NHM (CSIP) Generic Standards for Collection Storage and Display

**June 2014 Revision**

**1.0 Purpose and introduction**

The Collections Storage Infrastructure Project (CSIP) environmental standards document defines tiered environmental parameters for the storage and display of Natural History Museum (NHM) collections. These parameters represent the expected environmental conditions that should be maintained around collections on display (Appendix 1), both inside the Natural History Museum property and when on loan to a borrowing institution and in storage andduring transportation The document also lays out recommended guidelines for materials and storage furniture (Appendix 3) to be used in storage and display of museum objects.

The Tiered standards represent progressively increasing risk of damage to collections. Outside the Bronze standard, deterioration will occur on the entire range of materials stored at the NHM[[1]](#footnote-1). Specimens on display in environmental conditions outside the Bronze standard are not deemed to be of critical priority for conservation and will be deemed disposable with limited life. For critical or sensitive collections it is expected that the environment will be controlled more precisely to ensure improved control (precise levels of control for sensitive specimens are not defined in this document). For such specimens or as defined in 1.1, mechanical or passive, room, cabinet or specimen level control measures will be put in place. Reference should be made throughout this document on advice from the collections trust on security of objects, display cases and buildings.

The Museum recognises the PAS 198:2012 and PAS 197:2009, Bizot Group recommendations[[2]](#footnote-2) and the NMDC recommendations (2009). The NHM has taken note of the need to reduce carbon foot print, improve sustainability and where possible relax environmental standards in line with NMDC recommendations (2009) and the museum’s ISO 140001 certification.

Where specimens as defined in 1.1 are already stable in the open Gallery space or equivalent and no further deterioration will occur then recommendations by the National Museums Directors conference (NMDC, 2009) and Bizot Group 2012 which equate to the Bronze CSIP environmental standard. To accommodate the range of uses and sensitivity of materials (given current environmental storage conditions), the museum has agreed to implement a policy of tiered environmental standards appropriate to the secure maintenance and stability of the collections.

Heads of Collections for each Science Department will review the approved CSIP environmental guidelines on a yearly basis. The Head of Conservation will produce an annual review on attainment of these standards by the Museum for consideration by Collection Leaders.

**1.1 Sustainability[[3]](#footnote-3)**

The Museums vision statement states that we wish to “promote responsible use and enjoyment of the natural world.” The Museum is also registered IS014001 (Environmental Management).

The Museum is also required to comply with the Government’s Sustainable and Legal Timber Procurement Policy. Full information can be found at the Central Point of Expertise on Timber (CPET) website (<http://www.proforest.net/cpet>). Therefore the Museum requires that all wooden items are either FSC certified (or equivalent) or recycled material.

**1.1 Collections that are covered by the generic standards are**

* Taxidermy
* Entomology
* Skins
* Osteology
* Dry invertebrate Zoology specimens
* Dry plant material (including herbaria)
* Mineralogy (excluding minerals defined in 1.1)
* Palaeontology (excluding specimens defined in 1.1)
* Anthropology Collections
* Paper and Archives
* Eggs
* Slides
* Preparations of above mounted on SEM
* Art Work

**1.2 Materials that fall outside the generic CSIP standards and are covered in the Platinum standard;**

* Molecular Collections (defined as part of Molecular Collections Project)
* Film, Nitrate stock and Photographs (International Federation of Film Archives,FIAF Guidelines (2002),WS 5454:2000)
* Materials requiring specialist anoxic or environmentally controlled environments outside the CSIP standards (i.e. meteorites, material containing pyrite or other sulphides that deteriorate in a similar fashion)
* Archives and paper – BS 5454:2000 and PAS 198: 2012
* Minerals requiring specific humidity parameters (defined in Howie, 1992)

1.3 It is hoped that all parameters will be implemented sustainably and to ensure energy use is maintained to a minimum level. Older buildings will be reviewed to accommodate where feasible original ventilation systems. New builds will seek to make use of natural and or passive control systems. The parameters established below are an agreed cornerstone of all developments.

1.4 The parameters will be used to zone the institution and highlight areas of low, medium and high risk to collections.

1.5 For ventilation purposes on average, a maximum of 10 people would be using a storage area of 30 m x 20m at any one time.

1.6 For new build' or *‘*major renovation, storage space should be built separately to office and work areas. Office space should be separated from other areas with suitable barriers or buffers to ensure that storage and work space is maintained to agreed parameters. Work areas should be adjacent to storage areas and built to allow maintenance of agreed environmental standards.

1.7 For existing facilities the environment should where possible follow CSIP guidelines however it is expected that each building/area should at least meet its original specified parameters (see appendix 6.

**2.0 Parameters defined by this document are;**

* Relative Humidity
* Temperature
* Light
* UV
* Pest control
* Contaminants (Pollutants)

**2.1 Relative Humidity and Temperature**

The parameters for relative humidity (%) and Temperature ⁰C for collections are based on their stability parameters of specimens and the current condition of objects due to their current storage environment (see appendix )

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Standard | Level of RH control | Temperature Parameters | Monitoring | Materials falling under Standards |
| Platinum Standard | Specialist environmental conditions (and monitoring) | Dependant on stability parameters for materials | Standard Cross-museum monitoring system | Materials include objects containing pyrite, sensitive minerals, tissue and DNA. New collections with specialist requirements including low oxygen storage, controlled RH storage, frozen tissue storage should be stored at levels recommended in the appropriate collections management manual. |
| Gold Standard | CSIP 40-50 %RH[[4]](#footnote-4) | Temperature 16-20 ⁰C. Temperature levels and considerations are dependent on pest issues. | Standard Cross-museum monitoring system | Data critical Research Objects. When stored in Cabinets e.g. wet collections, Palaeontological, geological and mineralogical collections, botanical, entomological, zoological materials (DC1, DC2, NW Tower). |
| Silver Standard | 35 – 55% RH1 Absolute outside figures for RH. | Temperature 16-20 ⁰C. Temperature levels and considerations are dependent on pest issues. | Standard Cross-museum monitoring system | Open spaces in storage areas |
| Bronze standard | 35-60% | RH316-23 ⁰C Temperature levels and considerations are dependent on collection preservation issues (e.g. evaporation, ignition, IPM). | Standard Cross-museum monitoring system | Open Gallery Space, Open storage areas where large materials are stored e.g. petrological, large taxidermy, specimens that are currently areas without relative humidity control. Specimens stored in this environment may require conservation and/or restoration work for future use. |

The minimum fluctuation levels will apply to all the above standards with some seasonal drift. The museum should focus on passive management alongside active room and building control.

A maximum permissible cumulative range of 8% (total change) per day and a maximum Peak Range of 2.5% day in the open space of a store will be taken as the maximum fluctuation in relative humidity.

RH Set points of 42% in the winter and 47% in the summer for environmental conditions

RH set point for Gold standard for relative humidity in a storage area should be 45%

It is expected that the standard RH sensor would have an accuracy of +/- 5%. In zones of high humidity risk, sensors (e.g. Rotronic, Vaisalla) with an accuracy of +/- 2% will be used.

Fluctuation should not exceed a cumulative total change of 2% per day inside a storage enclosure (at cabinet/storage container level).

**2.1.1 Temperature**

The agreed parameters are defined for four separate areas and apply to all the relative humidity levels. It is expected that staff will not work in collection spaces but in spaces adjacent to stores. It is noted that staff and visitors may need to work in collection spaces, for instance when restoring specimens or dealing with loans or enquiries. In this case it is expected that individuals accessing areas should wear clothing suitable to the temperature they are working in. From the date of agreement of this document storage areas will only be developed that have no office space and with adjacent (direct access) layout space. Office and laboratory space will be separated from other areas with suitable barriers or buffers to ensure that storage and work spaces are maintained to agreed parameters. These parameters only apply to specimens that are stable at this temperature range and will not melt, volatilise or disassociate at these temperatures.

|  |  |  |
| --- | --- | --- |
| Standard | Area | Temperature range |
| Bronze | Display | Up to 23 °C |
| Silver | Non-collection storage space where staff are working with specimens | 16-20 °C |
| Silver | Collection Areas adjacent to work spaces or for current work spaces which include office space, where specimens are being removed on a daily basis | 16-20 °C |
| Gold | Collection stores that are static and not adjacent to work spaces | 16-20 °C |
| Gold | Wet Collections | 16 - 18 °C |

Temperature fluctuation will be no more than 1°C in cumulative total per day. Temperature should not vary by more than 2°C in a week.

Unless the specimen is clearly unstable at this temperature and prone to volatilisation or while on display temperatures may rise to a maximum of 23 °C. It is expected that at this temperature there may be some change in some the object. This will be noted in associated condition reports.

**2.2 Light**

Parameters for light levels apply to all the tiered standards. All of the stated light levels are the maximum level allowed to fall onto the surface of a specimen in a defined area. The target of the lighting design should be to make the light level on the working plane as close this level as possible, without exceeding the specified level on the surface of any sample under normal operation.

In storage light levels will be 0 lux when the spaces are not occupied (after a suitable delay). The lighting should have zoned control through presence detectors.

In areas where specimens are being displayed or handled:

Sensitive materials will be displayed/handled at 50 lux (e.g. specimens with pigments, specimens in fluid, certain minerals).

The maximum light levels that non-sensitive material from the science collections will be exposed to will be up to 400 lux (dependent on sensitivity). The exact level is to be determined on a specimen by specimen basis.

In storage areas where specimens are being located prior to removal to a work area the storage illumination will be a maximum of 400 lux. Lighting systems should be zoned and on timers/IR switches to ensure that lighting systems are used in an energy efficient way. Use of reflected light or reflective surfaces to increase light dissipation and reduce energy costs will be encouraged. Storage areas when not in use will be maintained at 0 lux.

A cumulative loading figure for all specimens (recorded in EMu Condition Module) will be defined for for each exhibit. This figure will define longevity of display.

No specimen will be allowed on display unless a cumulative loading figure has been established. Specimens will not be displayed once the cumulative loading figure has been reached.

At the time of production of this report it is currently difficult to establish exact light exposure limits for specimens. As the data becomes available it will be used to review light levels recommended in this document.

During research, collections management or investigation it is likely that specimens will be exposed to much higher levels of lighting for short periods of time. This can include lighting under a microscope or task lighting.

Where possible the standard lighting used should be a UV filtered fluorescent tube or LED. It is recommended lighting should be to the following specification.

Targets for Colour temperature and Colour rendering will be as follows:

Colour Temperature: 5800 – 6500 K

Colour Rendering Index: 76

**2.3 Ultra violet**

* 0 μW/Lumen or 0 μW/M2

**2.4 Pest control (NHM IPM Policy)**

All storage and layout space should be designed to be as pest proof as possible. All areas will comply with the NHM IPM Policy and Procedures.

Building and cabinet design must allow for implementation of a regular cleaning regime in all areas of the store.

**2.5 Contaminants[[5]](#footnote-5)**

Contaminants are either gaseous, vapour or particulate in nature. All materials (for storage and display) used around specimen in collections, on display or during research must not give off any solid, vapour, liquid or gas that could change the condition of an object. All materials should be tested and a record kept in the museums electronic collection management system. No materials used around collections will off-gas chemicals that could change the nature of materials stored within or on them (A list of materials that can be used can be found in appendix 3)

Particulate levels will be maintained at a minimum through the use of replaceable filters. Where particulates pose a high or unidentified risk of contamination to specimens, incoming air should be treated using High Efficiency Particulate Air (HEPA) filters. Rooms treated in this way shall be positively pressurised and shall be prepared in such a way as to meet a minimum air tightness level of 5m3/hr./m2 wall area. Such rooms shall be arranged such that there is no entry to them for any purpose other than to access the collection (i.e. such that there is no access to other spaces through them) and shall be provided with lobby areas separating them from any other spaces not treated in the same way.

Wherever collections can be identified as having a lower risk of contamination it is recommended that MERV (Minimum Efficiency Reporting Value) 15 grade filters shall be used.

Carbon type filters shall be included to control harmful gaseous substances from the external air.

**Radiation** Cabinetry storing radioactive specimens will be clearly marked, and comply with all local and national legislation.

**3.0 Airflow**

The airflow through storage areas should be low enough to ensure that fragile materials are not affected by airflow in any way. It should be high enough to ensure that there are no areas of static air in a collection space.

CO2 control shall be used wherever possible to minimise fresh air introduction. Where this is not possible a minimum fresh air rate of 10l/s per person shall be used.

Storage areas would ideally be under positive pressure relative to the surrounding areas to assist in the control of contamination. Lobbies should be provided wherever possible.

**4.0 Building security**

The building (room) must provide adequate security for the material that is stored in a specific area to ensure that the value (research, legal, financial, cultural, educational, historical) of the object is maintained at all times. Each area should be upgradeable to accommodate any material that may need to be stored in the space. Stores will be alarmed (to a central control room), have swipe/proximity card access, walls should be of sufficient integrity to resist any invasive action.

Buildings must be maintained to ensure their continuous integrity. All buildings, rooms and display and storage furniture should comply with the NHM security and fire policies.

**5.0 Fire Control[[6]](#footnote-6)**

Fire monitoring shall be provided to meet local legal requirements for life safety. A separate risk assessment based on risk to specimens (collections), property, asset and structure shall also be carried out to establish the need for appropriate fire suppression systems. Any suppression system installed should be appropriate to the needs of the collections and will be identified through a risk assessment procedure.

**6.0 Flood Risk**

The risk of flooding should be assessed and appropriate mitigating action taken as required. Areas of flood risk will be monitored using the environmental management system (Darca Heritage).

**7.0 Cabinets and Compactors (See appendix 3 & 4)**

All cabinetry must be built to ensure that the environmental parameters are maintained within specific levels. Cabinetry should reduce any relative humidity fluctuation and reduce ingress of contaminants, and pests to a minimum. Except for the short period when in use, all cabinetry doors should be kept fully closed to maintain the buffering capacity of the storage furniture. All seals, drawer runners etc. should be maintained to ensure that they are in original working condition.

**Appendix 1**

**Specifications for International Packaging Cases and environmental standards for touring museum specimens (for exhibitions)**

MUSEUM PACKING CASE CONSTRUCTION

All six faces of the case to comprise of 12mm (birch-faced) Plywood panels (not chinese sourced) edged with (rounded corner-fifth/unsorted, PAR (planed all round)) timber of 75mm x 25mm section reinforced with batten of the same (75mm x 25mm) section. All battening should be attached to the outside of the case leaving the plywood surface of the case interior free of projections. The stiffness and strength of the case is to be achieved by the use of suitable adhesive and countersunk screws in all joints. The screws are to be inserted through the plywood into the battens (from inside).

A further piece of 12 mm (1/2") plywood is to be added to the top surface of the case (on the exterior of the battens) to prevent the possibility of rainwater accumulation. This piece can also be used to locate the top edge of the lid.

Two additional cross battens to be attached to the bottom (travelling) edge, in the form of blocks sufficiently thick to lift the case body 100mm clear of the ground (to act as feet).

Base should be formed of a minimum of 18 mm (birch-faced) plywood panels (not Chinese sourced).

Handles in the form of rounded battens are to be firmly attached to either end of the case, bridging the two vertical battens to allow the hand to grip round them. The bottom of these handles should be 550mm from the floor. For larger cases over 1800mm high, a second set of handles of the same design should be placed 1400mm from the floor.

The case is to have side (large-faced) lid access, the lid to be secured with captive bolts. Four of the captive bolts should be set within 150mm of the case lid corners: all should be attached with the tapped receptor plate on the inside of the case, and all be rebated flush with the case edge. Case angles and corners, except the ends of the block feet, to be generously rounded before the application of paint to all exterior surfaces except the bottom surface of feet if required otherwise 3 coats of varnish (Dacrylate-Acrylic Sealant[[7]](#footnote-7)) will be applied.

The crates should be pained in colour code is: 06 D 43 (Sun Bronze) (water-based acrylic eggshell, Leyland[[8]](#footnote-8)

The case is to travel in the upright/landscape mode and is to be marked to this effect. All markings should be appropriate to international standards. Please note that the construction of the case in general and the attachment of lid to the case in particular should be sufficient to effect a waterproof seal and this should be further improved by the attachment of a Neoprene gasket seal between case and lid. Avoid tensioning the Neoprene tape when applying (to eliminate the risk of the tape’s corner joints opening up).

Before dispatching to the Museum, ensure that the case is stable and does not rock on its feet.

Cases should be lined with 50 mm Plastazote (black) density LD45 or LD 60 depending on materials being transported. Specimens should be boxed in protective enclosures and supported appropriately to the object.

**Appendix 2 Exhibition Criteria**

**2.0 Environmental guidelines for specimens in Exhibition**

Specimens will be stored as per the tiered environmental standards. Specimens stored in display cases should conform to gold standard storage conditions. All display cases to be buffered using a passive buffer to maintain the identified relative humidity.

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| --- | --- | --- | --- | --- | --- |
| Object Guide | Relative Humidity | Temperature | Tiered standard | **Pollutants** | Document reference |
| Sensitive specimens | 40-50% minimal drift[[9]](#footnote-9) | 18-23 ° C | Gold | None |  |
| Less sensitive specimens | 40-55% RH minimal drift (<5% cumulative per day) | 18-23 ° C | Silver | None |  |
| Casts | 35-60% and open display space | 18-23 ° C | Bronze | None |  |
| Light levels | 50 - 400 Lux (dependant on specimen sensitivity) | 18-23 ° C | Single Standard | None |  |
| UV levels | 0 μw/M2 | 18-23 ° C | Single Standards | None |  |

Open space storage must conform to CSIP Bronze Level storage (see sections 2.1, 2.2)

Clean space (regularly cleaned) and secure either with guards or camera monitoring 24/7.

Where appropriate specimens must be mounted on/in Plastazote™ foam nests or supports with suitable conservation grade separators. All materials should be inter, not off-gas and be light and moisture stable. A list of approved (and Oddy tested) materials can be found in appendix 7.

For external exhibitions outside mainland UK, specimens should be flown and transported directly to the venue for secure storage. Short Ferry/Road trips will be considered however transportation between venues (including secure storage areas) must be undertaken within a safe working day (maximum 12 hours).

**2.1 Display Case Specifications**

The level of protection to be provided by display cases should take account of the value, protection and aesthetic quality of the material to be displayed. The quality of the invigilation and the physical security of the museum or individual gallery where the case is located should always be considered. All display cases should have a usable life-time of 15 years with minimum maintenance and specifications should adhere to the following requirements: (see Guidance Notes: for choosing new display cases, SMC. 2003. 6pp ).

**2.2 Materials**

Construction materials should be chemically stable, inert and not off-gas substances that will harm the specimens displayed within them (i.e. materials such glass, aluminium or stainless-steel, stable air-dried wood are preferred). Medium Density Fibreboard (MDF) or similar particulate boards are not suitable in any part of the structure (except where it cannot affect the displayed objects e.g. in plinth bases. MDF should always be sealed with a Dacrylate acrylic (mdf) sealant or equivalent acrylic sealant. All materials should be fire resistant as per the NHM Fire Regulations (2.7) to reduce fire spread within the display areas. Fire resistant materials should not be used in the display case in the chamber within which the specimen is displayed or in the buffering compartment underneath. These areas should always be isolated from the main plinth and any supporting structure.

Samples of all materials should be available, prior to case manufacture, for approval by the NHM, and for testing where appropriate. The Contractor must allow sufficient time within the programme to facilitate testing and approval of samples, curing of materials, and air-tightness of cases.

All finishes should be selected to minimise maintenance. Metalwork should be finished in an appropriate, long lasting and durable coating in British Standard or RAL colours. Manufacturers to advise whether they are able to use AKZO Nobel/ Interpon.D/ Collection Futura finishes.

If the case is built over a storage compartment this should be secured separately with the case constructed to prevent access to the collection material via the storage compartment.

The case must be robust and sturdy so that it cannot be readily moved if knocked. Internally any shelving or display elements to be fitted to prevent collapse or movement if the case is knocked. The case should be damped to protect the specimens on display from transmitted floor vibration/shock.

**2.2 Glass specifications[[10]](#footnote-10)**

For objects of high value or where security of the object is required the glass must be a minimum of 11.5mm thick and conform to EN: 356 P4A (to resist manual attack) or

BS5544. It is recommended that this is laminated glass with a PVB[[11]](#footnote-11) laminate. Glass should also conform to BS 6206:1981

Unglazed sides to the case will need to be of an appropriate material, conforming to our material standards and specifications for non-contamination.

The glazing to display cases should be ‘water-white’ (low iron content), and the glass should have UV filter protection incorporated and have a low/non-reflective coating applied.

Inert, durable, effective seals and joints are required to minimize the ingress of dust, maintain air-tightness, and secure the glazed void, and should be installed at all joints, glass-to-glass and glass-and-metal. A stable sealant (that does not off-gas pollutants) should be used to seal any gaps between construction joints. A stable synthetic rubber may be used for the compression seals around the two opening panels.

**2.3 Air Tightness**

All display cases should minimise the ingress of dust, exclude pests and provide a sealed environment. The air exchange rate should be appropriate to the display and the display environment. Where possible it should be less than 0.1 air changes per day, to maintain the environmental conditions specified in the attached document. The case manufacturer will be required to provide evidence that the completed display cases meet the standard required (after installation at the NHM).

**2.4 Relative humidity and temperature**  
Display cases should be constructed such that a stable internal temperature and relative humidity are maintained (appropriate to the objects being displayed). Relative humidity temperature, pollution, Light and UV levels should be maintained at levels as defined in CSIP Gold Standard or where the material requires standards outside this, under agreement. Where appropriate other gas levels, e.g. oxygen should be considered. Any control mechanism should be separate to the environmental control systems for the gallery space and be included in the display case.

Provision must be made for environmental monitoring equipment inside the case. In some instance transmitter cases may need to be hidden within the display plinth. Probes will always have to be placed inside the display space. It should be noted that most museums do display environmental monitors visibly inside their display cases. It is important that this is considered at the beginning of the exhibition as it may be possible to change or adapt the cases in which the transmitters and sensors are fitted.

The NHM should test the environmental monitors, inside test display cabinets, to ensure that there are no issues with transmission (and to ensure efficiency of display cases). Discussions with the manufacturer will be needed.

**2.5 Display case Facility Void**

Humidity to be controlled within agreed parameters. Passive Control systems should be fitted inside the display cabinet and where necessary active control systems will be installed either internally or externally to ensure correct environmental conditions are maintained. Minimum maintenance and energy usage should be considered for the proposed solution. The facility void should be large enough to accommodate the amount of humidity buffer e.g. Artsorb, Prosorb, Rhapidsorb etc. required to achieve the agreed relative humidity for the case.

**2.6 Security**

The case is to be considered as a system that combines a base, glazing, joints, hinges and locks. Each individual component, and the fully assembled case itself, must meet the requirements of EN:356 P4A.

Hinges should be concealed and thereby protected from direct attack. However, if they are exposed they need to be supported by steel hinge bolts and be resistant to attack through the hinge pins being driven out.

All display cases are to be fitted with two separate locking mechanisms using e.g. Abloy locks or locks to a similar standard and specification. Any means of access into the display void must be locked with a minimum of two Abloy locks per door/opening panel. Ideally locks should be concealed and protected from direct attack. Keys should be individually specified.

All locks must be provided by the case manufacturer, exact specification to be discussed with client upon award (samples must be provided). Locks must all be supplied at the time of case delivery in working order and ready for installation.

An RFID or similar tracking device may be used to monitor the safety of the specimen. Prior to installation the supplier must ensure that the tag works appropriately within the display case and that signals can be received by the related receiver.

**2.7 Fire stability [[12]](#footnote-12)**

Temporary exhibition furniture being used for touring exhibitions should conform to UK Class 1, Euroclass C.BS476 Part 7. This is providing there is no further fire loading within the display case

Where perspex enclosures are to be used then they should then make up no more than 10%[[13]](#footnote-13) of the materials used in the exhibition and all other materials should conform to 0 class certification.

For permanent display cases the external fabric of the display case must conform to BS476 Part 6 - Fire Propagation test to determine a surface spread of flame Fire Propagation Index number - UK Class O, Euroclass B. This is providing there is no further fire loading within the display case. Risk assessment

Materials being used in a temporary gallery for less than 6 months can have a maximum fire Loading rating of 1. The total amount of material used in the display case that does not confirm to permanent exhibition requirements should take up no more than 10% of the total exhibition materials3f1

**2.8 Internal Lining**

The internal lining should meet standards as laid out in 2.1 and should be structurally sound to support the range of objects proposed for display.

**2.9 Lighting**

Low energy, sustainable lighting (LED or fibre optic) should be fitted internally in the display cabinets. This should have minimum heat production and should be insulated from the main display cabinet. Lighting should meet the agreed lighting standards for the display and be adjustable so that a range of lighting requirements can be achieved.

Electric wiring should be neat, unobtrusive and enclosed, and not affect the case’s function. The whole of the installation should be re-wirable without entering or causing disruption to the display void. All equipment should be easily replaceable. All light sources and associated control gear must be separate from the display void.

The lighting solution should be such that a minimal amount of access into the case is required for maintenance, with the light source to be away from the case. A non-disruptive procedure for maintaining lighting to be developed.

**2.10 Physical Stability**

Display cases should be rigid, strong, and inherently stable throughout all intended operations and must be mechanically secured to the existing plinths/setworks. Case tops must be of adequate strength to allow a person to clean, repair or service any element of the case in safety. They should buffer the objects from any vibration or shock that may happen to the case or be inherent in the display space.

Backboards and base boards must be able to be removed from the case for replacement without affecting its structural stability.

**2.11 Access**

The whole display void should be easily accessible. Opening sections or doors must allow, where possible, for access into 100% of the display void without affecting the structural integrity of the case. At no time should a specimen or person be put at risk through the opening or closing of the display case.

The glass front/top needs to be easily removable for the easy installation and removal of specimens. The design of the doors and the opening mechanism should allow for ease and safety of operation by one person with no lifting required and should be either manual sliding/hinged or hydraulic mechanisms.

All opening mechanisms must be well designed and engineered to be maintenance-free/low-maintenance and easy to use. Opening panels and doors must be fitted with all appropriate stops and safety devices to comply with safe working practices.

Any automated/hydraulic systems should have a manual override if the motor fails.

**2.12 Case Numbering**

Display cases should be discreetly numbered to identify maximum weight loadings and for security and auditing purposes. Details to be discussed with NHM, post-award.

**2.13 Approval of Drawings**

The NHM will require suitably detailed drawings to enable the Museum to ensure that the cases comply with this specification. The contract programme must allow for at least seven working days for approval of all drawings by the Museum at the appropriate stages. A list of all proposed materials to be used in the construction of the display case should also be provided. Samples should be available for testing or review at the request of the NHM.

A sample case with all working parts should be fabricated for review before any manufacturing goes ahead.

**2.14 Operation and Maintenance Manual**

An Operation and Maintenance Manual for the cases must be provided, which should include:

* Final specification of the total installation
* Fire protection
* Opening and closing operations
* Method of removing and inserting internal lining panels
* Method of focussing light fittings
* Safe weight loadings
* All operational requirements and maintenance procedures
* Full details of all surface finishes
* Performance testing results
* Certification that glass complies with BS standards
* Cleaning specification for all case surfaces, including method statements
* Electrical test and installation certificates
* Any guarantees or warranties for the cases and for any materials or associated equipment which must commence from the date of (agreed) Completion of the Contract
* All items requiring maintenance and details of maintenance support provided under the contract, including anticipated response times

**Appendix 3 Material specifications**

Materials (or any component of a material) should be;

* inert
* not off-gas
* not release dye (through contact or leaching)
* provide the required support for a particular object, where appropriate
* Have a given life of 20 years

1.1 Recommended materials for storage

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| --- | --- |
| Materials | Supplier |
| Plastazote (black and white foams) | Zotefoams |
| Volara (polyethylene) |  |
| Ethafoam (nitrogen blown) |  |
| Bubblepack (non-saran) | Various |
| Forex | TBC |
| Unbleached Calico | Conservation by Design |
| Ecophant card | Conservation by Design |
| Tyvek white |  |
| Cards and Papers confirming to specifications as below in 2.0 | Ryders Ltd.; Conservation by Design |
| Archival Polyester | Secol; Conservation by Design |
| Epopast |  |
| Aluminium |  |
| Ethafoam chips |  |
| Clear Polystyrene enclosures | Stewart Plastics/ |
| Escal Neo | Conservation by Design |
| Polythene (HD) |  |
| Polypropylene |  |
| Poly tri-fluro ethylene (PTFE) |  |
| Glass (borosilicate) |  |
| Cured polysiloxane sealant |  |
| Cured silicone sealant |  |
| Epoxy paint (cured) |  |
| Bondina |  |
| Cellite Panel Board (aluminium skin) | Conservation by Design |
| Correx (corroplast) |  |
| Dacrylate Acrylic MDF sealant | Dacrylux Ltd |
| European Lime |  |
| Paraloid B72 |  |
| Polyester wadding |  |
| Polypropylene Boxes (Stewart) |  |

**2.0 Specifications for Card Trays**

Card must be Lignin free (cotton-based or recycled archival card) and free of optical brightening agents)

Card should have a pH between 7.0 – 9.5. Card should be buffered or un-buffered (dependant on object, organics & minerals). Card can contain a buffer of 2% calcium carbonate or 2% reducible sulphur (less than 0.5 parts per million) for sensitive materials as required. Outer card should be plain matt e.g. Argentia photosafe acid free white paper.

Card must demonstrate light stability. Pigments/dyes should be lightfast (blue wool test 5-6). Dyes used for card should be white, tan or grey and have been tested for lightfastness to show that the card is stable and not light sensitive. In limited cases trays may need to be dyed either red or green. The dyes used should be stable and not cause any alteration to objects stored next to them.

Adhesives used should be ethylene vinyl acetates (EVA) or acrylic polymer adhesive with a pH of 7.0, not moisture sensitive, not pH buffered and contain no plasticizers. Adhesives should not change in pH over time and should not cause any alteration to specimens. They should be defined as part of the construction process. Acrylic emulsions or pH neutral poly vinyl acetate (PVAc) may also be acceptable but will be subject to age testing before approval.

Lids should be archival polyester, heat welded (200 micron).

Weights for the paper will be determined to suit each tray but should generally be 1000gsm, 1500gsm, 2000gsm.

Trays must comply with the following standards (or equivalent):

* **DIN 6738**:1992 Paper & Board, Class 24-85 (German standard). Please see <http://cool.conservation-us.org/byorg/abbey/ap/ap07-2/ap07-202.html> for further explanation.
* **ANSI/NIZO Z39.48**-1992 (Permancence Test). Please see <http://cool.conservation-us.org/byorg/abbey/napp/std.html> for further explanation.
* **ONORM A1119** (European standard for paper)
* **ISO CD 9706**:1994 (permanence test)

3.0 Specifications for Herbarium Sheets

* 100% Rag Paper
* off-white with a moderately textured surface
* buffered with approximately 3% calcium carbonate
* grain direction is parallel to the long dimension
* acid-free and lignin-free with a pH of 8.5
* weight between 550 micron or 1100 micron depending on object

**Archival Paper and Card should conform to paper standards for trays**

**Should be 100% cotton rag or recycled archival card e.g. Ecophant**

**Specifications for non-card containers**

**Appendix 4 Storage Cabinet Specifications**

**1.0 Entomology Cabinets – Type ‘A’ ‘B’ & ‘C’ Double & Single**

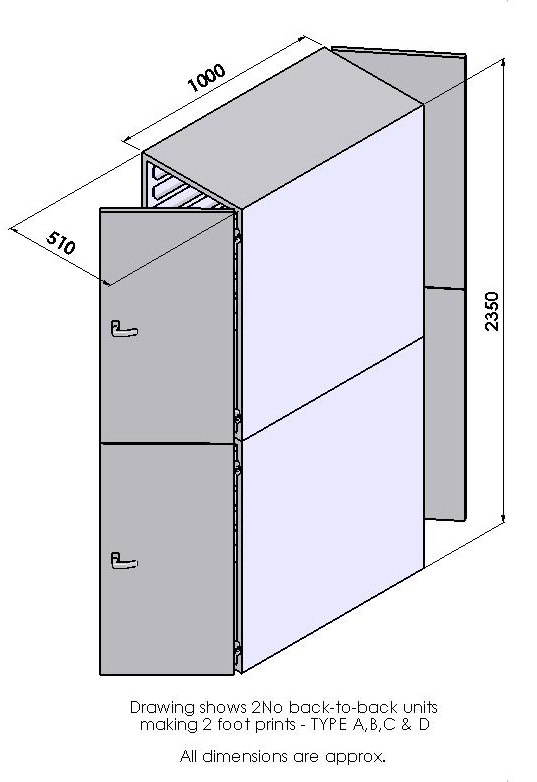
The C&D (Sheetmetal) Engineering Ltd collection cabinet units, is of the ‘Double’ style unit, this is a double cabinet of a back to back style, see diagram below. This design will have the benefit of the carcase being manufactured from two major components reducing welding time and achieving a major saving in labour content and installation time, but still giving the required strength and stability.

Carcases have the ability to be bolted side to side and top to bottom. On the end of a run or the top of a unit any holes not used for fixing will be plugged with a plastic bungs.

The units are manufactured from as few components as possible ensuring minimum joints. All areas within the cabinets are accessible for cleaning. This enables dust, dirt & museum beetle to be easily removed.

These unit carcases and doors would be jigged then welded and sealed to give a strong robust construction, with all seams welded, sealed and dressed to stop the ingress of pests.

The door is mounted and held on with two lift off hinges, the handle would incorporate a lock with two plastic flip keys, which can be suited or mastered if required locking would be via a 3 point locking system which would give compression on the ‘inert’ Plastizote seal, ensuring a tight seal all round.



Drawer runners will be clipped into the units at the required drawer spacing, each runner will be fitted with a buffer to stop the drawer in a controlled manner.

These runners can be removed to accommodate oversize drawers. Specify at point of order.

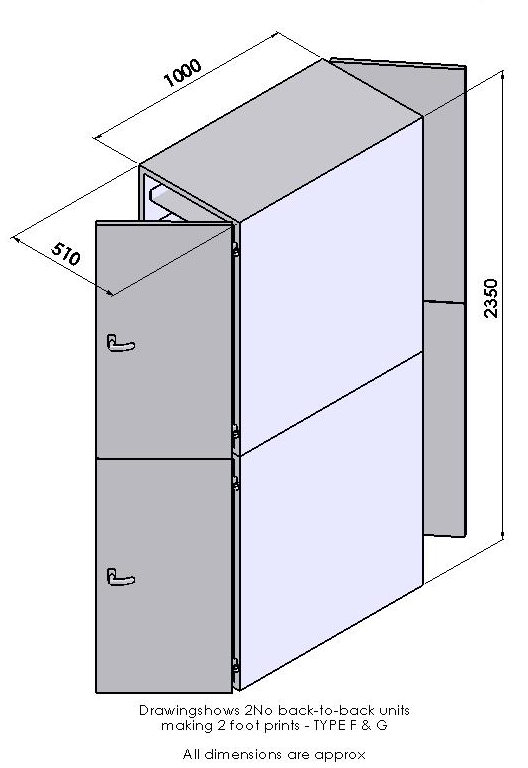
The units will be pre-treated before painting with an iron phosphate treatment which gives enhanced adhesion for the paint process and has anti-rust properties, the unit is then epoxy powder painted to the required colour.

The units are fitted to a 150mm plinth.

**2.0 Herbarium Cabinets – Type ‘F’ ‘G’**

This cabinet is manufactured to the same innovative design as the Entomology units, the ‘Double’ style unit, this is a double cabinet of a back to back style, see diagram below. This design will have the benefit of the carcase being manufactured from two major components reducing welding time and achieving a major saving in labour content and installation time, but still giving the required strength and stability.

Carcases would have the ability to be bolted side to side and top to bottom. On the end of a run or the top of a unit any holes not used for fixing will be plugged with a plastic bung.



The units are manufactured from as few components as possible ensuring minimum joints. All areas within the cabinets are accessible for cleaning. This enables dust, dirt & museum beetle to be easily removed.

The bottom shelf is easily removable for cleaning.

The units would be manufactured from as few components as possible ensuring minimum joints.

These unit carcases and doors would be jigged then welded and sealed to give a strong robust construction, with all seams welded, sealed and dressed to stop the ingress of pests.

The door would be mounted and held on with two lift off hinges, the handle would incorporate a lock with two plastic flip keys, which can be suited or mastered if required locking would be via a locking system which would give compression on the ‘inert’ Plastizote seal, ensuring a tight seal all round.

Shelves will be fitted to the unit at 135mm intervals or as required.

Each cabinet will be fitted with a ‘pull out’ shelf for resting folders on.

The units will be pre-treated before painting with an iron phosphate treatment which gives enhanced adhesion for the paint process and has anti-rust properties, the unit is then epoxy powder painted to the required colour.

The units are fitted to a 150mm plinth.

Type ‘F’ Double = 678mm w x 1010mm d x 1185mm h

Manufactured with a shelf size of: 300mm w x 460mm d x 135mm h

32 Shelf spaces per cabinet

Type ‘G’ Double = 780mm w x 1080mm d x 1185mm h

Manufactured with a shelf size of: 350mm w x 550mm d x 135mm h

32 Shelf spaces per cabinet

Type ‘F’ Single = 678mm w x 538mm d x 1185mm h

Manufactured with a shelf size of: 300mm w x 460mm d x 135mm h

16 Shelf spaces per cabinet

**3.0 Entomological Cabinets (specification from DC2 – CDS Sheet Metal)**

**Standard Cabinet Sizes:-**

Entomology

Type ‘A’ Double = 536mm w x 1085mm d x 1185mm h

Manufactured to take a drawer size of: 460mm w x 500mm d x 60mm h

36 drawers per cabinet

Type ‘B’ Double = 576mm w x 935mm d x 1185mm h

Manufactured to take a drawer size of: 500mm w x 425mm d x 60mm h

36 drawers per cabinet

Type ‘C’ Double = 636mm w x 1255mm d x 1185mm h

Manufactured to take a drawer size of: 560mm w x 585mm d x 70mm h

30 drawers per cabinet

Type ‘A’ Single = 536mm w x 600mm d x 1185mm h

Manufactured to take a drawer size of: 460mm w x 500mm d x 60mm h

18 drawers per cabinet

Type ‘B’ Single = 576mm w x 525mm d x 1185mm h

Manufactured to take a drawer size of: 500mm w x 425mm d x 60mm h

18 drawers per cabinet

Type ‘C’ Single = 636mm w x 680mm d x 1185mm h

Manufactured to take a drawer size of: 560mm w x 585mm d x 70mm h

15 drawers per cabinet

**4.0 Entomological Drawers**

* The sides & tops are manufactured from European Lime, mitred corners with hardwood feathers,
* Lids have a grooved top to create an air tight seal,
* 2 or 3mm thick glass seated in a rebate & beaded in.
* The bottoms come with either 4 or 6mm thick plywood
* The external drawer is finished with pre cat lacquer, hardwood knobs & brass cardholders

**5.0 Microscope slide Tray Cabinets**

These cabinets are 655mm wide x 480mm deep x 470mm high.

Two doors per cabinet, with a three point compression locking system (handle fitted to one door)

Cabinet manufactured with the minimum components, carcase weld, dressed & sealed to stop the ingress of pests.

Cabinet is fitted with an inert ‘plastizote’ seal.

Each cabinet is split into three compartments each compartment has 41off slide drawers fitted, each drawer is capable of holder the slides horizontally in place.

**6.0 Earth Science and Zoological Cabinets**

Cabinets should;

* fully support the dimensions and weight of objects to be stored in them
* Be pest and dust proof and enable easy inspection for cleaning both under and around for pests
* cabinets should be of a standard size (consistent across the museum)
* suitable material that will not flex or distort over time and will provide a buffer against fluctuating environmental condition
* Seals should be inert and not off-gas any volatile components that will cause damage to the collections or lead to breakdown of the seal
* Cabinets should be fully welded
* Cabinet should provide Fire protection for specimens to Class 0
* Should protect from Impact damage (from trolleys etc.)
* Cabinets to seal tightly to exclude incursion of dust and pests (but allow for air exchange with outside of up to 1 air exchange per day)
* Height of plinth, approximately 10 cm (4 inches). Minimise dead spaces and provide easy access to those that are unavoidable for cleaning and pest control.
* Lockable doors with countersunk handles that run smoothly
* Doors to open maximally, i.e. >120° - 180°. (Flat if possible.)
* Doors to be fitted with internal and external label holders (A5). Also label holders on the ends of a cabinet run (A4)
* Equally spaced runners - adjustable.
* Runners or drawers to be fitted with a switchable stop mechanism to allow intentional but prevent inadvertent full withdrawal.
* Drawers of suitable strength material (preferably metal?) that will not flex or distort with the weight of their contents.
* Dimensions of drawers to fit full width of cabinet, all of equal height – size to be decided but approximately 15.25cm (6 inches) internal height.
* Drawer fronts to fit tightly together when closed to create an additional seal.
* Additional label holders on drawer fronts.
* Any wood to be used must be not off gas and be from a sustainable source (as per CSIP)
* All materials to comply with the ISO14001 and PAS 198 standards as applicable.
* All materials (Paints (powder coated epoxy preferred), cabinet construction materials, seals etc.) should be stable for a minimum period of 20 years and should not off gas or release any compound that would be a health and safety risk or cause deterioration to specimens or storage furniture
* Products must meet relevant fire codes
* Product must ensure that Gold/Platinum CSIP environmental standards can be maintained within the cabinet with minimal buffering

**Appendix 5 Relevant Published Standards and agreements**

PAS 198:2012: Specification for managing environmental conditions for cultural collections

PD 5454:2012 (PD45) Guide for the storage and exhibition of archival materials

PAS 197:2009 Code of practice for cultural collections management

NMDC guiding principles for reducing museums’ carbon footprint. 2008. NMDC

Bizot Group Oct 2012 (green museum) http://www.juliesbicycle.com/media/content/Green\_Visual\_Arts\_Guide\_Environmental\_Conditions.pdf

Doerner Institut - The Munich Position on Climate and Cultural Heritage 2013; http://www.doernerinstitut.de/downloads/Climate\_for\_Collections.pdf

ASHRAE 2007, 10 "Museums, Galleries, Archives and Libraries”, Michalski, 2007 - The Ideal Climate, Risk Management, the ASHRAE Chapter, Proofed Fluctuations, and Toward a Full Risk Analysis ModelAmerican Society of Heating, Refrigeration and Air-Conditioning Engineers. (2007) Chapter 21: Museums, Galleries, Archives and Libraries. ASHRAE Handbook, Atlanta, GA

ANSI/NISO Z39.79-2001 Environmental Conditions for Exhibition of Library and Archive Materials.  American National Standard developed by the National Information Standards Organization. <http://www.kb.dk/export/sites/kb_dk/da/kb/nb/bev/Z39-79-2001_Udstillingsstandard.pdf>

Grattan, D. and S. Michalski, (2010) “Environmental Guidelines for Museums – Temperature and Relative Humidity (RH).” Canadian Conservation Institute. October 2010. [www.cci-icc.gc.ca/crc/articles/enviro/index-eng.aspx](http://www.cci-icc.gc.ca/crc/articles/enviro/index-eng.aspx)

Sebrera, Donald K.  (1994) “Isoperms: An Environmental Management Tool”  Washington DC: The Commission on Preservation and Access  <http://cool.conservation-us.org/byauth/sebera/isoperm/>

Thompson, Garry. (1978) The Museum Environment  Butterworth Heinemann

Weintraub, Steven.  (2006) “The Museum Environment: Transforming the Solution into a Problem.”  Collections: A Journal for Museum and Archives Professionals Vol 2. No 3 (February 2006) pp 195-21

**Appendix 6 Buildings with defined and agreed environmental conditions**

|  |  |  |  |
| --- | --- | --- | --- |
| Area | Details of location | RH Setpoint | Temp Stpoint |
| Darwin Centre 1 | AHU 1 Spirits Store West | 50%RH - 75%Rh(Dehum at 50%RH Shutdown at 75%Rh | 14⁰C +-1⁰C |
|  | AHU 2 Spirits Store East | 50%RH - 75%Rh(Dehum at 50%RH Shutdown at 75%Rh | 14⁰C +-1⁰C |
|  | AHU 8 Exhibition Space | No humidity control | 22⁰C +-1⁰C |
| Darwin Centre 2 | AHU/N/R/01 North Zone VAV | Return air humidity 45%RH +-5%RH (Deadband too small) | Compensated supply setpoint. Fixed or Auto. Supply 11⁰C at OAT 29⁰C. Supply 25⁰C at OAT 5⁰C |
|  | AHU/N/R/02 North Zone VAV | Return air humidity 45%RH +-5%RH (Deadband too small) | Compensated supply setpoint. Fixed or Auto. Supply 12⁰C at OAT 29⁰C. Supply 25⁰C at OAT 6⁰C |
|  | AHU/N/B/02 - Buffer Zone Plant | 50%RH +-5%RH | 21⁰C +-2⁰C |
|  | AHU/N/B/01 - Collections North Plant | Return moisture content 4.4gKg - 5.4gKg | Fixed supply setpoint 16⁰C +-2⁰C |
|  | AHU/S/B/03 - Buffer Zone Plant | Return 50%RH +-5%RH | 21⁰C +-2⁰C |
|  | AHU/S/G/01 - UKBDR Plant | Return 50%RH +-5%RH | 22.5⁰C +-2⁰C |
|  | AHU/S/B/01 - Collection South Plant | Return moisture content 4.4gKg - 5.4gKg | Fixed supply setpoint 16⁰C +-0.5⁰C |
| Paleo | JSF Theatre AHU 1 | 40%RH +-5%RH | 18⁰C +-1⁰C |
|  | East Zone AHU 2 | 45%RH +-2.5%RH | Supply 18⁰C-39⁰C +-1⁰C demand based from floor setpoints |
|  | North Zone AHU 3 | 45%RH +-2.5%RH | Supply 16⁰C -38⁰C +-1⁰C demand based from floor setpoints |
|  | South Core AHU 4 | 45%RH +-2.5%RH | Supply 16⁰C -35⁰C +-1⁰C demand based from floor setpoints |
|  | Centre Core AHU 5 | 45%RH +-2%RH | Supply 18-35⁰C +-1⁰C demand based from floor setpoints |
|  | ADNA AHU | No humidity control | 18⁰C +-1⁰C |
| Earth Galleries | Atrium Area AHU 1 | AHU 1 Dehum 60%, AHU 1 Void Dehum 70% | Atrium Cool at 23⁰C Heat at 21DegC. Roof cool at 23⁰C |
|  | AHU 2 Gallery Floor Area | AHU 2 Dehum 60%, AHU 2 Void Dehum 70% | Geo Cool at 22⁰C Heat at 21⁰C. Roof cool at 23⁰C |
| Waterhouse | Marine Invertebrates Gallery | No humidity control | Ave Room EF3 Setpoint 22⁰C, Ceiling Void EF4 22⁰C Setpoint. Coffer EF5-9 Setpoint 25⁰C. |
|  | Plant Life AHU | No humidity control | 21⁰C +-1⁰C |
|  | Sloan Books AHU | 40%RH +-2.5%RH | 17⁰C +-2⁰C |
|  | Treasures Gallery | No humidity control | Group Setpoint 20 - 21DegC |
|  | Western Galleries AHU 1 | Spencer dehum at 45%RH, Mammals dehum at 45%RH, Zoolodgydehum at 45%RH, Osteologydehum at 45%RH | Spencer 21⁰C +-1⁰C, Mammals 21⁰C +-1⁰C, Zoolodgy 21⁰C +-1⁰C, Osteology 21⁰C +-1⁰C |
|  | Eastern Galleries AHU 2 Jerwwod Gallery 26 | 42%RH +-10%RH | 19⁰C +-1⁰C |
|  | Eastern Galleries AHU 3 Jerwwod Gallery 26 | 42%RH +-10%RH | 19⁰C +-1⁰C |
|  | Eastern Galleries AHU 4 Hall Of Human Biology | HHB no humidity control, Geolodgy Link no humidity control | HHB 21⁰C +-1⁰C, Geolodgy Link 21⁰C +-1⁰C |
|  | Publications AHU | Common extract 55%RH | Room Setpoint 22⁰C +-1⁰C, Warehouse 1 20⁰C +-1⁰C, Warehouse 220⁰C +-1⁰C |
|  | Gallery 202M North AHU | No humidity control | Heat aat 21⁰C no cooling |
|  | Gallery 202M South AHU | No humidity control | Heat aat 21⁰C no cooling |
|  | General Herbarium | N/A | Heat at 23⁰C |
|  | Ecology Pavillion | N/A | Cool at 21⁰C |
|  | AHU 5 Gallery 34/37/40 | Humidfy at 40%RH Dehumidify at 50%RH | Heat at 24⁰C Cool at 24⁰C no deadband |
|  | AHU 6 Gallery 38 | Humidify at 30%RH Dehumidify at 48%RH | 17.3⁰C +-2⁰C |
|  | AHU 9 Gallery 30 | No humidity control | AHU8 WBX-17 23⁰C +-1⁰C, AHU8 WBX-02 23⁰C +-1⁰C, AHU8 WEB-O3 23⁰C +-1⁰C |
|  | AHU 10 Main Galleries | No humidity control | AHU10 Bmt Occ 21⁰C +-1⁰C, AHU10 Gal Occ 21⁰C +-1⁰C |
|  | AHU 16 Geolodgy Link | Humidify at 45%RH Dehumidify at 60%RH | 21⁰C +-1⁰C |
| North Block | Molecule Collection | No humidity control | 18⁰C +-1⁰C |
|  | Molecule Collection VRF's | No humidity control | All off with all figures defaulted to 0 |
|  | Map Room | No humidity control | 18⁰C +-1⁰C |
|  | Photography AHU 1 | 45%RH +-10%RH | Heat 19⁰C Cool at 20⁰C |
|  | Rare Books AHU 3 | 43%RH +-3%RH | Heat at 22⁰C Cool at 23⁰C |
|  | 1st Floor Library | No humidity control | Heat at 21⁰C |
|  | Ground Reading Room | No humidity control | Heat at 21⁰C |
| Wandsworth | AHU 1 G1 Zoology Animals | Humidify at 45%RH Dehumidify at 55%RH | Heat at 17⁰C Cool at 19⁰CC |
|  | AHU 2 G2 Zoology Animals | Humidify at 45%RH Dehumidify at 50%RH | Heat at 16⁰C Cool at 18⁰C |
|  | AHU 3 G3 Palaentology | Humidify at 45%RH Dehumidify at 50%RH | Heat at 17⁰C Cool at 19⁰C |
|  | AHU 4 G4-5 Zoology | Humidify at 45%RH Dehumidify at 50%RH | Heat 17⁰C Cool at 21⁰C |
|  | AHU 5 G6-6A | Humidify at 45%RH Dehumidify at 55%RH | Heat 17⁰C Cool at 21⁰C |
|  | AHU 6 | Humidify at 45%RH Dehumidify at 50%RH | Heat 17⁰C Cool at 18⁰C |
|  | AHU 7 1/1-2 Library | Humidify at 35%RH Dehumidify at 50%RH | Heat 19⁰C Cool at 21⁰C |
|  | AHU 8 2/2-3 Botany | Humidify at 35%RH Dehumidify at 45%RH | Heat 20⁰C Cool at 22⁰C |
|  | AHU 9 | Humidify at 35%RH Dehumidify at 50%RH | Heat 15⁰C Cool at 17⁰C |
| TRING | Spirit/Sleleton Store AHU | No humidity control | Spirit Store Heat at 18⁰C, Skeleton Store Heat at 19⁰C |
|  | Dog Gallery Ventilation | 80%RH +-10%RH | Heat at 19⁰C |
|  | Gallery Void |  |  |
|  | Cottage Gallery AHU | 50%RH +-10%RH | 21⁰C +-1⁰C |
|  | Ornithology AHU | Zone 1 Floor 1 46%RH +-3%RH, Zone 2 Floor 2 46%RH +-3%RH, Zone 3 Floor 3 46%RH +-3%RH | Zone 1 Floor 1 18.5⁰C +-1⁰C, Zone 2 Floor 2 18.5⁰C +-1⁰C, Zone 3 Floor 3 18.5⁰C +-1⁰C |

**Wandsworth Agreement**

**Appendix 7**

**Natural History Bibliography**

Bridson, Diane and Leonard Forman, editors. 1998. The herbarium handbook. 3rd ed. Royal Botanic Gardens, Kew, Great Britain. xii, 334 p.

Howie, F.M. 1992 The Care and Conservation of Geological Material. Minerals, Rocks and Lunar Finds. Butterworths

Collins, Chris. 1995. The conservation of palaeontological material. Butterworth Heinemann

Horie, V. (1990) Materials for Conservation, Butterworths, London.

Carter, D. and Walker, A. (Eds.) (1999) *Care and Conservation of Natural History Collections,* Butterworth-Heinemann, Oxford.

Metsger, Deborah A. and Sheila C. Byers, eds. 1999. Managing the modern herbarium : an inter-disciplinary approach. Contribution ... from the Centre for Biodiversity and Conservation Biology of the Royal Ontario Museum, no. 53. Society for the Preservation of Natural History Collections, Washington, DC, as a joint project with The Royal Ontario Museum, Centre for Biodiversity and Conservation Biology. xxii, 384 p.

Michalski, S, M. MacDonald, T. Strang, J. Tétreault, and R. Williams. 1992. *A Systematic Approach to the Conservation (Care) of Museum Collections, with Technical Appendices. Ottawa: Canadian Conservation Institute.*

Simmons, J. Herpetological Collecting and Collections Management. Herpetological Circulars No. 31. Rev. ed. Marceline, MO: Society for the Study of Amphibians and Reptiles, 2002.

Waller, R. 2003 Cultural Property Risk Analysis Model: Development & Application To Preventive Conservation At The Canadian Museum Of Nature (Goteborg Studies in Conservation). g Press Goteborgs Universitet Acta Univ  ISBN 9173464759

Collins, C, Cornish, L., Huxley, H. & Owens, S.J. (2006). SYNTHESYS Network Activity C-Assessing Standards of Collections in European Museums. Collection Forum 21 (2): 5-18, SPNHC, Washington

Thomson, G. (1986) *The Museum Environment, 2nd edn.* Butterworths & Co., London.

**References for Natural History Conservation**

Agnew, N. “The Corrosion of Egg Shells by Acetic Acid Vapour.” *ICCM Bulletin* 7, no. 4 (1981): 3-9.

Albert H, (1913) The use of oil as a final preservative for specimens, the natural colour of which is to be retained. Bull Int ASS Med Mus 1913 IV 44-45.

Alpert G. D. (1988) Integrated Pest Management: A Program For The Museum Environments in Zycherman, L.A. & Schrock J.R. A guide to Museum Pest Collection Washington: Foundation of the American Institute for Conservation of Historic & Artistic Works and the Association of Systematic Collections pg:169-173

American Society for Testing and Materials. Standard Guide for Handling Hazardous Biological Materials in Liquid Nitrogen. Guide E1556-00. Philadelphia: American Society for Testing and Materials, 2000.

American Society for Testing and Materials. Standard Practice for Preservation by Freezing, Freeze-Drying, and *Low-temperature Maintenance of Bacteria, Fungi, Protista, Viruses, Genetic Elements, and Animal and Plant* *Tissues*. Guide E1342-97. Philadelphia: American Society for Testing and Materials, 1997.

American Society of Ichthyologists and herpetologist. No. 2 Jan 1981. Curation Newsletter. About alcohol as a preservative.

American Society of Ichthyologists and herpetologist. No. 3 June 1981. Curation Newsletter. Different issues, paraformaldehyde problems, mailing specimens, preservation of colour…

Andrei, M. and H. Genoways. “Changes in pH in Museum Storage Fluids, I–Effects of Resistal Paper Labels.” *Collection Forum* 12, no. 2 (1991): 63-75.

Andrew, K.A., Tetreault, J. and Waller, R. 1993. A survey of pollutant concentrations in mineral collection cabinets. SSCR 4 (1).

Anon (1869) Glycerine for preserving the natural colours of marine animals. Mon Microsc J 1869 I 370

Anon (1924) Fixation et conservation de la coleur par I’emploi d’un sent liquide. Rev de Path Veg et Ent Agric de France 1924.14.228-329.

Arnold, R. B. (2006) *ASTM's Paper Aging Research Program 2002*, Pennsylvania.

Ashdown, J. and Gosnay, L. (2009) Conservation of the Smith Herbarium, *Pulse***,** 4-5.

Ashurst, J. and Dimes, F.G.1990. Conservation of Building and Decorative stone vol 1. Butterworth-Heinemann

Ashurst, J. and Dimes, F.G.1990. Conservation of Building and Decorative stone vol 2. Butterworth-Heinemann

ASIS Standing Committee on Museum, Library and Archive Security. *Suggested Guidelines in Museum Security*. Rev. ed. Alexandria: ASIS International, 1997. Available on the web at: <www.stevekeller.com/steve/pdf\_files/SecurityStandards/GuidelinesRev97.pdf>.

B. Neuhaus, A. Allspach, P. Bartsch, D. Burckhardt, C. O. Coleman, I. Fries, R. Fuchs, M. Gudo, M. Kotrba, M. Mentjes, S. Moore, D. Neumann, C. Oberer, A. Potthast, J. Riedel, R. Rudolf, T. Schnalke, D. Schönbohm, M. Schuda, A. van Dam, N. Widulin.2011. KUR-Projekt: Aufbau und öffentliche Kommunikation eines wissenschafts-basierten Sammlungsmanagements für naturkundliche Nasssammlungen. doi10.5165hawk-hhgepublication44. Campbell, L., Quenzer, M., Dröge, G., Kirchgessner, A., Simpson, J. & Tulig, M. (2012): Tissue and DNA banking at The New York Botanical Garden. *Collection Forum.* 26 (1-2): 120-129

Bagnara, JT and ME Hadley 1973. Chromatophores and Color Change. Prentice-Hall, N.J. 202pp.

Baird, T and Tennent, N.H., Electron optical studies of shell efflorescence. Inst. Phys. Conf. Ser. No. 78: Chapter 14.

Baker, R. “Some Thoughts on Conservation, Biodiversity, Museums, Molecular Characters, Systematics, and Basic Research.” *Journal of Mammalogy* 75, no. 2 (1994): 277-287.

Baker, R. and M. Hafner. “Curation of Collections of Frozen Tissues: Curatorial Problems Unique to Frozen Tissue *Collections.” In Collections of Frozen Tissues: Value, Management, Field and Laboratory Procedures, and* *Directory of Existing Collections,* edited by H. Dessauer and M. Hafner, 35-40. Lawrence: Association of Systematics Collections, 1984.

Baker, R. and M. Haiduk. “Collections of Tissue Cultured Cell Lines Suspended by Freezing.” *Acta Zoologica Fennica 170: 91-92.*

Bannister, F.A. (1937) Preservation of Minerals and Meteorites. Museums J. 36, 465-476.

Bansa, H. (2002) Accelerated Ageing of Paper: Some Ideas on its Practical Benefit, *Restaurator,* **23,** 106-117.

Bauer, E. P. and Fuortes, L. J. (1999) An Assessment of Exposure to Mercury and Mercuric Chloride from Handling Treated Herbarium Plants, *Vet Human Toxicology,* **41,** 154-156.

Bayer, J. and T. Counihan. “Length Changes in White Sturgeon Larvae Preserved in Ethanol or Formaldehyde.” *Collection Forum* 15, nos. 1-2 (2001): 57-64.

Beazley, K. (1991) Mineral Fillers in Paper, *The Paper Conservator .* **15,** 17-27.

Beck, C. 1970. Amber in Archaeology. Archaeology, 23, 7-11.

Beck, C.W. 1982. Authentication and conservation of amber: conflict of interests. In Brasmelle, N.S. and G. Thomson (Eds) Science and Technology in the Service of Conservation. 104-107. IIC Preprints Washington Congress, IIC, London.

Bégin, P. L., Deschatelets, S., Grattan, D., Gurnagul, N., Iraci, J., Kaminska, E., Woods, D. and Zou, X. (1999) The effect of air pollutants on paper stability, *Restaurator,* **20,** 57-115.

Bendall H(1880) Note on a new method of preserving the colours of tissues. J.Anat Physiol Lond 1880.14.511-512.

Bentley, A.C. 2004. Thermal transfer printers—applications in wet collections. *Society for the Preservation of Natural History Collections Newsletter* 18(2):1-2, 17-18.

Billy, A. “The Effects of Formalin and Isopropyl Alcohol on Length and Weight Measurements of *Sarotherodon* mossambicus Trewavas.” Journal of Fish Biology 21 (1982): 107-112.

Bizot Group (International Group of Organizers of Large Scale Exhibitions) Frankfurt October 25-27. 2012, Appendix 7

Blackshaw, S.M. and Daniels, V.D. (1978) Selecting safe materials for use in the display and storage of antiquities. ICOM committee for Conservation, 5th Triennial meeting, Zagreb 78/23/2/1-9

Blackshaw, S.M. and Daniels, V.D. The testing of materials for use in storage and display in museums, The Conservator. 3. 1979. pp. 16 - 19.

Blum J(1893)Formol als Conservierungsflussigheit.Zoo Anz 1893 434 450

Blum, F. 1893. Der formaldehyd als hartungsmittel. *Zeitschrift der wissenschaft fur mikroskopie* 10:314-315.

Blyth, V. (2001) Training for Museum Staff is a Pre requisite For Successful Insect Pest Management in Helen Kingsley, Integrated Pest Management for Collections London: James & James pg: 44-49

Boase, N. and R. Waller. “The Effect of Propylene Glycol on Ethanol Concentrations Determined by Density Measurement.” *Collection Forum* 10, no 2 (1994): 41-49.

Bogaty, H., Campbell, K. S. and Appel, W. D. (1952) Some Observations on the Evaporation of Water from Cellulose, *TRJ22***,** 75-82.

Bone, W. H. and Turner, H. A. (1950) Some effects of the evaporation of water from cellulose, *J. Soc. Dyers and Colourists,* **66,** 315–327.

Bridson, D. and L. Forman (editors). 1998. *The Herbarium Handbook*. Third edition. Royal Botanic Gardens, Kew, xii +334 pages.

Bridson, Diane and Leonard Forman, editors. 1998. The herbarium handbook. 3rd ed. Royal Botanic Gardens, Kew, Great Britain. xii, 334 p.

Briggs, D., Sell, P. D., Block, M. and I'Ons, R. D. (1983) Mercury Vapour: A Health Hazard in Herbaria, *New Phytologist,* **94,** 453-457.

Brown, P. “A Review of Techniques Used in the Preparation, Curation and Conservation of Microscope Slides at the Natural History Museum, London.” *The Biology Curator* Issue 10 Supplement. Biology Curators’ Group, 1997.

Burke, J. Vapor Barriers. WAAC Newsletter Vol. 14 No. 2

Burke, J. “Anoxic Microenvironments: A Treatment for Pest Control.” *Conserve O Gram* 3/9. Washington, D.C.:National Park Service, 1999.

Burroughs, G.E., K. Makos, C. Hawks, and T.J. Ryan. 2006. Exposure of museum staff to formaldehyde during some wet specimen activities. *Collection Forum* 20(1-2):49-54.

Buys, S. and Oakley, V. The Conservation and Restoration of Ceramics, 1993 Butterworth-Heinemann

Camacho, A. and J. Bedoya. “Evaluation of the Effects of Different Preservative and Fixative Fluids on Aquatic Invertebrates from Interstitial Waters.” *Collection Forum* 10, no. 1 (1994): 20-31.

Campbell, L., Quenzer, M., Dröge, G., Kirchgessner, A., Simpson, J. & Tulig, M. (2012): Tissue and DNA banking at The New York Botanical Garden. *Collection Forum.* 26 (1-2): 120-129

Canadian Conservation Institute. "Care of Ivory, Bone, Horn and Antler," CCI Notes 6/1, March 1988, Ottawa: Canadian Conservation Institute.

Canadian Conservation Institute*.* “Leather Skin and Fur.” *CCI Notes*, No. 1-4. Ottawa: Canadian Conservation Institute, 1986.

[Canadian Conservation Institute. Publications and Special Products Catalog. Ottawa: Canadian ConservationInstitute, 2003. Available at: <http://www.cci-icc.gc.ca>.](http://www.cci-icc.gc.ca/)

Carter, D. and Walker, A. (Eds.) (1999) *Care and Conservation of Natural History Collections,* Butterworth-Heinemann, Oxford.

Carter, J. 2002. DNA preservation in fluid preserved collections. *Society for the Preservation of Natural History Collections Newsletter* 16(1):14-15.

Carter, J. “An Investigation of pH Changes in a Selection of Formaldehyde Buffering Agents Used on a Fish Parasitology Research Collection.” *Collection Forum* 13, no 1 (1997): 1-10.

Cato, O. “Monitoring Insect Pests with Sticky Traps.” *Conserve O Gram* 3/7. Washington, D.C.: National Park Service, 1998.

Cato, P. and C. Jones (eds.). *Natural History Museums: Directions for Growth*. Lubbock: Texas Tech University Press, 1991.

Cato, P. and D. Schmidly. “Policies concerning the use and management of ancillary preparations in vertebrate systematic collections.” In *Natural History Museums: Directions for Growth*, edited by P. Cato and C. Jones, 91-104. Lubbock: Texas Tech University Press, 1991.

Cato, P. *Guidelines for Managing Bird Collections*. Museology No. 7. Lubbock: Texas Tech University Press, 1986.

Cato, P. S., Waller, R., Sharp, L., Simmons, J. And Williams, S. L. Developing Staff Resources for managing Collections. Virgina Museum of Natural History Museum, Special Publication No. 4 Martinsville 1996.

Cato, P., R. Waller, L. Sharp, J. Simmons, S. Williams. *Developing Staff Resources for Managing Collections*. Martinsville, Va.: Virginia Museum of Natural History and Canadian Museum of Nature, 1996.

Cato, Paisley S., Julia Golden & Suzanne B. McLaren 2003MuseumWise. Workplace Words Defined. Society for the Preservation of Natural History Collections 381 pages

Cato. P. “Racks and Dividers to Organize Small Frozen Samples.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 201-202. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Chakraborty, A., M. Sakai, and Y. Iwatsuki. 2006. Museum fish specimens and molecular taxonomy: a comparative study on DNA extraction and preservation techniques. *Journal of Applied Ichthyology* 22(2):160-166.

Chamberlin, J.C. 1925. Heavy mineral oil as a permanent non-volatile preservative for valuable biological material. *Science* 61(1590):634-635.

Chater, A. O. (2000) Collecting and Pressing Specimens, *Atlas 2000***,** 19.

Chatigny, M. E. 2000. The extraction of DNA from formalin-fixed, ethanol-preserved reptile and amphibian tissues. *Herpetological Review* 31(2):86-87.

Chatigny, M. E. 2000. The extraction of DNA from formalin-fixed, ethanol-preserved reptile and amphibian tissues. *Herpetological Review* 31(2):86-87.

Chicora Foundation, I. (1994) Managing Pests in Your Collections, *Different Approaches to Pest Management*.http://palimpsest.stanford.edu/byorg/chicora/chicpest.html

Child R. E. & Pinniger D.B (1987) Insect Pest Control in UK Museums in Black, J. Recent Advances in Conservation & Analysis of Objects Institute of Archaeology Jubilee Conference pg:303-307

Child, R. (ed.). Conservation and the Herbarium. Leigh, Worcestershire, U.K.: Institute of Paper Conservation, 1994.

Child, R.E. & Pinniger D.B. (1994) Insect Trapping in Museums and Historic Houses in Preventive Conservation Practice Theory & Research in Preprints of the Contributions to the Ottawa Congress, 12-16 Sep 1994 IIC

Childs, J., J. Mills, and G. Glass. “Rodent-Borne Hemorrhagic Fever Viruses: A Special Risk for Mammalogists?” *Journal of Mammalogy* 76, no. 3 (1995): 664-680.

Clark, P. “Ground Glass Stoppered Jars for Fluid Collections.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 221-223. Washington, D.C.: Society for thePreservation of Natural History Collections, 1992.

Clark, P., O. Crimmen, F. Naggs, A. Wahl, and M. Mansfield. “Transportation of Fluid -Preserved Natural History Specimens Stored in Glass Containers: New Solutions to an Old Problem.” *Collection Forum* 10, no. 1 (1994): 1-9.

Clark, S. (1986) Preservation of Herbarium Specimens an Archive Conservators Approach, *Taxon,* **35,** 675-681.

Clifford Rankin J and Davenport JA 1981 Animal Osmoregulation

Cohen, D. and R. Cressey (eds.). *Natural History Collections: Past, Present, and Future*. Special issue of the *Proceedings of the Biological Society of Washington*, Volume 82, pp. 559-762. Washington, D.C.: Biological Society of Washington, 1969.

Collins, C. 1988. A review of the breakdown and conservationof subfossil bone. Unpublished draft, presented at the annual meeting of the Society for the Protection of Natural History Collections.

Collins, C.J. The Environment and Geological Collections. S.S.C.R. Bulletin No.10 1988. pp.2-7.

Collins, Chris. 1995. The conservation of palaeontological material. Butterworth Heinemann

Conservation of Natural History specimens spirit collections. 1989 The Manchester Museum and Department of Enviromental Biology, The University of Manchester.

COOPER, D.W., (1988) The preparation and serial sections of platyhelminth parasites, with details of the materials and facilities required. Systematic parasitology 12:211-229

Cosgrove, J. 1992. “Tub and Divider System for Fluid Collections.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 205-206. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Cosgrove, J., D. Donaldson, G. Hughes, and W. Maloff. “Plague at the Museum: Disease Transmission Potential and Biosafety Precautions.” *Collection Forum* 8, no. 1 (1992): 1-8.

Crisan, D., E.M. Cadoff, J.C. Mattson, and K.A. Hartle. 1990. Polymerase chain reaction: amplification of DNA from fixed tissue. *Clinical Biochemistry* 23:489-495.

Criscuolo, G. 1992. Extraction and amplification of DNA from wet museum collections. *Ancient DNA Newsletter* 1(1):12-13.

Criscuolo, G. 1994. On the state of preservation of DNA from museum spirit collections. *Biology Curator's Group Newsletter* 6(4):39-41.

Croat, Thomas B. 1978. Survey of Herbarium Problems. Taxon 27(2/3): 203-218.

Cronyn, J.M. 1990. *The Elements of Archaeological Conservation*. Routledge: London and New York.

Crowther, P.R. and Collins, C.J. (Eds.) 1986. The Conservation of Geological Materials. The Geological Curator 4(6).

CURRAN, J. & HOMINICK, W.M. (1981). Effect of mounting methods on taxonomic characters of adult male mermithids. Nematologica. 26. 455-466

Cushing, P.E. and J.A. Slowik. 2007. Re-curation of alcohol-preserved specimens: comparison of gradual versus direct specimen transfer on specimen quality and assessment of specimen value. *Collection Forum* 22(1-2):1-9.

Dean, M.D., and J.W. Ballard. 2001. Factors affecting mitochondrial DNA quality from museum preserved *Drosophila simulans*. *Entomologia Experimentalis et Applicata* 98:279-283.

Delepine S(1914) On the arsenius acid glycerine method of preserving and mounting pathological specimens in their natural colours and on the use of new forms of receptacles for keeping museum specimens. J Path Bact 1914 XVIII 245-350

Dessauer, H. and M Hafner (eds.). Collections of Frozen Tissues: Value, Management, Field and Laboratory *Procedures, and Directory of Existing Collections*. Lawrence, Ks.: Association of Systematics Collections.

Dessauer, H.C., C.J. Cole, and M.S. Hafner. 1996. Collection and storage of tissues. Pages 29-47 in Hillis, D.M., C. Mortiz, and B.K. Mable (editors). *Molecular Systematics*. Second edition. Sinauer Associates, Inc., xvi + 655 pages.

DeWolf, Gordon P., Jr. 1968. Notes on Making an Herbarium. Arnoldia 28: 69-111.

Down, J. (1999) *Adhesive Research at the Canadian Conservation Institute as it relates to herbarium Collections.,* Elton-Wolf Publishing, Granville Island.

Down, J., M. MacDonald, J. Tétreault, and S. Williams. “Adhesive Testing at the Canadian Conservation Institute – An Evalulation of Selected Poly(vinyl acetate) and Acrylic Adhesives.” *Studies in Conservation* 41 (1996): 19- 44.

Dubeau, L., K.Weinberg, P.A. Jones, and P.W. Nichols. 1988. Studies on immunoglobulin gene rearrangement in formalin-fixed, paraffin-embedded pathology specimens. *American Journal of Pathology* 130(3):588-594.

Dubeau, L., L.A. Chandler, J.R. Gralow, P.W. Nichols, and P.A. Jones. 1986. Southern blot analysis of DNA extracted from formalin-fixed pathology specimens. *Cancer Research* 46:2964-2969.

Duckworth, W.D., Genoways, H.H. and Rose, C.L. 1993. *Preserving Natural Science Collections: Chronicle of Our Environmental Heritage*. National Institute for the Conservation of Cultural Property.

Dupont, A. L. (1996a) Degradation of Cellulose at the wet/dry interface. 1 The effect of some some conservation treatments on brown lines., *Restaurator,* **17,** 1-21.

[Edmondson, J. 1993. Conservation: conservation and the herbarium: report of the liverpool conference. Museum Management and Curatorship. Volume 12, Issue 3, September 1993, Pages 319–321](http://www.sciencedirect.com/science/article/pii/0964777593900803)

Egenberg, I. M. and Moe, D. (1991) Damage caused by a widely used herbarium mounting technique., *Taxon,* **40,** 601-604.

Elmhurst R.(1929) Preservation of colour in Marine organisms. Museums J 1929 29 6-8.

Espinoza, E. and M-J. Mann. *Identification Guide for Ivory and Ivory Substitutes*. 2d rev ed. Washington, DC: World Wildlife Fund, 1991.

Establier(1969) Prevencion quimica del ennegrecimiento(Melanosis) de los crustaceos congelados y conservados en hielo. Inst Inv Pesq 1969 33 55-68

Estep, A.D. 2004. Use of polycarbonate food storage pails in wet collections. *Society for the Preservation of Natural History Collections Newsletter* 18(1):1-2.

Fang, S-G., Q-H. Wan, and N. Fujihara. 2002. Formalin removal from archival tissue by critical point drying. *BioTechniques* 33(3):604-611.

Favret, C., K.S. Cummings, R.J. McGinley, E.J. Heske, K.P. Johnson, C.A. Philips, L.R. Phillippe, M.E. Retzer, C.A. Taylor, and M.J. Wetzel. 2007. Profiling natural history collections: a method for quantitative and comparative health assessment. Collection Forum 22(1-2):53-65.

Feller, R. and M. Wilt. *Evaluation of Cellulose Ethers for Conservation.* Research in Conservation 3. Los Angeles: Getty Conservation Institute, 1990.

Fenn, J. (1999) *Plastic Materials Used in the Herbarium,* Elton-Wolf Publishing, Granville Island

Fery, J., T. Yates, D. Duszynski, W. Gannon, and S. Gardner. “Designation and Curatorial Management of Type Host Specimens for New Parasite Species.” *Journal of Parasitology* 78, no. 5 (1992): 930-932.

Fitzgerald, G. 1988. Documentation guidelines for the preparation and conservation of paleontological and geological specimens. Collection Forum 4(2):38-45.

Fitzgerald, G. 1989. A form-fitted pallet for the storage of large fossils. Geological Curator 5(2):72-76.

FitzHugh, E. W., and Gettens, R. J. 1971. Calclacite and other efflorescent salts on objects stored in wooden museum cases. In Brill, R. H. (ed.), Science and Archaeology. M.I.T. Press. pp. 91-102.

Flint JM and Kellner C(1912) A new preservative for Pick-Kaiserling specimens. J.Am.med ASss 1912 LVIII 1277-1278.

Floray, S. “Safer Cleaning Alternatives for the Museum and Visitor Center.” *Conserve O Gram* 2/21. Washington, D.C.: National Park Service, 2003.

Florian, M -L. “The Effects of Freezing and Freeze-Drying on Natural History Specimens.” *Collection Forum* 6, no. 2 (1990): 45-52.

Florian, M.-L. (2002) *Fungal Facts: Solving fungal problems in heritage collections.,* Archetype Books Publications Ltd., London.

Florian, M.-L., Kronkright, D. P. and Norton, R. E. (Eds.) (1992) *The Conservation of Artifacts made from Plant Materials,* J.Paul Getty Trust, Princeton.

Fogle, Sonja, Toby Raphael and Katherine Singley. *Recent Advances in Leather Conservation*. Washington, DC: Foundation of the American Institute for Conservation, 1985.

Fosberg, F. Raymond and Marie-Helene Sachet. 1965. Manual for Tropical Herbaria. Regnum Vegetabile 39. IAPT, Utrecht, Netherlands.

Fox DL 1976 Animal Biochromes and Structural Colours (ed. 2) Univ Claif. Press, Berkeley 433pp

Fox, C.H. and C. Benton. 1987. Formaldehyde: the fixative. *Journal of Histotechnology* 10(3):199-201.

Fox, C.H., F.B. Johnson, J. Whiting, and P.P. Roller. 1985. Formaldehyde fixation. *Journal of Histochemistry and Cytochemistry* 33(8):845-853.

Franks, J. W. (1965) A Guide to Herbarium Practice, *The Museums Association,* **Handbook for Museum Curators,** 15-16.

Gage, K., R. Ostfeld, and J. Olson. “Nonviral Vector-Borne Zoonoses Associated with Mammals in the United States.” *Journal of Mamma* logy 76, no. 3 (1995): 695-715.

Gareis, P., C. Cowley, and H. Gallisdorfer. “Operating Characteristics of Biological Storage Vessels Maintaine with Liquid Nitrogen.” *Cyrobiology* 6, no. 1 (1969): 45-56.

Garner, R. and C. Horie. “The Conservation and Restoration of Slides of Mosses.” *Studies in Conservation* 29 (1984): 93-99.

Garrett, K. “Documentation Guidelines for the Preparation of Biological Specimens.” *Collection Forum* 5, no. 2 (1989): 47-51.

Gemeinholzer, B., Dröge, G., Zetzsche, H., Haszprunar, G., Klenk, H.-P., Güntsch, A., Berendsohn, W.G. & Wägele, J.-W. (2011): The DNA Bank Network: the start from a German initiative. *Biopreservation and Biobanking.* April 2011, 9 (1): 51-55.

[Gemeinholzer, B., Rey, I., Weising, K., Grundmann, M., Muellner, A.N., Zetzsche, H., Droege, G., Seberg, O., Petersen, G., Rawson, D.M., Weigt, L.A. (2010): Organizing specimen and tissue preservation in the field for subsequent molecular analyses. IN: ABC-Taxa, Volume 8 - Manual on Field Recording Techniques and Protocols for All Taxa Biodiversity Inventories, Chapter 7, 129-157. download link (free access): http://www.abctaxa.be/volumes/volume-8-manual-atbi/volumes/volume-8-manual-atbi/chapter-7](http://www.abctaxa.be/volumes/volume-8-manual-atbi/volumes/volume-8-manual-atbi/chapter-7)

Genoways, H., C. Jones, and O Rossolimo (eds.). *Mammal Collection Management*. Lubbock: Texas Tech University Press, 1987.

Germer ES and Dubinin VB (1954) New methods of making dry preparations of internal organs, embryos, and whole animals with the preservation of the natural colour. Zool Zh 1954 33 262-273.

Gershwin, L., 2002 : Curating Medusae. Published by the author, web page established May 2002, last updated 30 November 2003 . http://www.medusozoa.com/curating.html

Gisbert, J. and R. Garcia-Perea. “Double-jar system for types in fluid collections.” In *Storage of Natural History Collections: Ideas and Practical Solutions,* edited by C. Rose and A. de Torres, 225-226. Washington, D.C.:Society for the Preservation of Natural History Collections, 1992.

Gisbert, J., F. Palacios, and R. Garcia -Perea. “Labeling Vertebrate Collections with Tyvek® Synthetic Paper.” *Collection Foru*m 6, no. 1 (1990): 35-37.

Goelz, S., S.R.Hamilton, and B. Vogelstein. 1985. Purification of DNA from formaldehyde fixed and paraffin embedded human tissue. *Biochemical and Biophysical Research Communications* 130(1):118-126.

Goldberg, L. (1996) A history of pest control measures in the anthropology collections,National Museum of Natural History., *Journal of the American Institute of Conservation,* **35,** 23-43.

Golden J. Conservation of SEM Stubs and related Materials. In Collections, Chris Conservation of Palaeontological Materials, Butterworths 1995

Golden, J. “Storage for SEM stubs.” In Storage of Natural History Collections: Ideas and Practical Solutions, edited by C. Rose and A. de Torres, 271-272. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Golden, J. 1989. Golden oldies: curating SEM specimens. Collection Forum 5(1):17-26.

Goodway, M. “Storage System for Microscopical Preparations.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 269. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Gorton, P., F. Schieppati, and M. Conquino. Health and Safety for Archaeologists and CRM Professionals. Buffalo: Panmerican Environmental, Inc. and Panamerican Consultants, Inc., 1999.

Graves, G.R., and M.J. Braun. 1992. Museums: storehouses of DNA? *Science* 255(5050):1335-1336.

Green, L.R. and Thickett, D. 1995. Testing Materials for use in the storage and display of antiquities - a revised methodology. Studies in Conservation vol.40. no.3 August.

Greenspan, L. Humidity fixed points of binary saturated solutions. Jnl. of Res. of the National Bureau of Standards -. Physics and Chemistry vol. 81A, no. 1 Jan-Feb 1977.

Greer, C.E., S.L. Peterson, N.B. Kiviat, and M.M. Manos. 1991. PCR amplification from paraffin-embedded tissues. Effects of fixative and fixation time. *American Journal of Clinical Pathology* 95:117-124.

Groedder E. (1984) Fluid Inclusions, Reviews in Mineralogy 12. Min. Soc America. Wasington

Gwyn Miles. 1988. International Journal of Museum Management and Curatorship, Volume 7, Issue 2, June 1988, Pages 159-163

Hackney, S. 1984. The distribution of gaseous air pollution within museums. Studies in Conservation, 29, 105 - 116.

Haines, Betty. *Monograph Series on Leather*. Northampton: The Leather Conservation Center Ltd., 1991.

*Haines, Betty. The Conservation of Bookbinding Leather, A Report by the British Leather Manufactures’* Research Association for the British Library. London: The British Library, 1984.

Hall, A. V. (1988) Pest Control in Herbaria, *Taxon,* **37,** 885-907.

Hall, D. W. (1981) Microwave: A Method to Control Herbarium Insects, *Taxon,* **30,** 818-819.

Hammond J.B.W, Spanswick G and Mawn JA (1996) Extraction of DNA from preserved animal specimens for use in randomly amplified polymorphic DNA analysis. Analytical Biochemistry 240: 298-300.

Hangay, G and M. Dingley. Plants, Invertebrates and Techniques. Vol 1 Biological Museum Methods. London . Academic Press 1985.

Hare, P. E. 1980. Organic geochemistry of bone and its relation to the survival of bone in the natural environment. In Behrensmeyer, A. K., and A. P. Hill (eds.), Fossils in the making: vertebrate taphonomy and paleoecology. Chicago: The University of Chicago Press. pp. 208-219.

Harmer SF(1922) Experiments on the fading of Museum specimens. Museums J. 1922 21 205-222

Harris, R. A Selective Bibliography on Preservation, Macro and Micro-anatomical Techniques in Zoology. Report No. 3. Biology Curators’ Group, 1984.

Harris, RH 1990 Zoological preservation and Conservation Techniques. Journal of Biological Curation 1(2):5-24.

Haselkorn, R., and P. Doty. 1961. The reaction of formaldehyde with polynucleotides. *Journal of Biological Chemistry* 236(10):2738-2745.

Haussermann, V., 2004 : Identification and taxonomy of soft-bodied hexacorals exemplified by Chilean sea anemones; including guidelines for sampling, preservation and examination. J. Mar. Biol. Ass. UK (2004), **84**, 931-936

Hawks, C. “An Introduction to Respirator Use in Collections Management.” *Conserve O Gram* 2/13. Washington, D.C.: National Park Service, 2000.

Hawks, C. A. and Bell, D. (1999) Removal of stains caused by mercuric chloride treatments from herbarium sheet labels, *12th triennial meeting ICOM-CC Committee`,* **II,** 723-727.

Hawks, C. A., and S. L. Williams. 1986. Care of specimen labels in vertebrate research collections. Pp. 105–108, in Proceedings of the 1985 Workshop on Care and Maintenance of Natural History Collections (J. Waddington and D. M. Rudkin, eds.). Life Sciences Miscellaneous Publications, Royal Ontario Museum, Toronto, Canada, v + 121.

Hawks, C. A., Makos, K., Bell, D., Wambach, P. and Burroughs, E. (2004) An inexpensive method to test for mercury vapour in herbarium cabinets, *Taxon,* **53,** 783-790.

Hawks, C. and D. Von Endt. “Mercury and Mercury Compounds in Natural History Collections: An Annotated Bibliography.” *Natural History Conservation* 5 (1990): 4-19.

Hawks, C. and S. Williams. “Care of Specimen Labels in Vertebrate Research Collections.” In *Proceeding of the* 1985 Workshop on Care and Maintenance of Natural History Collections, edited by J. Waddington and D. Rudkin, 105-108. Life Sciences Miscellaneous Publications. Toronto: Royal Ontario Museum, 1986.

Hawks, C., and K. Makos. “Inherent and Acquired Hazards in Museum Objects: Implications for Care and Use of Collections.” *CRM* 23, no. 5 (2000): 31-37.

Hawks, C., M. McCann, K.A. Makos, L. Goldberg, D. Hinkamp, D.C. Ertel, Jr., and P. Silence (editors). 2010. *Health and Safety for Museum Professionals*. Society for the Preservation of Natural History Collections and the Health & Safety Committee of the American Institute for Conservation of Historic & Artistic Works, New York, 646 pages.

Hawks, C., S. Williams, and J. Gardner. *The Care of Tanned Skins in Recent Mammal Collections*. Museology No. 6. Lubbock: Texas Tech University Press, 1974.

Hawksworth, D., I. Sastramihardja, R. Kokke, and R. Stevenson. *Guidelines for the Establishment and Operation of Collections of Cultures and Microorganisms*. World Federation for Culture Collections, 1990.

[Health Canada, Pest Management Regulatory Agency. Effective Control of Rats and Mice. Ottawa: Health Canada, Pest Management Regulatory Agency, 2001. On the web at: http://www.pmraarla. gc.ca/english/consum/ratsandmice-e.html#5.](http://www.pmraarla/)

Hendler, G., 2004 : Collecting, Preserving and Archiving Echinoderms http://clade.acnatsci.org/rosenberg/archiving/taxa/echinoderms.html

Heyer, W., M. Donnelly, R. MacDiarmid, L-A Hayek, and M. Foster (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Washington, D.C.: Smithsonian Institution Press, 1994.

HM Treasury. 2004. The Orange BookManagement of Risk - Principles and Concepts. Crown copyright

Hoagland, K. (ed.). Guidelines for Institutional Policies and Planning in Natural History Collections. Washington, D.C.: Association of Systematics Collections, 1994.

Hochberg, E. “Colored Dots for Coding Fluid Collections.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 267-268. Washington, D.C.: Society for thePreservation of Natural History Collections, 1992.

Hollmann M (1974) Einbettungstechnik mit Schwerigal nach neuresten Erkenntnissen (natural colour embedding technique) Praparator 1974 3/4/77-95

HOOPER, D.J. (1986) Handling, fixing, staining and mounting nematodes. in: Southey, J.F. (ed.) Laboratory methods for work with plant and soil nematodes. MAFF, London: 59-80.

Hooper, D.J. (1990) Extraction and processing of plant and soil nematodes. in:Luc, M.; Sikora, R.A. & Bridge, J. (eds.) Plant parasitic nematodes in subtropical and tropical agriculture. CAB International, Wallingford: 45-6

Horie , C.V and Francis, D.M. A pilot study of moisture vapour transmission rate through stewart's plastic boxes. Conservation News, 23, 1984.

Horie, C. “Fading of Feathers by Light.” Pp. 431-435 in *Preprints of the ICOM Committee for Conservation 9th Triennial Meeting, Dresden, Germany, 26-31 August 1990. Paris: ICOM Committee for Conservation.*

Horie, C. V. (1994) *Materials for Conservation: organic consolidants, adhesives and coatings,* Butterworth-Heinemann, Oxford.

Horie, C.V. and Murphy, R.G. (eds) 1988. *Conservation of Natural History Specimens: Vertebrates*. University of Manchester, Department of Environmental Biology and the Manchester Museum.

Horie, C.V. and Murphy, R.G. (eds) 1989*. Conservation of Natural History Specimens: Spirit Collections*. University of Manchester, Department of Environmental Biology and the Manchester Museum.

Horie, V. (1990) Materials for Conservation, Butterworths, London.

Houde, P., and M.J. Braun. 1988. Museum collections as a source of DNA from studies of avian phylogeny. *The Auk* 105:773-776.

Howie, F.M. 1992 The Care and Conservation of Geological Material. Minerals, Rocks and Lunar Finds. Butterworths

Howie, F.M.P (1992) Natural Science Collections: Extent and Scope of Problem in Vol. 3. Current Initiatives and Future Directions for the Preservation and Conservation of Natural History Collections. eds. Rose, C.L., Williams, S.L., and Gisbert, J. International Symposium and First World Congress on the Prservation and Conservation of Natural History Collections, Madrid 1992. Pub. 1993 .

Howie, F.M.P. (1984) Materials used for conserving fossils since 1930: a review. In Brommelle et al (Eds), Preprints IIC Congress Adhesives and Consolidants. IIC, London.

Howie, F.M.P. (1986) Conserving and Mounting Fossils - a historical review. Curator, 29, 5-24.

Howie, F.M.P. (1995) Aspects of Conservation of fossil resins and lignitic material p 47 - 52 in Collins, C. The Care and Conservation of Palaeontological Material. Butterworth-Heinemann, London.

Howie, F.M.P. 1977. Pyrite and Conservation. Newsletter of the Geological Curator's Group, 1. pp. 457 - 65.

Howie, F.M.P. 1979. Storage Environment and the conservation of geological material. Conservator 2. pp. 13 -19.

Howie, F.M.P. 1984. Conservation and storage: geological material. In Thompson, J. (ed.), Manual of Curatorship. Toronto. pp. 308-318.

Howie, F.M.P.(1985) in Guidelines for the curation of geological materials, Brunton, H., Besterman, T. and Cooper, J. Geol. Soc. Misc.paper.no. 17.

Howie. 1979. Museum climatology and the conservation of palaeontological material. Spec. Papers in Palaeontology No. 22, pp. 103 - 125

<http://www.abctaxa.be/volumes/volume-8-manual-atbi/volumes/volume-8-manual-atbi/chapter-22/chapter_22.pdf>

<http://www.abctaxa.be/volumes/volume-8-manual-atbi/volumes/volume-8-manual-atbi/Part1_low_resolution.pdf>

<http://www.hornemann-institut.de/doi/44.php>

http://www.zoogene.org/main/sample\_preservation\_protocol.html

Hughes, G. and J. Cosgrove. “pH Change in a Formalin Borax Solution with Inferences about Uses of Neutralized Formalin in Vertebrate Collections.” *Collection Forum* 6, no. 1 (1990): 21-26.

Hughes, G.W. and J.A. Cosgrove. 1990. pH change in a formalin borax solution with inferences about uses of neutralized formalin in vertebrate collections. *Collection Forum* 6(1):21-26.

Hughey, J.R., P.C. Silva, and M.H. Hommersand. 2001. Solving taxonomic and nomenclatural problems in Pacific gigartinaceae (Rhodophyta) using DNA from type material. *Journal of Phycology* 37:1091-1109.

Impraim, C.C., R.K. Saiki, H.A. Erlich, and R.L. Teplitz. 1987. Analysis of DNA extracted from formalin-fixed, paraffin-embedded tissues by enzymatic amplifications and hybridization with sequence-specific oligonucleotides. *Biochemical and Biophysical Research Communications* 142(3):710-716.

Insect Collection News. N.8.Nov 1992. Reports from ECN meeting Reno 1992. (This issue contains brief information about research done on materials used in biological curation and also contact details of some of the people involved.)

Irvin, A., J. Cooper, and S. Hedges. “Possible Health Hazards Associated with the Collection and Handling of Post-Mortem Zoological Material.” *Mammal Review* 2, no. 2 (1972): 43-54.

Jackson, V. 1978. Studies on histone organization in the nucleosome using formaldehyde as a reversible cross-linking agent. *Cell* 15(3):945-954.

Jeppesen PC 1988. Use of vacuum in rehydration of biological tissues with review of liquids used. Crustaceana, 55(3) : 268-273

Johnson, E. 1985. Current developments in bone technology. In M.B. Schiffer (ed.), Advances in Archaeological Method and Theory, Vol.8. Academic Press.

Jones, M.L. 2001. To fix, to harden, to preserve—Fixation: a brief history. *Journal of Histotechnology* 24(3):155-162.

Judah EL (1913) Personal modifications in the technique of Kaiserling method for colour preservation. Bull Int Ass med Mus 1922 VIII 62-64.

Kaiserling C. 1896. Ueber die Conservirung van Sammlungspräparaten mit Erhaltung der natürlichen Farben [About the Preservation of Collection Specimens to Maintain the Natural Colours]. *Berliner Klinische Wochenschrift. 33(35): 775-777.*

Keene, S. 1991. Audits of care: a framework for collections condition surveys. *Storage. Preprints for UKIC conference, Restoration ‘91. London, U.K. 6-16pp.*

Kigawa, R., H. Nochide, H. Kimura, and S. Miura. “Effects of Various Fumigants, Thermal Methods, and Carbon Dioxide Treatment on DNA Extraction and Amplification: A Case Study on Freeze-Dried Mushroom and Freeze-Dried Muscle Specimens. *Collection Forum* 18, nos. 1-2 (2003): 74-89.

Kilpatrick, C. W. 2002. Noncryogenic preservation of mammalian tissues for DNA extraction: An assessment of storage methods. Biochemical Genetics, 40: 53-62.

King V.T.(1982) The care and starving of deliquescent minerals. Rocks Miner., 57, 245.

King, R..J. (1983) The care of minerals. section 3A:The curation of minerals. J. Russell Soc., 1, 94-114

Klanton, S.O., L. van Herwerden, and J.H. Choat. 2003. Acquiring reef fish DNA sequences from formalin-fixed museum specimens. *Bulletin of Marine Science* 73(3):771-776.

Kolbe, G. (2004) Gelatin in historical paper production and as inhibiting agent for iron-gall ink corrosion on paper., *Restaurator,* **25,** 26-39.

Koob, S.P. 1984. The consolidation of archaeological bone. In N.S. Brommell, E.M. Pye, P. Smith and G. Thomson (eds.) Adhesives and Consolidants. Preprints of the contributions to the Paris Congress, 2-8 September 1984. London: The International Institute for Conservation of Historic and Artistic Works. pp. 98-102.

Koob, S.P. Unpublished dissertation

Koshiba, M., K. Ogawa, S. Hamazaki, T. Sugiyama, O. Ogawa, & T. Kitajima. (1993). The effects of formalin fixation on DNA and the extraction of high-molecular-weight DNA from fixed and embedded tissues. Pathology Research and Practice. 189, 66-72.

Kotrba, M., and K. Golbig. 2009. A new approach to stabilize the pH in fluid-preserved natural history collections. *Collection Forum* 23(1-2):18-22.

Krahn, Ann Howatt. “Conservation: Skin and Native-Tanned Leather.” *American Indian Art Magazine* (Spring), 1987.

Krebs, J., M. Wilson, and J. Childs. “Rabies–Epidemiology, Prevention, and Future Research.” *Journal of Mammalogy* 76, no. 3 (1995): 681-694.

Kronkright, D. P. (1992) In *The Conservation of Artifacts made from Plant Materials*, Vol. 1 (Eds, Florian, M.-L., Kronkright, D. P. and Norton, R. E.) J. Paul Getty Trust, Princeton, pp. 166.

Kuch, U., M. Pfenniger, and A. Bahl. 1999. Laundry detergent effectively preserves amphibian and reptile blood and tissue for DNA isolation. Herpetological Review 30(2):80-82.

Lafontaine and Wood 1982 – stabilization of ivory against relative humidity fluctuations. Studies n Conservation 27(3):109-117

Lambert, M. (1994) Ionising radiation associated with the mineral collection of the National Museum of Wales. Collection Forum, Fall 1994. Vol 10. No. 2.

Lawrence, George H. M. 1958. Field and Herbarium Techniques. Chapter XI (pp. 234-262) in: Taxonomy of Vascular Plants. The MacMillan Co., New York, NY. Leenhouts, P. W. 1968. A Guide to the Practice of Herbarium Taxonomy. Regnum Vegetabile 58. IAPT, Utrecht, Netherlands. 60 pp.

Layne, S. *The Cultural Property Protection Manual*. Denver: Layne Consultants International, 2002.

Leal-Klevezas, D.S., I.O. Martínez-Vázquez, B. Cuevas-Hernández, and J.P. Martínez-Soriano. 2000. Antifreeze solution improves DNA recovery by preserving the integrity of pathogen-infected blood and other tissues. *Clinical and Diagnostic Laboratory Immunology* 7(6):945-946.

Levi, Herbert W., 1966 : The Care of Alcoholic Collections of Small Invertebrates. Systematic Zoology **15**, 183-388.

Linnie, J. M. (1990) Pest Control in Museums - the use of chemicals and associated health problems., *International Journal of Museum Management and Curatorship,* **9,** 419-433.

Linnie, M. “Use of a Low-Oxygen Atmosphere for the Control of Insect Pests.” *Collection Forum* 14, no. 1 (2000): 57-65.

Linnie, M. J. (1994) Pest Control in Natural History Museums; a world survey., *Journal of Biological Curation,* **1,** 43-58.

Linnie, M. L. (1987) Pest Control: A Survey of Natural History Museums in Great Britain and Ireland in The International Journal of Museum Management and Curatorship (1987), 6,277-290

Lohrer, F. “Magnetic Label Holders for Metal Storage Equipment – System No. 1. and System No. 2.” In *Storage* of Natural History Collections: Ideas and Practical Solutions, edited by C. Rose and A. de Torres, 261-264.Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Makos, K. (2001) Hazard identification and exposure assessment related to handling and use of contaminated collection materials and sacred objects., *Collection Forum,* **17,** 93-112.

Malik, K. (ed.). Technical Information for Culture Collections Curators in Developing Countries. Paris: UNESCO and World Federation of Culture Collections-Education Committee, 1992.

Mandrioli, M., F. Borsatti, and L. Mola. 2006. Factors affecting DNA preservation from museum-collected lepidopteran specimens. *Entomologica Experimentis et Applicata* 120:239-244.

Marking of Specimens Wood, Rose.” A note on Inks” SPNCH Newsletter 2 (1988): 1

Mary Peever, 1989. A Treatment for Bison Hornsheaths 32- 37 Collection Forum Spring, Vol 5. No.1

McCoy, C. “Packing Fluid-Preserved Herpetological Specimens for Shipment.” *Collection Forum* 9, no. 2 (1993): 70-75.

McGinley, R.J. 1993. Where’s the management in collections management: Planning for the improved care, greater use, and growth of collections. In *Current issues, initia­tives, and future directions for the preservation and conservation of natural history col­lections*. ed. C.L. Rose *et al*. Consejeria de Educación y Cultura, Comunidad de Madrid, Direccion General de Bellas Artes y Archivos, Ministerio de Cultura, Madrid. 309-338.

McLaren, S. and J. Braun (eds.). *GIS Applications in Mammalogy*. Norman: Oklahoma Museum of Natural History and The Carnegie Museum of Natural History, 1993.

McLaren, S., P. August, L. Carraway, P. Cato, W. Gannon, M. Lawrence, N. Slade, P. Sudman, R. Thorington, S.Williams, and S. Woodward. Documentation Standards for Automatic Data Processing in Mammalogy: Version *2.0*. American Society of Mammalogists, Committee on Information Retrieval, 1996.

Merritt, E. “Conditions on Outgoing Research Loans.” *Collection Forum* 8, no. 2 (1992): 78-82.

Merryman, H. *Cryobiology*. London: Academic Press, 1966.

Messenger, C. L. B., M.R. (1993) Freezing versus chemical fumigation as methods of insect pest control in herbaria: a response to Egenberg and Moe., *8th Annual Meeting of SPNHC***,** 47.

Metsger, Deborah A. and Sheila C. Byers, eds. 1999. Managing the modern herbarium : an inter-disciplinary approach. Contribution ... from the Centre for Biodiversity and Conservation Biology of the Royal Ontario Museum, no. 53. Society for the Preservation of Natural History Collections, Washington, DC, as a joint project with The Royal Ontario Museum, Centre for Biodiversity and Conservation Biology. xxii, 384 p.

Metzger, D. and S. Byers. Managing the Modern Herbarium: An Interdisciplinary Approach. Washington, D.C.: Society for the Preservation of Natural History Collections and The Royal Ontario Museum, Centre for Biodiversity and Conservation Biology, 1999.

Metzger, D. and S. Byers. Managing the Modern Herbarium: An Interdisciplinary Approach. Washington, D.C.: Society for the Preservation of Natural History Collections and The Royal Ontario Museum, Centre for Biodiversity and Conservation Biology, 1999.

Michalski, S, M. MacDonald, T. Strang, J. Tétreault, and R. Williams. 1992. *A Systematic Approach to the Conservation (Care) of Museum Collections, with Technical Appendices. Ottawa: Canadian Conservation Institute.*

Michalski, S. (2002) Double the life for each five-degree drop, more than double the life for each halving of relative humidity, *ICOM Committee for Conservation 13th Triennial Meeting,* **1,** 66-72.

Michalski, S. 1990. An overall framework for preventive conservation and remedial conservation. The American Institute for Conservation of Historic and Artistic Works: preprints of papers presented at the annual meeting. pp. 589-591.

Michalski, S. 1994 A systematic approach to preservation: Description and integration with other museum activities. *Preprints of the 15th International Congress*. Interna­tional Institute for Conservation of Historic and Artistic Works. 8-11.

Miles, C. (1986). Wood coatings for display and storage cases. Studies in Conservation 31:114-124.

[Miles, G. 1988. Conservation and collection management: Integration or isolation Original Research Article. International Journal of Museum Management and Curatorship. Volume 7, Issue 2, June 1988, Pages 159–163](http://www.sciencedirect.com/science/article/pii/0260477988900209)

Miller, E. (ed.). Museum Collections: Their Roles and Future in Biological Research. Occasional Papers Series No. 25. Victoria: British Columbia Provincial Museum, 1985.

Mills, J., T. Yates, J. Childs, R. Parmenter, T. Ksiazek, P. Rollin, and C. Peters. “Guidelines For Working With Rodents Potentially Infected with Hantavirus.” *Journal of Mammalogy*, 76, no 3 (1995): 716-722.

Mills, J.S. White, R. 1994. The Organic chemistry of museum objects. Butterworth-Heinemann 2nd Ed.

[MLA, 2002 Benchmarks in Collection Care for Museums, Archives and Libraries http://www.mla.gov.uk/resources/assets//B/benchmarks\_pdf\_6849.pdf](http://www.mla.gov.uk/resources/assets/B/benchmarks_pdf_6849.pdf)

MLA, 2003 Registration Scheme for Museums and Galleries: Registration Standard - draft for consultation. http://www.mla.gov.uk/resources/assets//M/musregstd\_drft\_eng\_pdf\_6803.pdf

Monk, R. Bar Code Use in the Mammal Collection at the Museum of Texas Tech University. Museology 8. Lubbock: Texas Tech University Press, 1998*.*

Moore, S. 2009. Adhesives for fluid-preserved specimens. *NatSCA News* 16:32-35.

Moore, S.J., 1990 : Investigation into the state of preservation of the E.T. Browne collection of hydromedusae. J. Mar. Biol. Ass. UK (1990) **70**, 477-480

Morth, A.H. and Smith, E.E. 1970. Kinetics of Sulfide to sulphate reaction. American Chemical Society Division of Fuel Chemistry, 10 (1), 83 - 92.

*Museum Management and Curatorship*, *Volume 12, Issue 3*, *September 1993*, *Pages 319-321*

Museums and Galleries Commission. *Standards in the Museum Care of Archaeological Collections*. 1992. Relative humidity and temperature for display and storage of archaeological materials, p. 57; Maximum levels of illuminance and ultraviolet radiation for archaeological materials, p. 58; Relative humidity and temperature for storage of archaeological records, p. 59. Note: this publication acknowledges the need for case-by-case analysis and debate about acceptable levels for storage of archaeological records.

Museums and Galleries Commission. Standards in the Museum Care of Biological Collections. 1992.

Museums and Galleries Commission. 1992. Standards in the Care of Museum Geological Collections. Museums and Galleries Commission, London.

Nassau, K. (1983). The Physics and chemistry of colour. John Wiley and Sons. NY.

Nathanson, David, and Diane Vogt-O’Connor. “Care and Security of Rare Books.” *Conserve O Gram* 19/2. Washington, DC: National Park Service, Curatorial Services Division, 1993.

National Park Service. *Conserve O Gram* series. Washington, D.C.: National Park Service. Available at <http://www.cr.nps.gov/museum/publications/conserveogram/conserv.html >.

National Research Council Committee on Hazardous Biological Substances in the Laboratory. *Biosafety in the* Laboratory: Prudent Practices for Handling and Disposal of Infectious Materials. Washington, D.C.: NationalAcademy of Sciences, 1989.

Netherlands Ministry of Welfare, Health and Cultural Affairs 1992a. *Deltaplan, Preser­vation of cultural heritage in the Netherlands*.

Netherlands Ministry of Welfare, Health and Cultural Affairs 1992b. Deltaplan for the preservation of cultural heritage in the Netherlands. Fact Sheet C-11-E-1992.

Nevling, Lorin I., Jr. 1973. Report of the Committee for Recommendations in Desirable Procedures in Herbarium Practice and Ethics. II. Brittonia 25(3): 307-310.

Norton, R. (1990) Technology of Plant Material used in Artefacts in Mary- Lou Florian, Kronkright, D. P. & Norton, R.E. The Conservation of Objects Made From Plant Material. Los Angeles: Getty Conservation Institute pg: 97-99

Norton, R. E. (1996) A Case History of Managing Outbreaks of Webbing Clothes Moth (*Tineola bisselliella*) in ICOM committee for conservation, 11th triennial meeting in Edinburgh, Scotland, 1-6 September 1996: Preprints Vol. I pg: 61- 67

Nudds, J. and C. Pettitt (eds.). The Value and Valuation of Natural Science Collections. Proceedings of the International Conference, Manchester, 1995. London: The Geological Society, 1997.

Nuovo, G.J., and R.M. Richart. 1989. Buffered formalin is the superior fixative for the detection of HPV DNA by *In Situ* hybridization analysis. *American Journal of Pathology* 134(4):807-842.

Nuovo, G.J., and S.J. Silverstein. 1988. Comparison of formalin, buffered formalin, and Bouin’s fixation on the detection of human papillomavirus deoxyribonucleic acid from genital lesions. *Laboratory Investigation* 59(5):720-724.

O'Connor, T. P. (1987). On the structure, chemistry and decay antler, and ivory. Proceedings of a conference held by the United Kingdom Institute for Conservation, Archaeology Section. pp. 6-8.

Odegaard, N., Sadongei, A. and & associates (2005) *Old Poisons, New Problems: a museum resource for managing contaminated cultural materials,* AltaMira Press, Oxford.

Oyarzun, R., Higueras, P., Esbrí, J. M. and Pizarro, J. (2007) Mercury in air and plant specimens in herbaria: a pilot study at the MAF Herbarium in Madrid Spain, *Science of the Total Environment,* **387,** 346-352.

Padfield, T., D. Erhardt, and W. Hopwood. 1982. Trouble in store. In Brommelle, N. S., and G. Thomson (eds.), Science and technology in the service of conservation. Preprints of the Contributions to the Washington Congress, 3-9 September 1982. London: The International Institute for Conservation of Artistic and Historic Works. pp. 19-23.

Palero, F et al. 2010. DNA extraction from formalin fixed tissue: new light from the deep sea. Scientia Marina, 74(3) 465-470.

Pandey, V. N. and Srivastava, A. K. (1995) Prevention of Fungal Damage to our Cultural Heritage of Wood and Leather by Volatile Constituents of Higher Plants, *Biodeterioration of Cultural Property 3,* **1,** 542-547.

Parker T. A. (1988) Study on integrated pest management for libraries and archives London: Diana

Parsons, A.L. (1922) The preservation of mineral specimens.

PAS 197:2009, Code of practice for cultural collections management

PAS 198:2012 Specification for managing environmental conditions for cultural collections. BSI 2012

PD 5454:2012, Guide for the storage and exhibition of archival materials (PD 5454:2012 superseded BS 5454:2000, Recommendations for the storage and exhibition of archival documents and PD 0024:2001, Archival documents – Guide to the interpretation of BS 5454:2000)

Peigler, R. “Shipping of Pinned Insects .” *Collection Forum* 8, no. 2 (1992): 73-77.

Pequignot, A., Tumosa, C.S. and von Endt, D.W. 2006. The effects of tanning and fixing processes on the properties of taxidermy skins. *Collection Forum* 2006; 21(1-2): 133-142.

Pinniger, D. & Winson, P. (2001a) Integrated Pest Management: Practical, Safe and Cost- Effective Advice on the Prevention and Control of Pests in Museum Tokyo Tokyo: National Research Institute of Cultural Properties

Pinniger, D. (1994) *Insect Pests in Museums,* Archetype, London.

Pinniger, D. (2001b) New Pests for Old: The Changing Statues of Museum Insect Pests in the UK in Helen Kingsley, Integrated Pest Management for Collections London: James & James pg: 9-13

Pinniger, D. (2001c) Pest Management in Museums, Archives & Historic Houses London: Archetype

Pinniger, D. “Controlling Insect Pests: Alternatives to Pesticides.” *Conserve O Gram* 3/8. Washington, D.C.: National Park Service, 1998.

Pinniger, D. Insect pests in Museums. Archetype publications. 1989

Poole, M. “Preliminary Analysis of the Effects of Cold Storage on Fur Garments and Mammal Skins.” *Collection Forum* 13, no. 1 (1997): 25-39.

Prendini, L. et al. 2002. Obtaining, storing and archiving specimens and tissue samples for use in molecular studies. In: Techniques in Molecular Systematics and Evolution. DeSalle, R., Giribet, G and W. Wheeler Eds. Springer Press.

Pritchard, M. and G. Kruse (comps.). *The Collection and Preservation of Animal Parasites*. Lincoln: University of Nebraska Press, 1982.

Pritchard, Mary Hanson, and Gunther Kruse, compilers. The Collection and Preservation of Animals Parasites, The Harold W.Manter Laboratory Technical Bulletin No1 Lincoln and London: University of Nebraska Press, 1982.

Purewal, V. (1994) Collection's Condition Survey of Herbarium and Non-herbarium material in the National Museum of Wales Botany Storerooms., *Conservation and the Herbarium***,** 19-28.

Purewal, V. “An Investigation into the Composition of Botanical Wax Models with a View to Their Conservation.” *Collection Forum* 13, no. 1 (1997): 11-19.

Purewal, V. “The Identification of Hazardous Pesticide and Fungicide Residues on Herbarium Material.” *SSCR Journal* 10, no. 4 (1999): 5-9.

Purewal, V., Colston, B. and Röhrs, S. (2008) Developing a simple screening method for the identification of historic biocide residues on herbarium material in museum collections, *X-Ray Spectrometry,* **37,** 137-141.

Raphael, Toby, and Ellen McCrady. “Leather Dressing: To Dress or Not To Dress.” *Conserve O Gram* 9/1. Washington, DC: National Park Service, Curatorial Services Division, 1993.

*Raphael, Toby, and Ellen McCrady. Ethnographic Skin and Leather Products: A Call for Conservative Treatment. Published* Proceedings of Symposium ‘86: The Care and Preservation of Ethnological Materials. Ottawa, Canada: Canadian Conservation Institute, 1986.

Raphael, Toby. “An Insect Pest Control Procedure: The Freezing Process.” *Conserve O Gram* 3/6. Washington, DC: National Park Service, Curatorial Services Division, 1994.

Raphael, Toby. “Preventive Conservation Recommendations for Organic Objects.” *Conserve O Gram* 1/3. Washington, DC: National Park Service, Curatorial Services Division, 1993.

Ratcliffe, B. and C. Messenger. “Vial Support System for Fluid Collections.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 21-214. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Reed, R. *Ancient Skins, Parchments and Leathers*. London: Seminar Press, 1972.

Richmond, J., and R. McKinney (eds.). *Biosafety in Microbiological and Biomedical Laboratories*. 4th rev. ed. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, and National Institutes of Health, 1999. Available on the web at: <http://www.cdc.gov/od/ohs/biosfty/biosfty.htm>.

Ritchie J. 1924. Preservation of Zoological specimens in Fluid to preserve their natural colour. Museum J 1924 23 191-193.

Rixon, A., 1976 Fossil Animal Remains - Their Preparation and Conservation, Athlone Press.

Robilliard GA(1969) a method of colour preservation in opiesthobranch molluscs Veliger 1969 11 289.

Rogers, B.B., L.C. Alpert, E.A.S. Hine, and G.J. Buffone. 1990. Analysis of DNA in fresh and fixed tissue by the polymerase chain reaction. *American Journal of Pathology* 136(3):541-548.

Rogers, B.B., L.C. Alpert, E.A.S. Hine, and G.J. Buffone. 1990. Analysis of DNA in fresh and fixed tissue by the polymerase chain reaction. *American Journal of Pathology* 136(3):541-548.

Rogers, S., M. Schmidt, and T Gütebier. An Annotated Bibliography on Preparation, Taxidermy and Collection *Management of Vertebrates with Emphasis on Birds*. Special Publication No. 15. Pittsburgh: Carnegie Museum of Natural History, 1989.

Rohdenburg GL (1930) The preservation of specimens in colour. Science NY 1930 71 134-135.

Rollins, Reed C. 1955. The Archer method for mounting herbarium specimens. *Rhodora* 57: 294-299.

Rose, C. L., and A. R. de Torres (eds.). Storage of Natural History Collections: Ideas and Practical Solutions. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Rose, C., C. Hawks, and H. Genoways (eds.). Storage of Natural History Collections: A Preventive Conservation *Approach*. Washington, D.C.: Society for the Preservation of Natural History Collections, 1995.

Rose, C., S. Williams, and J. Gisbert. (eds.). Current Issues, Initiatives, and Future Directions for the Preservation *and Conservation of Natural History Collections*. Vol. 3 in Proceedings of the International Symposium and First World Congress on the Preservation and Conservation of Natural History Collections, Madrid, 10-15 May 1992. Madrid: Consejería de Educación y Cultura, Comunidad de Madrid, y Dirección General de Bellas Artes y Archivos, Ministerior de Cultura, 1993.

Rose, C.L., and de Torres, A.R. (eds) 1992. Storage of Natural History Collections: Ideas and Practical Solutions. Society for the Preservation of Natural History Collections.

Rose, C.L., Hawks, C.A. and Genoways, H.H. (eds) 1995. Storage of Natural History Collections: A Preventive Conservation Approach. Volume 1. Society for the Preservation of Natural History Collections.

Russ, J.L., C.J. Kolman, S.L. Jewett, and N. Tuross. 1997. The whites of their eyes: criteria for selection of fluid stored fish for molecular studies. Poster abstract, annual meeting of the Society for the Preservation of Natural History Collections, University of Wisconsin-Madison, 8-13 July 1997.

Ruysch, F 1710. Thesaurus Animalium. Amsterdam.

S.B. Hanna, The use of organo-silanes for the treatment of limestone in an advance state of deterioration. 171 - 176 In Adhesives and Consolidants, preprints, IIC meeting Paris, 1984

Sambrook J, Firitsch E.F. and Maniatis T (1989) Molecular cloning. 2nd edition Cold Spring Harbor Laboratory Press, Cold Spring harbour, NY.

Samyn, Y., et al : Sea cucumber preservation for taxonomic identification in : Advances in sea cucumber aquaculture and management FAO Fisheries Technical Paper 463, Ed. Lovatelli, A. http://www.fao.org/docrep/007/y5501e/y5501e1c.htm#bm48

Saunders, D. (1997) Lighting for Conservation, *National Museum Practice,* **6,** 42-45.

Savile, D. B. O. (Ed.) (1962) *Collection and Care of Botanical Specimens,* Research Branch, Canada Department of Agriculture, Ottawa.

Scott, N. and A. Aquino-Shuster. “The Effects of Freezing on Formalin Preservation of Specimens of Frogs and Snakes.” *Collection Forum* 5, no. 2 (1989): 41-46.

Sendall, K. and G.W. Hughes. 1996. Correcting alcohol concentrations. *Society for the Preservation of Natural History Collections Newsletter* 11(1):6-7.

Seutin, G., B.N. White and P.T. Boag. 1991. Preservation of avian blood and tissue samples for DNA analysis. *Canadian Journal of Zoology* 69:82-90.

Shchepanek, M. “Observations of Temperature and Relative Humidity During the Cooling and Warming of Botanical Specimens for Insect Pest Control.” *Collection Forum* 12, no. 1 (1996): 1-7.

Shedlock AM, Haygood MG, Pietsch TW and Bentzen P 1997: Enhanced DNA extraction and PCR amplification of mitochondrial genes from fomalin fixed museum specimens. Biotechniques 22(3) : 394-400

Shetler, S. G. 1969. The Herbarium: Past, Present, and Future. Proc. Biol. Soc. Wash. 82: 687-758.

Simione, F. “Storage in Standards and Ultra-Cold Freezers: Living Biological Specimens.” In *Storage of Natural* History Collections: A Preventive Conservation Approach, edited by C. Rose, C. Hawks, and H. Genoways,157-186. Washington, D.C.: Society for the Preservation of Natural History Collections, 1995.

Simione, F. “Storage of Living Cells in Culture.” In Storage of Natural History Collections: Ideas and Practical *Solutions*, edited by C. Rose and A. de Torres, 273-274. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Simmons, J. *Herpetological Collecting and Collections Management*. Herpetological Circular No. 16. Tyler, Texas: Society for the Study of Amphibians and Reptiles, 1987.

Simmons, J. Herpetological Collecting and Collections Management. Herpetological Circulars No. 31. Rev. ed. Marceline, MO: Society for the Study of Amphibians and Reptiles, 2002.

Simmons, J.“Storage in Fluid Preservatives.” In Storage of Natural History Collections: Ideas and Practical Solutions, edited by C. Rose and A. de Torres, 161-186. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Simmons, J.“Vial Supports for Cleared and Stained Specimens.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 215-216. Washington, D.C.: Society for the Preservation of Natural History Collections, 1992.

Simmons, J.E. 2002. *Herpetological Collecting and Collections Management*. Revised edition. Society for the Study of Amphibians and Reptiles Herpetological Circular 3, vi + 153 pages.

clip_image002.gif

Singh, J. (2001) Insect Pests in Historic Buildings: Misunderstood, Misdiagnosed and Mistreated in Helen Kingsley, Integrated Pest Management for Collections London: James & James pg: 5-8

Sirois Jane P and Snasoucy Genevieve. Analaysis of Museum Objects for Hazardous Pesticide Residues: A Guide to Techniques. Collection Forum 2001; 17(1-2): 49-66.

Snyder, A. (comp.). 1994. Proceedings of the 1993 ASIH Workshop on Collections Care and Management Issues in *Herpetology and Ichthyology*. American Society of Ichthyologists and Herpetologists. 51 pp. [2] + 20 pp.

Snyder, A. (comp.). Proceedings of the 1992 ASIH Workshop on Collections Care and Management Issues in *Herpetology and Ichthyology*. American Society of Ichthyologists and Herpetologists, 1993.

Society for the Preservation of Natural History Collections. “Guidelines for the Care of Natural History Collections.” *Collection Forum* 10, no. 1 (1994): 32-40.

Sorby HC (1908). On the preservation of marine animals in their natural colours. Museums J 1908 7 223-227

Spears, R. A., Purewal, V. and Thompson, J. P. (2007) Exposure to heavy metals from herbarium specimens in the National Museum of Wales (NMW), Cardiff., *XXVII International Congress of the European Association of Poisons Centres and Clinical Toxicologists***,** 1.

SPNHC. Guidelines for the care of Natural History Collections 32 - 40 - Collection Forum Spring 1994 vol 10, no.1

*Stambolov, T. Manufacture, Deterioration and Preservation of Leather: A Literature Survey of Theoretical Aspects and Ancient Techniques*. Amsterdam: ICOM, Central Research Laboratory, 1969.

Staniforth, S. 1994. Light and environmental measurement and control in National Trust houses. In Knell, S. (ed) *Care of Collections*. London: Routledge. 117-122.

Stansfield, G. (1984) Conservation and storage: biological collections, *Journal of Conservators***,** 289-294.

Stansfield, G., J. Mathias, and G. Reid. *Manual of Natural History Curatorship*. London: HMSO, 1994.

Starling, K. and Watkinson, D. (eds. ) Archaeological Bone, Antler and Ivory. UKIC, Occ. Paper., 5, 6-8.

Steedman, H. (ed.). *Zooplankton Preservation and Fixation*. Monographs on Oceanographic Methodology 4. Paris: The UNESCO Press, 1976.

Steedman, H.F. (editor). *Zooplankton Fixation and Preservation*. Monographs on Oceanographic Methodology 4. The Unesco Press, Paris, 350 pages.

Steedman, H.F., 1976 : Zooplankton fixation and preservation. Paris : the Unesco Press. 350 pp.

Steedman,H.F. (ed) 1976. Zooplankton fixation and preservation . Paris Unesco Press. Monographs on oceanographic methodology 4.

Steigerwald, M. and S. Laframboise. 1996. Tape application: a jar sealing method for reducing ethanol evaporation in fluid-preserved collections. *Collection Forum* 12(2):45-54.

Steinmann W (1972) Uber die Fixierung un Konservierung in Flussigheit. Colour presertvation in general) Praparator 1972 1/2/ 3-18

Steinmann, W. 1972. Über die Fixierung und Konservierung in Flüssigkeit [About the Fixation and Preservation in Fluid]. *Der Präparator* 18:3-18

Stephenson, A.B., and Riley, J.L., 1995 : Fixation and preservation of museum marine collections using formaldehyde/glutaraldehyde mixes. Collection Forum, **11**, 39-45

Stoddard, D. “Fixatives and Preservatives: Their Effects on Tissue.” In *Conservation of Natural History Specimens: Spirit Collections*, 1-25. Manchester: Manchester Museum and Department of Environmental Biology, University of Manchester, 1989.

Storch, Paul (Editor). *Leather Conservation News*. Objects Conservation Laboratory, Minnesota History Center, 345 Kellogg Boulevard, West St. Paul, MN 55102-1906.

Strang, T. “A Review of Published Temperatures for the Control of Pest Insects in Museums.” *Collection Forum* 8, no. 2 (1992): 41-67.

Strang, T. “Detecting Infestations: Facility Inspection Procedure and Checklist.” *CCI Notes* 3/2. Ottawa: Canadian Conservation Institute, 1996.

Strang, T.. “Controlling Insect Pests with Low temperature.” *CCI Notes* 3/3. Ottawa: Canadian Conservation Institute, 1997.

Strang, T.“The Effect of Thermal Methods of Pest Control on Museum Collections.” In *Biodeterioration of Cultural Property 3*. Edited by C. Aranyanak and C. Shinghasiri, 334-353. Proceedings of the 3rd InternationalConference on Biodeterioration of Cultural Property, 4-7 July 1995, Bangkok, Thailand. Bangkok: Thammasat University Press.

Strang, T.J.K A review of published temperature for the control of pest insects in Museums

Strlic, M., Kolar, J. and Rychly, J. (2002) Paper conservation chemistry: a review of chemiluminescence studies of cellulose stability, *Conservation Science***,** 182-187.

Stuart, B.L., K.A. Dugan, M.W. Allard, and M. Kearney. 2006. Extraction of nuclear DNA from bone of skeletonised and fluid-preserved museum specimens. *Systematics and Biodiversity* 4(2):133-136.

Stuart, J. “Observations on Formalin-Induced Darkening of Herpetological Specimens.” *Collection Forum* 11, no. 2 (1995): 39-45.

Sullivan, Brigid and Donald R. Cumberland, Jr. “Use of Acryloid B-72 for Labeling Museum Objects.” *Conserve O Gram* ¼. Washington, DC: National Park Service, Curatorial Services Division, 1993.

Suzumoto, A. “Storage Containers for Fluid-Preserved Specimens.” In *Storage of Natural History Collections: Ideas and Practical Solutions*, edited by C. Rose and A. de Torres, 217-220. Washington, D.C.: Society for thePreservation of Natural History Collections, 1992.

Swen C. Renner & Dirk Neumann & Michael Burkart & Ute Feit & Peter Giere & Andreas Gröger & Axel Paulsch & Cornelia Paulsch & Mario Sterz & Katrin Vohland. 2012. Import and export of biological samples from tropical countries–considerations and guidelines for research teams. Organisms Diversity Evolution 12 (1) / DOI 10.1007/s13127-012-0076-4.

[Swen C. Renner, Iris Heynen, Dirk Neumann, Ute Feit, Peter Giere, Christoph Häuser, Axel Paulsch, Cornelia Paulsch, Mario Sterz & Katrin Vohland. 2012. Im- und Export ornithologischer Proben aus den Tropen. Vogelwarte 50, 2012: 21 – 36. http://www.do-g.de/fileadmin/do-g\_dokumente/Vogelwarte\_50\_2012-1.pdf](http://www.do-g.de/fileadmin/do-g_dokumente/Vogelwarte_50_2012-1.pdf)

Taylor WR 1977. Observations on specimen fixation. Proc.Biol.Soc.Wahsington, 90: 753-763.

Tello, H., Jelen, E. and Unger, A. (2005a) Decontamination of Ethnological Collections using Supercritical Carbon Dioxide., *ICOM Committee for Consevation,* **1,** 110-119.

Tennent, N. and T. Baird. “The Deterioration of Mollusca Collections: Identification of Shell Efflorescence.” *Studies in Conservation 30 (1985): 73-85.*

Tennent, N.H. and Baird, T. (1985) The deterioration of mollusca collections: identification of shell efflorescence. Stud. Cons. 30 pp. 73 - 85.

Tétrault, J. 1991. Materials for exhibit, storage and packing. CCI Thesis

Thompson, J.M.A. 1994. *Manual of Curatorship: A Guide to Museum Practice*, 2nd edition. Museums Association. Oxford: Butterworth-Heinemann Ltd.

Thomson, G. (1986) *The Museum Environment, 2nd edn.* Butterworths & Co., London.

Toyama K and Miyoshi G (1963) Prevention of fading of aquatic animals under preservation I. Test on preservatives to retain red colour in fish and crustacean specimens. J Tokyo Univ Fish 1963 50 43-49.

Tsuda, Roy T. and Isabella A. Abbott. 1985. *Collection, handling, preservation and logistics,* pp. 67-68. In: Littler, M.M. and Littler, D.S. (eds.), *Ecological Field Methods: Macroalgae. Handbook of Phycological Methods.* Cambridge Univ. Press, New York, 617 pp.

Upton, M. “Aqueous Gum-Chloral Slide Mounting Media: An Historical Review.” *Bulletin of Entomological Research* 83 (1993): 267-274.

Vachot AM and Monnerot 1996: Extraction, amplification and sequencing of DNA from formaldehyde-fixed specimens. Ancient Biomolecules 1: 3-16.

van Cleave HJ and Ross JA 1947. A method for reclaiming dried zoological specimens. Science NY, 105: 318.

van Dam JA. DMDM-Hydantoin: The promising result of a search for an alternative in fluid preservation of biological specimens. Collection Forum 2003; 18(1-2):104-115

van Dam, A “The Interactions of Preservative Fluid, Specimen Container, and Sealant in a Fluid Collection.” *Collection Forum* 14, no 1 (2000): 78-92.

van Dam, A. “DMDN-Hydantoin: The Promising Result of a Search for an Alternative in Fluid Preservation of Biological Specimens.” *Collection Forum* 18, nos. 1-2 (2003): 104-115.

van Dam, A.J. 1997. Conservation of fluid preserved specimens, properties of sealants and their effect on preservation quality. *Bulletin of the European Association of Museums of the History of Medical Sciences* 23:22-28.

van Dam, A.J. 2000. The interactions of preservative fluid, specimen container, and sealant in a fluid collection. *Collection Forum* 14(1-2):78-92.

van Dam, A.J. 2004. Decision Making Model for the Conservation and Restoration of Fluid Preserved Specimens. *ICOM-CC Working Group Natural History Collections.* http://www.icom-cc.org/54/document/decision-making-model/?id=268#.UGrefa6yB8F

Verril AE (1865) Preservation of starfishes with natural colours of marine animals. Am J Sci 1865 39 228.

Verril AE (1870) Glycerine for preserving natural colours of marine animals Am Nat 1870 3 156

Vink, C.J., S.M. Thomas, P. Paquin, C.Y. Hayashi, and M. Hedin. 2005. The effects of preservatives and temperatures on arachnid DNA. *Invertebrate Systematics* 19:99-104.

Vink, C.J., S.M. Thomas, P. Paquin, C.Y. Hayashi, and M. Hedin. 2005. The effects of preservatives and temperatures on arachnid DNA. *Invertebrate Systematics* 19:99-104.

Von Endt, D. “Spirit Collections: A Preliminary Analysis of Some Organic Materials Found in the Storage Fluid of Mammals.” *Collection Forum* 10, no. 1 (1994): 10-19.

Von Endt, D., E Yourd, and P. Hare. “Spirit Collections: Accelerated Aging Studies Concerning the Stability of Keratin in Ethanol and Formalin.” *Collection Forum* 14, no. 1 (2000): 66-77.

Waddington, J. 1993. Floor loading considerations in a palaeontological collection. Collection Forum. Fall Vol9. No.2

Waddington, J. and D. Rudkin (eds.). Proceedings of the 1985 Workshop on the Care and Maintenance of Natural *History Collections*. Life Sciences Miscellaneous Publications. Toronto: Royal Ontario Museum, 1986.

Waddington, J. and J. Fenn. “Preventive Conservation of Amber: Some Preliminary Investigations.” *Collection Forum* 4, no. 2 (1988): 25-31.

Wagstaffe, R. and Fidler, J.H. 1968. *The Preservation of Natural History Specimens, volume 2(2), Vertebrates*. London: H. F. and G. Witherby Ltd

Waller R. 1980 The preservation of Mineral Specimens. Preprints 8th Annual meeting The American Institute of Conservation pp 116-127

Waller RA and Eschmeyer WN (1965) A method of preserving colour in aquatic vertebrates and invertebrates. Turtox News 1969 47 296-297

Waller, R. (1984). The prevention of Deliquescence, Efflorescence, and Hydration in Mineral Specimens. ICOM 7th triennial meeting Preprints Copenhagen 1984.

Waller, R. (1987) An experimental ammonia gas treatment method for oxidised pyritic mineral specimens. ICOM 8th triennial meeting Preprints Sydney 1987.

Waller, R. 1994. Risk management applied to preventive conservation. *Preprints of the 15th International Congress*. International Institute for Conservation of Historic and Artistic Works. 12-16.

Waller, R. 2003 Cultural Property Risk Analysis Model: Development & Application To Preventive Conservation At The Canadian Museum Of Nature (Goteborg Studies in Conservation).  Press Goteborgs Universitet Acta Univ  ISBN 9173464759

Waller, R. and D. McAllister. “A Spot Test for Distinguishing Formalin from Alcohol Solutions.” In *Proceedings* of the 1985 Workshop on the Care and Maintenance of Natural History Collections, edited by J. Waddingtonand D. Rudkin, 93-99. Life Sciences Miscellaneous Publications. Toronto: Royal Ontario Museum, 1986.

Waller, R. and D.E. McAllister. 1986. A spot test for distinguishing formalin from alcohol solutions. Pages. 93‑99 in Wadington, J. and D.M. Rudkin (eds.). *Proceedings of the 1985 Workshop on the Care and Maintenance of Natural History Collections*. Life Sciences Miscellaneous Publications, Royal Ontario Museum, v + 121 pages.

Waller, R. and J.E. Simmons. 2003. An exploratory assessment of the state of a fluid-preserved herpetological collection. *Collection Forum* 18(1-2):1-37.

Waller, R. and T. Strang. “Physical Chemical Properties of Preservative Solutions–I. Ethanol-Water Solutions.” *Collection Forum* 12, no. 2 (1996): 70-85.

Waller, R. Temperature and Humidity sensitive mineralogical and petrological specimens, in Howie 1992

Waller, R., and T.J.K. Strang. 1996. Physical chemical properties of preservative solutions--I. Ethanol-water solutions. *Collection Forum* 12(2):70-85.

Waller, Robert, and Thomas Strang. Physical Chemical Properties of Preservative Solutions-I. Ethanol-Water Solutions” Collection Forum 12(1996): 70-85

Warford, A., J.H. Pringle, J. Hay, S.D. Henderson, and I. Lauder. 1988. Southern blot analysis of DNA extracted from formol-saline fixed and paraffin wax embedded tissue. *Journal of Pathology* 154:313-320.

Waterer, John. A Guide to the Conservation and Restoration of Objects Made Wholly or in Part of Leather. New York, NY: Drake Publishers Inc., 1972.

Webber, W. B., Ernest, L. J. and Vangapandu, S. (2011) Mercury exposures in university herbarium collections, *Journal of Chemical Health and Safety,* **18,** 9-12.

White DA EJ Peters 1969. A method of preserving color in aqutic vertebrates and invertebrates. Turtox News, 47:296-297.

William, S.L. and Mclaren, 1990. S.B Modification of Storage Design to mitigate insect problems. Collection Forum. Spring Vol. 6 No. 1 p 27-32

Williams, R., J. Waddington, and J. Fenn. “Infrared Spectroscopic Analysis of Central and South American Amber Exposed to Air Pollutants, Biocides, Light, and Moisture.” *Collection Forum* 6, no. 2 (1990): 65-75.

Williams, S. “Investigation of the Causes of Structural Damage to Teeth in Natural History Collections.” *Collection Forum* 7, no. 1 (1991): 13-25.

Williams, S. and C. Hawks. “Deterioration of Bone and Ivory: An Annotated Bibliography.” *Natural History Conservation* 5 (1990): 25-27.

Williams, S. and C. Hawks. “History of Preparation Materials Used for Recent Mammal Specimens. In *Mammal Collection Manageme*nt, edited by H. Genoways, C. Jones, and O. Rossolimo , 21-48. Lubbock: Texas Tech UniversityPress, 1987.

Williams, S. and C. Hawks. “Arsenic in Natural History Collections.” *Leather Conservation News* 2, no. 2 (1986): 1-4.

Williams, S. and C. Hawks. “Inks for Documentation in Vertebrate Research Collections.” *Curator* 29, no. 2 (1986): 93-108.

Williams, S. and L. Brandstetter-Wolansky. “Examination of Macroscopic Particles from Dust Accumulations in Collection Storage Areas.” *Collection Forum* 18, nos. 1-2 (2003): 90-97.

Williams, S. and P. Cato. “Interaction of Research, Management, and Conservation for Serving the Long-Term Interests of Natural History Collections.” *Collection Forum* 11, no. 1 (1995): 16-27.

Williams, S. and S. McLaren. “Modification of Storage Design to Mitigate Insect Problems.” *Collection Forum* 6, no. 1 (1990): 27-32.

*Williams, S. Destructive Preservation: A Review of the Effect of Standard Preservation Practices on the Future Use of Natural History Collec*tions. Göteborg Studies in Conservation 6. Göteborg, Sweden: Acta UniversitatisGothoburgensis, 1999.

Williams, S. L., R. Laubach, and H. H. Genoways. 1977. *A Guide to the Management of Recent Mammal Collections*. Special Publication 4. Carnegie Museum of Natural History, Pittsburgh. 105 pp.

Williams, S.T. 2007. Safe and legal shipment of tissue samples: does it affect DNA quality? *Journal of Molluscan Studies* 73(4):416-418.

Wilson, D., F. Cole, J. Nichols, R. Rudran, and M. Foster (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals.* Washington, D.C.: Smithsonian Institution Press, 1996.

Womersley, J. S. (1981) Plant Collecting and Herbarium Development., *Food and Agriculture Organisation of the United Nations***,** 66-73.

Wood, R. and S. Williams. “An Evaluation of Disposable Pens for Permanent Museum Records.” *Curator* 36, no. 3. (1993): 189-200.

Woodward, S. and W. Hlywka. “A Database for Frozen Tissues and Karyotype Slides.” *Collection Forum* 9. no. 2 (1993): 76-83.

*Workplace Words Defined.* Society for the Preservation of Natural History Collections 381 pages

Yu, D. S. Klein, and D Reindl. “An Evaluation of Silica Gel for Humidity Control in Display Cases.” *WAAC (Western Area for Art Conservation) Newsletter 23, no 1 (2001): 14-19.*

Zimmerman, J et al. 2008. DNA damage in preserved specimens and tissue samples: a molecular assessment. Frontiers in Zoology, 5:18. Botanical Materials

Zycherman, L. and J. Schrock (eds.). *A Guide to Museum Pest Control*. Washington, D.C.: Foundation of the American Institute for Conservation and the Association of Systematics Collections, 1988.

**NMDC**

**Bizot**

**Pas 198**

**Pas 197**

**Approved on behalf of NHM**

at the Collections Committee meeting

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Position | Date | Signature |
| Chris Collins | Head of Conservation |  |  |
| Kevin Rellis | Head of Estates |  |  |
| Jane Smith | Head of Libraries |  |  |
| Alan Hart | Head of Collections, Earth Sciences |  |  |
| Clare Valentine | Head of Collections |  |  |
| PEG Representative |  |  |  |

Document Owners: CSIP Environmental Standards Group

Date for Review: 10.12.2013

1. It is recognised that the poor or non-existent control of the environment in Wandsworth and the Waterhouse building has meant that large sections of the NHM collections are stored in extreme environmental conditions ranging between 75 and 23% RH and 14 – 29 ⁰C. These figures not only fall well outside the CSIP standards, the (agreed) building parameters for the buildings, but also the NMDC and Bizot group standards.

   In Wandsworth, G1 and G2 store the taxidermy collections show shrinkage and tear damage due to long term exposure to fluctuating, raised or low relative humidity and pollution damage. The relative humidity regularly goes above 70% with consequent mould risk and mould eating insects have been found in the store. Many of the specimens have deteriorated to a point where they will require conservation work before future use but currently show minimal signs of on-going deterioration. [↑](#footnote-ref-1)
2. Bizot Group (International Group of Organizers of Large Scale Exhibitions) Frankfurt October 25-27. 2012, Appendix 7 [↑](#footnote-ref-2)
3. The document currently lacks data on energy costs for maintaining (low) temperatures at a recommended relative humidity or has been able to undertake cost benefit analysis on collection stability versus energy management . when these become available then a cost-benefit analysis of environmental conditions, energy costs and collection preservation will be undertaken [↑](#footnote-ref-3)
4. RH figures are absolute with no error factor [↑](#footnote-ref-4)
5. **The following caveats apply:** It is recognised that many existing cabinets in the museum have been contaminated by compounds used for pest control or from storage of specific minerals or fossils. These materials include paradichlorobenzene (PDB), Naphthalene, Mercuric Chloride, Mercury, Arsenic, Arsenic Trioxide. It is hoped that the museum will slowly remove contaminated cabinetry and replace it with a modern standard. Cabinetry will require treatment locally when a pest infestation is identified with chemicals approved by the Integrated Pest Management Group and will thus become contaminated through their lives. Certain cabinetry will produce an internal contaminant and will not meet the expected parameters for pollutants. This will be clearly marked in line with Health and safety legislation. [↑](#footnote-ref-5)
6. FIRE PRECAUTIONS - PERMANENT, TEMPORARY AND TRAVELLING EXHIBITION DESIGN NHM Fire Safety Note Guide MI06 [↑](#footnote-ref-6)
7. http://www.dacrylate.co.uk/Products/Wood/116Line.html [↑](#footnote-ref-7)
8. http://www.leyland-paints.co.uk/leylandtrade\_viewcolours.asp [↑](#footnote-ref-8)
9. As per CSIP Standards and specimens indicated on spreadsheet (???) or where specimens require different and tighter criteria. [↑](#footnote-ref-9)
10. See collections trust security information for glass and frame [↑](#footnote-ref-10)
11. PVB Poly Vinyl Butyrl [↑](#footnote-ref-11)
12. FIRE PRECAUTIONS - PERMANENT, TEMPORARY AND TRAVELLING EXHIBITION DESIGN NHM Fire Safety Note Guide MI06 [↑](#footnote-ref-12)
13. Pers comm Fire Officer, NHM, October 2013 [↑](#footnote-ref-13)