



# Environmental Monitoring

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## ACKNOWLEDGEMENTS

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This factsheet has been adapted for use in Australia by Sarah Slade for AMaGA Victoria with kind permission from the Scottish Museums Council.

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# MONITORING THE MUSEUM ENVIRONMENT

Temperature, humidity, light, pollutants and pests can cause severe damage to museum collections. The first step in preventing this is to find out what the actual levels of these factors are and this is done by **monitoring** them.

**What** the adverse effects of temperature, light, pollutants and pests are and **why** they should be monitored is explained in a number of separate factsheets Temperature and Humidity, Air Pollution, The Effects of Storage and Display Materials in Museum Objects and Conservation and Lighting. This factsheet explains **how** these risks they can be monitored and how a monitoring program can be developed to suit your museum.



Photo: Tiny Empire Collective

# HOW OFTEN?

Collecting information about the museum environment is an on-going process that can take up considerable time. This time is only spent usefully if the information is then analysed and used to improve the environment. Remember: monitoring is not an end in itself, it is a means to finding out what the environmental conditions are and whether they need adjustment.

## Temperature and humidity

Temperature and humidity should be monitored and recorded continuously, 24 hours a day. They can fluctuate frequently and dramatically and most museum items are affected one way or another by excessive levels or frequent fluctuations.

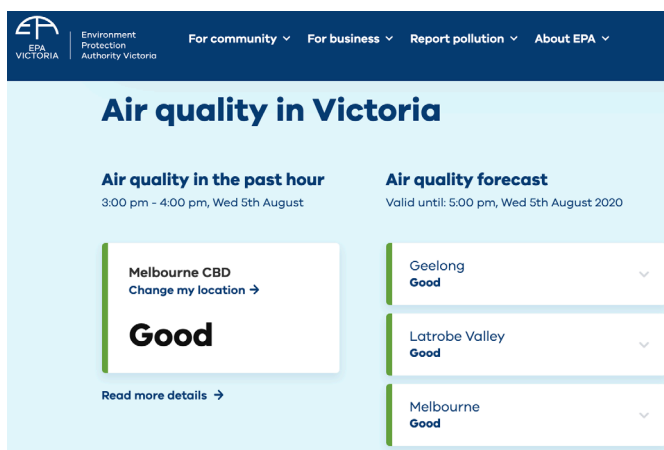
## Light and ultraviolet radiation

Light and ultraviolet radiation should be monitored every time a display containing light-sensitive material is installed. After that the levels should be checked regularly throughout the museum, and the readings recorded.

## Pollutants

Pollutants generated outdoors can fluctuate and should ideally be monitored continuously, but this can be a costly and difficult exercise. Information about pollutant levels can be collected from the Environmental Protection

Agency Victoria. Their website contains the most up-to-date information on air quality levels and common pollutants. Indoor pollutants usually fluctuate less: if a material gives off harmful vapours it is likely to do so at a fairly constant rate. Short testing periods may be sufficient to identify their presence.



Data available via Environment Protection Authority Victoria.

Image: [www.epa.vic.gov.au](http://www.epa.vic.gov.au)

## Pests

Pest inspection can be part of a regular, weekly, housekeeping and cleaning program - provided cleaning staff are trained to recognise and report any evidence of insects. If an infestation is suspected, daily (or even more frequent) inspections of the area are required to identify the source. Museum Victoria offers an insect identification service through their Discovery Centre. They need your contact details, information about where you found the insect and what you would like to know. They can be contacted by email on: [askus@museum.vic.gov.au](mailto:askus@museum.vic.gov.au) Remember that although they can help with identification, they can not give pest control advice.

# DIALS, CHARTS, METERS & MONITORS

## Temperature and Humidity

Temperature and humidity are closely related, and are therefore often measured with one instrument. Temperature is expressed in degrees Celsius (°C). Relative humidity is expressed as a percentage (%RH).

A commonly used instrument is the **whirling** or **aspirated hygrometer** (also called psychrometer). Two thermometers, a wet bulb and a dry bulb, are used to measure the temperature and calculate the humidity. Although the measurement is very accurate, human error during use and calculation can easily give rise to misleading results.

Other instruments and aids are **thermohygrographs, dial hygrometers, electronic hygrometers** and **humidity indicator cards**. Thermohygrographs and dial hygrometers measure the temperature with a bi-metallic coil and the humidity with a bundle of human hair that expands and contracts depending on its moisture content. Care should be taken when moving these instruments, as it may affect their calibration. Electronic hygrometers have an electronic sensor, which is less vulnerable to movement.

Humidity indicator cards have patches, impregnated with cobalt chloride, which change colour at a certain humidity level. The cards give an indication of humidity levels, but they are less accurate than the instruments mentioned above. They can be useful to monitor the conditions inside a display case.

The thermohygrograph is the only instrument that **records** readings and that can therefore be used to monitor conditions continuously. All other instruments can be used to take **spot-readings** of current values. Spot-readings taken at very frequent intervals (every 30 minutes) can produce results similar to continuous recordings, and electronic data logging systems make use of this principle (see **Electronic Monitoring and Data Logging Systems** below).

## Light and Ultraviolet Radiation

The intensity of visible light is measured with a **light meter**. It measures the light in lux: one lux is one light unit (lumen) per square metre. The light meter, which contains a photosensitive cell, must be able to match the way the human eye perceives light (the luminous efficiency must be similar) and it should also be cosine-corrected: it should measure the light coming in from all directions without reflecting any of it.

Ultraviolet radiation is measured with a **UV monitor** and is usually expressed in microwatts per lumen ( $\mu\text{W}/\text{lm}$ ). This indicates the amount of UV radiation **within one unit of light** wherever it falls in the room.

Both light meters and UV monitors can only be

## Data monitoring systems

Electronic data logging and computer-based monitoring systems are becoming more popular and affordable. Small, unobtrusive electronic sensors for temperature, humidity, light, UV radiation and flooding can be positioned throughout the museum in display areas, stores and display cases. They take readings at pre-set intervals (30 minutes is sufficiently frequent for museum purposes) which are either held in the data-logger ready to be down-loaded into a computer or transmitted directly to a computer. The software package in the computer then assembles, summarises and presents the data in tables, charts or graphs ready for analysis. If the data-loggers are connected directly to the computer the information is live and the computer can be programmed to set off alarms or otherwise indicate when pre-determined levels are exceeded. If the data-loggers are stand-alone then the information is historic and will show you what the conditions were during the recording period.

It should be noted that not all data-loggers display current readings, so if the loggers are not connected to your computer it may be sensible to install a dial or digital hygrometer so you can see what is happening when passing through a room.

Electronic data-loggers and computer-based monitoring systems can be an excellent alternative to traditional monitoring equipment.



Photo: Tiny Empire Collective

## Pollutants

There is no simple monitoring device for accurately identifying and measuring the level of pollutants. **Polished lead, silver or copper strips, which corrode when exposed to polluted air**, can be used to identify the presence of substances that are harmful to these metals. Another way of checking materials for the emission of harmful pollutants is to have a sample of the material tested. Advice on materials and the availability of materials testing should be obtained from a conservator.

## Pests

Regular inspections of windowsills, dark corners, cupboards and drawers are a very effective way of revealing an infestation at an early stage. However, insects often only come out at night and may not be noticed until damage has been done.

Insect traps can help in detecting nocturnal activity. The sticky base of these small, inexpensive cardboard traps holds any insect that walks over it. It should be noted that they do not attract or kill insects, but are purely for monitoring purposes.

# AN ENVIRONMENTAL DIARY

An environmental diary can be a very useful monitoring tool to record the date, time, location and results of spot-readings, regular inspections and additional observations. Unusual events, such as an evening reception, failure or servicing of equipment, calibration of instruments etc, should be noted in the diary.

The diary can take the form of a book, or separate forms, with a standard layout in two sections. Section one includes columns with (a selection of) the following headings: time, location, light, UV, temperature, relative humidity (RH), control equipment, insect traps and observations. Section two provides space for a description of the weather in a few words and any unusual events.

The result could be a page looking like this:

DATE	DAY	TIME	RH%	TEMP (C)	DEHUMIDIFIER on Y/N	HEATING ON Y/N	NOTES	WEATHER	OUTSIDE TEMP (C)	INITIAL
8/4	S	12.30	41	16	N	Y	Setting up exhib	Rain/sun	9	EH
9/4	M	12.30	43	16	N	Y	" "	Rain	11	EH
10/4	T	12.45	42	17	N	Y	" "	Rain/sun	12	EH
11/4	W	12.00	41	16	N	Y	" "	Sun	10	EH
12/4	T	12.00	56	15	Y	Y	Press photos	Rain/Sun	12	EH
13/4	F	12.00	50	16	Y	Y	Open for season	Sun	11	EH
14/4	S	12.45	56	15	Y	Y	Busy day	Rain/sun	12	JR
15/4	S	12.15	50	17	Y	Y	Easter	Sun	13	JR
16/4	M	12.30	49	17	N	Y		Rain/Sun	12	JR

## General Notes:

12 April: press photos for new exhibition first thing – many more people than we thought and had to leave front doors open for ages while they brought their equipment in.

13 April: Opening of new exhibition for friends and volunteers and families in the evening.

14 April: Very busy first day! Doors open a lot. Many people brought wet coats into the museum.

## Developing a monitoring program

Consistency and continuity are the most important factors to ensure the success of a monitoring program:

- one person should be in charge of developing the program and interpreting the readings. This person must have a thorough understanding of the needs of collection items and of the risks that threaten them.
- wherever possible, recording equipment should be installed and left in one
- place to avoid disturbance of the readings
- successive spot-readings should be taken with the same instrument, in the same location, at the same time, using the same procedure, so that the results can be directly compared
- instruments should be calibrated or serviced regularly, once every six to twelve months

Certain tasks in the monitoring program can be delegated, such as recording daily readings, maintaining the environmental diary and calibrating and maintaining instruments.

Staff entrusted with these tasks should be trained in the use, maintenance and calibration of the instruments. They will feel more involved in a monitoring program when they know why it is important to monitor the conditions and what levels and conditions are aimed for. Knowledge of the desired levels for various parts of the museum enables staff to warn the person in charge if their readings show that levels are being exceeded. However, the responsibility for acting upon these changes should remain with the person in charge.

## Choosing equipment that suits your needs

Each museum situation is different and the choice for equipment must therefore be tailored to your museum, but there are some guidelines that can be followed. For a **small to medium-sized museum with a mixed collection**, the basic set of equipment should contain:

- at least one instrument that can be calibrated, to record temperature and humidity continuously. This instrument should be set up near the most sensitive items. If thermohygrographs are used, don't be tempted by the convenience of two- or three-monthly charts. Use weekly charts initially. This allows the analysis of gradual changes, diurnal cycles and short-term fluctuations such as the arrival of large coach parties, a run of particularly hot days or the failure of any air conditioning or cooling system. Once monitoring over a longer period has shown that conditions are stable, monthly charts can be used, but beware: if something goes wrong, it may take up to a month before it is discovered.

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- one light meter and one UV monitor for spot-readings throughout the museum
  - humidity indicator cards, dial hygrometers or simple digital hygrometers for use in display cases with very sensitive material
  - insect traps for storage and display areas where vulnerable organic material is kept, or where an infestation is suspected
  - an environmental diary
  - some money set-aside for calibration, charts and replacement pens for the thermohygrograph and for additional insect traps if necessary

For a **larger museum**, or as future development of the program allows, the basic set can be expanded with:

- additional thermohygrographs for separate display areas and storerooms, or an instrument to take spot-readings in several rooms. The latter will take more staff time and requires a regular discipline. Spot-readings of temperature and humidity should be taken at least once a day, preferably more (two or three times). The readings should be recorded in the diary. The hand-held instrument is also useful to check the calibration of thermohygrographs.
- additional humidity indicator cards, dial hygrometers or simple digital hygrometers for each display case and storage cabinet with organic and/or vulnerable material
- a dedicated budget for charts, pens, calibration and maintenance of all equipment and the occasional testing of new materials

Ideally, a **full monitoring program**, once up and running, should include:

- continuous monitoring of temperature and humidity in each room or set of interconnected rooms with the same environmental conditions. One spare instrument (whether thermohygrograph or electronic sensor) should be available in case one of the instruments needs calibration or repair.
- a hand-held electronic (or whirling) hygrometer to take spot-readings and calibrate the thermohygrographs, and a set of calibration salts to calibrate electronic instruments (or a budget to have instruments calibrated annually)
- humidity indicator cards, dials or digital hygrometers in each display case
- insect traps in each storage or display area holding organic materials, including inside storage boxes and display cases
- some form of monitoring for outdoor pollutants
- a comprehensive environmental diary
- summaries for each three- or four-monthly period
- materials testing (unless it is known that the material is inert)



Large museums, or museums spread over several locations, may find a comprehensive electronic data logging system more cost-effective in the long run. The approach outlined above can be adopted for starting up, or expanding, such a system.

With all of the options, trained staff and sufficient time should be allocated to check instruments, indicator cards, dials, digital hygrometers and sensors at regular intervals; to gather and interpret the recorded readings, including notes in the diary; and to prepare summaries of the results.

These summaries are very helpful when determining control strategies or communicating with management, contractors or funding bodies.

### When disaster strikes....

There are some incidents that hopefully will not occur in your museum - fire, flooding and theft - but when they do the effect can be devastating. It is therefore worth investing in monitoring devices for these hazards. The risk of fire can be monitored with smoke detectors, the risk of flood with water sensors and the risk of theft with intruder alarms and/or movement sensors. The systems, which are inactive in normal situations, are activated and set off alarms when an undesirable event arises. Many insurance companies now insist on the installation of these warning systems and may reduce the premium if one or more are in place. Warning systems for fire, flooding or theft complete a comprehensive monitoring program and are invaluable in caring for the collection.

## Further information

Resource	Source	Link
Museum Methods	AMaGA	<a href="https://www.amaga.org.au/museum-methods">https://www.amaga.org.au/museum-methods</a>
Recollections, Damage and Decay	Heritage Collections Council	<a href="https://aiccm.org.au/wp-content/uploads/2020/01/3_damage_and_decay.pdf">https://aiccm.org.au/wp-content/uploads/2020/01/3_damage_and_decay.pdf</a>
Collection Care	AICCM	<a href="https://aiccm.org.au/conservation/collection-care/">https://aiccm.org.au/conservation/collection-care/</a>

AMaGA Victoria can provide assistance with the location of further information on collections care and conservation. Please contact: 03 8341 7344 or [info@amagavic.org.au](mailto:info@amagavic.org.au)

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*AMaGA Victoria respectfully acknowledge the Traditional Owners of the land on which we work, the Boon Wurrung and Woi Wurrung peoples and honour their Ancestors, Elders and next generations of community and pays respect to the Elders of all the Nations of Victoria, past, present and emerging.*