



Framework for Preserving Heritage Collections

Strategies for Avoiding or Reducing Damage

AGENTS OF DETERIORATION

CLIMATE CHANGE AND SUSTAINABILITY ISSUES

BUILDING FEATURES (includes features that are permanently attached to, or are part of, the main structure of the building)

PORTABLE FITTINGS (includes furnishings or equipment that can be purchased or installed as part of ongoing operations)

PROCEDURES (to be carried out by staff or volunteers)

Physical Forces

Impacts, shock, vibration and gravity can:

- break, distort, puncture, dent, tear, flake, scratch and/or abrade all types of objects

Sustainable practices

- design and construct earthquake-resistant buildings to reduce costly and resource-intensive recovery measures
- design loading bays to limit additional HVAC energy usage costs
- use stable materials to construct long-lasting storage mounts
- reuse and recycle packaging where possible (e.g. knock-down crates, double case systems, reusable corner pad cushions)
- group small items into larger packages and palletize multiple packages to increase the efficiency of packaging and transport; ship full truckloads where possible

A GENERAL – Avoid locating facilities in seismic zones; if seismic risk exists, avoid soft, loose soils. Provide adequate access ramps. Ensure that floor surfaces and transitions from one area to another are smooth. Avoid flat roofs.

TRANSIT – Ensure that the loading bay can receive large trucks with room to unload long items and palletized shipments. Install a smooth operating dock leveler system.

B GENERAL – Construct new earthquake-resistant buildings in seismic zones and upgrade existing buildings. Ensure adequate floor strength and space for collections. Use protective barriers to protect fragile objects or heritage components of the building during construction work.

TRANSIT – Use stopping or reversing systems on loading bays. Install an impact-absorbing perimeter (e.g. rubber surround) around doors.

C GENERAL – Provide adequate space to allow inspection of structural elements, building systems and collections.

D GENERAL – Install automatic systems to protect against earthquake-related effects (e.g. fire, smoke, flooding).

A STORAGE AND DISPLAY – Use stable shelves, cabinets and display cases. Provide adequate shelf space and barriers to separate collections from the public.

TRANSIT – Use standard shipping crates or tested designs, with handles at convenient height. Use lifts and dollies to move objects.

B STORAGE AND DISPLAY – Secure and restrain objects. Ensure adequate strength of shelves, supports and hanging hardware. Use crates and fitted supports. Use anchoring hardware to secure unstable objects or tall narrow display cases to solid bases or to the floor.

C STORAGE AND DISPLAY – Use storage hardware and display cases, which allow easy inspection and retrieval.

TRANSIT – Use shock, vibration and tipping indicators and data-loggers. Design packages for easy access and inspection of contents. Maintain exterior finishes (e.g. painted or packaged) to readily indicate rough handling.

D TRANSIT – Use data-loggers with remote notification to track shipments and warn of hazardous conditions.

A GENERAL – If objects are in imminent danger, consider relocation. Control and monitor construction activities. Plan the movement of objects and exhibits. Know the weight of objects being moved, floor strength, etc. Maintain clear access routes.

STORAGE – Avoid unnecessary handling through organized storage and clear labelling. Avoid locating services, equipment and work areas in storage locations.

TRANSIT – Train staff in proper object handling techniques. Select reputable carriers with well-maintained fleets. Use specialized handling (riggers) for heavy items.

B TRANSIT – Know and apply best packaging practice for safe shipment.

C STORAGE AND DISPLAY – Look for cracks, deflection, deformation or other effects in structures. Monitor construction activity that may pose a threat to collections. Monitor collectors for signs of damage.

TRANSIT – Inspect deliveries upon arrival. Analyze data from shipping indicators and data-loggers. Document the condition of objects with notes and good quality photos.

D STORAGE AND DISPLAY – Promptly seek engineering services to investigate structural deficiencies when detected. Implement disaster plan when warranted (e.g. earthquake, war).

TRANSIT – Investigate causes of damage promptly. Do not sign off on shipping documents if there is evidence of damage or rough handling.

Thieves and Vandals

Thieves

- steal objects, especially small portable ones, causing loss to collection

Vandals

- disfigure, break or harm valuable, popular or symbolic objects

Sustainable practices

- focus resources on the most vulnerable objects and those most likely to be affected by this agent
- foster community involvement to strengthen public ownership of heritage collections and to discourage property vandalism and opportunistic theft

A GENERAL – Do not locate facilities in high-crime areas. For small, less secure institutions, such as seasonal museums during the off season, move high value objects to more secure facilities.

B GENERAL – Provide a strong building envelope (e.g. walls, roof, doors, windows, bars and locks) so intruders are delayed sufficiently to allow security or police to respond. Provide an open perimeter with clear sight lines to all entrances.

STORAGE – Provide study areas outside storage to prevent theft by visitors.

TRANSIT – Enclose and secure the loading bay.

C GENERAL – Provide clear sight lines and appropriate lighting throughout the building. Install electronic detectors (e.g. security systems, video cameras).

D GENERAL – Provide offices and security posts for security staff.

A TRANSIT – Do not use prominent labelling on packing cases.

B STORAGE – Use a controlled access system and install adequate locks on cabinets that hold valuable items.

DISPLAY – Secure display cases and shelves. Provide separate access to the light box. Set up psychological barriers such as ropes, floor markings, etc.

TRANSIT – Use strong packing cases (locks optional).

D GENERAL – Connect all electronic detectors to a central annunciator panel.

DISPLAY – Use proximity detectors, etc. to give audible warning of visitors crossing thresholds.

STORAGE AND DISPLAY – Provide communication equipment to security personnel.

A N/A

B GENERAL – Implement and integrate the security program with other museum services and with municipal security services. Provide personnel with responsibility for security with adequate training. Maintain access and perimeter security systems. Keep doors and windows locked. Control the circulation of keys.

D GENERAL – Station personnel in public areas. Maintain a catalogue to identify losses. Routinely inspect the collections and the building.

R GENERAL – Train staff in the appropriate response to intruders. Inform the local police department of the museum layout and the location of valuable objects. Report theft or vandalism to police.

Fire

- destroys and scorches all types of objects
- creates smoke and soot that can deposit residues on all types of objects

Climate change

- fire risks may increase in areas where temperatures rise and rainfall decreases

Sustainable practices

- use building materials and fittings that do not emit toxic and environmentally harmful gases when they burn
- avoid fire suppressants that use greenhouse gases

A GENERAL – Do not locate facilities in areas with high crime or vandalism, or near buildings with higher-than-average fire risk. Keep combustible materials or plants away from the museum building. Make sure that wiring and electrical systems meet code and are in good working order. Ensure that there are systems or provisions to shut off natural gas to buildings in the event of an earthquake.

STORAGE – Provide proper storage area for flammable objects or materials according to health and safety regulations. Do not use storage areas for workshops.

B GENERAL – Use fire-resistant construction materials. Keep fire doors closed.

D GENERAL – Use a centrally monitored smoke and heat detection system.

R GENERAL – Provide an automatic fire suppression system.

TRANSIT – Ensure that the fire suppression system will deal with vehicle fires in the loading bay.

A STORAGE – Do not include electrical wiring within shelving.

DISPLAY – Do not use unsafe or incorrectly installed electrical equipment. Ensure that any heat-producing equipment is well ventilated.

B STORAGE – Use closed fire-resistant cabinets. Leave adequate space (1.5 m) between shelving and walls.

DISPLAY – Use smoke-tight, fire-resistant display cases.

TRANSIT – Use smoke-tight, fire-resistant packing cases.

D N/A

R STORAGE AND DISPLAY – Place enough portable fire extinguishers of adequate capacity and suitable type near exits.

A GENERAL – Implement a fire safety program as part of the disaster plan. Ensure that appropriate permits and safety measures are in place with any work involving open flames. Ensure that local fire authorities are familiar with your building and operation.

B GENERAL – Maintain fire barriers (especially during construction or maintenance work). Keep fire doors closed.

D GENERAL – Inspect and maintain the fire detection system regularly. Test fire detection systems. Maintain an active disaster plan. Execute fire emergency practices.

R GENERAL – Activate a disaster response plan. Make sure that the plan includes a description of the building layout, including the location of valuable, sensitive or flammable objects. Train staff in fire response procedures.

Water

- causes efflorescence or tide marks in porous materials
- swells organic materials, leading to deformation and splitting, and loosening of joined components
- corrodes metals
- dissolves some materials (e.g. glue)
- delaminates, tents and/or buckles layered components of an object
- shrinks tightly woven textiles or canvases
- causes colours to bleed, migrate, wash out and stain associated materials
- weakens materials such as paper or cardboard
- can lead to mould

Climate change

- flooding risks may increase in some areas due to altered rain, snow and melting patterns
- increased risk of water penetration into buildings as a result of heavier rainfall in some areas

Sustainable practices

- in areas with high rainfall, higher standards of building maintenance and more attention to roof and window sealing, eavestroughing and drainage may be required

A GENERAL – Do not locate facilities in flood plains. Ensure that water drains away from the building. Provide a reliable pitched roof and eavestroughing to carry water away from footings. Insulate windows, cold water pipes, etc. to prevent condensation. Do not rely on electrical devices such as sump pumps unless no other drainage option is possible. Route plumbing away from all rooms where collections reside (use service corridors).

STORAGE – Do not use basements for storage.

DISPLAY – Avoid skylights.

TRANSIT – Do not locate the loading area below grade.

B GENERAL – Ensure that all floors are watertight and have drains. Provide dams around mechanical rooms.

D GENERAL – Keep all plumbing easily accessible and well organized for quick inspection.

R GENERAL – Allocate space to store emergency supplies for floods.

A GENERAL – Keep objects on shelves or in cabinets and display cases at least 10 cm above floor level, and at least 10 cm from exterior walls or windows. Do not place any shelving under or near plumbing.

TRANSIT – Use packing cases that are supported by sides or feet.

B STORAGE – Ensure that cabinets are water-resistant and have a covering above the top shelf to divert water away from it. Use water-resistant storage containers.

DISPLAY – Use water-resistant display cases with tops that shed water and will not collapse. Design light boxes to drain water away from objects.

TRANSIT – Wrap objects and place inside water-resistant packing cases. Design drain channels on the packing case lid to prevent water accumulation.

D STORAGE AND DISPLAY – Install water detectors and connect them to a central annunciator panel.

R STORAGE AND DISPLAY – Stock cleaning equipment (e.g. pumps, mops, wet vacuum cleaner).

A GENERAL – Implement a flood or water disaster plan. Inspect and maintain the sprinkler system, roof and plumbing. Keep all collections and objects off the floor and away from walls and water sources (e.g. air conditioning units). Train cleaners on appropriate cleaning near collections.

B GENERAL – Maintain water barriers (e.g. waterproofs on display and storage areas). If leaks are anticipated, protect objects with temporary water covers. Ensure that the covers will not allow water to pool. Label and maintain shut-off valves.

D GENERAL – Inspect collections for water, especially after heavy rain or periods of thaw, or following electrical failures.

R GENERAL – Store emergency supplies. Activate the flood disaster plan. Get qualified help.

Pests

Insects

- consume or damage materials, especially furs, feathers, skins, insect collections, textiles, paper and wood

Rodents, birds and other animals

- gnaw organic materials and displace smaller items
- toil objects with faces and urns
- gnaw through inorganic materials if they present an obstacle
- harbour collection-damaging insects in their nests and bodies

Mould and microbes (see also **Incorrect Relative Humidity – Damp**)

- weaken or stain organic and inorganic materials
- may be a health hazard (infectious agent or allergen source) to staff and visitors

Climate change

- changes in the range and number of pests can occur with shifts in regional climates

Sustainable practices

- ensure that travelling exhibitions are pest-free to avoid the introduction of invasive species that pose a threat to the ecosystem
- reduce the use of pesticides and fumigation by applying an IPM approach that emphasizes preventive actions and targeted use of response methods
- consider sanitation, thermal control with cold (20 to -30°C) or heat (55°C) or controlled-atmosphere fumigation (CO₂ or N₂) prior to choosing toxic gas fumigants or pesticide application
- caution – although reducing air conditioning saves energy, raising interior temperatures will increase the risk and rate of growth of insect infestations

A GENERAL – Reduce pest habitats inside or outside of the building. Keep the building site and interior clean, especially access points and food preparation areas. Ensure that the site has good drainage, and remove encroaching foliage. Use lighting that drowns insects away from entrances, but still provides security. Discourage bird and mammal nesting on or within the building. Avoid creating inaccessible cavities in display or storage areas. Place food waste in secure containers outside of the building, or in a covered storage room within the building that is designed for waste management.

B GENERAL – Use mineral and metal building facades and appropriate window screening. Provide effective seal details. Partition storage, display, workshop and eating areas; if possible, also use separate HVAC zones. Create sanitary perimeters to reduce pest habitats inside and outside of the building.

TRANSIT – Ensure that the loading bay door and interior access doors have good seals. Isolate the loading areas in a separate HVAC zone.

D GENERAL – Provide a quarantine and inspection room close to the loading bay for incoming objects. Ensure access to all corridors and service areas to allow for detection activities.

R GENERAL – Provide space for pest control equipment (e.g. freezer capacity, a heated, controlled-atmosphere fumigation room in a separate HVAC zone).

A STORAGE – Avoid clutter. Create sanitary perimeters ensuring access to all areas (e.g. along the walls); arrange cabinets and shelving for easy cleaning, and elevate them to allow vacuuming underneath.

DISPLAY – Do not use infested materials in displays. Do not use fresh cut wildflowers. Avoid carpeting. Design the layout of the display for effective cleaning.

TRANSIT – Do not use infested packing cases and materials. Ensure that packing materials meet international standards for restricting pest transmission (e.g. International Standards for Phytosanitary Measures). Choose heat-treated wood pallets, solid timber less than 6 mm thick, or manufactured wood products. Use treated carriers with clean trucks.

B GENERAL – Use well-sealed insect- and vermin-resistant containers, storage cabinets, frames, display cases and packing cases.

STORAGE – Subdivide storage into small sealed units to limit the spread of pests and facilitate treatment.

D STORAGE AND DISPLAY – Provide easy access between cabinets and between objects. Use appropriate traps for pests and analyze results to determine patterns of infestation, type of pest and efficacy of IPM operations.

R GENERAL – Acquire pest control equipment (e.g. magnifying loop, identification guide, freezer, controlled-atmosphere chamber, oxygen absorbers and barrier films, polyethylene bags, insect and rodent traps).

A GENERAL – Establish an IPM program. Use CCI Technical Bulletin 29, *Combating Pests of Cultural Property*, as a guide. Keep collections neat, clean and free of foodstuffs. Ban food from display areas, or ensure prompt sanitation after events in galleries. Contain and isolate food waste and garbage promptly. Establish custodial guidelines for collections and non-collections areas.

B GENERAL – Maintain sanitary perimeters and all seals, especially at ground level, as door seals are common failure points. Quarantine and examine incoming objects, building materials and packing cases.

D GENERAL – Conduct visual inspection, monitor traps, log and map data, and interpret trends to guide the IPM program steps. Handle dead pests and detritus with caution. Run a detection program during and after construction work.

R GENERAL – Respond to infestations based on IPM methods. Remove and quarantine infested objects. Determine health risks before handling infestations. Choose a HEPA vacuum to remove insects and dust. Learn how to use cold, heat and controlled-atmosphere fumigation to kill pests in objects. Do not use pesticides unsuitable for contact with objects. Restrict pesticides to tactical use, such as cracks and crevice sprays or baits, to reduce breeding problems. Choose mechanical rodent traps over poison baits, and seal the building to eliminate interior rodent populations. When appropriate, use fungicides, such as borates, for protection against wood rot and wood borer. When required, employ a pest control service and educate them about the requirements within your institution and the sensitivities of objects.

Pollutants

Airborne pollutants (including dust) originating outdoors or indoors, falling debris, spills, substances transferred by contact and intrinsic pollutants (part of the original object or materials added during treatment) can:

- acidify, corrode, discolour, disfigure and weaken materials

Climate change

- increased photochemical smog events may occur as a result of global climate changes

Sustainable practices

- use and reuse quality products that have a long lifetime
- choose green products where possible and when safe for objects
- recycle materials at the end of their useful life
- save energy by recirculating air within building

A GENERAL – Do not locate facilities in high pollution areas (e.g. industrial areas, high traffic, unpaved roads). Choose non- or low-emissive building products.

B GENERAL – Ensure that the building and/or rooms are airtight. Filter external air coming into the building. Add vestibules for the main doors and open windows judiciously. Use dedicated exhaust systems for the areas that generate the most pollutants (e.g. kitchens, workshops, loading bays and chemical storage rooms). Provide automatic HVAC shutdown in the event of fire. Ensure that the air intake is located away from any sources of pollutants.

D N/A

R N/A

A GENERAL – Choose non- or low-emissive products. Use only stable, clean, lint-free materials.

B GENERAL – Ensure that enclosures (cabinets, boxes, bags) are airtight and are good gas barriers. Choose non- or low-emissive films or coatings that are good gas barriers. Use a barrier film (e.g. plastic film) to block transfer of pollutants through contact.

D GENERAL – Measure short- and long-term levels of pollutants.

R STORAGE AND DISPLAY – Use portable filter or fan units for small rooms. For harmful emissive sources inside enclosures, increase ventilation or use gas sorbents.

DISPLAY – Use gas sorbents.

A STORAGE AND DISPLAY – Identify objects at risk; CCI's publication *Airborne Pollutants in Museums, Galleries and Archives: Risk Assessment, Control Strategies, and Preservation Management* can provide guidance. Separate emissive objects from other potentially vulnerable objects. Establish a list of suitable building and display materials. Test unknown products. Maintain cleanliness. Ensure that hands are clean or wear gloves for handling objects. Do not allow inappropriate visitor contact. Ensure that objects do not contact the earth, floor or other surfaces contaminated with salts. Establish appropriate policies for food and beverages.

B STORAGE AND DISPLAY – Inspect and ensure the integrity of barriers to pollutants. Maintain particle filters and verify the efficiency of gas sorbents. Use protective coverings where warranted.

D STORAGE AND DISPLAY – Check for signs of typical damage and for possible threats, such as unsuitable products or activities that could release significant amounts of dust or gases.

R GENERAL – Turn off the HVAC system if a fire or serious chemical spill occurs near the building. Remove or monitor objects at risk. Document the damage. Identify the source of the pollutant and mitigate the impact.

Light, Ultraviolet and Infrared

Light

- usually fades and sometimes darkens the exposed colour of light-sensitive materials

UV

- chalks, disintegrates, shrinks, embrittles, fades, darkens and/or yellows the outer layer of organic materials and some coloured inorganic materials

IR

- generates heat, which can cause organic objects to lose moisture, resulting in shrinkage, cracking or embrittlement

Sustainable practices

- reduce illumination and use good display design to maximize visibility at low illuminations and reduce energy consumption
- use "green" lamps (based on efficiency and life cycle cost) to reduce energy consumption
- use daylight where feasible, but only in combination with appropriate filtration, energy saving windows and practical light control systems

A STORAGE – Do not have windows in storage areas. Do not light storage areas unnecessarily. Provide multiple circuits that control small areas, each controlled by a timer switch.

DISPLAY – Have minimal windows in display areas. Do not use unnecessary electric lighting for collection areas. Provide separate security and maintenance lighting. Ensure that lighting conditions are familiar with museum requirements.

TRANSIT – Ensure that hallways used frequently for object movement or temporary storage have only moderate light levels.

B GENERAL – Provide appropriate shills, shutters, solar screens, filters or blinds, with reliable control mechanisms, on any existing windows.

DISPLAY – When planning visitor circulation routes, allow visual adaptation between areas with different light levels, such as public areas (e.g. foyers) and exhibition areas.

D N/A

R N/A

A GENERAL – Select light sources with low UV and IR emission.

STORAGE – Provide task lighting instead of general lighting. In the case of visible storage, use on-demand illumination.

DISPLAY – Do not light objects unnecessarily. Use timers and multi-level lighting.

B GENERAL – Use UV filters on any task or display light-source with high UV emission.

DISPLAY – If external light sources are high in UV, use UV-filtered glazing on display cases and picture frames.

D GENERAL – Use UV meters, light meters, light meters and data-loggers.

R N/A

A DISPLAY – Establish a lighting policy and exposure guidelines (using either fixed lux levels or a risk management approach based on object sensitivity and an acceptable rate of fading) and do not exceed them. Include a conservator on exhibit design teams.

B DISPLAY – When the museum is closed or no viewers are present, implement dynamic light blocking procedures (e.g. close curtains, blinds and shutters; turn off display lighting; reduce light covers on cases).

STORAGE AND DISPLAY – Turn off all unnecessary lights after hours or when spaces are not in use.

D DISPLAY – Measure new installations for UV and light levels. Monitor light data-loggers and dosimeters. In museums with uncontrolled lighting, develop a map of the annual exposure in various locations.

R STORAGE AND DISPLAY – When lighting guidelines are exceeded, reduce light levels or exposure times. When unacceptable fading or UV damage is noticed, minimize exposure time.

Incorrect Temperature

Too high

- each additional 5°C will approximately double the rate of disintegration or discoloration of organic materials; at 20°C materials considered "chemically unstable" will become unusable within decades (e.g. acidic paper, colour photographs, nitrate film)

Too low

- embrittles paints and other polymers, which can result in fractures, especially when combined with rough handling

Fluctuations

- fracture and delaminate brittle, solid materials, especially if they are layered
- cause RH fluctuations (see **Incorrect Relative Humidity**)

Climate change

- more extreme seasonal temperatures may occur as a result of global climate changes

Sustainable practices

- build energy efficient buildings (e.g. Leadership in Energy and Environmental Design (LEED))
- establish the actual needs for temperature control through collection risk assessment; many collectors do not need narrow temperature control or human comfort temperatures
- provide separate insulated zones to allow heating and cooling only as required for collections or human occupancy
- use seasonal adjustments to minimize summer and winter energy use
- allow reduced interior temperatures during winter to lengthen lifetimes of chemically unstable collections

A GENERAL – Permissible temperature fluctuations for collections vary depending on collection vulnerability, as well as lenders' requirements; CCI's Web document *Agent of Deterioration: Incorrect Temperature* can provide guidance. Avoid solar heat exposure (e.g. attic, skylights).

TRANSIT – Enclose the loading bay, if possible.

B GENERAL – Insulate the floors, walls and roof of the facility. Use double or triple glazing on windows.

STORAGE – Build well-insulated walls around special collection storage areas (e.g. cold rooms).

D GENERAL – Use a separate HVAC zone for the loading area to prevent incorrect temperatures from spreading to other areas.

R GENERAL – Add a reliable high quality thermostat, even for elementary mechanical systems. Ensure accessible read-outs and an alarm function.

R GENERAL – Provide a reliable, easily maintained, high quality HVAC system where necessary. Ensure that the HVAC system has multiple zones, is of adequate size for the load conditions, and provides good distribution of conditioned air.

A STORAGE AND DISPLAY – Do not locate cases or cabinets near heat sources (e.g. radiators, heaters, HVAC outlets). Do not use lamps that produce heat, especially inside cases or cabinets.

TRANSIT – Use temperature-controlled vehicles.

B STORAGE – Leave adequate space (1.5 m) between shelving or cabinets and exterior walls. Use insulated cabinets if necessary.

DISPLAY – Leave space between exterior walls and display cases, shelving or cabinets.

TRANSIT – Use insulated packing cases.

D STORAGE AND DISPLAY – Use hygrothermographs, thermometers and data-loggers. Provide remote alarms to signal temperatures outside the control limits.

R STORAGE AND DISPLAY – Use portable heaters or air conditioners to correct temporary local problem areas.

STORAGE – Use freezers for cold storage.

A GENERAL – Assess the sensitivities of each collection to incorrect temperature, then define the range of acceptable temperature for each. Plan a response to failures of the HVAC system or other temperature control systems.

STORAGE – Identify objects that require cold storage.

TRANSIT – Allow time for packing cases to reach room temperature before opening.

B GENERAL – Maintain insulation. Ensure adequate distance between objects and hot or cold surfaces. Wrap bare objects when moving them around the building.

D GENERAL – Monitor temperatures and interpret the data.

R GENERAL – Maintain control systems currently in place, such as the HVAC system and cold storage. Assess the current risks due to incorrect temperatures. Develop cost-effective risk reduction options and then implement.

Incorrect Relative Humidity

Damp (above 75% RH)

- causes mould which stains and weakens organic and inorganic materials, rapid corrosion of metals and shrinkage of tightly woven textiles

RH above or below a characteristic critical value

- hydrates/delhydrates some minerals and corrodes metals that contain salts

RH above 0%

- gradually disintegrates and discolours organic materials, especially materials that are chemically unstable (e.g. acidic paper)

Fluctuations beyond the proofed fluctuation

- crush or fracture restrained organic materials, and loosen joints
- cause layered organic materials to delaminate, tent and/or buckle

Sustainable practices

- establish the actual needs for humidity control through collection risk assessment; many collectors do not need narrow humidity control
- integrate the design of the building with that of the fittings and other means of local control in order to achieve reliable and sustainable RH control
- use appropriate packaging and localized control of RH inside cabinets or display cases to achieve stable, long-term RH control of collections at low cost
- use appropriate packaging and crates to achieve the most sustainable solutions for RH control during transit
- use passive RH control where possible
- in cold climates, do not humidity heated buildings if collections are predominantly chemically unstable (e.g. acidic paper)

A STORAGE AND DISPLAY – Permissible RH fluctuations for collections vary depending on collection vulnerability, as well as lenders' requirements; CCI's Web document *Agent of Deterioration: Incorrect RH* can provide guidance. Keep objects at least 50 cm from windows, 50 cm from exterior walls, and 10 cm from cold floors.

STORAGE – Do not use damp basements or very dry attics as storage areas for vulnerable collections. Do not include windows in new or renovated designs.

TRANSIT (EXTERNAL) – Do not subject objects that are in transit to extreme RH conditions for longer than the buffering capacity of the package. Ensure that the temperature gradient from one end of a crate to the other is less than 10°C.

B GENERAL – Add a continuous vapour barrier to the walls, the roof and the floor. Install zoned RH control. Use double or triple glazing on windows.

D GENERAL – Use reliable high quality humidistats, even for elementary mechanical systems. Provide accessible read-outs and an alarm function.

R GENERAL – Follow guidelines on system design for museums, galleries and archives available in CCI's Web document *Agent of Deterioration: Incorrect RH*. Use redundancy on humidification. Very long-term reliability and ease of local maintenance are more important than narrow control.

A STORAGE AND DISPLAY – Keep objects and cabinets at least 50 cm from windows, 50 cm from exterior walls, and 10 cm from cold floors.

B STORAGE – Use airtight cabinets, boxes or bags. If temperature changes are more than 10°C, provide sufficient barrier in sealed enclosures.

DISPLAY – Use well-sealed cases.

TRANSIT – Wrap objects and seal to prevent RH fluctuations.

D STORAGE AND DISPLAY – Use hygrothermographs, psychrometers, humidity indicator cards and data-loggers. Provide remote alarms to signal RH levels outside of the control limits.

TRANSIT – Place a data-logger or hygrometer with an external read-out in the packing case.

R STORAGE AND DISPLAY – Use buffers such as silica gel, wood, cotton and paper. Provide a slow supply of RH-controlled air to cabinets or display cases.

TRANSIT – Use buffers such as silica gel, wood, cotton and paper, if required.

A GENERAL – Assess the sensitivities of each collection to incorrect RH, then define the range of acceptable RH for RH fluctuation, use the "proofed RH" concept, i.e. fracture risk is significant only when fluctuations exceed the worst historical fluctuation. Inform relevant staff.

STORAGE AND DISPLAY – Maintain HVAC systems. Plan a response to HVAC system failures.

TRANSIT – Allow time for packing cases to reach room temperature before opening.

B GENERAL – Maintain seals around windows, doors, etc. Ensure adequate distance between objects and cold surfaces. Measure enclosure leakages, and seal if necessary. Wrap bare objects when moving them around the building.

D GENERAL – Monitor RH and interpret the data.

R GENERAL – Maintain control systems currently in place, such as the HVAC system or silica gel buffers. Assess the current risks due to incorrect RH. Develop cost-effective risk reduction options, if necessary, and then implement.

Dissociation

Loss of information or of significance (for example, misplacement of object, loss of object link to its collection or of its identifying information, such as its accession number; loss of object ownership) can:

- reduce the ability to find objects
- reduce the meaning and value of objects

Sustainable practices

- build data migration strategies into the maintenance of information systems to ensure sustained access to collections and their related information

A STORAGE – Plan collection storage areas to avoid clutter and provide adequate space for good organization. Provide dedicated study and examination areas. Provide sufficient warehouse space for non-collection-related items to ensure sustained access to collections and non-collection material.

B N/A

D N/A

R N/A

A STORAGE AND DISPLAY – Label storage and display units clearly with location codes using high performance (permanent) materials to facilitate the tracking of objects. Use a system that is logical, as simple as possible, clear to all and that can expand with time as the collection grows.

STORAGE – Enclose all pieces of an object in the same container to avoid accidental mixing.

TRANSIT – Attach clear documentation and inventory during transit. For international transport, ensure that all necessary documentation is prepared. Consider using available options to track objects (e.g. with radio-frequency identification detectors).

B N/A

D N/A

R N/A

A GENERAL – Document and record every object so that all movements and locations of objects can be tracked both inside and outside of the building. Label objects with accession numbers using durable (permanent) and safe methods. Verify that all component parts are labelled if detached for any reason. Avoid storing collection records (files, servers, etc.) in areas that are vulnerable to agents of deterioration like flooding or theft. Keep a backup of all electronic or paper-based inventories at an off-site location. Deaccession objects as necessary.

STORAGE – Reserve objects' collection space when objects are temporarily removed to facilitate their rehoming in the correct location.

DISPLAY – Ensure that collection objects are labelled with their accession number and other objects are marked as being non-collection.

TRANSIT – Ensure that all required permits and documentation are in place.

B N/A

D GENERAL – Establish regular collection surveys (e.g. location code spot checks). Proofread all transcribed data.

R GENERAL – Ensure that all staff know to report apparently misplaced objects to a collection care authority. Document the location and content of any objects that are thought to belong to a collection but are not labelled.

ROWS

Each row is dedicated to one of the 10 agents of deterioration: **Physical Forces, Thieves and Vandals, Fire, Water, Pests, Pollutants, Light, Ultraviolet and Infrared, Incorrect Temperature, Incorrect Relative Humidity and Dissociation.**

COLUMNS

The first column includes the name of an agent of deterioration and a list of the types of damage that can occur as well as the types of collections most commonly at risk. The second column, shown in green, identifies issues related to climate change and sustainability that may arise in association with each agent, or the methods for dealing with these issues. The remaining columns explain how the agents of deterioration can be controlled through appropriate **Building Features, Portable Fittings and Procedures.**

Building Features and Portable Fittings are listed separately because they usually have different budgets and personnel, and they are dealt with at different times in the life of a museum. The **Procedures** column outlines actions that can be taken by staff or contractors once the building features and portable fittings are in place.

A AVOID

Avoiding an agent of deterioration is always better than having to deal with it and/or its consequences by other means of control. If avoidance is not possible, other control measures must be established.

B BLOCK

If an agent of deterioration cannot be avoided, preventing it from reaching or affecting objects is frequently the most practical stage of control. Examples include fire walls and compartments that can be used to block fire; effective seals to block pests; and vapour barriers to block moisture and contaminants. Building enclosures can be designed to block not only fire, criminals and water, but also pests, outside contaminants, UV and unnecessary light, incorrect temperature, and incorrect RH. Portable enclosures, such as cases, cabinets, crates, boxes and bags are just as important as building features for blocking agents from reaching individual objects.

D DETECT

If an agent of deterioration cannot be avoided or blocked, then its presence must be detected. Detection can focus directly on the agent (e.g. on the source of direct physical forces) or on its effects (e.g. on the physical damage caused by direct physical forces). To ensure that agents of deterioration are detected early enough to prevent extensive damage, regular inspection is necessary. The frequency of inspection depends on the rate and risk of the agent. Agents such as fire and criminals, which act quickly and present a major risk, require constant monitoring. Agents such as pests and pollutants, which act more slowly, or small water leaks, which present a lower risk, require only periodic monitoring.

R RESPOND

Once an agent's presence has been detected, action must be taken. Response strategies should be established in advance. Appropriate response times depend on the rate and risk of the agent. Minutes count when responding to fire or criminals, but a day or more may be acceptable when responding to water, pests or damp. Continue response activities until the agent is eliminated. A response frequently includes a review of the previous stages to determine if any of the measures under **Avoid, Block or Detect** need to be improved.

ABBREVIATIONS

CCI – Canadian Conservation Institute
RH – relative humidity
IPM – integrated pest management
IR – infrared
RH – relative humidity
UV – ultraviolet

Visit www.cci-icc.gc.ca for more information on the conservation of heritage collections.