Code of Practice for the Recovery of Flood Damaged Buildings

1 DEFINITIONS

For the purpose of this document, the following definitions refer:

BLACK WATER (sewage)
Water containing bodily or other biological wastes, such as from toilets or drains.

CAPILLARY MOISTURE
Moisture held in the capillaries of a material, and which exerts no positive pressure on the structure.

CAVITY DRAIN MEMBRANE
Dimpled, flexible, high-density polyethylene (HDPE) or polypropylene sheets, which can be placed against the internal face of the structure after construction and used to control infiltrating water.

CONDENSATION
The process by which water transitions from a gas (or vapour) phase into a liquid phase.

DAMP PATCH
Area which, though visibly damp has no surface water.

DRYING PHASE
The period of the flood recovery process between the initial strip out and reinstatement when flood, water is being removed from the fabric of the building.

ESCAPE OF WATER
The unplanned escape of water from services or plumbing resulting in water flowing through the building.

Damage that results from a release of water is often managed in the same way as a flood however, as the water is usually present for a short period of time, the extent of rectification and drying can be less than for a flood or inundation.

FLOOD
An overflowing of water on an area normally dry. Inundation, deluge or other source of water that can damage the fabric of the building.

FLOOD RESILIENCE
Materials and construction methods that can perform as designed after being subjected to a flood can be described as being flood resilient.

FLOOD RESISTANCE
Buildings that have an ability to resist the ingress of flood water can be described as flood resistant.

FREE WATER
Water that is not held chemically or physically within the structure or material of a building.

GREY WATER
Non-industrial wastewater generated from domestic processes such as washing, laundry and bathing.

HYDROSTATIC PRESSURE
Pressure created by a static head of water.

INTERSTITIAL CONDENSATION
Condensation occurring within the structure as opposed to surface condensation.

PLASTER
Any applied coat whose cementing action comes from either gypsum or cement/lime.

PRESSURE
A load that is spread across an area, e.g. hydrostatic pressure.

RENDER
Any applied coat, which is made up of a sand/cement/ lime mix, and can be used for coatings applied internally or externally. It may incorporate accelerators, plasticisers, or other approved additives.

RISING DAMP
Upward capillary movement of water in masonry.

SALTS
Chlorides, Nitrates, Sulphates: These are soluble salts that can be found in the ground or within some building materials.

SURVEYOR
The person responsible for inspecting the flood affected building.

VAPOUR CHECK
Any layer which reduces the passage of water vapour.

VAPOUR CONTROL LAYER
A vapour control layer is a strategically placed vapour check, used where control of water vapour is required.

VAPOUR RESISTANCE
The degree to which a material or structure can resist water vapour.

WHITE WATER
Clean water or water that escapes from a source of drinking water.

WATERPROOF
A material or layer that is impervious to the passage of water.

WATERPROOFING
The application of a material that is impervious to water.

WATER RESISTANT
A material or layer with a high resistance to the passage of water.

WATER VAPOUR
Water in its gaseous phase.

2 FOREWORD

Flooding often represents a personal disaster for the people who are directly affected. The consequences of any flood can have a significant impact on those affected, emotionally, physically and financially.

It is important that any professional involved in the recovery of flood affected buildings understands this to ensure the needs of the individual can be accommodated as part of the overall flood recovery package.

It is essential that all agencies involved in the recovery process deliver assistance while resisting the temptation to rush or cut corners. Doing so may well subdue distressed occupants in the short term but is very likely to lead to defects later.

3 THE OBJECTIVES

3.1 General consideration

This document is aimed at:

- Providing guidance for insurers, their agents, contractors, surveyors and other specialists involved in the recovery of buildings affected by flooding or the uncontrolled release of water in building.
- Offering guidance to people directly affected by flooding to help them understand the recovery process.
- Diagnosing the nature and extent of the recovery works that may be necessary in a sensible and professional way.
- Providing a framework to for a structured recovery plan.
- Minimising the risk of future consequential defects.

The PCA seeks to promote best practice and thus help to reduce the time between the flood and reoccupation.

Where the principles set out in this code of practice are adopted, the frequency and severity of defects that can occur in the post flood rectification works will be minimised.

4 STANDARDS

4.1 Product certification

As a general principle, materials used in the recovery of flood affected buildings should usually hold a current British Board of Agrément Certificate or have accreditation through appropriate independent testing.

4.2 Complementary codes and standards

The following codes/specifications are directly relevant:

- BSI PAS 64. Professional water damage mitigation and initial restoration of domestic dwellings. 2006.
- BRE. Repairing flooded buildings an insurance industry guide to investigation and repair. 2006.
- English Heritage. Flooding and historic buildings. 2004.
- BRE. Repairing flood damage, a set of 4 guides. 1997.
- BRE Digest 245. Rising damp in walls diagnosis and treatment. 2007.

5 TRAINING

All surveying and site staff must receive training and instruction commensurate with their duties.

Work connected with listed or other historic buildings must be guided by conservation officers or practitioners who understand the technical and legal implications of working on protected structures.

Note: General advice on training and training courses for surveyors and technicians is available from the Property Care Association. www.property-care.org

6 HEALTH AND SAFETY AT WORK

Legislation requires every employee to be responsible, in so far as reasonably practicable, for the provision of a safe working environment, the provision of appropriate safety equipment and instruction, training and information on the safe use of plant, equipment and materials necessary for the job.

Employees in turn, have an obligation to make proper use of the safety equipment provided and to act upon the information and training given to ensure their own safety and that of others who may be affected by their acts or omissions.

6.1 General risk assessment

A suitable and sufficient risk assessment should be made by a suitably trained and competent person before inspection or recovery works are undertaken. The information contained in this Code of Practice may assist in the formulation of such a risk assessment.

7 INITIAL ASSESSMENTS

To achieve the best outcomes it is strongly recommended that an adequately trained and competent specialist surveyor forms part of the recovery team from the outset. The individual should be fully conversant with the process of recovery detailed in this Code of Practice.

The surveyor should have the relevant expertise to provide assistance in the management and delivery of

the flood recovery process. Members of the PCA Flood Restoration Group are able to offer such services.

7.1 Understanding the flood

Before any site investigations begin, the nature and extent of the flooding event should be established. This information may be gathered from many sources.

Immediately after a major flood, an accurate account of the events may be difficult to obtain so, where information is provided, it is worthwhile checking alternative sources of information for corroboration.

The following facts should be established as soon after the event as possible.

7.1.1 What was the source of the flood water?

Establishing the source of the water is important in order that the risks associated with contamination can be assessed and the appropriate action taken.

Flooding for example may have resulted from one or more of the following:

- Surface run off
- River overflow
- Tidal surge
- Burst water main
- Sewage system failure
- Leaking pipes or appliances

The possibility that the water came from one or more sources must be considered.

7.1.2 Has the building been contaminated by agents carried in the water?

Establishing the presence of contamination is extremely important and will dictate the way that the property is managed at all stages of the recovery process.

Common forms of contamination include.

- Black water/grey water
- Oil or chemical contamination
- Sea water
- Biological
- Silt, soil and sand

Though white water may not contain contaminants as it escapes it may pick up contaminating materials as it passes through or over the ground or building fabric.

7.1.3 How long was the building flooded?

This is important when assessing the amount of water that may have been absorbed into the building materials.

7.1.4 How high did the floodwater reach and what were the flow rates of the water?

This should be considered when assessing the risk to the property of structural defects associated with the pressures exerted onto the building during the flood.

Where there is any uncertainty in relation to the structure or there is evidence the building has been flooded to a height greater than 0.9 metres or in cases where there is evidence of movement or cracking to structural elements, then the services of a structural engineer must be sought before any other recovery operations are put into effect.

Ignoring the structural consequences of the flood could pose a serious health risk to site workers and occupants as well as leading to inadequate repair strategies.

7.2 Understand the building

In order to determine the best methods to adopt in the recovery of a flood affected building it is essential that the practitioner has a good understanding of the building and its history.

7.2.1 Flooding history

Knowing that the building has a history of flooding can be very useful. Buildings that flood periodically will probably have been repaired several times. This can result in the use of a great many construction materials and repair techniques, all of which may have an effect on the way the property dries and is subsequently repaired.

Repeated flooding can introduce significant amounts of salt or other contaminants into the building fabric that will need to be considered when drying and formulating repair strategies.

7.2.2 Site condition location and access

The location and accessibility of the site can be an important factor in determining a strategy for repair. The availability of power and clean water must also be a consideration.

7.2.3 Construction methods

The way that the building has been constructed needs to be established. It is crucial to have some knowledge of the construction methods that may have been used in the building.

For example, external brick walls may be of solid or cavity construction and may vary greatly in thicknesses and design. A cavity wall consisting of two independent leaves of brick separated by an unobstructed cavity can, in certain circumstances, be reinstated quite quickly as it may be possible to dry the internal leaf of masonry leaving the external leaf of brickwork to dry slowly.

Walls consisting of two leaves of interconnected bricks forming a solid brick structure or a cavity wall filled with insulation may, on the other hand, require a far more cautious approach.

7.2.4 Construction materials

Establishing the range and locations of construction materials that have been utilised within the building can be very important. The materials used to build the walls and floors are usually of greatest significance.

Knowing what materials have been used in the construction of the building will provide an indication of the densities of these materials, their drying characteristics, and their susceptibility to water damage. This information will also assist with locating voids and other water retaining spaces within the fabric of the building.

Where historically or architecturally important materials are encountered, it will be necessary to seek guidance on the characteristics and recovery of these materials from the local conservation officer.

7.2.5 Previous repairs and alterations (Damp-proofing, Timber preservation treatments)

Historic repairs and alterations may influence the way in which a flood affected building is treated.

The presence of a chemical DPC will usually indicate a historic problem with rising damp and even though this may be unaffected by the flood, the presence of ground salts within the structure should be a consideration.

Buildings that have been affected by dry rot (Serpula lacrymans) in the past may have a substantially increased risk of further outbreaks of this fungus if the property becomes wet for any reason. It is good practice to make enquiries with the client or property owner to establish the existence of any previous outbreaks of dry rot. For further guidance see section 12.5.1.

Extensions and additions to buildings can often result in voids being created between the original structure and the newer addition. Extensions can often conceal original drains and service ducts and can restrict ventilation to sub floor areas.

7.3 Understand the client

When trying to achieve a satisfactory outcome, understanding the client requirements is often as important as construction knowledge.

Who is responsible for the costs of flood recovery must be established. In most cases the entity responsible for the payment of any fees associated with flood recovery will be the client.

Establishing service levels with the client should be a priority. Service level agreements and contract agreements should then be subject to written confirmation.

7.4 Special considerations

It is important that any significant construction issues are identified early in the recovery process.

7.4.1 Basements

Rooms that are partially or fully underground are particularly susceptible to flooding and may remain under water for significantly longer than rooms above ground level. In basements that have been waterproofed to make them suitable for occupation, floodwater could affect the wall finishes and insulation materials incorporated in the design. It is also possible for flood water to become trapped in voids created by waterproofing works below ground. Examples include water within the dimples on what is usually the dry side of cavity drain membranes, below floors and behind stud walls.

7.4.2 Historic buildings

Buildings that are listed or have important architectural features may be subject to strict controls and it should be stressed that these remain relevant in flood recovery. Before any work is undertaken in such properties relevant interested parties, such as the local conservation officer must be contacted and consulted to ensure an appropriate course of action.

On no account should any stripping out or forced drying work be undertaken until consultation with the appropriate authority has taken place.

7.4.3 Electrical systems

Flooding will, in most cases, damage or interfere with electrical supplies within the affected property or district.

It is important therefore, that electrical supplies are inspected and declared safe by an appropriately qualified electrical engineer before any electrical systems are re-energised.

7.4.4 Gas services

Water can extinguish pilot flames and can damage gas appliances. It is important therefore, that an appropriately qualified gas engineer inspects and re-commissions the gas supply after the flood.

8 SURVEYING & INVESTIGATION

8.1 Communication

It is common for a number of individuals and agencies to be involved, in some way, in the flood recovery process. Those involved are likely to include insurers and their agents, loss adjusters, tenants, landlords and the local authority.

Establishing good lines of communication with third parties and the client will assist with the decision making process and will help reduce misunderstandings, disputes, and delay, and in turn costs associated with these problems will be minimized.

When communicating with the occupiers of flood damaged buildings it should be remembered that the circumstances surrounding the flood event may have been traumatic and shocking. Victims of flooding should be treated with sensitivity. Where flood damage has been severe, occupiers are often forced to vacate the premises during the recovery process. It is important therefore, to ensure that contact details remain current so that communication is maintained.

8.2 Investigation

Ideally, detailed site investigations should begin as soon as possible after the flood has been discovered or

any standing water or toxic contamination has been removed from the building.

An early initial site investigation may be the surveyor's only opportunity to see the building before stripping out work is undertaken. Examining the building at this early stage can provide evidence of construction faults and latent defects that may not be visible when wall coverings, plaster and fixtures are removed.

Undertaking investigations before the drying process has begun will allow the surveyor to understand how wet the building had been immediately after the flood and will assist in establishing a baseline that can be used to monitor the drying process.

8.3 Floors

The surveyor should establish the construction of the floors.

8.3.1 Suspended timber floors

Inspections from above, and where possible, from the void below the floor should be carried out. The surveyor should establish and record the moisture content of the timber forming the floor.

Investigation will often require disturbance to floorboards or ceilings

The surveyor should check for evidence of insect attack or fungal decay which could indicate defects that predate the flood.

Special attention should be paid to timbers where they bear into masonry walls. Air movement is required below any suspended timber floor so the provision of sub-floor ventilation should be given special consideration.

8.3.2 Solid floors

It is acknowledged that there are a wide range of floor designs that are commonly described as solid. For the surveyor to understand how these may have been affected by floodwater it is important to establish how the floor is constructed and the materials used. To discover this, some destructive testing and/or the digging of test holes may be necessary. This is particularly the case in older buildings where construction records are unavailable or visual observations are inconclusive.

The surveyor should establish the following:

- The existence of waterproof membranes incorporated into the floor.
- The presence of voids or hollows within or below the solid floor eg. Block and beam floors.
- The density and porosity of any floor slab.
- The presence of insulation within the floor.
- Has the floor been subject to structural damage caused by the flood (flotation)?
- The presence of screeds (particularly waterproof screeds).
- The moisture content of the slab and screed.
- The presence of reactive or salt sensitive materials incorporated within the solid floor.
- The location of pipes and services within the floor.

8.4 Walls

Both internal and external walls can be built in a huge variety of ways. Walls can be constructed with very dense materials such as reinforced concrete, but very lightweight and porous materials, like aerated blocks or timber, are also common.

For the surveyor to understand how the walls may have been affected by floodwater it is important to establish how the walls have been constructed and the materials that have been incorporated into the structure. In order to establish this, some destructive testing and or opening up may be necessary. This is particularly the case in older buildings where construction records are unavailable, where it is known that particulate insulation is present or where visual observations are inconclusive.

8.4.1 Masonry walls

The surveyor should establish the following:

- The materials that have been used to construct the walls.
- The materials that have been used in wall plaster and finishes.
- The presence of water retaining voids or hollows within the walls eg. Cavity walls, voids formed within bricks and blocks.
- The density and porosity of the walls and the materials forming the joints between bricks, blocks or panels.
- The presence of insulation within the walls.
- Whether the walls have been subject to structural damage caused by the flood.
- Have the walls been rendered or covered with other impervious materials.
- The moisture content of the wall and the wall finishes.
- The presence of reactive or salt sensitive materials within the structure of the wall.
- The location of pipes and other services within the wall.

8.4.2 Timber framed buildings and timber partition walls

Timber framed buildings that have been affected by flooding should be subject to a thorough investigation in order that any water retaining voids and timbers that may be susceptible to fungal decay are identified and located.

In more modern timber framed buildings the use of vapour barriers, waterproof building paper and other impervious materials may result in water being retained within the structure long after the majority of any flood water has been removed. It is essential for the surveyor to consider the possibility of trapped water, and ensure that this can be identified and eliminated. Failure to do so may lead to fungal decay in the structural timbers.

Some opening up and destructive testing will usually be required to ensure that water is not trapped within the structure.

The surveyor must understand that flood water within the fabric of the building can evaporate and condense. This can result in condensate occurring well away from the flood affected section of the building. Walls that are constructed using timber studs or metal formwork walls should be inspected as described above.

Traditional timber framed buildings that are constructed using large section timbers with infill panels of masonry or other traditional materials must be subject to investigation by practitioners with appropriate specialist expertise.

In most cases, materials used in older buildings can be very resilient to flood damage however, it is essential that trapped water is removed as quickly as possible and that timbers do not remain in an excessively damp condition for extended periods.

8.4.3 Built in timbers

Timbers are often incorporated into the fabric of the building in ways that are obvious (exposed lintels) or less apparent (concealed wall plates). The surveyor must be aware of the possibility that timbers that are in direct contact with damp masonry are susceptible to fungal decay. Every effort must be made to locate, expose, and examine timbers that are built into the structure and have been affected by flood water. Prior approval must be sought before any exposure work or destructive testing is undertaken in listed buildings.

8.4.4 Joinery timbers/ fixtures/ fittings

Non structural joinery timbers occur throughout most buildings. It is important to locate and inspect any timbers that have been affected by floodwater.

Composite materials such as some chipboard fibreboard and plywood are damaged easily by floodwater, whereas oil tempered chipboard, water resistant MDF and marine plywood can be more resistant to water damage.

It is important that the surveyor is able to locate any joinery timbers within the flooded area and has knowledge of their durability.

8.5 Latent defects – pre-existing complications

Pre-existing or inherent defects can be overlooked in the initial stages of the flood recovery process. Failure to detect and manage such defects can lead to problems after the property has been repaired and reoccupied.

Eg. Failure to recognise that a wall has been affected by damp penetration resulting from a defective external drain or fall pipe, may lead to a wall being re-plastered without repairing the underlying defect. Ongoing damp penetration, combined with probable salt contamination, will result in dampness and deterioration in the new plaster. Dampness appearing in walls and floors that have been subject to flood recovery can often lead to disputes between the client and the flood recovery agencies.

Some of the common defects that may be encountered by the surveyor examining a flood affected building may include:

8.5.1 Mould growth associated with condensation

Mould or mildew on walls or ceilings may indicate that the building has been affected by condensation before the flooding event.

Mould and mildew can grow very quickly following a flood. If the initial inspection was delayed for even a few days after the flood, mould growth may have resulted from the evaporation and deposition of floodwater.

Where there is evidence that the property was affected by condensation or mould growth that predates the flood, this should be documented and brought to the client's attention.

8.5.2 External drainage

Defects in external drainage systems will lead to water penetration. Roofs, guttering, downpipes, gullies and drains should be subject to inspection in order to ensure that these are in good condition and are functioning effectively.

Defects in the external drainage systems should be rectified as quickly as possible to avoid additional water ingress during the flood recovery process.

8.5.3 Internal plumbing and drainage

Defects in internal plumbing and drainage systems will lead to water damage. Inspection of the internal drainage and plumbing systems will usually be carried out by a plumber. Evidence of any plumbing defects should be reported to the client so that they can be rectified by a suitably qualified plumber.

Where it is known that a property is to remain empty for an extended period, water heaters and boilers should be inspected by a qualified engineer before being decommissioned. The engineer should be asked to identify faults that may be apparent and take steps to minimise problems associated with re-commissioning after a long period of inaction.

8.5.4 Penetrating and rising damp

It may be difficult to identify walls that have been affected by rising or penetrating damp before a flood. The presence of decayed skirting boards, loose plaster, spalling masonry and defective pointing may be indicative of pre-existing defects associated with these types of water ingress.

Masonry walls that have been affected by rising or penetrating damp are likely to have been contaminated by ground salts. This must be a consideration during the drying and reinstatement process.

Guidance on the effects of flooding in walls that have previously been protected by a chemical DPC is available from the Property Care Association.

8.5.5 Insulation and voids

Buildings are constructed using materials and techniques that often result in the formation of voids. These spaces can be difficult to access and can, in some circumstances, retain floodwater for significant periods of time. A good understanding of the materials and construction types is critical to understanding where these water retaining voids may occur and what materials will absorb water vapour.

Some particulate or open celled insulation materials will soak up and retain water. Closed cell insulation materials and free draining insulation materials (polystyrene beads), will not usually retain significant volumes of water within their structure, but may conceal water retaining voids.

It is essential that the surveyor identifies any areas within the building that may contain and retain free water within voids and insulation materials. Such areas should be opened up, inspected and included in the overall drying and repair strategy.

9 RECORDING INFORMATION

The surveyor has a duty to undertake his responsibilities diligently and report on what is found. Furthermore, when dealing with flood affected buildings, it will be necessary to monitor the drying process so that the correct repair strategies can be implemented. The surveyor should therefore have the skills and equipment necessary to measure and record any findings and observations.

Surveyors should be adequately equipped. This will normally include moisture meters(s), floorboard lifting tools, torch, mirror, portable ladder, hammer, chisel, measuring equipment, the means for securing and labelling samples, and a note book. Additional surveying aids may be required in accordance with site conditions. Useful equipment may include ladders, optical boroscope or endoscope, deep wall probes and calcium carbide meter. Digital cameras can be used to provide a photographic record of findings and site conditions.

Initial inspections should aim to establish the condition of the building, the construction methods, and the materials that will be encountered. Investigations should attempt to locate water retaining voids and insulation materials within the structure that retain water and restrict drying.

Quantitative moisture sampling should be undertaken to critical elements of the structure and the results recorded. These results will be used to establish the amounts of water held within construction materials and allow the drying process to be accurately monitored.

In areas where salt contamination is suspected, samples of materials should be taken and sent for analysis in the laboratory.

Salt analysis kits are available for use on site however, they should be used only to establish the presence of salts as results obtained using this type of sampling are not quantitative.

Electronic moisture meters do not provide accurate quantitative percentage moisture contents in materials other than timber. Such measuring devices can be useful for screening large areas of masonry wall or plaster for evidence of dampness, but should not be relied upon when there is a need to measure moisture content accurately within plaster or masonry.

All significant observations and recommendations should be recorded and retained for future reference.

It is not reasonable in most cases to estimate the extent of the likely repairs at the time of the initial investigation. This may only be possible when the process of drying is complete or almost complete.

10 STRIPPING OUT

10.1 Initial strip out

Where soft furnishings, carpets and floor coverings have been contaminated with flood water, these should be removed from site. These items should then be restored or disposed of by the appropriate specialist.

Hard furnishings and composite building materials that are damaged in such a way that prevents economic repair should also be removed from site.

Where timber strip flooring, vinyl, laminates or impervious floor coverings exist, it may be necessary to remove these in order to allow the underlying structure to dry. An assessment should be made of the condition of these materials so that these can be retained for reinstatement or disposed of.

Insulation materials incorporated within masonry and timber walls should be inspected and accessed. In some circumstances these materials should be removed from the building to assist drying, however, before removal of any wet insulation, guidance should be sought from the company responsible for drying the flood affected property.

In situations where flooding has been very severe or where harmful contamination has occurred, it may be necessary to remove and dispose of any timbers and wall coverings that have been exposed to the floodwater.

In most situations the wholesale removal of timber floors and wall plaster is not necessary in the immediate aftermath of a flood. The surveyor, working in partnership with the drying company, should assess the condition of each element of the building and strip out and remove only those items that are either

defective, heavily contaminated, or clearly beyond economic repair.

Some stripping out, removal of wall coverings and opening up may be justified where this can significantly reduce drying times or prevent the deterioration of the building fabric.

10.2 Timber preservatives

Where a flood results in a significant risk of fungal growth in damp timbers, the use of chemical preservatives can be considered. These treatments should only be used in circumstances where structural timbers cannot be dried sufficiently quickly to prevent decay.

Timber preservatives should be applied by suitably trained and competent persons. Care should be taken to ensure preservatives are applied to the timber elements only and that soil and standing water is not contaminated.

10.3 Waste disposal

All waste generated as part of the flood recovery process must be disposed of responsibly, and in accordance with local and national regulations.

Guidance should be sought from the Environment Agency where materials are contaminated with agents that may be harmful to humans or the environment.

11 DRYING

This code will not attempt to provide advice on how to dry buildings affected by floodwater but, will provide guidance in understanding the process of drying and the types of drying in common use.

11.1 Flood drying

Drying in respect of flood recovery can be described as the process of removing floodwater from the fabric of the building.

Problems can occur when drying attempts to remove pre-existing water from the structure, ie water that was not introduced by the flood. This could be rising or penetrating damp or water that occurs within building materials when they are in equilibrium with their wider environment.

11.2 Principle of drying

Energy is required for drying. Energy is used to convert free water into vapour so that this can then be exhausted from within the building. Natural drying can be accelerated by utilising mechanical devices that provide:

- Atmospheric control dehumidification
- Heat
- Ventilation

In most circumstances, combinations of these will be used together. If properly managed, accelerated or focused drying techniques can be very effective at removing flood water in most situations.

The speed of drying will depend on the amount of energy input and the rate at which water vapour is expelled.

11.3 What is dry?

It is not possible to define what dry is as a percentage moisture content for a building. The different materials that combine to form a building contain varying quantities of water when in their dry state. The amount of water held within a dry material may be affected by their condition, density, composition, the presence of salts and may vary with the time of the year.

In most cases it will not be necessary to decide when the building is dry, but it will be necessary for the surveyor to decide when the building is in a suitable condition to allow reoccupation or repair.

The decision to end drying may be dependent on:

- When it is judged that the moisture content of the building has reached equilibrium with the wider environment.
- When the removal of water from the structure is no longer economic or practical.
- When it is judged that the building can be reoccupied without risk to the health and wellbeing of the occupants and there is no further risk of deterioration of the building and its contents.

At the point when the drying phase is complete, it will be possible for the surveyor to accurately assess the full extent of any repair that is required and to draw up a schedule of works that, when completed, will return the property to occupation.

12 MONITORING

12.1 Why monitor?

Monitoring and understanding the way that the building is behaving during the drying process is critical to a successful outcome.

The surveyor must have the skills and experience necessary to enable them to recognise defects, monitor, and test construction materials and interpret the results of these investigations.

Testing should be undertaken using methods and techniques that are robust and that can be repeated throughout the flood recovery process.

The results of these tests and investigations must be recorded in a way that allows easy retrieval and interpretation.

The interpretation of information gathered during the drying stage will assist those responsible for drying to provide an effective and efficient service.

The same information will allow the surveyor to decide when a building has reached a point when drying activities can be stopped, and will influence the materials and techniques that can be used in the restoration of the building.

12.2 Processes and techniques

So that any monitoring can provide meaningful results, the initial survey should establish the condition of the building. Data collected should include an accurate measurement of the water content within the following:

- Structural timbers
- Joinery timbers
- Masonry walls
- Solid floor slabs and screeds
- Retained fixtures and fittings
- Wall finishes (plaster dry lining)
- Retained insulation materials

It is often useful when monitoring, to take a photographic record of the building which can be referred to later.

The results obtained during these initial investigations will help establish a baseline and will enable the drying process to be monitored accurately.

Establishing the air temperature, relative humidity and vapour pressure within the building can prove useful when monitoring the efficiency of the drying process. Atmospheric monitoring can be of limited value when trying to establish and monitor the amount of water in construction materials.

12.3 Monitoring techniques and equipment

12.3.1 Damp testing

The moisture content of building materials can be established using a number of devices and techniques that include:

12.3.2 Gravimetric Method

Drilled samples are taken from the test area and are placed in securely sealed bottles. The total moisture content is then determined by oven drying in the laboratory. By using the detailed technique described in BRE Digest 245, the moisture content, due to the presence of hygroscopic salts, can also be determined.

12.3.3 Chemical method

A sample of standard weight is mixed with calcium carbide powder in a pressure vessel fitted with a gauge. The reaction between calcium carbide and any water in the sample produces acetylene, and the volume produced, is directly proportional to the moisture content of the sample. The gauge is calibrated to give a direct reading of the moisture content of the sample.

12.4 Electrical methods

12.4.1 Conductivity meters

An electrical circuit through the meter is completed by placing two probes on the surface, or by embedding them in the depth of the wall. The electrical resistance of the wall is influenced by the moisture content of the wall. The variations in resistance are then indicated on the meter.

12.4.2 Capacitance meters

Either the meter itself (carrying adjacent conducting plates) or separate head (carrying conducting concentric rings) are placed on the surface where moisture content is to be measured. The meter readings measure the fringe capacitance in the sensor, which is influenced by the moisture content in the wall. Some instruments (of both types) use a flashing light, or audible tones to indicate changes in moisture content, either instead of, or as well as, the conventional meter dial or digital read out.

12.4.3 Atmospheric sampling/relative humidity

It is possible to make assumptions about the water content of materials, (usually floor screeds and concrete floor slabs), by measuring the relative humidity within a confined space that is in equilibrium with the material that is being tested.

This can be achieved by creating a vapour proof tent above the material being tested. The air within the tent reaches a state of equilibrium with the base material. Using the appropriate apparatus, it is possible to record the relative humidity within the trapped air. This, together with temperature readings and knowledge of the humidity and temperature in the surrounding environment, will show if the material is altering the water content of the air within the tent. Elevated relative humidity at similar temperatures will indicate that the material is liberating water and is therefore still drying.

The same tests can be done by drilling into the material creating a void. This space is then sealed before testing data is collected. Proprietary kits are available that can assist in this process.

Further detail can be seen in BS8203 Annex 3 Dampness Testing.

12.4.4 Infra-red/thermo graphic

The use of infra red imaging equipment may help in the detection of water leaks and water present within a building following a flood. The infra red monitor is used to detect temperature variations within the fabric of the building.

In some situations these temperature variations may indicate sections of the property where thermal insulation performance has been reduced by the presence of water. When used in leak detection, infra-red equipment can indicate areas that are heated or cooled by the ongoing escape of water or other fluids.

12.4.5 Real time monitoring

Sensors can be placed within elements of the building fabric or within voids. These can be attached to relays that can allow the building to be monitored remotely. In some circumstances, the testing equipment can be connected to a modem so that information can be accessed via the internet. Temperature, relative humidity, electrical conductivity and vapour pressure can be collected and broadcast in this way.

The use of such equipment can allow the surveyor to gather information at any time and at regular intervals without having to make repeated visits to site. This facility can be very useful when monitoring the drying process, particularly where heat is being used to dry the building and/or when sensitive of fragile building materials are being recovered.

12.5 Monitoring – uses and limitations of monitoring equipment

This equipment must be used and interpreted with great care by competent operators in order to avoid misdiagnosis.

Further information relating to the uses and limitations of damp monitoring equipment is available as a guidance note from the PCA. www.property-care.org

13 REPAIR AND RE-FIT

The point at which the drying phase is stopped, and the process of reinstatement can begin, will depend on a number of variables:

- Moisture content of the retained building fabric.
- The risk of fungal decay or mould growth.
- The general condition of the building and the presence of defects or contamination.
- The materials to be used in the recovery process.
- The way materials are used in the recovery.
- The benefit that will be derived from further drying compared with the cost of continued drying.

The move from the drying phase to the reinstatement phase of the flood recovery process should be made after carefully considering all the relevant factors, including those listed above.

Only in exceptional circumstances should reinstatement work begin whilst any form of forced dying is underway.

13.1 Final strip out

As and when the drying phase is complete, the flood damaged property should be subject to a further evaluation to determine what further elements of the building need to be removed and renewed.

The surveyor should pay special attention to the condition of any retained timbers, plaster, or other wall finishes and any other element of the building that may have been altered or damaged by the flood water, or by the drying process.

Elements of the building that are found to be unsuitable for retention or, are considered beyond economic repair, should be removed.

The surveyor should seek advice from the local conservation officer before disturbing or removing any element of a historic or architecturally important building.

13.2 Reinstatement

It should be remembered that the reinstatement phase inevitably begins with further opening up. At this stage unanticipated defects may be uncovered. These should be reported to the client and his agents and then acted upon. A considerate, flexible approach to the process of reinstatement is advised.

The process of repair and reinstatement may inevitably result in the involvement of several specialist trades. Failures to schedule works correctly can lead to delays and additional cost but may also result in one trade compromising the work undertaken by the other. Eg. A service engineer (electricians or plumbers) may be forced to cut into new plasterwork. This not only leads to additional unnecessary rectification but, unless this repair is carried out properly, the plaster system may be compromised and fail.

Though it is not practical to provide a guidance document that covers all the possible aspects of the reinstatement process, this section of the Code will consider some basic principles that should be born in mind by those recovering flood effected buildings:

13.3 General principles

Impervious materials should not be used in an attempt to permanently seal trapped water into the structure. Water resistant Portland Cement renders or impervious screeds applied to wet floor slabs can have the effect of masking a problem for a short period however the use of such materials can lead to future problems.

If water resistant materials are used on damp walls and floors then consideration must be given to the water that remains within the building's fabric.

Materials that have some resistance to the damaging effects of moisture should be used where significant levels of flood water are known to exist within the building.

Where it is desirable to allow some moisture movement through wall finishes, porous or vapour permeable materials can be used. Where vapour permeable building products are used, these should not be compromised by inappropriate decoration.

Where impervious linings or membranes are utilised to isolate damp masonry from wall or floor finishes, consideration must be given to the effects of any water that may remain trapped behind the membranes, and to the possibility of interstitial condensation.

The use of gypsum plaster or adhesives should be restricted to areas that are suitably dry and are free of any form of salt contamination. This is particularly important where walls have, or continue to be, affected by rising damp or contamination from ground salts.

Decorative finishes can affect the performance of underlying building material. It is essential therefore that guidance on decoration is provided by the contractor or surveyor who provided the specification for the reinstatement work.

Wherever possible, timbers should be eliminated from areas where they can come into contact with damp masonry. Any structural timbers that were removed from the building following a flood, should be replaced with new pre-treated timber, steel or masonry as appropriate.

Where buildings are being recovered from surface water flooding and there is a risk of future flooding, it is wise to consider a recovery strategy that incorporates some degree of future flood resilience/resistance (see section 10)

All reinstatement should be undertaken in accordance with all relevant building regulations and accepted best practice.

13.4 Special considerations

13.4.1 Historic/buildings

When repairing historic or architecturally important buildings any repairs should be undertaken with the guidance of a conservation officer. It is likely that any replacement of the building fabric will be kept to a minimum and the use of materials and building practice similar to those that have been removed will be encouraged or insisted upon.

13.5 Remedial treatment guarantees

13.5.1 Timber

Many older buildings have been treated to protect them from wood destroying beetle infestation and/or timber decay. Flooding may have an adverse effect on the treatments that have been carried out. Where such treatments have been undertaken the original contractor should be made aware of the extent of the flood so that they can recommend any additional remedial action.

Special care should be taken where treatments for the eradication of dry rot have been undertaken. It is the nature of dry rot that it can remain in a relatively inactive but viable state for an extended period of time after being treated. The introduction of flood water can result in new growth months, or even years, after the flood has passed and the building repairs associated with the flood have been completed.

In some circumstances treatment guarantees for wet rots and wood destroying beetles may be withdrawn. It should be expected that any guarantees for dry rot treatments will be withdrawn in areas that have been subject to flooding or water ingress.

13.5.2 Chemical DPC

A chemical DPC that has been installed several months before a flood should remain stable if inundated with flood water. After the flood water is removed from the building the chemical DPC should remain an effective control to capillary rise of water from the ground.

If a flooded property has a chemical DPC the contractor who installed it must be informed. The flooding event may constitute a material change to the building and can invalidate any guarantees that have been issued.

Guidance must be sought from the damp proofing contractor before plasters, and/or renders are removed. In most cases these will form a part of a damp proofing system and their removal can invalidate any guarantee.

Failure to notify the contractor of the flood, making material changes to the wall plaster, or replacing the wall plaster with unsuitable materials, can result in defects and will almost certainly result in the withdrawal of any guarantees that may have been issued.

If the contractor who installed the damp proofing system is no longer trading but the system is protected by insurance, the insurers should be informed of the flood as if they were the installer.

Additional guidance is available from the Property Care Association www.property-care.org.

14 FLOOD RESILIENCE AND RESISTANCE

It may not yet be possible to make an existing building totally flood proof but very high levels of water resistance and flood resilience can be achieved.

14.1 What is flood resilience/resistance?

Flood resilience/resistance is the ability of a building to resist or endure a flood.

This is usually achieved in the following ways:

- Installation of temporary or permanent barriers around the building to prevent water reaching the protected structure.
- Preventing water entering the building by closing openings and creating a water proof outer shell.
- Prevention of water entering the building by closing openings and using a waterproof membrane that is applied to the inner faces of walls and floors.
- Prevention of water entering the building by closing openings then managing and expelling water that has entered the building using channels and pumps.
- The use of building materials and techniques that will not be affected by water and that

assist in the recovery of the building following flooding.
- Positioning water sensitive items above the level of future floodwater.

In most projects where flood resilience is being considered, a combination of the techniques listed is often recommended.

14.2 What can be achieved?

In situations where few design or cost constraints exist it can be possible to achieve very high levels of flood resilience.

In most situations cost and design limitations will exist but it can be possible to significantly reduce the impact of future flooding events without significantly increasing the cost of recovering the flood damaged building.

Future flood resilience should be considered when the flood recovery strategy is being formulated. Making provision for flood resilience at this stage can prove cost effective and will ensure compatibility with the general repairs that are being planned. Members of the flood restoration group of the Property Care Association can provide guidance on what can be achieved and can undertake flood resilient repair.

15 PROBLEM SOLVING

The following is a summary of some of the common problems that are reported by the occupants of buildings that are being recovered from flooding:

15.1 Condensation

Water in the form of vapour is liberated into the atmosphere by occupation and by the evaporation of water from standing water or water held within building materials. Condensation is dampness that is deposited (condensed) from the atmosphere when the dew point is reached.

It is essential to the recovery of the building following a flood that environmental controls are in place to prevent the transfer of atmospheric water to areas where it can condense and cause further damage.

If condensation problems persist after the building has been recovered and reoccupied following a flood, then detailed investigations will be required to determine the causes of any condensation problem. In many cases the condensation will be unrelated to the flood water.

Information guidance and practical solutions to condensation are available from members of the Property Care Association.

15.2 Mould growth

Mould or mildew growth is often symptomatic of an underlying problem or defect, and can be the result of a number of factors. These may include trapped flood water, surface or interstitial condensation, plumbing leaks, water ingress.

If mould or mildew growth is apparent, a thorough investigation of the causes should be made by a suitably qualified surveyor.

15.3 Fungal decay in timbers

Where drying, ventilation or the isolation of timbers is inadequate or inappropriate attack by wood destroying fungi is likely to affect vulnerable timbers.

Where outbreaks of wet rot or dry rot are detected following a flood, it will be necessary to undertake detailed diagnostic investigations. This is necessary in order to quantify the extent of the outbreak, identify and eliminate any source of water, and draw up specifications for treatment.

The identification and treatment of fungal decay in buildings is dealt with in PCA Code of Practice for Remedial Timber Treatment.

15.4 Water marks/damp patches

The appearance of damp patches following a flood is common. This is usually the result of water trapped within the structure migrating to the surface of walls and floors.

In some circumstances these areas of dampness may dry out without causing deterioration to the buildings fabric, however, where they persist or result in the deterioration of finishes, further investigation and rectification work must be considered.

15.5 Damp staining

This can occur when water within the building contains salts or other forms of contamination. The water can transport these materials in solution as it moves through the building, and is often deposited in the wall and floor finishes when the water evaporates into the atmosphere.

Staining that is found to be the result of the deposition of inert particulate matter, may be masked by using sealants.

Where staining is a result of the deposition of hygroscopic salts, this should be subject to proper investigation and, may result in the removal and renewal of contaminated materials.

15.6 Salt deposition

In some circumstances crystals may be deposited on the surface of new plaster coats. In most circumstances these can be removed without causing damage and will only be a problem for a short time after the rectification work has been completed. Where they persist or result in damage to the wall plaster, further investigations and rectification work may be necessary.

15.7 Fluctuations in moisture levels

Building materials sometimes seem to dry down very slowly or not at all. Occasionally walls and floors appear to dry down and then become wet again without any obvious source of new water.

These effects are usually the result of a combination of the following factors:

- An over reliance on the electric conductivity meters.
- The presence of hygroscopic components within the building materials.
- The presence of naturally conductive materials.
- Poor atmospheric control.

This is usually observed in structures that contain high levels of salt or other absorbent or hygroscopic materials. Such materials can retain relatively high levels of water in their normal state.

Some old brickwork can contain relatively large amounts of water when in equilibrium. This can be artificially reduced by the use of drying apparatus. When the atmospheric moisture content rises with the removal of the drying equipment, the brickwork will absorb moisture from the atmosphere and the wall will appear to "wet up".

Where this process is observed, it will be necessary to formulate recovery strategies that make allowance for these elevated levels of water that are essentially bound into the structure.

Misleading observations can also be obtained from materials that are naturally conductive and the primary diagnostic damp monitoring tool is an electronic conductivity meter. The importance of thorough and effective moisture monitoring cannot be overstated.

15.8 Lamination swelling and shrinkage

Materials will naturally absorb and release water as the atmospheric conditions fluctuate. It is important therefore to ensure that construction materials that are susceptible to lamination swelling or shrinkage when exposed to variations in temperature and moisture content, are not used in areas that are not fully dry or cannot be protected from the effects of variations in temperature and moisture content.

Laminate, timber strip flooring and timber wall panelling can be particularly susceptible to the effects of variations in temperature and humidity. It is essential that these are reinstated only when the adjacent structures are known to be "dry" or can be permanently isolated from damp materials.

16 SUMMARY

The recovery of flooded buildings can be a complex process that will inevitably involve a considerable number of professionals and specialists who must work together to deliver solutions.

In this Code of Practice we have provided information that reinforces the need for a holistic approach to the process of flood recovery based on first rate diagnostic investigations good building practice and excellent communication.

The PCA believes that if the principles set out in this code are followed buildings will be reoccupied sooner and problems associated with the reinstatement work will be significantly reduced.

17 PCA TRAINING

The PCA Code of Practice for the recovery of flood damaged buildings highlights the need to engage trained and competent practitioners at every stage of the flood recovery process.

Further guidance and information about training courses is available on the Property Care Association website www.property-care.org

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