

Repair and allied processes for the conservation of documents — Recommendations

01.140.20

Committees responsible for this British Standard

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- BCS — British Computer Society
- British Library
- British Museum
- British Records Association
- Chartered Institution of Building Services
- Conservation Centre, Camberwell College
- D. Allsopp
- Institute of Paper Conservation
- London College of Printing
- M.M. Foot
- Museums and Galleries Commission
- Public Record Office
- Royal Commission on Historical Manuscripts
- Royal Institute of British Architects
- Society of Archivists
- Storage Equipment Manufacturers Association

The following bodies were also represented in the drafting of the standard through panel IDT/2/9/2, Binding materials:

- Bodleian Library
- Cambridge University Library
- Cedric Chivers Ltd
- National Library of Scotland
- National Library of Wales
- National Preservation Office
- Riley Dunn and Wilson Ltd
- Scottish Record Office
- Sheffield Archives
- Trinity College Dublin

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Foreword

This British Standard has been prepared by Subcommittee IDT/2/9. It supersedes BS 4971-1:1988 and BS 4971-2:1980, which are withdrawn.

The continuing awareness of the value and need to conserve archives and other documentary information sources of long term value is evident in the institutions that have a responsibility for the care of such materials, in the development of the National Preservation Office and in the professional organizations serving conservation. The sheer quantity of documents known to be in need of treatment continues to be a problem and conservators remain concerned about the limited durability of materials, inks and colours of the documents, as well as some of the materials and methods available for their treatment.

The first edition of BS 4971 was published in 1973 and revised in 1988. This revision has been prepared to take account of research and advances made in document conservation treatments and knowledge gained since the last revision. It has been structured differently to provide a more logical approach to the assessment and provision of treatment and attempts to address treatment differences for paper and parchment by having separate clauses covering the repair of each material. Also, the recommendations are given in a single standard instead of two parts. This is because the revision panel felt that binding, previously covered in BS 4971-2, was too large and complex a subject to be adequately dealt with by incorporation into this standard. A new clause on books and codices has been introduced, as has a clause on protective housings. The methods recommended reflect current thinking in the conservation profession and can be safely undertaken by a trained conservator.

It has been assumed in the drafting of this standard that the execution of its provisions will be entrusted to appropriately qualified and competent people, for whose use it has been produced.

WARNING. This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations. Attention is drawn to the statutory regulations listed in 5.1.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 36, an inside back cover and a back cover.

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1 Scope

This British Standard gives recommendations for remedial treatments and allied processes for use in the conservation of documents that have a long term value and are held in archives, libraries or private collections. It is not applicable to photographs, works of art on paper or electronic media.

NOTE Information about the storage of various kinds of photographic material is given in BS 1153. Photographic film of archival quality is specified in BS 5699-1 and BS 5699-2.

The standard is applicable to treatments that might be necessary to ensure the continued preservation of paper, parchment and seals. Methods of treatment are explained in detail only if information about them is not easily available elsewhere.

These recommendations apply to the conservation of documents in the United Kingdom but might be appropriate for other countries with similar, temperate climates.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 2924-1, *Aqueous extracts of paper, board and pulp — Part 1: Method for determination of pH.*

BS 5454, *Recommendations for the storage and exhibition of archival documents.*

BS 7258-2, *Laboratory fume cupboards — Recommendations for the exchange of information and recommendations for installation.*

BS EN 149, *Respiratory protective devices — Filtering half masks to protect against particles — Requirements, testing, marking.*

BS EN ISO 2062, *Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break.*

BS EN ISO 3696:1995, *Water for analytical laboratory use — Specification and test methods.*

BS EN ISO 9706, *Information and documentation — Paper for documents — Requirements for permanence.*

BS EN ISO 20534, *Method for determination of thickness and apparent bulk density or apparent sheet density of paper and board.*

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

3.1

alkaline reserve

compound that has been added to paper to counteract or neutralize subsequent acid attack

3.2

analytical grade

grade of chemical used for laboratory work which has a higher degree of purity than reagent grade

3.3

aqueous cleaning

process of cleaning a document with water either by immersion or supported on the surface of water

3.4

archival quality

quality of materials which have been produced to a standard that makes them appropriate for use in the conservation or preservation of archive and library materials

3.5

archival specification material

material which contains no substances that will harm the original and which has long term stability

3.6

archive

collection of documents intended for long term preservation because of their continuing intrinsic value

3.7

bifolium

sheet folded in half to form two leaves (four pages)

3.8

blast freezing

process that uses a current of air to cool material rapidly to a temperature not higher than -10°C

3.9

bullae

round leaden papal seal attached to a document

NOTE The term can also refer to the whole document of a papal edict.

3.10

BP quality

quality specified in a monograph in the British Pharmacopoeia

3.11

chemical sponge

dense sponge made from vulcanized rubber used for collecting surface dirt, particularly smoke particulates

3.12

collagen fibre material

prepared natural membrane from the appendix of cattle, or fish swim bladder membrane, or sausage casing made from reconstituted cattle skin, bone or cartilage

NOTE The membrane from the appendix of cattle is commonly known as “gold-beater’s skin”.

3.13

colophony resin

pale yellow, orange or brown resin consisting of abietic and dehydroabietic acids used as a consolidant when combined with wax

3.14

conservation

practical treatments and processes used to protect archive documents from further deterioration without adversely affecting the integrity of the original

3.15

controlled tension

method of eliminating distortion in a document when reducing the moisture content of the document during drying, or while in storage

3.16

deacidification

process of removal and neutralization of acids present in paper by using aqueous, non-aqueous or gaseous alkaline substances and depositing alkaline salts as a buffering agent

3.17

deep freezing

freezing documents below -18°C

3.18

document

combination of a carrier, the information recorded on it, and the medium used to record it

3.19**dye**

substance in solution which can be used to impart colour to a variety of materials such as paper, leather and parchment

3.20**encapsulation**

process by which a document sheet is protected by placing it between two sheets of transparent polyester film subsequently joined around the edges

3.21**enzyme**

naturally occurring, complex proteinaceous substance that acts as a catalyst in a biochemical reaction

3.22**evidential hole**

hole in a document that provides evidence of its history

NOTE Examples include worm holes, holes for filing thongs and, in parchment, holes that were in the skin before text was applied.

3.23**felt mark**

impression remaining in paper after being pressed using papermaker's felts

3.24**fixative**

substance that is applied to an ink or dye before treatment when it is believed that the medium or its binder will be fugitive or liable to change when exposed to a treatment solvent

3.25**fixing**

process of rendering stable or permanent

3.26**fluorescence**

reaction of a substance emitting rays of greater wavelength than those received

3.27**friable**

easily crumbled or reduced to powder

3.28**fugitive**

movement or change of an ink, dye or pigment on its carrier when a solvent is applied

3.29**fumigation**

gaseous process carried out under controlled conditions to inhibit fungal growth or insect infestation

3.30**gutta percha**

coagulated latex of various Malaysian trees of the sapodilla family

3.31**heat-set**

thermoplastic adhesive coating that sets after heat and pressure have been applied

NOTE This is usually a blend of hard and soft acrylic emulsions in water, made either in the workshop or commercially.

3.32**humidification**

process to increase the moisture content of a material by increasing the amount of water vapour in the environment in which it is temporarily placed

3.33

hydration

process of increasing the water content of a document

NOTE This is usually done to make it more flexible (see also **3.57** relaxation).

3.34

illuminated manuscript

manuscript decorated or illustrated with coloured pigments, gold or silver

3.35

ink

fluid or viscous compound used for writing, drawing or printing

NOTE It can be in the form of a dye or pigment, the viscosity of the medium varying depending on the intended use.

3.36

iron gallotannate ink

ink produced by the reaction of tannins in conjunction with an iron salt such as ferrous sulfate

NOTE After application, for example to paper, the ink is darkened by oxidation.

3.37

lamination

process of fastening sheets of tissue, paper or transparent plastics material with a transparent adhesive to one or both sides of a sheet of paper to strengthen and protect it

NOTE This is achieved by using either a solvent, or heat and pressure.

3.38

leaf-casting

process that uses a suspension of paper pulp applied by vacuum suction or gravity, to fill in missing areas of a document

3.39

lignin

non-carbohydrate substance which, together with cellulose, forms the woody cell walls of plants

NOTE It adds mechanical strength and bonding to the plant.

3.40

machine direction

direction in which paper pulp travels through a paper making machine and the direction in which a significant proportion of the fibres lie

3.41

make-up

method and order of fastening membranes or sheets together to constitute a complete document or volume, or the manner in which a single sheet is folded

3.42

mechanical cleaning

surface cleaning of a document using physical methods

NOTE These methods include use of a brush, eraser and chemical sponge.

3.43

mechanical wood pulp

pulp produced from disintegrated or ground wood, usually spruce, from which impurities have not been removed

3.44

medium

ink, dye, pigment or other substance attached to the surface of a carrier to provide visual information content or decoration

3.45**membrane**

single skin, or part of a skin, of parchment or vellum

3.46**non-ionic detergent**

synthetic chemical which reduces the surface tension of water thus enabling it to penetrate paper easily

3.47**non-woven polyester**

open, heat-sealed web of polyester fibres used to support documents during treatment

3.48**parchment thong**

long narrow strip of twisted parchment on which loose parchment or paper documents are threaded, or narrow strips of parchment on which sections of books can be sewn

3.49**pH value**

point on a logarithmic scale showing the concentration of hydrogen ions in a solution

NOTE This is used to denote acidity or alkalinity on a scale of 1 to 14, neutral being pH 7.

3.50**pigment**

insoluble particles of a coloured material in suspension in a fluid which, after application, evaporates leaving a solid surface coating of the particles

3.51**pressure sensitive adhesive**

adhesive that produces a tacky film which readily adheres to a material after a brief application of pressure

3.52**propolis**

reddish resinous substance collected by bees from the buds of trees to consolidate the interior of their hives

3.53**preservation**

all management, financial and technical issues involved in preserving archive and library materials in all formats, and/or their information content, so as to maximize their useful life

3.54**reagent grade**

grade of chemical commonly used for laboratory work when small amounts of impurities will not harmfully affect the behaviour of the reagent

3.55**reconstituted collagen**

re-hydrated natural protein of skin, bone and connective tissues used in parchment repair

3.56**relative humidity**

ratio of the absolute humidity to the maximum possible density of water vapour in the air at the same temperature, expressed as a percentage

3.57**relaxation**

process of making a document more flexible to rectify over-tight folding, creasing, cockling or distortion, without strain or damage

3.58

release paper

paper coated with a stable layer of material, such as a silicone resin, to which other substances, including adhesives, do not stick permanently

3.59

repair

techniques and/or materials applied to a document in order to make it usable

3.60

reprographic method

process which allows reproduction from an original

NOTE The most common reprographic methods are electrostatic copying, photography and microfilming.

3.61

restoration

process used in reconstructing damaged archive and library materials to a perceived original form

NOTE It does not necessarily include good conservation practices.

3.62

reversible

status that will allow certain treatments to be reversed, as far as is possible, allowing a document to be returned to its pre-treatment condition

3.63

size

substance used to strengthen paper and to decrease its absorbency

3.64

spanish wax

compound of cinnabar and colophony resin

3.65

substrate

carrier holding the information media

3.66

surfactant

substance that alters the interfacial tension of water and other liquids or solids

3.67

tub-sized paper

newly formed paper which has been immersed in gelatin size, as opposed to surface coating

3.68

ultrasonic humidification

production of a fine cold mist of water using ultrasonic equipment which is then used for relaxing parchment or paper without directly wetting it

3.69

vacuum desiccator

glass container connected to a vacuum pump

NOTE This is used during treatment to evacuate air from a friable seal.

3.70

vacuum table

perforated flat surface that allows documents to be supported under tension using a vacuum created below the surface

3.71**wetting agent**

substance which lowers the surface tension of water and is used in washing to aid the removal of soluble substances from paper

NOTE Ethanol, acetone and non-ionic detergents may all be used as wetting agents.

4 General principles**4.1 Maintaining the integrity of documents**

Custodians of archive and library materials are responsible for maintaining the integrity of the documents in their care. This means preserving the textual, pictorial and physical content and character of the documents.

Changes to the original arising from unnecessary or inappropriate conservation interventions can destroy unique and important evidence of the document's status, production, historical context and provenance. This compromises the document's value to research, and in the case of an archival document undermines its legal authenticity.

Owing to the above considerations, the option to conserve a document should be very carefully considered and taken after consultation between curatorial and conservation experts. It should be viewed as a final option in an overall collections care programme, which in the first instance should employ preventive techniques (effective environmental control, good handling practices, protective enclosures, substitutes) to prevent and reduce deterioration of the document from its original condition. An effective collections care programme should ensure that documents that have received conservation treatment are returned to a protective environment.

A collection that has remained virtually undisturbed might have a special historical value or significance and should therefore be treated as a whole, and not as a collection of individual items.

4.2 Principle of minimum intervention

Minimum intervention should be used to support and stabilize items to ensure preservation of the integrity of the document and to minimize the risk of further damage during treatment. No original material should be removed during treatment, unless it threatens the long-term preservation of the whole item. Materials and techniques should be used which will not harm the item and which will not impede future examination, treatment or function of the item. Repairs should be capable of being undone without damaging the document.

Material used in the course of treatment should be distinguishable from the original document, but aesthetically acceptable. Treatment to prolong the life of an archival document is distinct from the process of restoration.

4.3 Selection and assessment of documents for treatment

The assessment process should involve examination by curatorial and conservation experts and subsequent decisions should reflect the concerns of both. Consultation between the two parties should be ongoing as necessary during treatment so that account can be taken of evidence exposed and, if necessary, decisions adjusted.

Selection of documents for treatment should be structured and systematic in order to ensure that treatment is necessary and that all factors affecting treatment are identified. This is important in order to encourage appropriate and effective use of resources. It is recommended that a clear policy is in place which should include a selection procedure and clear lines for consultation and be drawn up in the light of overall conservation objectives. Decisions should be made in the context of an on-going collections care programme, a condition assessment of the material, the function of the item and its future use and storage. For example, a document that is likely to be frequently exhibited or consulted might well require different treatment from one that will rarely be exhibited or consulted. Where a document is part of a collection, it is useful to carry out a general assessment of the collection to assist in establishing priorities. Priorities for treatment should be regularly reviewed with due consideration of the resources available.

4.4 Testing prior to treatment

In order to minimize the risk of causing damage and change during treatment, and in order to identify the parameters within which treatment can proceed, it is essential that areas of the substrate and media to be treated are tested prior to commencing treatment. The contact time of the test should reflect that of the intended treatment. Consideration should be given to the effect of the test on the document, bearing in mind that treatment might not always follow. Documents that have loose or friable media require special consideration.

4.5 Documentation

See 7.4 for recommendations regarding conservation records.

5 Health and safety

5.1 Legislation

5.1.1 Under the Health and Safety at Work etc. Act 1974 [1] it is the responsibility of employers, line managers and individuals to ensure that appropriate safety measures are in place to protect themselves, colleagues and others, within and outwith the work place. This includes risk related to exposure to chemical, physical and biological agents.

5.1.2 Some of the chemicals referred to in this standard have physical and chemical properties that present a significant health and safety risk. Attention is drawn to the Control of Substances Hazardous to Health (COSHH) Regulations 1994 [2], the Control of Pesticides Regulations 1986 [3] and the Environmental Protection Act 1992 [4] and its subordinate legislation. Attention is also drawn to The Personal Protective Equipment (PPE) Regulations 1992 [5].

5.2 Fume cupboards

Fume cupboards should have a face velocity sufficient for the chemicals used and be sited according to the recommendations given in BS 7258-2.

6 General recommendations

6.1 Materials used for treatment

Materials brought into contact with the document during treatment should not cause additional deterioration to the document either immediately or in the longer term. Reagents and materials should be used which have known constituents with the minimum of impurities.

Full specifications for materials should be obtained from suppliers and spot testing should be carried out to check key constituents. Examples of spot testing are given in A.1.

6.2 Erasers

Material used for surface cleaning should not abrade the substrate or image, and should not leave any harmful residue. For example, erasers made of solid or granular material containing vulcanized fatty oil or other additions such as pumice should not be used. Suitable erasers include chemical sponges and vinyl erasers.

6.3 Water

Water conforming to grade 3 as specified in BS EN ISO 3696:1995 should be used in the preparation of reagent solutions and in analytical determinations, and should be used for all processes.

7 Preparation for treatment

7.1 Selection of documents for treatment

Collection documents should be selected for treatment only after a survey has determined the overall needs, in terms of the state of the material, storage and the nature of use the document will receive. Priorities for treatment should be regularly reviewed, with due consideration of the resources available for it.

7.2 Examination and assessment of documents

All documents should be thoroughly examined prior to treatment. Documents should undergo an initial assessment as part of the process of selection for treatment. An examination should then be carried out before commencing treatment to ensure that what is proposed is appropriate, and to establish the parameters within which the treatment can proceed safely. Systematic and disciplined examination should be carried out to ensure that the conservator is fully familiar with the document and to enable monitoring of the effects of treatment as it proceeds.

Examination and assessment should be restricted to what is necessary to give information on the proposed treatment. This is particularly the case when techniques are destructive or involve sampling.

For routine examination and assessment, simple, non-destructive methods should be the first line of approach. These include examining the document with the naked eye in normal light and then introducing various degrees of magnification, and lightly handling the document to assess its characteristics (e.g. thickness, texture, flexibility and behaviour). The use of ultra-violet radiation, raking light and transmitted light is also recommended. This examination should provide guidance for further testing methods to be used that involve more intervention with the document, such as the measurement of pH and the solubility of inks and pigments, and determine whether certain materials require further identification. A range of analytical methods is available. Examples of methods and their uses are given in Annex B.

7.3 Faded and obliterated text

Advice on the treatment of faded and obliterated text is given in Annex C.

7.4 Documentation

All details of the document, its physical characteristics and its condition should be recorded prior to treatment. All materials, chemicals and methods used in the treatment, and the results of tests should be recorded. Where appropriate, photographs should be used to support written documentation, with photographic records made before, during and after treatment. The removal of any original material during treatment should be fully documented and the material preserved with the records. Records should be accessible on a permanent basis.

7.5 Materials

All materials used in conservation of documents should be of archival quality. It is essential that the strength of solutions and deacidification agents is maintained during use.

8 Treatment of insect infestation and fungal growth

8.1 General

Insect infestation and fungal growth can be largely prevented if the storage area is kept clean and the environmental conditions are in accordance with BS 5454. Documents and other materials brought into a repository or library should be examined and if necessary tested for insect infestation and fungal growth before they enter the storage area and promptly treated if any is found.

All processes that involve the use of pesticides are subject to the provisions of the Control of Pesticides Regulations 1986 [3]. The list of approved materials is given in the annual publication, *Pesticides* [6].

8.2 Treatment of insect infestation

8.2.1 Preparation of documents for treatment

Documents with insect infestation may be cleaned before or after they are treated (see 8.3.1). If they are to be frozen, they should be made into bundles up to 50 mm thick, packed in polyethylene bags or film wrap with as much air as possible evacuated, and sealed. Books should be packed separately to prevent bindings from sticking. The bundles should be packed loosely in crates.

8.2.2 *Freezing*

Deep freezing in sealed polythene bags is accepted as a safe, efficient treatment for documents and books with insect infestation. Freezing is not effective against fungal growth. Documents should be stored at around 20 °C for several days before they are frozen. Blast freezing is preferred. Failing this, documents should be frozen as quickly as possible with plenty of air circulating round them to hasten freezing. They should be kept at approximately –30 °C for at least 72 h and then allowed to return to room temperature and humidity gradually. If it is not possible to achieve a temperature of –30 °C, a period of at least 7 days at –18 °C is acceptable.

8.2.3 *Fumigation*

8.2.3.1 *General*

Fumigation is a way of treating infestations of insects and fungal growth. Insects can be killed by asphyxiation with an oxygen deficient atmosphere (see 8.2.4) or poisoned using a toxic gas. Toxic fumigants should only be used by appropriately qualified personnel. However, it should be noted that asphyxiant gases e.g. nitrogen, can also be lethal in certain circumstances.

Fumigants which are potentially reactive gases might be harmful to documents and asphyxiant gases might be inconvenient to use, thus other methods of treating infested documents are generally preferred e.g. freezing. It is recognized, however, that there are situations where there are few options, and fumigation with potentially reactive gas is the only available or viable option. This is acceptable when the risks associated with treatment are less than those associated with non-treatment.

8.2.3.2 *Fumigants*

When fumigation is the chosen treatment, the use of fumigants that are of low mammalian toxicity, are harmless to the document and do not leave a residue in the material is preferred.

When a freezing treatment might cause damage to certain types of document, fumigation with carbon dioxide or asphyxiation (see 8.2.4) are preferred.

8.2.4 *Oxygen deficient atmospheres*

Oxygen deficient atmospheres suitable for treating insect infestations can be achieved in an oxygen impermeable enclosure by displacing air with a gas, usually humidified nitrogen, or by adding an oxygen absorber.

8.3 Treatment of fungal growth

8.3.1 *Cleaning*

Documents or books on which there is fungal growth should be cleaned with vacuum equipment applying a low power vacuum through a soft bristled tool head and with exhaust filtration <3 µm.

To avoid breathing in mould spores and dust, a dust mask conforming to BS EN 149 should be worn when cleaning documents, or they should be cleaned in a fume cupboard (see 5.2). Eye protection, gloves and protective clothing should also be worn (see 5.1.2).

8.3.2 *Fumigation*

Fumigation is also a way of treating fungal growth. See 8.2.3.

9 Cleaning

9.1 Mechanical cleaning

9.1.1 *General*

Unless required as historical evidence, surface dirt and debris may be removed from paper or parchment mechanically if:

- a) the text or image is not at risk;
- b) the material is firm enough to withstand the treatments described in 9.1.2;
- c) the document is dry, otherwise the dirt will tend to smear and be worked into the surface of the document.

9.1.2 Methods

If there is a heavy layer of dirt on the document, a low-suction vacuum cleaner, with a gauze filter in the nozzle, may be used. The nozzle should be moved outwards from the centre of the document to the edges, to avoid sucking in the material. A very soft brush may be used to remove surface dust from the document after vacuum cleaning, or as the first treatment if the material is not strong enough for vacuum cleaning. A very soft eraser, grated eraser applied under cotton wool, or a chemical sponge (see 6.2) may be used to remove any dirt that has worked into the surface of the document. A swab of cotton wool may be drawn or rolled over the surface to complete the removal of any remaining surface dust.

Extra care should be taken if the document bears illumination or decoration.

9.2 Liquid cleaning

9.2.1 Testing and preparation of inks and pigments prior to liquid cleaning

Before a document is treated with water or other solvent, the media on the document, and the substrate, should be tested according to the methods given in Annex A to check whether the solvent would dissolve or otherwise damage them. The solvents used in cleaning and relaxing methods and solutions used to remove adhesives should not alter or dissolve any colour in the document. The test area should be as small as possible to minimize any damaging effect.

Inks and pigments that might be adversely affected by exposure to solvents may be fixed by the local application of a substance impervious to the solvent. The choice of a fixative will depend on the need to remove it after treatment. Fixatives should normally be removed after treatment. Fixing should be considered as a last resort. The priority should be to identify an effective treatment solution that does not affect the media.

Membrane documents should not be immersed in water.

9.2.2 Aqueous cleaning of paper

9.2.2.1 General

Documents that are fragile, or will become fragile on immersion in water, should be supported, e.g. on porous paper of high wet-strength, or non-woven polyester. When many sheets are to be immersed together, individual sheets should be interleaved with similar porous materials.

Before aqueous cleaning begins all surface deposits should be removed by mechanical means as given in 9.1.2. The conservator should check that the paper of the document will withstand immersion and that its inks and pigments are not fugitive (see 9.2.1). Water-soluble stains on paper may be reduced by immersing the document in purified water. Application of a surfactant, such as industrial methylated spirits, or a wetting agent assists penetration of water. If traditionally tub-sized paper is soaked in water, its gelatin content will be reduced. Aqueous deacidification may follow directly before drying.

NOTE Art paper, that is paper with a high surface content of clay, whether in the furnish or added by surface coating, should not be washed with water.

9.2.2.2 Float washing

Float washing may be used when paper requires treatments in aqueous solutions and the media will not tolerate immersion. The principle of float washing involves supporting a sheet of paper using the surface tension of the water (media facing uppermost). Impurities usually migrate downward and away from the paper.

This treatment might not be possible if the paper is particularly weak, or contains holes or tears. In such cases the damaged areas of the paper would not be supported by the surface tension and water would flow over the sheet. This can be avoided by using a rigid support material (such as a plastics light diffuser grid) which allows the water to fill level with its surface.

Alternatively, very fragile documents, or those with unstable media, may be gradually washed on a rigid surface with a thick blotter or similar acting as a moisture reserve. The blotter is replaced with fresh ones as waterborne staining is gradually drawn out.

9.2.2.3 Use of a vacuum/suction table

A vacuum or suction table can be used to safely hold and support works of art on paper and printed material undergoing some conservation treatments. For example, the suction created can be used for pulling aqueous or non-aqueous solutions applied to remove staining through the paper so that the wetting does not cause tide lines or secondary staining on the paper. Other uses include drying wetted material flat, providing support during repair and for lining fragile items.

NOTE Unless the surrounding environment is sufficiently clean there is a risk that airborne impurities will be drawn into the document.

9.2.3 Non-aqueous liquid cleaning of paper

A paper document that is stained or contaminated with organic matter that is not soluble in water may be immersed in an organic solvent or exposed to solvent vapour. Information regarding organic solvents is given in Annex D. Any solvent used should be completely and readily volatile, or capable of being removed by another solvent that is readily volatile. The solvent may be of reagent grade, or of analytical grade. If the solvent is toxic or flammable, it should be used in a fume cupboard (see 5.2) and, if flammable, should also be kept away from exposed flames and excessive heat. The conservator should check that neither the solvent used nor any adhesive on the document will interact with any ink, pigment or binding media (see 9.2.1) using the testing methods given in Annex A.

10 Relaxation of parchment and paper**10.1 General**

A paper or parchment document is normally relaxed by having its moisture content temporarily increased. The document surface should be mechanically cleaned in accordance with 9.1.2 before its moisture content is increased, otherwise any dirt on it will become fixed when the document dries.

10.2 Temperature

If material is subjected to humidification for an extended period of time the temperature should be maintained as low as possible to reduce the risk of mould growth.

10.3 Humidity

The relative humidity required to relax a document will depend on its condition and any change in relative humidity should be gradual and carefully controlled. Placement in an environment with a relative humidity above 80 % is usually necessary to achieve relaxation. The time needed for a piece of parchment to become relaxed will vary for different skins and should be carefully measured.

10.4 Parchment

Creases and cockling in parchment documents can be reduced by relaxing the document, preferably in a humid atmosphere, by ultrasonic humidification or by localized application of a mixture of propan-2-ol and water beginning with a 80/20 solution proceeding to a 50/50 solution if necessary. Drying should take place under controlled tension.

Treatment should only be applied after it has been determined that loose and friable pigments and inks are fixed in accordance with 9.2.1 and the methods given in Annex A.

The document should not be pressed while damp otherwise it might become translucent and/or risk pigment off-set or loss.

NOTE Illuminated manuscripts on parchment are vulnerable to damage when damp, because dimensional changes in the parchment might cause cracking and flaking in the pigment and binder layers.

10.5 Paper

In certain circumstances, where the surface, print impression, texture and felt marks would not be damaged or altered in any way, it might be possible to reduce creases in paper by raising the moisture content of the paper and supporting it under light pressure.

NOTE Tests for fugitive inks and pigments should be made in accordance with Annex A (see also 4.4 and 9.2.1). If the paper contains water-soluble fillers, or if water-soluble gum has been used as a binder, it should not be subjected to high humidity.

11 Repair — General principles

11.1 Preservation of intrinsic evidence

The process of repair should do nothing to remove, diminish, falsify or obscure in any way intrinsic evidence of the document's age, authenticity, provenance and history.

11.2 Repair of evidential holes

Evidential holes should not be repaired unless they weaken the fabric of the document.

11.3 Use of repair materials

The amount of new material used in any repair should be kept to the minimum. The weight of the repair materials should be as light as adequate strength allows. Excess new materials may be trimmed off, provided that evidence is left of the extent of the repair. The direction of the majority of the repair material fibres should be aligned with the direction of the fibres in the original.

11.4 Changes in flexibility and thickness

Any change in flexibility and any increase in the thickness of the document resulting from repair should be kept to a minimum. A repair should not concentrate stress where the repair material meets the original material of the document.

11.5 Maintaining legibility

Repair material applied over areas of damaged text should impair the legibility of the text as little as possible.

11.6 Protection of ink

Special care should be taken, through the choice of treatment or by fixing the ink, to avoid the text being damaged by contact with solvents in which it is soluble (see 9.2.1).

11.7 Consolidating inks and pigments

The condition of inks and pigments should be assessed and the need for consolidation be considered as discussed in Annex E.

11.8 Swelling of treated areas

When single sheets and bifolia are repaired in the same areas on the edges or within the margins of each sheet, the conservator should take into account that the increase in thickness of the repaired areas might cause excessive swelling if the sheets are bound or boxed. This should be avoided because it can cause distortion and, possibly, fracture of unrepaired areas of fragile sheets.

11.9 Measurements of maps and scaled drawings

When a map or scaled drawing is to be mounted or treated in any way that involves the use of moisture or heat, before any treatment other than simple mechanical cleaning is carried out, all four sides and both diagonals should be measured accurately. If the sides are not straight, the measurements should be taken from clearly defined points near the corners. These measurements should be noted and preserved with the conservation record.

12 Paper — Treatment

12.1 Deacidification

12.1.1 General

The principles described in 11.6 and 11.7 might result in the methods given in Annex A and Annex E being used to protect documents of paper that can be treated with aqueous or non-aqueous solutions against acid attack. For archival purposes it is desirable that the pH value of paper should be between 6 and 9. For determination of the pH value of paper see Annex F.

Washing with water alone can remove most of the free acid from paper. However, paper containing intrinsically acid components such as mechanical wood pulp might not be deacidified sufficiently. Previously acid paper washed in this way contains no alkaline reserve to neutralize the future occurrence of acids e.g. from air pollution or oxidation of the paper.

12.1.2 Choice of method

The choice of solution and method of application will be dictated by the condition and composition of the document. Ink, whether print or manuscript, might consist of a colouring matter compounded with a medium which is either intrinsically weak or has decayed and allowed it to become detachable. Colouring matter present in the paper or as image/text might be soluble in water or the common organic solvents or both, or they might be insoluble in these solvents but likely to dissolve in or react with the reagent solutions used for deacidification.

12.1.3 Side effects of deacidification

The paper, ink or colouring matters of documents might contain components that are adversely affected by the chemicals used in deacidification. Lignin, present in mechanical wood pulp, becomes more brown in alkaline conditions. Those most likely to be damaged are inks, whether iron gallotannate or coloured, and colouring matter used in maps, drawings etc. Iron gallotannate inks might fade after treatment with aqueous solutions of high pH value. Some colouring matters and coloured inks might dissolve in water and the organic solvents used for deacidification solutions; some might change colour. No document should be deacidified until the paper and all inks and colouring matters have been tested to determine the effect of the solutions to be used. A choice has to be made between stabilization and the document's appearance, for example some change in the colour of a highly acid, heavily lignified paper might have to be accepted if the document is to be treated.

NOTE The colours used in colour-coded documents such as maps might be affected by the processes of deacidification. Documents that are specially prepared to prevent tampering for the purposes of fraud, etc. might have fugitive components in the paper and fugitive inks, whether print or manuscript.

12.1.4 Documents with seals

12.1.4.1 General

A number of factors should be considered before deacidifying documents with shellac seals since the methods used might have adverse effects on the seal.

12.1.4.2 Aqueous methods

Totally immersing documents in some alkaline solutions can soften and alter the colour of shellac or leave a white deposit of calcium or magnesium on its surface which can be removed using a moistened swab. Shellac is also soluble in alcohol and some sealing waxes soften in temperatures above 30 °C, so if deacidification of a document in an alkaline solution is required, a pre-wetting solution using alcohol should be avoided and the immersion bath should be below 30 °C. If alcohol and an alkaline solution has to be used, vulnerable shellac seals can be protected with a thin coating of wax using the method given in Annex G and the temperature kept below 30 °C. During immersion adequate support should be given to the document, particularly if the paper is thin, as the weight of the seal might tear the paper around it. Care should also be taken to ensure any tiny broken fragments are not dislodged or lost. It is recommended therefore that as an alternative, either the side opposite the seal should be deacidified by spraying with the aqueous solution or the seal should be covered if spraying both sides is preferred.

12.1.4.3 Non-aqueous methods

Such methods are not recommended as they can dissolve or cause serious damage to the surface of the seal. This includes the addition of alcohols as surfactants.

12.1.5 Preparatory treatments

Deacidification by immersion in an aqueous solution is assisted if the document is immersed in water (see 9.2.2) beforehand and deacidified without first drying.

Material affected by mould might need to be pre-wetted with a solution of industrial methylated spirit and water to aid complete penetration of the deacidification solution.

12.1.6 *Methods of deacidification*

The chemical compounds used for deacidifying documents may be applied in solutions, aqueous or non-aqueous, in which the documents are immersed, or the solutions may be sprayed or brushed on to the documents. Immersion is always to be preferred because it ensures that all parts of the document are evenly treated. Spraying or brushing may be used for documents that cannot safely be immersed or for bound volumes if it is difficult or undesirable to disbind them. However, care should be taken to ensure that the most acid areas of the paper have received sufficient solution to effect deacidification, treating both sides of the paper if necessary.

Documents that are fragile, or will become fragile on immersion in water, should be supported, e.g. on porous paper of high wet-strength, or non-woven polyester. When many sheets are to be immersed together, individual sheets should be interleaved using similar porous materials.

The compounds calcium hydroxide, calcium hydrogen carbonate, magnesium hydrogen carbonate, magnesium methoxide and methyl magnesium carbonate all fulfil the basic requirements for the process of deacidification, i.e. each will effectively neutralize any strong acid that might be present and each will leave a residue (from the excess normally applied) that acts both as a reserve of alkalinity and as a stabilizer for cellulose.

12.1.7 *Use of aqueous based solutions* (see Annex H)

12.1.7.1 *Calcium hydroxide*

This creates a high initial pH which might fade iron gallotannate inks and discolour lignified paper.

12.1.7.2 *Calcium hydrogen carbonate*

This gives a lower pH than calcium hydroxide. It is more suitable for pH sensitive inks and colouring matter.

12.1.7.3 *Calcium hydroxide and calcium hydrogen carbonate*

These can be used in a two stage process which deposits twice as much alkaline reserve as use of either compound alone.

12.1.7.4 *Magnesium hydrogen carbonate*

This gives a low initial pH. It is suitable for pH sensitive inks and colouring matter.

NOTE A solution with a high pH will swell paper fibres more which might have a detrimental effect on badly degraded paper.

12.1.8 *Spraying with aqueous solution*

When applying the solution by spraying, an apparatus that delivers a fine spray free from droplets should be used. The document should be lightly sprayed on both sides. The spraying may be repeated if areas are not sufficiently deacidified.

12.1.9 *Use of non-aqueous solution*

If inks or pigment are water-soluble, or the paper is too fragile to treat with water, a suitable non-aqueous deacidification solution should be used. The document should be immersed if practicable, or the solution sprayed or brushed on both sides.

A useful deacidifying treatment can be prepared by saturating a solution of magnesium methoxide with carbon dioxide. This solution is available commercially, sometimes further diluted with inert solvents. It is variously known as methoxy magnesium methyl carbonate, methyl magnesium carbonate or magnesium methyl carbonate. This solution can be used as a spray or for immersion of documents.

Significant research has shown a suspension of magnesium oxide in perfluoroheptane to be effective for deacidifying paper. Two particular advantages of using this solution are the little or no effect it has on many of the common inks used and its good health and safety characteristics. It can be applied by spray but systems using this solution are available for deacidifying material in what is often described as a mass or bulk process.

NOTE Visible deposits of magnesium or calcium carbonate on the surface of the paper should be avoided.

12.2 Repair materials

12.2.1 *General*

Repair materials should be chosen so that changes in moisture content during repair and subsequent storage minimizes distortion of the document.

All repair papers should:

- a) be as chemically stable as possible;
- b) have a pH value within the range 6 to 9, when measured by one of the methods described in **F.3**;
- c) be lignin free, without mechanical wood-fibre;
- d) have surface characteristics, manufacturing methods and an appearance compatible with the original.

NOTE When considering the use of old papers the same criteria should apply. Modern recycled papers are not recommended for use as repair papers.

Additional desirable characteristics for paper used to repair tears are that it should be:

- 1) as lightweight as possible;
- 2) translucent.

Long fibred oriental papers are particularly suitable for this purpose.

12.2.2 *Missing portions*

12.2.2.1 *Paper infill*

Missing portions of a document may be replaced using an infill of repair paper with an edge profile to match that of the damaged area and bonded with an overlap of free fibres extending from the edge of the repair paper.

12.2.2.2 *Pulp infill*

An infill of cellulose fibres suspended in water may be used to form new paper in a missing area. This can be applied either manually or mechanically using a leaf-casting machine. A bonding agent such as a cellulose ether may be used to strengthen the repair.

12.2.3 *Weakened documents*

When minimal intervention is required a document may be supported by encapsulation as detailed in **14.1**.

A document that is weakened may be supported with repair material over the whole of its reverse area, provided that no extensive text, however faded, or other evidence of provenance, make-up, etc. appears on the reverse. Where there is text on the reverse it might be necessary, depending on the severity of the damage, to:

- a) treat all over with a translucent tissue;
- b) expose the text through “windows” in the lining.

12.2.4 *Maps and scaled drawings*

Information about special considerations for the treatment of maps and scaled drawings is given in Annex I (see also **11.9**).

12.3 Adhesives

Aqueous based adhesives such as starch paste and cellulose ethers are recommended. Solvent activated synthetic adhesives may be used when contact with water needs to be avoided.

12.4 Sizing

12.4.1 *General*

Paper documents should not be sized as a matter of course but only if an examination has established the need for sizing. If a document to be sized bears ink that is insoluble in water, a water-based size formulation can be used but if the document bears ink that is soluble in water, size made of a suitable sizing agent in an organic solvent that will not dissolve the ink should be used.

12.4.2 *Immersion*

The document should be placed on a support, immersed in a solution of size and then dried flat on a suitable support.

12.4.3 *Brushing and spraying*

If the material or text of a paper document will not bear immersion a brush or spray application may be made and the document dried flat.

13 Parchment — Treatment

13.1 General

The methods used to repair parchment are different from those used to repair paper documents because of the nature of the material, although the ethics and principles are the same. In general it is recommended that parchment documents be repaired with similar membrane materials and adhesives that react in the same way as the original to changes in relative humidity. To avoid distortion of the document and its repairs, the whole conservation and repair process should be conducted in a stable workshop environment so that the moisture content of the document and repair materials remain constant. Chosen methods should avoid changes to the original which cause it to become more translucent, or darker.

It is important to note that:

- a) parchment should not be pressed while damp, otherwise it is liable to become translucent;
- b) if parchment is left damp for more than a day, the temperature should be kept below 20 °C.

13.2 Repair materials

A range of materials may be used to repair parchment. When paper is used it should be in accordance with 12.2.

In particular, the following recommendations should be followed.

- a) A prepared moisture or solvent activated adhesive coated long fibred tissue is recommended for mould damaged and denatured parchment.
- b) Parchment and transparent membrane materials should be used for the repair of chemically sound but mechanically damaged documents.
- c) The animal species of the repair parchment need not be the same as the original. It may be modified to match the original so as to give the correct degree of flexibility, thickness and texture. Such prepared material should be pre-conditioned to remove excessive tension produced by the manufacturing process (see 10.4). Natural membranes are preferred for repair but reconstituted collagen may be employed as a substitute.
- d) For sewn repairs advantage should be taken of previous sewing and stitching perforations as a permanent means of repair or attachment. Linen thread and narrow parchment thongs may be used.

13.3 Adhesives

Whatever adhesive is used the bond between the original and the repair material should be secure because, for various reasons, the stresses imposed on parchment repairs are much greater than those on paper. It should be noted that:

- a) for attaching parchment infills and repair overlays to tears, edible leaf gelatin (12 %) or parchment size are preferred adhesives;
- b) gelatin, cellulose ethers and starch may be used as adhesive coatings in the preparation of moisture activated tissue;
- c) acrylic dispersions or solutions may be used for preparing repair materials such as solvent activated tissue and transparent membranes such as gold-beater's skin and fish swim bladder.

13.4 Drying

When treatment has resulted in an increased moisture content in a document it should be returned to an acceptable level using controlled tension. Special care should be taken to protect illuminations and weakened areas.

13.5 Consolidation

Severely mould damaged parchment can be consolidated using a solution of gelatin. Such a solution should be as light as possible to avoid the risk of shrinkage on drying causing the parchment to become brittle. The process, normally employed on a suction table, uses a 0.125 % gelatin solution in 50/50 isopropanol and water. The application is preceded by spraying the parchment with 80/20 isopropanol and water to even out creases and provide a high alcohol environment in which the gelatin solution will quickly precipitate. Consolidant solution is then sprayed over the parchment followed by a spray application of 100 % isopropanol to reduce further the surface tension of the solution and avoid any risk of shrinkage. It is preferable to allow the parchment to dry on the suction table if used, to restrain the skin during drying. Alternatively the parchment can be dried between acrylic fibre and blotting papers under a single pressing board, the paper being replaced regularly.

13.6 Tears, infills and support

13.6.1 *Minor tears*

The inherent strength of parchment means that minor tears, up to approximately 5 mm, may be left untouched at the discretion of the curator or conservator. Tears on a thin parchment subject (e.g. 0.07 mm to 0.10 mm) can be efficiently repaired with a one sided patch of adhesive coated paper tissue or thin transparent membrane, or two sided at the discretion of the conservator. Thicker grades of subject parchment will require proportionally more robust grades of transparent membrane or skived parchment, adhered with gelatin. Infills should always be marginally thinner and more flexible than the subject.

Occasionally the traditional method of stitching with soft linen thread or thin parchment lacing may be used.

13.6.2 *Collagen fibre material*

Collagen fibre material in its natural or reconstituted form is an appropriate medium for the support of degraded and perforated text. The thinnest and most transparent gauge should be selected, as tensile strength is not important in this context. A solvent activated acrylic adhesive film is preferred as it is more resistant to reactive elements remaining in the image or text pigment, e.g. copper and iron. Before treatment commences these unstable areas can be buffered (and sized/fixed if necessary) with a non-aqueous solution method. The use of water based treatments can lead to further damage to the substrate parchment and to loss of the image.

13.6.3 *Extensive damage*

If torn surfaces cannot be joined directly because the damage is extensive or the tear is old, the repair should be reinforced with material compatible with the original, and, if necessary, translucent material such as collagen or fish swim bladder applied. Every effort should be made during the hydration and flattening process (see 10.4) to manipulate and align the abutting edges of old tears and the text; if possible gaps should be closed before repair work commences.

Temporary abbreviated repairs can be made to align disjointed parts using solvent activated adhesive coated tissue, followed by humidity chamber hydration and tensioning (see 13.3). On drying, these supports are removed with the appropriate solvent (e.g. acetone) and replaced with a complete and permanent repair.

14 Methods of physical support

14.1 Encapsulation

A document may be placed for protection between two transparent sheets of material, provided that:

- a) the protective sheets are free from substances that might harm paper or parchment and are without surface coatings or texture which might cause abrasion;
- b) the materials used for encapsulation have anti-static properties and the sheets move easily against each other;
- c) the document is, if necessary, deacidified and resized before encapsulation;
- d) there is no adhesive between the sheets fastening them together (see 18.5).

14.2 Lamination

14.2.1 General

Heat-set lamination should not be used as a routine method of repairing documents as the long term effects at present are unknown. It should be used only if alternative treatments cannot be justified.

Lamination will also reduce legibility and might reduce the effect of ultraviolet radiation in improving legibility. It is unlikely that a microfilm could be produced to optimum preservation standards if a document has first been laminated.

14.2.2 Conditions for use

Lamination is not recommended for documents other than paper. It is advisable for paper only when:

- a) paper with a pH value of less than 6 has first been deacidified;
- b) processes used do not leave the document brittle or discoloured and can be reversed without damaging the document;
- c) materials used have high chemical stability and are not liable to be degraded by heat, light or oxidation, or to produce strongly acidic compounds;
- d) the laminate used has a pH value between 6 and 9;
- e) there are no plasticizers present in the laminate;
- f) suitable adhesives are used.

14.2.3 Adhesives

Adhesives used in many proprietary and other systems of lamination are of synthetic or semi-synthetic origin and, with other materials used, might cause colours present in the document to run, fade or change hue, both during the process of lamination and in subsequent storage. Systems that require the use of pressure-sensitive adhesives are not suitable for archival work (see 15.4). Adhesives suitable for use in lamination are described in Annex J. In addition to having the qualities listed in J.3, the adhesives should be:

- a) known not to dissolve or alter any colour present in the document, either at the temperature of the lamination process or the temperature of subsequent storage;
- b) soluble, to allow delamination, using solvents that are known not to affect any colouring matter present in the document or the properties of the paper, either by their own action or in conjunction with the action of the adhesive (see clause 15).

15 Reversing adhesive bonds

15.1 General

The possibility of safely removing an adhesive of any type will depend on:

- a) the nature of the adhesive;
- b) the extent to which ageing has modified it;
- c) the response of the materials of the document to the materials and processes used to dissolve or swell the adhesive.

Some adhesives cannot safely be removed because of the range of materials found in documents, although sometimes the attached material can be removed mechanically without removing the adhesive. If the risk of removing an adhesive outweighs the benefits consideration should be given to leaving the original repair in place.

If an adhesive is to be removed from a fragile or fragmented document, the document may be consolidated with a permeable material or fastened with such a consolidant to a suitable tissue that will support it during treatment.

15.2 Adhesives soluble in organic solvents

A solvent used to remove synthetic, semi-synthetic and natural adhesives soluble only in organic solvents should be free from excessive acidity and residue upon evaporation. The solvent should not be used if ink is soluble in it.

15.3 Use of enzymes

Enzymes may be used to remove old repairs and starch- or protein-based adhesives from paper. For further information about enzymes, see Annex K.

15.4 Pressure-sensitive adhesives

There is no universal solvent for pressure-sensitive adhesives, especially those that have decayed with age. The solvents suitable for any particular case can often be discovered only by experiment, and there can be no certainty of complete removal. Some solvents might dissolve the adhesive or soften it sufficiently to enable the material to be scraped away, provided time is allowed for the solvent to act. Adhesives used in pressure-sensitive adhesive materials might be solvents for colours, particularly modern inks whether printed or manuscript, either by their own action or in conjunction with solvents used to remove them, even if those solvents on their own would not affect colours.

The application of localized heat applied through silicone release paper might help to release pressure sensitive tape.

16 Repair of seals

16.1 General

Seals need particular protection because they are vulnerable to the risk of fracture and abrasion. These recommendations apply to seals, whether detached, attached to paper or parchment, made of wax, cellulose acetate, Spanish wax, gutta percha, wafer/paste or shellac. Also, the brittle nature of shellac seals means that seals made from this material are prone to crack and are virtually impossible to treat using the same material. It is therefore recommended that beeswax should be used when carrying out any repair. Lead seals and bullae have different properties to the above. It is particularly important for them to be stored in accordance with the recommendations given in BS 5454. Some materials used to attach pendant seals to documents might need the skills of a conservator from a different discipline.

16.2 Cleaning

Seals should preferably be cleaned mechanically using dry methods (see 9.1). When this is not sufficient aqueous methods may be used (see 9.2).

The embossing on wafer seals (paper covered paste) can be easily damaged. Paste seals should therefore be cleaned using dry methods or the surface made no more than barely damp. Documents with this type of seal applied should not be immersed in water.

16.3 Repair

After seals have been cleaned and consolidated, they may be repaired with unbleached beeswax or, where a harder repair is required, a mixture of 92 % unbleached beeswax and 8 % colophony resin can be used. For filling cracks, the mixture should be at a temperature high enough to allow it to run into the cracks and low enough to avoid damage to the original. With applied seals the temperature should be kept as low as possible to avoid marking the documents.

Fragments may be reassembled by running molten wax between the joints in the same manner as for cracks. Only in extreme cases should large fragments of a seal be reinforced by heating and inserting fine pins. If the seal was dropped because of poor handling the pins would break through the surface of the seal causing far more damage than just breaking at the newly formed joints.

It should be clear from the colour of any new repair material that it is not part of the original seal.

16.4 Fungal growth

The composition of some seals makes them immune to fungal growth. Seals containing copper compounds (many green and some brown seals) and red seals coloured with true vermilion are considered safe. It is thought that seals are not generally prone to fungal growth. Often mistaken for fungus is an effect due to a gradual loss or drying out of fatty acids due to alkalinity, a process called saponification. Whatever the cause, if what appears to be mould is found on the surface of a seal it should be treated by wiping with a soft cloth or by lightly brushing as described in 8.3.1.

17 Books and codices

17.1 General

The conservation of books requires:

- a) an understanding of the history of the book and codex form;
- b) the application of appropriate skills;
- c) an understanding of the science of the materials used.

17.2 Existing bindings

The book or codex as a three dimensional object is a complex structure of multiple and/or separate components that presents a variety of problems. For items of artefactual or historical significance, it is essential that the integrity of the item is recognized and preserved. Before any work is undertaken there should be an understanding of the history and archaeology of a particular book or codex.

The variety of binding styles and periods i.e. Coptic, Romanesque, Medieval, to the modern day give only a brief glimpse of the many forms that have survived. Mid-sixteenth century to the nineteenth century is a period displaying deterioration in both quality of materials used and craftsmanship. These are factors that should be included in any consideration and assessment for treatment.

The bindings and materials used, together with the design and mechanics of the structures, vary considerably depending on the period and ethnic origin. It is essential that the curator and conservator are aware of these differences and agree on any interventional conservation work to be performed. Consultative agreements should be clearly stated with any potential difficulties noted and reassessed at various work stages.

All original material which is not re-used should be retained and boxed where appropriate with the conserved item, or kept and returned for a decision on its future treatment and/or retention.

17.3 Rebinding

If a book or codex is to be rebound an appropriate sewing technique should be used. For example a heavy vellum/parchment text block requires a different approach from that required for a delicate paper volume. The sewing style used should hold the quires or gatherings together and also support the text block, whilst allowing it to open so that the leaves lie flat providing access to the whole text or information carrying area.

Leaves supporting coloured media should not be within a structure that will create stress and weaken or break the bond that holds the media to the leaf.

There should also be concern for leaves that are fragile and easily damaged by inappropriate binding techniques. The thickness of the sewing thread and technique used should relate to the material, its condition and quality.

The boards for a cover should be of a weight that will provide a sufficient pressure to support the text block. The attachment of the text block to the boards is a particularly vulnerable area for breakdown. It should be substantial enough for the purpose and, if a cord attachment, a flax cord or braid of suitable weight or ply should be used, or in some cases an alum tawed skin if thongs are used.

The covering material should be of a known quality and durability and appropriate for the purpose.

17.4 New bindings

Before deciding on whether to apply a new binding the historical value of the item should be carefully assessed and judgement made on whether it is appropriate to do so. A decision on whether to recreate a contemporary binding for a book or codex is one consideration, however, any assembly method used should protect the book whilst allowing it to function in a manner that will not cause stress either to the leaves or structure. Such a binding should be sympathetic in appearance to the book or codex and not distract from it.

18 Protective housing methods

18.1 Binding

The containment of a number of leaves or pages assembled in a chosen order within a protective structure, is a long practised and common method of providing protection in a form that allows useful and convenient access. Items that have historical significance and value should be treated in a way that preserves the integrity of the item as described in clause 17.

Other items may be bound as a means of providing protection during storage and use. A variety of binding methods are available but the chosen method should take account of the quality, form and condition of the materials involved, the need to function efficiently, to provide access and to safely protect the textual matter.

The advantages of binding are:

- it provides physical protection during storage, movement and use;
- it allows containment in a chosen sequence;
- it aids security;
- it is a convenient form for consultation.

The disadvantages of binding are:

- it interferes with the original form;
- it might change the original or intended format;
- the quality and condition of the material needs to be sufficient to carry the load placed on it;
- it might be relatively expensive.

Materials should be as follows:

- paper should conform to BS EN ISO 9706;
- adhesive should be in accordance with the recommendations in Annex J;
- board should have a pH value between 6 and 9 and be lignin and sulfur free;
- covering materials should be woven cotton or linen preferably coated with a non-migratory resinous substance. The surface should be non-friable with the surface fibres fully coated;
- sewing thread should be linen, cotton or cotton covered polyester with a breaking strength not less than 15 N as measured in accordance with BS EN ISO 2062.

18.2 Guarding and filing

Guarding is a procedure for securing a length of material to a loose document or documents without obscuring the information content.

Filing is a method of securing a number of loose guarded documents together to form a single well balanced unit within a protective cover, allowing each side of a document to be easily read.

The advantages of guarding and filing are:

- they provide a practical method of securing or fastening a collection of documents of various shapes and sizes into a single format;
- they provide protection;
- the sequence of documents is retained;
- they aid security;
- documents can be easily extracted and replaced.

The disadvantages of guarding and filing are:

- there is physical and chemical contact with the document;
- it is relatively labour intensive;
- filming a particular folio while still in the file can be difficult;
- it changes the original format;
- weakened documents might not be adequately supported;
- it causes bulking and so takes up more space.

Materials should be as follows:

- guards should be of a suitable weight, strength and flexibility for the document(s) to which they are to be attached. They should also be in accordance with BS EN ISO 9706;
- adhesive should be in accordance with the recommendations in Annex J;
- board should have a pH value between 6 and 9 and be lignin and sulfur free;
- covering material should be coated with a non-migratory resinous substance. The surface should be non-friable with the surface fibres fully coated;
- sewing thread should be linen, cotton or cotton covered polyester with a breaking strength not less than 15 N as measured in accordance with BS EN ISO 2062.

18.3 Boxes and enclosures

18.3.1 *General*

Boxes and enclosures provide good protection. They may be in various forms made from different materials. The more common boxes and enclosures are described in 18.3.2, 18.3.3, 18.3.4, 18.3.5 and 18.3.6.

18.3.2 *Box (for bound or unbound material)*

A box is a rigid construction customized to the individual needs of the contents; it can have a drop down spine or drop down front flap. For bound items the box should hold the book firmly and accommodate any projections there might be on the bindings such as claps. The box lining should be smooth and inert and not present any risk to the contents.

18.3.3 *Phase box (mainly for storing bound volumes)*

A phase box is a semi-rigid enclosure made from one or two pieces of archival folding boxboard. The board is cut and creased to the exact dimensions of its contents. Depending on the method of construction it might be necessary to secure it by means of thread and polythene washers on the outside foreedge. The use of staples or wire stitching in manufacture should be avoided, but if used should be of non-corroding material and not come into contact with the box contents.

18.3.4 *Storage box*

A storage box is a rigid or semi-rigid one or two piece construction enclosing the contents.

18.3.5 *Portfolio (for thinner bound volumes or unbound loose materials)*

A portfolio is a customized cloth covered case with the top and bottom boards being the same size but slightly larger than the contents they are to hold. They may or may not have flaps attached to the rear board. Cloth ties on the foreedge only, or foreedge, head and tail, can be added to hold the contents more securely.

18.3.6 *Four flap enclosure*

A four-flap enclosure is lightweight, can be made from a variety of materials, usually paper, and may be in one or two pieces, but always with four flaps enclosing the item. The materials used should not present any risk to the item enclosed.

18.3.7 *Advantages and disadvantages of using boxes and enclosures*

The advantages of using boxes and enclosures for storage are:

- minimum intervention is required;
- they provide good protection from disasters, e.g. water damage;
- they provide protection from pollutants and environmental changes;
- they provide protection from physical contact in storage;
- they provide protection during transit;
- they hold loose material securely together;
- they facilitate handling.

The disadvantages of using boxes and enclosures are:

- loose materials are less secure against theft;
- they might trap harmful substances present in the document;
- the contents are not readily visible for monitoring;
- they cause bulking and so take up more space;
- there is physical contact with the document.

18.3.8 *Materials*

Materials should be as follows:

- board should be archival boxboard or board with a density of 0.8 g/cm³ when measured in accordance with BS EN 20534. The weight of the board used should be adequate to support the item the box or enclosure contains;
- cloth should be coated with a non-migratory resinous substance. The surface should be non-friable with the surface fibres fully coated;
- paper should be in accordance with BS EN ISO 9706;
- adhesives should be in accordance with the recommendations set out in Annex J.

18.4 *Fascicules*

Fascicules consist of a number of folded leaves sewn together through the fold to form a single section. Fascicules are a safe and efficient method for the protection and preservation of single leaf archive and library materials. They may also be used for slightly larger items e.g. thin pamphlets or a series of leaves where it is vital for them to remain together.

Compensation guards are included to match the combined thickness of the material to be protected. These are either narrow strips of the same paper folded in half, or hooked guards formed by the sheet being slightly wider than the finished fascicule and folded. Guards and full sized sheets should alternate. A cover made from a thin card or manila is provided for each fascicule.

To obtain the best results a narrow strip of Japanese tissue is guarded to the item with starch paste, normally to the verso edge ensuring that no textual areas are covered. The material used for the guard should be thinner and more flexible, as well as lighter in colour, than the item itself.

A number of completed fascicules are normally boxed together for added protection.

The advantages of using fascicules are:

- there is minimum interference to the original item;
- they provide excellent physical protection;
- there is separation of each item;
- there is no or minimal finger contact with items during use;
- extraction of items for exhibition or reproduction is easy.

The disadvantages of using fascicules are:

- they temporarily change the original format;
- they are less secure against theft.

Materials should be as follows:

- paper should conform to BS EN ISO 9706;
- tissue should be free from acid and lignin;
- cover paper should be free from acid and lignin;
- paste should be starch based.

18.5 Encapsulation

The process of encapsulation is the placement of an item, usually a single leaf, between two sheets of clear inert polyester material that is sealed or fastened around the edges using electromagnetic or ultrasonic welding techniques. No adhesives are used to hold the item in place. See 14.1. Single sheet encapsulation is most common but several encapsulated sheets can be assembled in book form.

Professional judgement should be exercised as to whether an item needs to be stabilized chemically before encapsulation.

The advantages of encapsulation are as follows:

- it is a method of protection with minimum interference to the original item;
- the integrity of an item is preserved;
- it provides support for fragile and delicate items;
- it is a method of support that is quickly and easily reversed;
- it provides protection from abrasion and surface contact during storage and consultation;
- it provides protection from contact with water or other contaminants in a disaster incident.

The disadvantages of encapsulation are as follows:

- it adds weight and bulk to storage systems such as plan chest drawers;
- the study of some bibliographical features is temporarily denied;
- polyester will abrade easily which might require periodic re-encapsulation;
- the static charges generated by polyester make it an unsuitable method for loose media.

Only polyester film that is chemically inert and free from plasticizers, surface coatings, textures and patterns, dyes and other impregnates should be used for encapsulation. Available films can differ in their “slip” characteristics. Some low “slip” films are very smooth and can give an unsightly appearance when two surfaces make contact.

Polyester film suitable for archival use is manufactured by two companies¹⁾. These are listed below with an indication of their “slip” characteristic.

MYLAR™

type D: high slip (clear)

type B: low slip (clear)

type A: high slip (slightly hazy)

MELINEX™

type 516: high slip (clear)

type O: low slip (clear)

type S: high slip (slightly hazy)

¹⁾ MYLAR™ and MELINEX™ are trade marks owned by Du Pont and ICI respectively and are examples of suitable products available commercially. This information is given for the convenience of users of this standard and does not constitute an endorsement by BSI of these products.

Film is available in different thicknesses, most commonly 50 µm, 75 µm and 100 µm. The choice of thickness should be based on the degree of support needed for the encapsulated item.

18.6 Mounts

A mount is a rigid support for a document, which provides physical protection and presents the document in an aesthetically pleasing manner. Typically a mount is made up of a window overlay hinged to a backing board. The document is attached inside so that the window frames it. The window overlay may just cover the edges of the document or be cut slightly larger to reveal them. Mounts are used to provide protection during storage, display, handling and transportation.

The advantages of mounting documents are as follows:

- it provides a rigid support and effective physical protection;
- it is an adaptable construction, which can be designed to meet a range of requirements;
- it is effective in protecting documents with vulnerable surfaces and media;
- it improves security as items are fixed to the mount;
- it enhances the appearance of the item;
- it provides replacement of an inappropriate housing which might be the cause of deterioration;
- it reduces the need for physical contact during consultation.

The disadvantages of mounting documents are as follows:

- the methods of attachment to the mount normally involve physical intervention with the item;
- it changes the way in which a document is viewed, which might be at variance with its original context, purpose or meaning.

Materials should be as follows.

a) Mount boards

- 1) Mount board for short term storage: "Conservation board", comprising chemically purified wood pulp buffered with calcium carbonate;
- 2) Mount board for long term storage: "Museum" or "Rag" board, a fibre board containing high grade cotton fibres and cotton linters, buffered with calcium carbonate;
- 3) Mount board for specialist applications (e.g. photographs): cotton fibre board unbuffered and sulfur free;

b) Other materials

- 1) All materials in contact with the document should be in accordance with the recommendations for materials employed during conservation treatment (see 6.1).
- 2) The mount should be constructed only from archival specification materials.

Annex A (normative)

Methods for testing solubility and stability of media and substrates

A.1 Media

Using low power magnification, apply the solvent to a suitably insignificant area of the media using one of the following methods, given in order of preference.

- a) With a small pointed brush, apply the solvent to the media area. Blot with a small square of white blotting paper.
- b) With a small pointed brush, wet but not dripping with water or solvent, lightly brush the media area; avoid leaving an excess of water or solvent.
- c) Using 100% cotton wool, form a small ball, with an extended tail and flattened base. Immerse in solvent, blot and place on the area to be tested. A number of "balls" can be used to test all sensitive media present. Check the base of the ball and the test area at regular intervals for signs of change. Continue the test until change occurs or for up to 1 h, rewetting the ball as necessary by applying solvent with a small brush.

Using magnification, examine the media for signs of change such as, feathering, bleeding, discolouration, disintegration. Examine the blotting paper, brush or cotton wool for signs of media. If the results of a first test are negative, repeat the test using more solvent on the same spot and leave for longer.

Consider the results of the tests before deciding whether to carry out the proposed treatment.

A.2 Substrates

Using a small pointed brush wetted with the solution or solvent, wet a discrete area of the substrate where any change can readily be observed. Allow to dry, note the response of the material to the liquid, and examine for change. It might be necessary to repeat the test, particularly in the case of heavily sized paper.

Annex B (informative)

Methods of examination and analysis

A wide range of techniques are available, destructive and non-destructive, involving sampling or working directly on the document and the materials present. The simpler techniques are also useful for testing the suitability of repair and storage materials.

Examples of some methods of examination and analysis, and their uses, are as follows.

- a) Ultra-violet radiation 400 nm to 320 nm
 - Examination for mould growth.
 - Identification of pigments and previous damage and repair.
 - Enhancement of faded or abraded text.
- b) Infra-red radiation 750 nm to 900 nm
 - Deciphering faded, abraded and corrected text.
 - Identification of under-drawing.
- c) Beta radiography
 - Recording watermarks and other features of paper structure.
- d) Polarized light microscopy
 - Identification of pigments and fibre types. Often combined with chemical analysis and staining.
- e) Staining
 - Identification of proteins, starches and other materials.
- f) Scanning electron microscopy (SEM)
 - Identification of surface characteristics. Often combined with elemental analysis by EDX (see item h).
- g) Infra-red or Raman spectroscopy
 - Identification of compounds.
- h) Energy dispersive X-ray (EDX)

- Identification of elements.
- i) X-ray diffraction analysis
 - Identification of crystalline materials.
- j) Digital imaging
 - Enhancement of faded or abraded text and other physical features.

Annex C (informative)

Faded and obliterated text

C.1 General

Handwriting or printing can be lost from a document when:

- a) it is removed either mechanically, e.g. by abrasion, or in solution, e.g. by water damage;
- b) its colour is changed so that it loses contrast with the background, e.g. by chemical action, including that of light and micro-organisms, on ink and other colouring matter;
- c) it is obliterated by material that has become opaque and cannot be removed without risk to the text.

If an archival document is known or thought to bear faded or obliterated text, it may be examined by optical, electro-optical, photographic or digital methods, but only after it has been determined that the process presents no risk to the item.

C.2 Optical and reprographic methods

C.2.1 Principles

As there are reliable text books on optical and reprographic methods of recovering faded text, **C.2.2** and **C.2.3** deal with general principles rather than detailed methods. Any method that requires illumination to an extent likely to cause further fading of the text or to cause the document to be physically changed by heat should not be used.

C.2.2 Impressions

If the writing instrument has left impressions on the document although the ink has been lost, it might be possible to detect the writing by glancing light illumination, i.e. a flat beam of light almost parallel to the surface of the document, to photograph traces of writing, to reveal them by photocopying the document, or to aid viewing using a digitally enhanced image.

C.2.3 Residual compounds

Chemical change of ink can leave residual compounds that have the property either of fluorescing and emitting radiation at a wavelength different from, and always longer than, that of incident light, or of specifically absorbing incident light or quenching fluorescence. It might then be possible to detect the writing visually or photographically, provided that some contrasting emission or absorption of light can be created, with photographic film that is either especially sensitive or insensitive to certain wavelengths of light or is insensitive beyond a limited wavelength; in addition, filters that specifically pass or absorb various wavelengths of light may be constructed.

Annex D (informative)

Organic solvents

D.1 Use

Organic solvents may be used for localized relaxation, as a vehicle for consolidants and adhesives or to remove impurities or unsuitable material. Organic solvents may be used in their own right, or where water is to be avoided or is unsuitable. They may be used in mixtures to modify action, or to aid the penetration of other liquids (e.g. as a wetting agent).

D.2 Selection

Organic solvents should be selected according to the task, with reference to relevant literature and following testing of media and the substrate for sensitivity.

When using organic solvents to remove adhesive and adhesive tapes, the polarity of the solute is a useful guide as to which solvent will be most effective with least effect on the substrate. Charts that plot the bonding behaviour of different solvents can be a useful guide during treatment. A valuable testing sequence to establish the polarity of the solute is water followed by industrial methylated spirits, acetone and toluene. A range of methods are available for the application of solvent. Care should be taken to avoid the spread of dissolved matter within the substrate.

D.3 Recommended solvents for removal of pressure-sensitive adhesive tape

Often no single solvent will remove pressure-sensitive adhesive tape. Ketones, alcohols, toluene, white spirit or amyl acetate may be tried. A solvent with a high boiling point such as white spirit can often be used to retain a solvent with a low boiling point such as acetone. It might be helpful to wet a pad of cotton wool with solvent and leave it on the substance to be dissolved for some time; it should be removed while still wet.

D.4 Purity

Solvents are obtainable commercially in a form pure enough for conservation work; reagent grade is usually satisfactory.

Industrial methylated spirits is used for routine document repair work. If a pure solvent is required, either methanol or propan-2-ol is an adequate substitute for industrial methylated spirits. Mineralized (coloured) methylated spirits should not be used.

D.5 Acidity

Many organic solvents, particularly alcohols, dissolve appreciable quantities of carbon dioxide, which gives them for conservation purposes, a misleading acidity. Apart from chlorinated hydrocarbon solvents, they are normally quite free from the strong inorganic acids that would be harmful. If it is necessary to ensure that no harmful acidity is present, the solvent should be shaken with a little powdered sodium hydrogen carbonate (sodium bicarbonate) or calcium carbonate in a suitable container, e.g. a separating funnel, any excess pressure caused by the evolution of carbon dioxide released and then the insoluble residue filtered off. For old chlorinated hydrocarbon stock, the solvent should be shaken with a little water in a separating funnel, any excess pressure released and the aqueous layer discarded before the sodium hydrogen carbonate or calcium carbonate is added.

D.6 Precautions

Attention is drawn to the COSHH Regulations 1994 [2].

D.7 Disposal

Advice should be sought about safe methods of disposing of waste solvents. If the solvents are hazardous, local authorities should also be consulted.

Annex E (normative)

Consolidation and fixing of pigments

Consolidation or fixing of pigments is described as the application or regeneration of the binding material to improve cohesion of loose or friable medium, re-attaching it if necessary to its support.

Examples of damage requiring treatment include the separation of various pigment layers, cupping of paint, cracked, flaking and dessicated binding media.

The investigation to establish the condition of pigments, as well as choice and suitability of any possible treatment, should be carried out with the aid of a microscope.

When choosing a consolidant the most important consideration should be the effect it will have on the pigment/medium being treated, in particular colour change, shrinkage, surface appearance, as well as the strength of adhesion. The processes used are usually not reversible. Multiple applications of consolidant increases the likelihood of pockets of concentration, leaving it visible over the surface of the pigment. Re-application of the consolidant should therefore be avoided to prevent damage. The consolidant used should be of a reasonable density. It can be applied in a number of ways, however, greater control of the consolidant can be achieved by application with a very fine (size 000) sable brush using a microscope. Mechanical techniques which introduce the consolidant in the form of a mist are also used when larger areas are being treated. Care should be taken when using such equipment to avoid over-wetting, or the deposition of large droplets of moisture.

Particular care should be taken if gold or silver has been used. Gold and silver were beaten to form leaves which were in turn applied over size (glue) or a bole (clay) or a gesso layer of white chalk, plaster etc. with a binding medium and burnished. Gold and silver could also be ground up, mixed with a medium, then used like paint or ink (shell gold). This was painted or penned on after other pigments that might have been used, particularly when used for highlighting. Because silver tarnishes easily it was not often used for illumination.

Temporary and localized fixing of some fugitive writing inks may also be carried out to enable aqueous or non-aqueous treatments to be applied.

Annex F (normative)

Determination of the pH value of paper

F.1 General

Methods suitable for testing original material are given in F.2 and methods suitable for repair material in F.3. The pH value is measured either with a pH meter using glass/calomel electrodes or with indicators colorimetrically evaluated against a reference standard.

Different areas of a document or volume will give different pH readings (e.g. edges are likely to have a lower pH than the central areas of a sheet). Several readings should therefore be taken.

F.2 Original material

F.2.1 Method 1

This method uses a pH meter fitted with flat-surface glass/calomel electrodes

Lay a piece of clean, dry glass under the paper being examined. Add one or more drops of gas-free (boiled-out) water, to ensure good electrical contact between the paper and the electrodes and between the electrodes themselves. Touch the wetted surface of the paper with the flat-surface glass/calomel electrodes. Record the pH value when the meter gives a steady reading.

F.2.2 Method 2

Add a drop of water to the paper. Place a fragment of non-bleeding indicator strip on the wet part and press. Record the pH value corresponding to the colour change of the indicator.

F.3 Repair material

F.3.1 Method 3: Cold extract

Macerate 2 g of the paper, reduced into small pieces untouched by hand, with 100 ml of gas-free (boiled-out) water in a stoppered flask and leave to stand for 1 h at 20 °C. Shake the flask at least once during this time. Decant the extract into a small beaker and measure the pH of the solution using a calibrated pH meter with an appropriate electrode in accordance with BS 2924-1.

F.3.2 Method 4

Detach a fragment of the paper, about 1 mm across, and with a clean needle agitate it in one drop (about 0.05 ml) of indicator solution placed on a white glass surface. Determine the pH value of the solution from its colour. For this method the indicator solutions need to be:

- a) very dilute, approximately 0.1 g/l, and have been adjusted to a pH value corresponding to the mid-point of the colour change range;
- b) kept in chemically resistant bottles in the dark, because they might be unstable.

F.3.3 Method 5

As a rough sorting test, apply an indicator solution to repair paper to determine whether it is very acid, not very acid or alkaline. The concentration of the indicator solution should be about 0.5 g/l, with water or ethanol as solvent, and its pH value adjusted to the mid-point of the colour change range. The accuracy of the test is limited, because it is affected by the colour of the paper and the comparatively concentrated solution required to produce a readily visible coloured spot.

Annex G (normative)

Cleaning and consolidation of seals

Seals can be cleaned with a 1 g/l solution of non-ionic detergent in water, using a short, non-abrasive, natural bristle brush. The seal should then be rinsed and left to dry. Detached seals in a powdery or flaky condition should be immersed, preferably using a vacuum desiccator, in a 2 % mixture of propolis and glycerol in ethanol. Propolis is now seen by many conservators to be the most suitable consolidant as it is produced by bees and highly compatible with beeswax. The added advantage is that it can be applied in layers directly to the surface of a seal using a soft brush.

Annex H (normative)

Solutions for deacidification

H.1 General

The choice of solution will depend on the paper and other materials, including text and colouring matter, of the document to be deacidified, and on safety considerations, e.g. if organic solvents are used, and on the facilities available.

Test all materials of a document for reactivity (according to the principles of 4.4 and the methods given in Annex A) before the solution is applied.

H.2 Determination of concentration

Although deacidification solutions are normally used in large excess and need not be made up to a predetermined concentration, it might be helpful to know the concentration of a deacidification solution, either to check the method of preparation used or to find out whether it has deteriorated in storage.

H.3 Preparation and use

The solutions should be used as follows.

- a) *Calcium hydroxide*. Immerse the paper in a 1:1 mixture of a saturated filtered solution of calcium hydroxide (approximately 2 g/l) and water for at least 30 min.
- b) *Calcium hydrogen carbonate*²⁾. Immerse the paper in a 2 g/l filtered solution of calcium hydrogen carbonate for 20 min.

²⁾ Calcium hydrogen carbonate is the same as calcium bicarbonate but the former is the preferred term.

c) *Calcium hydroxide and calcium hydrogen carbonate.* Immerse the paper in a saturated filtered solution of calcium hydroxide (approximately 2 g/l) for 20 min, then place it in a 2 g/l solution of calcium hydrogen carbonate for a further 20 min.

d) *Magnesium hydrogen carbonate.* Immerse the paper in an approximately 4 g/l filtered solution of magnesium hydrogen carbonate for 20 min.

Magnesium hydrogen carbonate and calcium hydrogen carbonate may be prepared by bubbling CO₂ through a solution of 4 g of either magnesium carbonate (light) or calcium carbonate in 1 l of de-ionized water. This can be achieved either by producing small quantities of CO₂ in a soda siphon or larger quantities through the use of a CO₂ cylinder.

Annex I (informative)

Maps and scaled drawings

I.1 Hand-made paper

Since the effect of humidity changes on maps or drawings produced on hand-made paper is to distort them approximately equally in all directions, provided that no undue stress is applied during repair or mounting, the ordinary scale on the map or drawing may be used in any direction of the paper.

I.2 Machine-made paper

Maps and drawings produced on a machine-made paper tend to distort unequally, the movement being greatest across the machine direction. If a map is gridded, measurements of distances between points on the map should be calculated from the grid references of those points if the highest accuracy is required. The extent of the distortion of the map may be determined by comparing the measurements of the grid in both directions of the paper and, if this is found to be negligible, the scale printed on the map may be used in both directions. An external scale, e.g. a ruler, should not be used to determine distances directly on the map without reference to the printed scale unless this has been shown to be free from error in both directions of the paper.

If a map is produced on a machine-made paper without a reference grid, the utmost caution should be exercised in using the scale on the map in any direction of the paper other than that along which the scale lies.

I.3 Parchment

Maps and drawings on parchment might be expected to distort unevenly and unpredictably, especially when the parchment is unrestrained. For this reason, it is desirable that some degree of control is imposed. However, this control should be gentle enough not to put the parchment under undue strain, which might lead to damage.

Annex J (normative)

Adhesives

J.1 Natural adhesives

The adhesives traditionally used in the repair of documents are based on wheat, common rice starch or mixtures of them, or parchment or purified gelatin. They are chemically safe if made from materials of good quality, e.g. starch of BP quality. For additional information see BS 1133-16.

J.2 Synthetic adhesives

Adhesives such as the cellulose ethers, acrylics, ethylene vinyl acetate and polyvinyl acetate resins are commercially available in many grades. It is important that the correct grade is obtained. Polyvinyl acetate emulsion adhesives should not be used.

Proprietary adhesives of known composition which have been tested for long term stability should be used.

J.3 Desirable qualities

Adhesives used in the repair of documents should be:

- a) of pH value near neutrality, i.e. within the range 6 to 9;
- b) colourless and not liable to subsequent discoloration;
- c) not liable to cause extreme dimensional changes;
- d) not liable to cross-linking with the production of insoluble compounds;
- e) not liable to affect any colouring matter on the document, on their own or in conjunction with the solvents needed for their removal;
- f) readily removable without damage to the document.

Annex K (informative)

Enzymes

K.1 General

The use of enzymes should only be considered when other methods have failed.

Most enzymes are highly specific in their action. They may be used to remove old repairs and residual adhesives based on starch or protein provided that the image is not water-soluble; α -amylases are used to remove starches and proteases to remove proteins. Account should be taken of the binding medium of the ink or pigment if it is starch-based and starch is being removed, or protein-based if protein is being removed. Additionally, account should be taken of whether the size content of the paper is starch or protein based.

Enzymes are most effective when used in controlled conditions. Enzymes with a known quality and activity should be chosen which contain no substance harmful to the document.

K.2 pH value

The enzyme chosen should be active at a near-neutral pH value and be prepared for laboratory use with a relatively high activity. If the temperature at which the enzyme is used exceeds 40 °C, control of the pH value of the solution becomes more important.

K.3 Temperature

Enzymes double their activity with each 5 °C rise in temperature. Above 40 °C they continue to increase their activity, but become increasingly unstable until the heat denatures them. The temperature of denaturing varies with different enzymes.

K.4 Buffer solution

A buffer solution and water may be used to maintain the optimum pH value, but even small traces of heavy metal (zinc, copper, mercury), fungicide or solvent can deactivate enzymes. Primary alcohols are reversible inhibitors that make enzymes precipitate.

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³⁾ Available from Stockholder of Publications: 77 Raingate Street, Bury St Edmunds, Suffolk IP33 2AR. Tel: 01284 352350.

⁴⁾ Available from Abbey Publications Inc., 7105 Geneva Drive, Austin, TX 78723, USA. Email: abbeypub@flash.net. Web site: <http://palimpsest.stanford.edu/byorg/abbey>.

⁵⁾ Available from the American Institute for Conservation of Historic and Artistic Works, 1717 K Street, NW, Suite 200, Washington, DC 20006, USA. Web site: www.palimpsest.stanford.edu/aic/.

⁶⁾ Published by the Getty Conservation Institute in association with the International Institute for Conservation of Historic and Artistic Works.

⁷⁾ Available from the Canadian Conservation Institute, 1030 Innes Road, Ottawa ON K1A 0M5, Canada. Email: cci-icc_publications@pch.gc.ca. Web site: www.cci-icc.gc.ca.

⁸⁾ Available from The Getty Conservation Institute, Getty Trust Publications, 1200 Getty Centre Drive, Suite 700, Los Angeles, California 90049-1684, USA. Web site: www.getty.edu/.

⁹⁾ Available from the United Kingdom Institute for Conservation of Historic and Artistic Works (UKIC), 109 The Chandlery, 50 Westminster Bridge Road, London SE1 7QY. Email: ukic@ukic.org.uk. Web site: www.ukic.org.uk.

¹⁰⁾ Available from the Society of Archivists, 40 Northampton Road, London EC1R 0HB. Email: societyofarchivists@archives.org.uk. Web site: www.archives.org.uk.

¹¹⁾ Available from The Institute of Paper Conservation (IPC), Leigh Lodge, Leigh, Worcester WR6 5LB. Email: information@ipc.org.uk. Web site: <http://palimpsest.stanford.edu/ipc/>.

¹²⁾ Available from Carfax Publishing, Taylor & Francis Ltd, Customer Services Department, Rankine Road, Basingstoke, Hants RG24 9PR, UK. Email: enquiry@tandf.co.uk. Web site: www.tandf.co.uk.

¹³⁾ Available from the International Institute for Conservation of Historic and Artistic Works, 6 Buckingham Street, London WC2N 6BA, UK.

¹⁴⁾ Available from the IFLA PAC, Bibliothèque nationale de France, 2 rue Vivienne, 75084 Paris Cedex 02, France. Web site: www.ifla.org.

Web sites

Conservation DistList (ConsDistList): consdist-request@lindy.stanford.edu
consdist@lindy.stanford.edu

Conservation Information Network (CIN) containing the international Bibliographic Database on Conservation (BCIN) managed by the Canadian Heritage Information Network (CHIN) and initiated by the Getty Conservation Institute: www.chin.gc.ca

The Conservation link: www.museion.net/k11/kons/main_e.htm

Conservation OnLine (CoOL): www.palimpsest.stanford.edu/

Conservation research discussion list: conservation-research@jiscmail.ac.uk,
www.jiscmail.ac.uk/user-manual.htm

National Preservation Office: www.bl.uk/npo/ or www.bl.uk/services/preservation

Northeast Document Conservation Centre: www.nedcc.org/

Solinet Preservation Service: www.solinet.net

