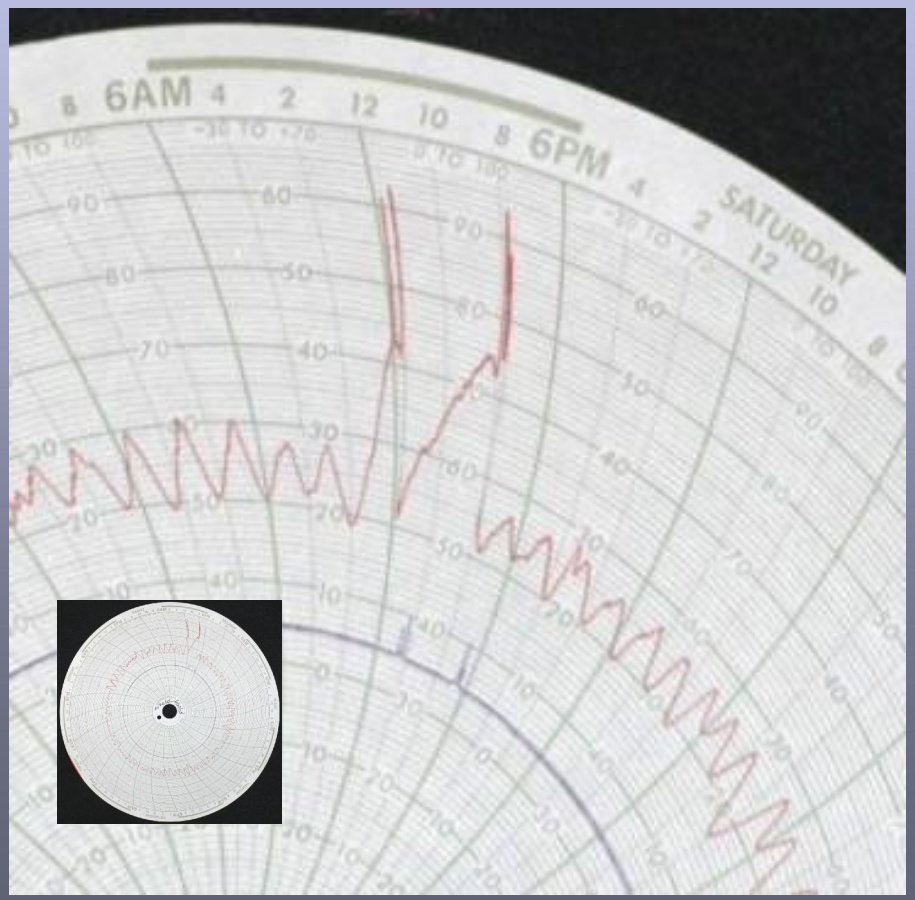
- Digital Methods
  - Digital Spot-meters
  - Digital Data-loggers

Data-loggers collect data over time and can be down-loaded to a computer for analysis.

A digital thermometer – tells you the temperature RIGHT NOW, but no data collection.

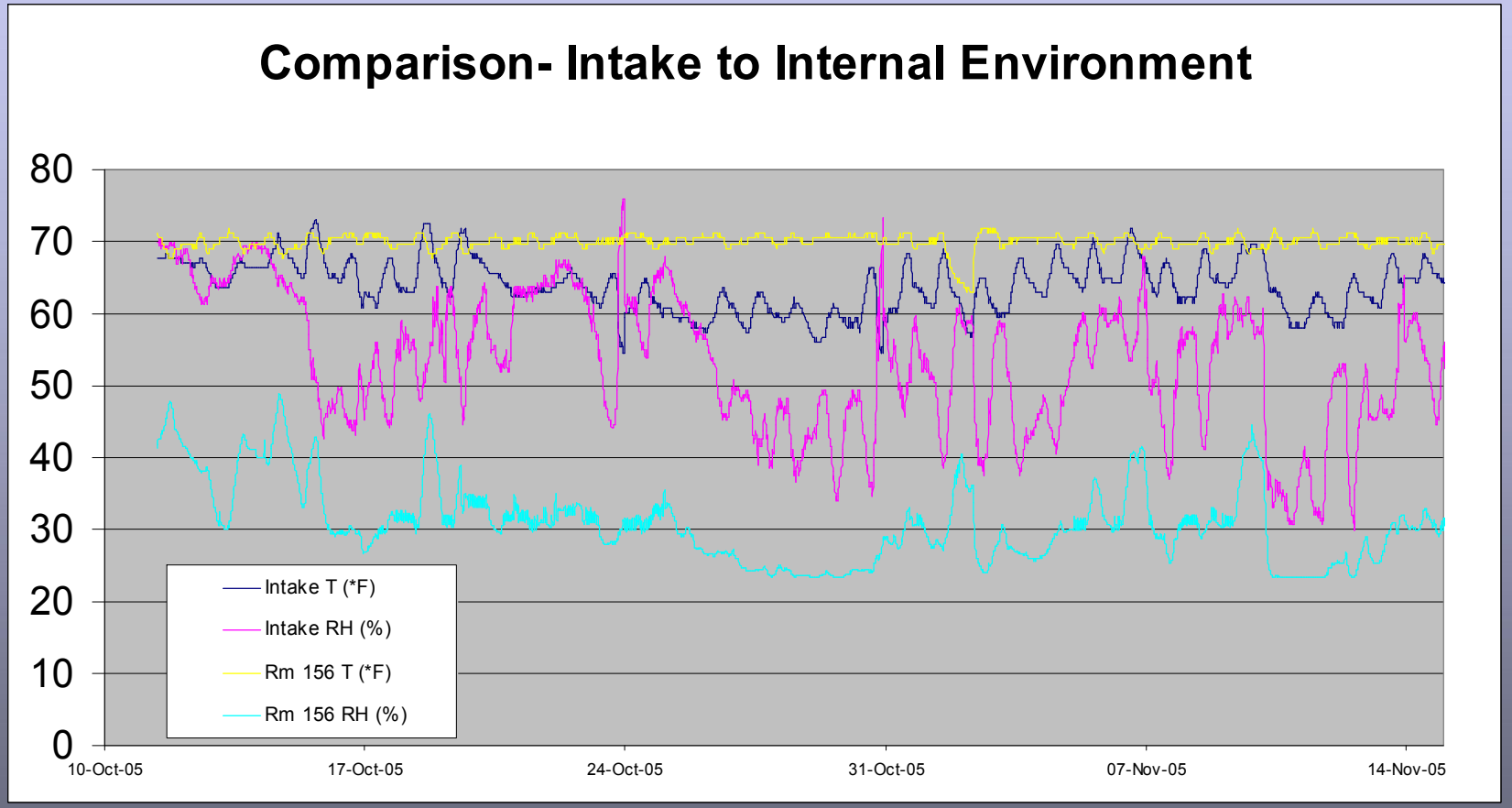
Interpreting the Data: What do your charts tell you?

All the graphs in the world won't help you if you don't read them, interpret them, and apply the information:



This chart of one week's data from a refrigerated storage unit shows temperature (purple) and Relative Humidity (red). The temperature is steady except for two spikes. The RH fluctuates hourly as the controls turn on and off, but show two large spikes at the same time: the timing of the events suggest someone opened the door on a warm summer evening…

Interpreting the Data: What do your charts tell you?



Over a four-week period, data-logger information shows the difference between outside air, and the treated environment: T is more tightly controlled, with daily variations, and RH is much reduced, but still with large variations due to external climate – the system still needs some adjustment.

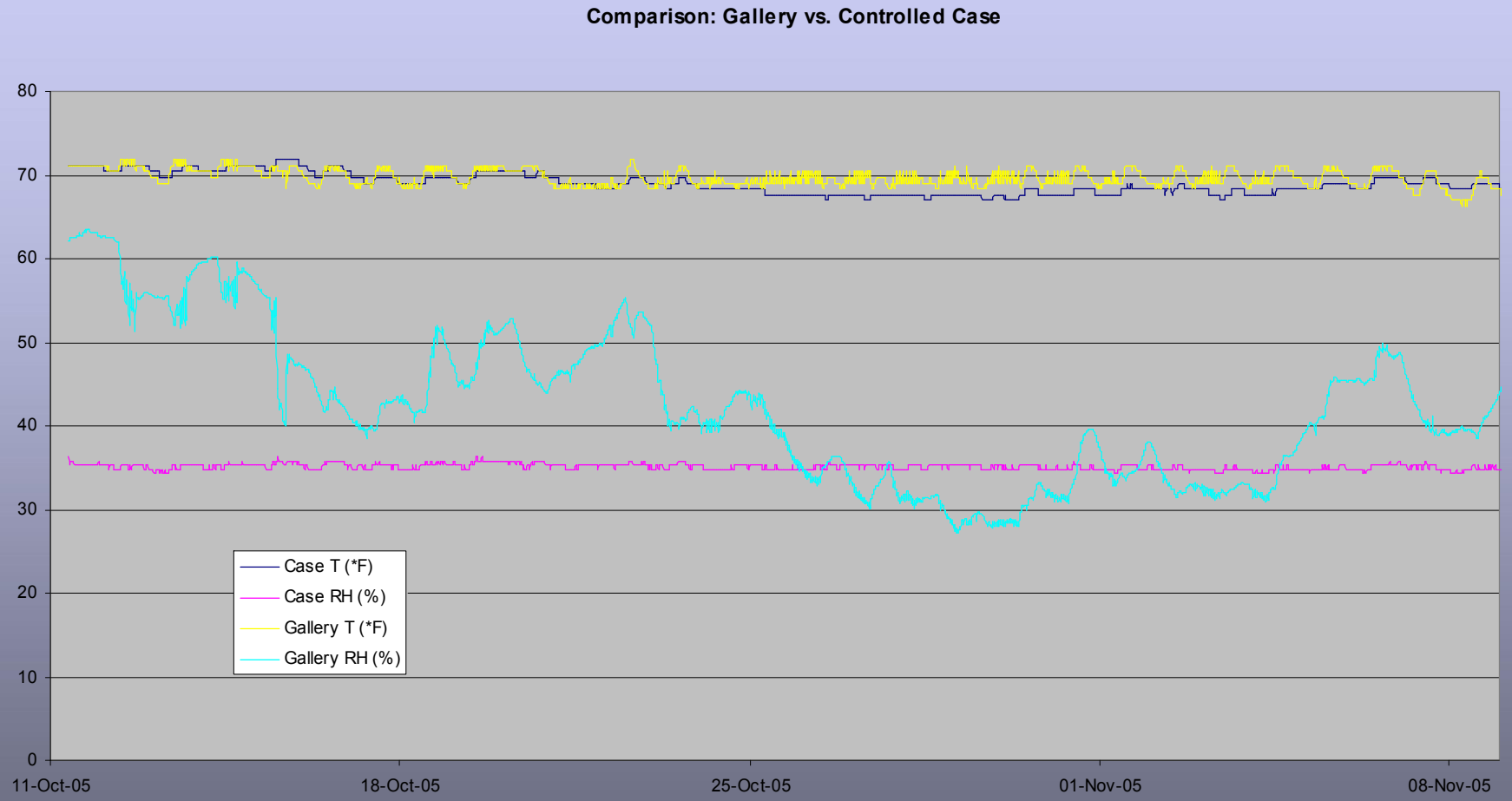
Temperature and Humidity – the solution: Macro-environmental

- There are many systems designed to control Temperature & Humidity
  - A/C, HVAC, Dehumidifiers, etc.
- Choose the system to achieve the necessary environment – consult a qualified engineer to determine:
  - Cost vs. efficiency
  - How to fit the system to the storage area

Controlling Relative Humidity: Micro-environments

- A Micro-environment is a small area or container that has environmental condition different from the greater storage area. You may need to create micro-environments where:
  - Macro-controls are not possible,
  - Specific objects need specific environments, such as in display cases, or for materials that are very humidity sensitive
- Micro-environments work on the principle that if you can control the Absolute Humidity, then changes in temperature will not cause fluctuations in RH.
- Sealed containers with a buffering material lock up AH, and keep RH at a pre-determined point:
  - e.g., desiccated silica gel will absorb atmospheric moisture from a sealed container, keep RH < 20%.
  - Buffering materials like salt solutions, buffered silica gel, or organic materials like wood will absorb and release moisture to keep RH stable at more moderate levels

The Case for Micro-environments



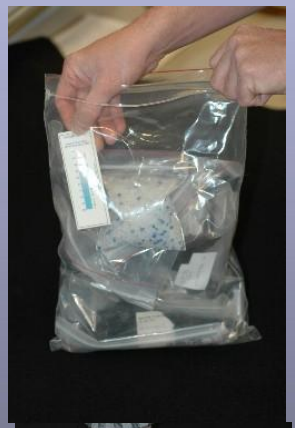
While the temperature in the Gallery and in the Case are much the same, adding desiccated silica gel keeps the RH inside the case low and stable, protecting the iron artifacts inside. The same principle will work for sealed storage containers.

Making a micro-environment

Start with a bag of desiccated silica gel, perforated so air can circulate

Then place the desiccant bag into a sealable container (freezer box) with the objects (in their individual bags, also perforated.

Then seal the container with a humidity monitor strip visible through the box wall.



Or you can place the bagged objects, silica gel bag, and monitor inside a large unperforated bag, seal it, then place that whole assembly inside another bag, and repeat one more time. Triple-bagging in 4mil bags works as well as a freezer box, but the bags will not stand up to constant opening and closing.

Other Specialty Micro-Environments

- Oxygen Scavengers will absorb oxygen from a sealed container, thus halting metal corrosion, and killing biological activity
  - Ageless™ (requires moisture to work, not recommended for metal)
  - RP System™ (can be combined with a desiccant for storing metal)
- They require special sealed film bags to ensure minimal transfer of air and moisture through the seal.

Controlling Inherent Vices

- "Inherent Vices" are decay and corrosion conditions brought on by the materials within an object, but may be influenced by the outside environments
  - Chloride salts in metals – iron chlorides, copper chlorides, etc which are natural corrosion products of excavated metal will react with atmospheric moisture and accelerate the corrosion cycle.
  - Acidic papers contain organic acids that will lead to their own degradation.
  - Soluble salts in porous materials (like ceramics) will can become mobile in high humidity, and precipitate at the surface or under glazes, causing damage and disruption.
- Inherent vices can be slowed by proper storage, but not halted.
  - pH buffered papers can control and neutralize acidic papers
  - Desiccated storage will slow metal corrosion cycles.
  - Controlled humidity environments will slow the movement of soluble salts
- Interventive treatment may be necessary
  - De-acidifying washes can remove organic acids from paper and photos.
  - Electrolytic cleaning or alkaline soaks can remove some chloride corrosion products from metals.
  - Desalination washing in purified water can remove soluble salts from ceramics.