Communities and Local Government

Guidance and standards for drying flood damaged buildings

Signposting current guidance – BD2760

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Executive summary

The aim of this research was to address recommendations in the Pitt review to examine the processes involved in drying flooded buildings and the guidance available. These recommendations were based on the belief that the drying process was a major contributor to the delay in reinstating flooded properties following the summer 2007 floods.

Specific objectives of the project were to identify and examine existing guidance on the drying of flooded properties and the current use of such guidance; to produce generic guidance and establish how it could be made more widely available; and to identify areas where knowledge gaps exist.

The research consisted of three elements: an extensive desk based study of existing guidance and other literature related to drying of properties including previous surveys of restoration professionals; interviews with practitioners on the availability and use of guidance; and a workshop of stakeholders in the drying process. The research was overseen by a stakeholder steering group.

The results of the research demonstrate that there is a great deal of guidance available on common methods for drying buildings and on managing and monitoring the drying process. Some of this guidance is available in the public domain free of charge and more is available to buy, but some is proprietary to particular damage management companies. The study has identified the stages in drying (see Figure 1.1) and the key issues associated with the process. A summary of the best guidance to address each issue has been a key output of this study, and can be found in Table 1.1 and 1.2.

There were also gaps identified in currently available guidance in relation to: Initial assessment reports including initial moisture measurement; impacts of speed drying; environmental impact of drying choices; mapping of drying method and time to building type; guidance on factors affecting drying times; improved monitoring methods; drying reports and certificates; health and safety issues during the drying process; communication of the process and protocols between professional partners and between restorers and flooded households. It was also shown that the advice available to householders is sometimes contradictory, particularly in terms of drying times. Current information on ideal drying times provided by restoration professionals is summarised in Appendix 2.

Use of the guidance is generally widespread in the industry. However, during a major emergency the guidance is less widely adhered to, particularly by companies not usually engaged in this type of activity. Therefore a new guidance document would be welcomed by the industry, which if developed, should be readily accessible, should signpost more detailed information where necessary and should address some of the gaps identified in the existing guidance. Alongside this was a need for clear and consistent guidance for the public which would allow them more quickly to take the right actions in the immediate aftermath and to know what to expect from the reinstatement process. A detailed summary of current guidance by topic can be found in Section 6.2 of Appendix 1.

Addressing the identified gaps in the existing guidance is outside the scope of this project, which has found that lack of adequate drying guidance should not in itself cause the delays in re-occupying homes. This report, therefore, addresses the objective of signposting existing guidance while recommending that the identified gaps be addressed by further work, and that new guidance is prepared once these issues have been addressed.

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1 Introduction

This project has been concerned with a review of the issues associated with the drying of buildings following a major flood, and whether new guidance would improve the perceived problem of delays in householders re-occupying their homes. The project came about as a result of the Pitt Review into the summer 2007 floods, and the recommendation for Government, Insurers and other stakeholders to investigate the apparent problems in the drying and re-occupation process. This project has therefore undertaken a comprehensive review of guidance and other technical documents on the restoration of flooded buildings (see Appendix 1), and together with views from stakeholders (via consultations and a workshop – see Appendix 2) has reached a view on what are the substantive issues. In summary (see the Stage Report in Appendix 3), the delays in re-occupation that have occurred after major flooding are not just the result of problems in the drying process. A general shortage of competent damage management contractors and other key stakeholders (including loss adjusters, chartered surveyors and specialist drying firms) following a major event also contribute to delays. The responsiveness of the different participants (insurers, loss adjusters, surveyors, contractors, etc.) as well as the time needed for the repair and redecoration phases following drying are other factors that need to be considered.

Figure 1.1 shows the various stages that occur following a flood and before properties can be re-occupied, and where different organisations play a role. We have shown local authorities as having a role throughout the whole process, but this only applies where they are the property owner. For private dwellings, they may only have an advisory role in the immediate aftermath of the flood (in addition to their regulatory role through the Building Regulations). The literature review showed in general that existing documents do provide much of the guidance needed for an effective drying and restoration process, covering the phases in Figure 1.1, although the most useful information is not in one single document. Tables 1.1 and 1.2 summarise the main issues covered by the key documents reviewed in this study (taken from Appendix 1). The stakeholder workshop endorsed the view that new guidance would be welcomed if it provided this collation function, and also addressed the perceived weaknesses of poor communication between organisations and with the householder. There also exists some debate among members of the damage management sector with regard to the level of strip-out needed following the drying phase with some firms preferring to attempt careful drying of flood affected materials and elements and others preferring to remove (and therefore replace) these. Some definitive and well-founded guidance in this respect, acknowledging that each property needs to be considered on an individual basis and that no one solution fits all, would really serve the industry well.

However, following an extended break in the project between March 2009 and January 2010, DCLG and Defra have now confirmed that it would be premature to develop new guidance, given what already exists, and that instead a final report should be produced to summarise the work undertaken and possible future research needs. Therefore this report provides a short summary for each of the main stages involved in drying and restoring buildings, and a review of existing guidance and practice. The report also provides clear ‘signposting’ of the key documents for each stage and also the areas where further work or guidance could/should be considered. It therefore provides a clear summary for the type of guidance document envisaged by the key representatives who attended the stakeholder workshop.

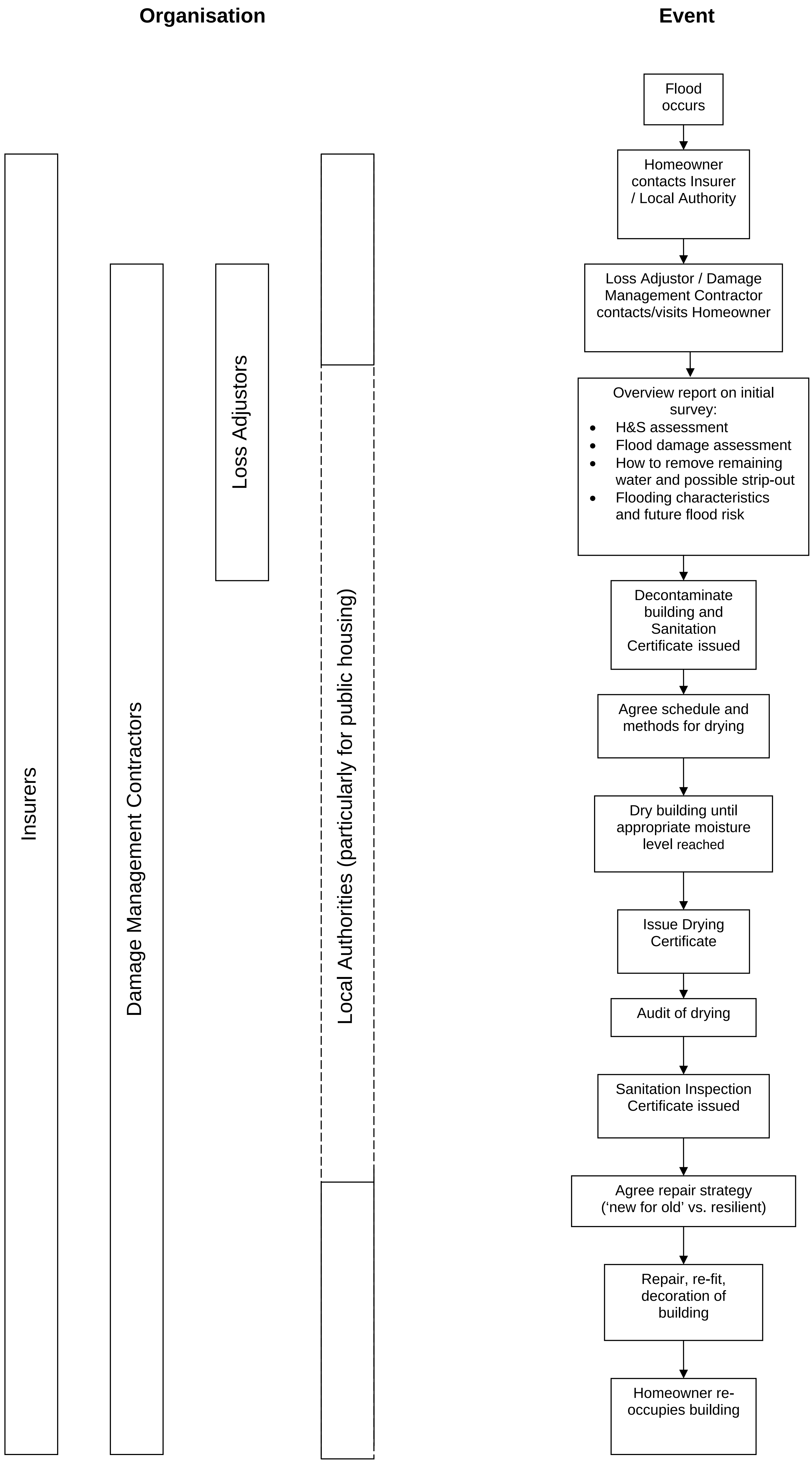

Figure 1.1 Stages in restoration of flooded buildings

Table 1.1 Summary of how documents address major issues – Guidance Documents

Issue	BRE (1974)	BRE GRG 11 – 1 (1997)	BRE GRG 11-2 (1997)	BRE GRG 11 – 3 (1997)	ODPM (2003)	PAS 64 (2005)	CIRIA (2005)	RFB (2006)	BDMA (2007)	EA leaflet (2007)
Advice to homeowners	**✗**	**✓**	✓	✓	**✗**	**✗**	**✓**	**✓**	**✓**	✓
Advice on emergency organisation immediately after flood	**✗**	**✗**	**✗**	**✗**	**✗**	✓	**✓**	✓	**✓**	✓
Survey of property after flood (including flood characteristics)	**✗**	**✓**	**✓**	✓	✓	✓	**✓**	**✓**	✓	✓
Assessment of stakeholder needs and drying goals	✓	**✗**	**✗**	**✗**	**✗**	✓	✓	**✗**	**✗**	**✗**
Options for drying	**✓**	**✓**	✓	✓	**✗**	**✗**	✓	**✓**	**✗**	✓
Equipment / process to use based on flooding / property type	**✗**	**✗**	✓	✓	**✗**	✓	✓	✓	**✗**	**✗**
How to measure and record moisture (when is it 'dry')	**✓**	**✗**	✓	✓	**✗**	**✓**	**✓**	✓	✓	**✗**
Health and safety aspects (including vermin)	✓	✓	**✗**	**✗**	**✗**	✓	**✓**	✓	✓	✓
Links between drying & repair contractors (& homeowner and insurers)	**✗**	✓	**✗**	**✗**	**✗**	✓	**✓**	**✓**	**✗**	**✗**

Notes:

Symbol in bold black denotes guidance is given that fully addresses the issues

Symbol in grey denotes some but insufficient guidance

Legend:

BRE (1974) -

BRE GRG 11 – 1 (1997) – BRE Good Repair Guide 11 Part 1

BRE GRG 11 – 1 (1997) – BRE Good Repair Guide 11 Part 2

BRE GRG 11 – 3 (1997) - BRE Good Repair Guide 11 Part 3

ODPM (2003) - Preparing for floods. Interim guidance for improving the flood resistance of domestic and small business properties

PAS 64 (2005) – Professional Water damage mitigation and initial restoration of domestic buildings

CIRIA (2005) – Standards for the repair of buildings following flooding

RFB (2006) – Repairing flooded buildings

BDMA (2007) – "Self help for victims of flooding, what you can do" and "Understanding basic flood recovery procedures"

EA leaflet (2007) - After a flood: practical advice on recovering from a flood

Table 1.2 Summary of how documents address major issues – Technical Publications

Issue	Soetanto & Proverbs (2003)	Proverbs & Soetanto (2004)	CIRIA (2005a)	CIRIA (2006)	CIRIA (2007)	Phillipson et al (2007)	Rhodes & Proverbs (2008)
Advice to homeowners	×	**✓**	✓	✓	✓	×	×
Advice on emergency organisation immediately after flood	×	**✓**	✓	✓	✓	×	×
Survey of property after flood (including flood characteristics)	✓	✓	✓	✓	✓	✓	×
Assessment of stakeholder needs and drying goals	✓	✓	✓	✓	✓	×	×
Options for drying	**✓**	**✓**	✓	✓	✓	✓	×
Equipment / process to use based on flooding / property type	✓	×	×	×	✓	×	×
How to measure and record moisture (when is it ‘dry’)	**✓**	✓	×	×	✓	✓	×
Health and safety aspects (including vermin)	×	×	✓	✓	✓	×	×
Links between drying & repair contractors (& homeowner and insurers)	×	✓	×	×	✓	×	**✓**

<u>Notes:</u>
Symbol in bold black denotes guidance is given that fully addresses the issues
Symbol in grey denotes some but insufficient guidance

<u>Legend:</u>
Soetanto & Proverbs (2003) - Methods of drying flooded domestic properties: the perceptions of UK building surveyors
Proverbs & Soetanto (2004) – Flood Damaged Property. A Guide to Repair
CIRIA (2005a) – Improving the flood resilience of buildings through improved materials, methods and details Report no. WP2C Review of existing information and experience
CIRIA (2006) – Improving the flood resilience of buildings through improved materials, methods and details. Report no. WP5C Final Report – Laboratory tests
CIRIA (2007) – Improving the flood resilience of buildings through improved materials, methods and details, Report WP6 - Collation and analysis of post-flood observational data
Phillipson et al (2007) – Moisture measurement in building materials: an overview of current methods and new approaches
Rhodes & Proverbs (2008) - An investigation of the current state of preparedness of the flood damage management sector in the UK: what lessons have been learnt?

2 Property surveys

The *PAS 64 - Professional water damage mitigation and initial restoration of domestic dwellings* provides guidance and recommendations for the restoration of water-damaged buildings and contents. The role of an initial survey is stressed, to assess the type of property (age, materials), the type of flooding (depth, duration) and the setting of a method statement and drying goals based on the degree of damage. This Code of Practice establishes Categories of Water Damage, from Category One (water from a clean source) to Category Four (water from a source that carries significant quantities of pathogenic agents and/or toxic elements). Categories of Risk are also established ranging from Minor (up to 3 rooms) to Major (if 4 or more rooms are affected); subdivisions within the Minor risk category are based on the presence of structural damage or health risk.

Several sample forms are included in the Annex of this code to help the management of the recovery from flood damage. The one that is most relevant to the property survey is the loss assessment form, which contains several useful features but should be revised to include the enhancements given below:

- **Loss assessment form**
  In this form the characteristics of the room being assessed are summarised, including dimensions, temperature and relative humidity, construction materials and coverings. Moisture readings and drying goals are also recorded, as well as the cause of the claim and actions taken by both the home occupier and the loss assessor. Although the PAS 64 recommends that moisture readings are taken on unaffected components to obtain base readings as well as on affected components, the exact nature/location of the moisture readings in the form is not given, apart from whether it is on the floor, ceiling, wall, etc. The form is therefore not entirely clear.
  Recommended enhancements: include the date of the event, the type of flood (river, pluvial, groundwater, etc), the level of the flood water and to specifically include moisture readings on unaffected components as well as on affected ones for comparison purposes and to help set appropriate drying goals; include the category of water damage and categories of risk, as per Annex E.

In "Repairing Flooded Buildings" (Flood Repair Forum 2006) several forms are included. Among them the two following ones, which relate to the property survey, are summarised below together with suggested improvements:

- **Building condition report in respect of flood damage**
  This form collates important information on the building and building services including general descriptions of the walls and floors and existing condition and defects. The form also requests other information which is considered to be very relevant to the definition of the drying measures required; this is the height of flood level and the date of the event.

Recommended enhancement: explicitly request information on the building materials used for the walls and ground floor (rather than a general description). This would aid the estimation of likely drying times based on findings from recent laboratory work (CIRIA, 2006).

- **Report of flooding event**

This form is used to identify the issues involved, to summarise the work carried out and to highlight any problems likely to arise. Once the repairs are completed, this report should be presented to the owner and for inclusion in the building user's manual (if available).
Recommended enhancement: indicate the duration of the flood event in the section "Details of the flooding event".

At the property survey stage it is necessary to consider historic or older buildings as a separate category, as they are likely to require specialist advice such as historic preservation experts (Tagg *et al* 2009, National Trust for Historic Preservation 1993).

Key publications:
British Standards Institution (2005) *PAS 64;* Flood Repair Forum (2006)
National Trust for Historic Preservation (1993)

Areas for further study:
Production of guidance on what to include in the initial assessment of the flooded property report, with recommended recording templates

3 Methods of drying buildings

The process of drying a building (i.e. the removal of floodwater from the fabric of the building) can start at the moment that safe access to the building is possible after a flood. Choices are immediately made regarding whether to assist the natural process via pumping out, assisted drying and stripping out or to let natural processes take precedence. Figure 3.1, taken from Garvin *et al* (2005) illustrates the whole process of drying and decontaminating the building. It is not possible to separate the drying process from making safe the building. This section on drying methods concentrates on part 6 “Drying the building” until the moisture content of the materials reaches an appropriate level.

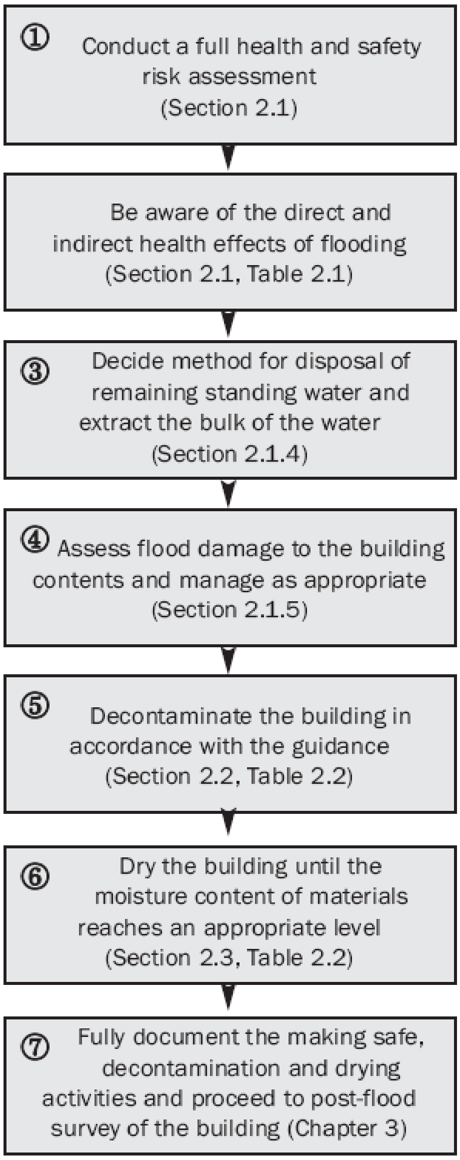

Figure 2.1 *Method for safe and effective decontamination and drying of a flooded building*

Figure 3.1 The process of drying and decontaminating a building following flooding (after Garvin *et al* (2005))

Once the water is extracted and wet materials stripped out, the drying of the building and remaining in situ fixtures and fittings can begin. Fundamentally drying is a process which involves evaporation from the surface of wet materials into air which is at a lower relative humidity than the material itself. Relative humidity is a concept which is central to the drying process and is described in (Building Research Establishment 1990) where an example of a psychrometic chart is also presented. Differences in relative humidity determine the speed of evaporation. There are three basic methods available:

- Naturally with ventilation and possibly fan assisted. This is the slowest method of drying a building and can be severely affected by the prevailing ambient conditions.
- Convection drying using heat and ventilation. This method includes high temperature "speed drying" methods and traditional fan heaters but could also encompass use of the in situ heating system and open windows.
- Use of dehumidifiers. Dehumidifiers should be used in a closed environment as they rely on creating an unnaturally dry atmosphere; the speed of drying is largely dependent on the capacity of the equipment relative to the space to be dried.

Drying methods are described in BRE publications (Building Research Establishment 1974, Building Research Establishment 1997) and in the Flood Repair Forum guide (Flood Repair Forum 2006). Technical guidance and method statements are also available from various in-house and propriety training courses and manuals. Methods for cleaning and drying some materials are available in various publications, for example the CIRIA guide (Garvin *et al.* 2005). Some guidance on types (Building Research Establishment 1997) and ideal methods (Proverbs and Soetanto 2004) is given. However there is no adequate technical guidance available which recommends a particular drying method based on building or flooding characteristics. The choice of drying method is usually dependant on a variety of factors such as the building type, tolerance to further building damage, resources available and building occupancy (Soetanto and Proverbs 2003). The National Flood School have identified 23 different types of construction which affect the drying decision (Tagg *et al.* 2009). It seems clear that certain drying goals may be more easily achieved with particular methods; if speed of drying is the overriding consideration then there seems no doubt that the application of high heat with powerful ventilation and heat exchangers will be faster than other methods. However, there is still some doubt as to the possibility of damage to building contents (Lambert 2006) and this method is not recommended for historic buildings (National Trust for Historic Preservation 1993, Fidler *et al.* 2004, Cassar and Hawkings 2007). It is also clearly inappropriate in buildings which are partially occupied or which are attached with adjacent buildings occupied (Farrington *et al.* 2009). The environmental issues surrounding the choice of methods may also have an influence. It may be appropriate to balance energy used during drying against embedded energy in building materials stripped out and replaced (Tagg *et al.* 2009). Drying methods may also be varied during the drying process as different phases are reached (Building Research Establishment 1974, Soetanto and Proverb 2003, Garvin *et al.* 2005).

Key publications:
Building Research Establishment (1997), Proverbs and Soetanto (2004).

Areas for further study:
Impacts of speed drying on vulnerable building elements
Environmental and sustainability impact of drying choices
Mapping of appropriate drying method to building type

4 Equipment used for drying

The choice of drying method should determine the type of equipment to be employed, although in some circumstances availability of equipment may determine the method, especially likely following major flood events. No specific guidance is available that recommends particular drying equipment. From the consultations and discussions at the workshop the following commonly applied drying equipment was identified.

4.1 Pumps

To extract standing water pumps are used. Vacuum pumps can be fitted to a variety of delivery mechanisms. These include mats and wheeled devices which will extract moisture from floor coverings. Absorbent material can also be used to remove surface water.

4.2 Dehumidifiers

There are two types of dehumidifier: refrigerant and desiccant. Refrigerant dehumidifiers cool down the air and extract water through condensation. This type of equipment operates best between 15-28^{o}C and at 60-98% relative humidity. Desiccant dehumidifiers use chemicals which can attract water (desiccants) to draw water from the air. They operate best between 0-25^{o}C and 40-90% relative humidity. Thus desiccant dehumidifiers have a greater range of operation and can be used to push dry air into closed spaces.

4.3 Heaters

When using heat to dry flooded buildings it is essential to also ensure adequate ventilation and air movement. Heat allows greater moisture absorption by the air and so increases evaporation from wet building elements. This warm saturated air needs to be evacuated, usually to the outside of the building. Drier air replaces it allowing more moisture to be absorbed. Fan heaters are often used or heaters accompanied by separate fans. Fuel based heaters should not be used as they add moisture and increase drying times (Tagg *et al.* 2009). Heat exchangers may also be used. The available heaters vary by their power output and therefore by the temperature of air they supply and the speed in which moisture can be evaporated from building elements. They may vary from domestic sized fan heaters sited in each room to superheating trailers designed to heat multiple rooms over 60^{o}C. Superheating trailers can dry very quickly but may damage vulnerable elements (Tagg *et al.* 2009). Alternatively it is possible to use the in situ heating, such as the central heating system (Proverbs and Soetanto 2004).

4.4 Air movers

Moving air with or without heat assists drying. Air movers can be generalised fans which create wide circulation or can be directed to cover particular areas. Pipes can be attached which can be directed through drill holes or vents to access voids, for example cavity walls. This is sometimes called injection drying.

4.5 Combined models

Some products are now available which combine methods, for example the use of dehumidifiers with heating and dehumidifiers which blow or suck dry air through voids.

4.6 Software and digital calculators

In order to decide on the level of drying equipment appropriate to install in flooded properties, a series of calculations involving moisture load and room dimensions are necessary. Skilled operatives can carry out these calculations using tables and drying equipment specifications but there are more automatic procedures available. Some tools/software are available, for example the National Flood School Moisture Wizard; hand held digital calculator type devices are also available.

5 Determination of target drying times

The time taken to dry flooded buildings is a central subject of this report and indeed a crucial parameter in flood damage restoration. It is important to realise that defining dryness as a percentage of moisture content for a building is not possible since the various materials that form a building have varying levels of moisture in their dry state. Rather than stating that a building is dry, the surveyor needs to decide when it is suitable for re-occupation (PCA, 2009). It is recommended that the desired moisture condition(s) should be set out before any drying takes place and communicated to the homeowner.

Natural drying of buildings can take months (Garvin *et al.* 2005) and the desire to dry quickly usually means some form of assisted drying is preferred. It is possible to dry many properties very quickly using "speed drying" techniques and yet there are reports of properties which are not dry after 12 months. The Publicly Available Specification PAS64 suggests that drying can take place in 3 weeks and practitioners concur that this is possible under ideal conditions (British Standards Institution 2005, Tagg *et al.* 2009, Farrington *et al.* 2009). Conversely, the Association of British Insurers guidance says that several months may need to be allowed for drying (Association of British Insurers 2007).

These facts are hard to reconcile but once again the answer is that target drying times must be seen within the context of the type of drying method used, the ambient conditions and the aims of the repair process in general. Restorers may decide there is little point in investing money and energy in drying a property quickly if the reinstatement cannot commence immediately after the property is dry. This may ensue if property owners are unsure about the type of reinstatement or there are lead times on the supply of replacement fixtures and fittings. It is also true that average drying times from major events are longer than for stand-alone property flooding because of the availability of experts and equipment (Association of British Insurers 2009). The setting of drying goals is crucial and the target should be recorded on the restoration plan (British Standards Institution 2005, The Flood Repairs Forum 2006)

5.1 Evidence from research

Evidence presented to the project in consultations and the workshop undertaken in 2009 suggested that using traditional techniques, all other things being equal, in standard construction houses under ideal conditions it is possible to dry a property in 3 weeks. However in reality a good target to dry a property for reinstatement would be 4-8 weeks (Farrington *et al.* 2009, Tagg *et al.* 2009). However there are no guidelines available that detail these generalised rules. Estimates of typical drying times were available from research data which suggested that thick walls with masonry infill can take up to four months to dry (Cassar and Hawkings 2007) and that the presence of insulation can delay drying for 10-12 weeks (Escarameia *et al.* 2006). The National Flood School estimates showed speed drying reduced drying times to an eighth of traditional methods while Lambert found that the system was effective at drying building materials within 42 hours and caused no damage during drying, only during wetting (Lambert 2006). A conclusion supported by the National Flood School (Tagg *et al.* 2009).

5.2 Evidence from flood events

There were also actual measurements of drying time from properties affected in the 2007 floods taken from two practitioner sources. The National Flood School showed drying times averaging 30 days for the drying process alone (see Figure 5.1). Average duration for clean up and drying from the ABI resilience report showed around 115 days and from the Pitt Review, 50% had dried out within 3 months and 82% within six months. Drying times can be affected by non standard construction, weather issues, pre-existing conditions, duration of flooding, surface treatments (Proverbs and Soetanto 2004) and even the action of property owners switching off or moving equipment (Tagg *et al.* 2009). Professionals employ rules of thumb and rely on their experience to judge likely drying times. Monitoring of the drying conditions clearly assists them in this task. However, there is no guidance available which details these factors and new guidance in this area was identified as a worthwhile goal (Farrington *et al.* 2009). The provision of minimum or target drying times for varied construction types, methods and conditions would require a significant research effort.

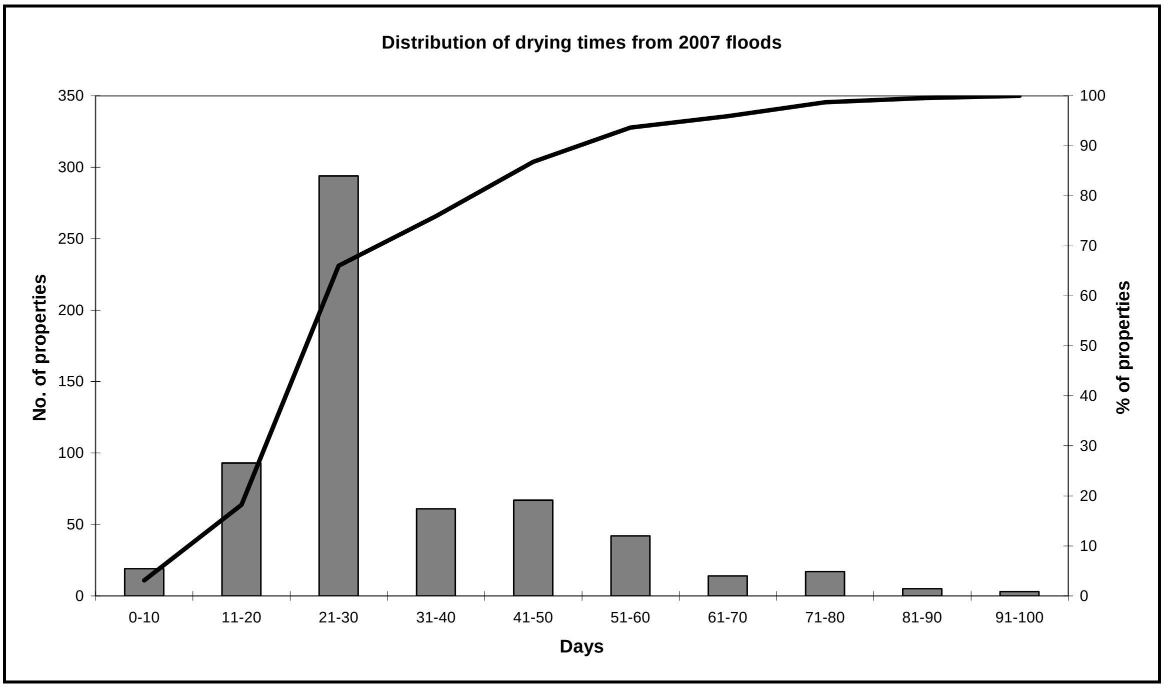

Figure 5.1 Drying times from 2007 floods (from National Flood School)

5.3 Setting the target

The target should be set in consultation with the property owners and occupiers with reference to the above considerations. The use of forms similar to the loss assessment form presented in PAS64 (British Standards Institution 2005) can aid in recording this process. Pre existing conditions should be included in the report. It is also recommended that moisture measurements of unaffected parts of the building (or adjacent buildings) are explicitly recorded and final finishes to be applied are established in order to provide dryness goals for specific materials. Although British Standards are available for some materials they may not always be appropriate dependent on final finishes required (Tagg *et al.* 2009). Target drying time can then be based on the dryness goal, available methods, cost/environmental benefit and other factors mentioned above. Pre-existing defects that can impact on the moisture level of building components need to be identified, as well as any previous repairs. These include: insufficient ventilation leading to mould growth due to condensation, defects in external drainage and internal plumbing, penetrating or rising damp (PCA, 2009). The Code of Practice for the Recovery of Flood Damaged Buildings from the Property Care Association also provides useful advice on reasons for the appearance of water marks and damp patches following a flood and a restoration process, which if not understood can lead to overly extended drying periods.

Key publications:
British Standards Institution (2005) PAS 64, Flood Repair Forum (2006)

Areas for further study:
Mapping of average drying times against types of building and method used
Investigation of other factors affecting the speed of drying
Production of guidance on drying times

6 Monitoring the drying process

Monitoring the drying process is necessary for two main reasons: during the drying process, monitoring enables better control of the environment and allows the perfect drying chamber to be maintained more easily. Monitoring is also used to signal the end of the drying process. In order to get meaningful results, the initial condition of the various elements of the building should be established and photographic records should be taken.

It is important not to over-dry; this wastes energy and time and increases the risk of damage to building components. Equally important is to restore the moisture level to the appropriate level for reinstatement and to be sure that restored components are not damaged by trapped moisture or high humidity levels. As with the drying process it may be that more than one moisture measurement technique will be used to test moisture in different materials and at different drying stages. In the first phase the drying conditions are most crucial and as drying progresses towards phase 3 the moisture measurement of building components becomes more critical. Different monitoring equipment is available to achieve both these aims. When drying goals have been reached a drying certificate may be issued. Currently this is usually issued on hand-over between drying company and reinstatement company. However, given that reinstatement may reintroduce moisture to the building it may be more appropriate to issue this at the end of the process with interim statements at hand-over (Tagg *et al.* 2009).

6.1 Monitoring the drying conditions

It is important to monitor the drying conditions in the chamber, the temperature and relative humidity, to ensure optimum drying times and prevent secondary damage. This can be done by inspection but another common method for achieving this is to use humidity sensors. Humidity sensors rely on measuring the relative humidity of air next to materials. Some drying equipment will include sensors and may have automatic control of drying conditions. Continuous monitors are available but most often the control will rely on operatives taking measurements at regular intervals. The frequency of these measurements may therefore affect the speed of drying as optimum drying conditions may not be maintained. During the workshop it was suggested that monitoring reports should be issued at least weekly. Forms for monitoring the drying process are included in PAS64 (British Standards Institution 2005).

6.2 Monitoring the moisture content of materials

All moisture measurement techniques have advantages and disadvantages and require some level of skill in the operator. Not least because measures of moisture are expressed in different ways depending on the method used and to some extent the equipment chosen (Tagg *et al.* 2009). Most moisture measurement methods do not directly measure water content - they use material properties, such as electrical conductivity, which vary with moisture level. Most indirect methods are inaccurate at very high levels of moisture (Tesarek *et al.* 2005, Farrington *et al.* 2009). In order to directly measure moisture content it is necessary to remove samples of the material from the building element and use oven drying or chemical reaction to remove the water. Taking samples in itself requires care in the method and siting of samples and is destructive of the material tested. Whatever method is used the operator will need to be aware of the possibility of trapped moisture and be cognisant that some areas are likely to be wetter than others, ensuring that all necessary readings are taken. This may be particularly important if heat is used in drying as the elements may take some time to reach equilibrium once heat is removed.

Guidance on moisture measurement is available from a CIRIA publication C538 (Dill, 2000), *A review of testing for moisture in building elements*. This publication lists the usual and some more unusual methods of testing for moisture in materials. A useful set of selection tables gives some indication of which test method may be appropriate for a given situation and building material.

Moisture detecting equipment is available at a vast range of sophistication and cost. Monitoring equipment which can download stored results to laptops, or can transmit wirelessly via weblinks, can help to control the drying process. Many probes feature combinations of test methods, for example temperature with humidity or resistance with capacitance. Kits with a suite of methods are also available. In theory it is possible to monitor all facets of the drying process and take remedial action when conditions change. Practitioners believe that current methods are adequate for testing dryness in the hands of skilled technicians but most of these techniques require expertise, training and investment in equipment. Problems may also occur in estimating initial wetness and therefore drying time. New methods are also currently being researched (Phillipson *et al.* 2007, Tagg *et al.* 2009).

Key publications:
British Standards Institution (2005) PAS 64
Dill (2000)

Areas for further study:
Methods for assessing initial moisture content of flooded buildings
Non-invasive monitoring methods
Automatic methods and methods requiring less skill
Production of requirements for monitoring and auditing the drying including information that should be provided on a drying certificate

7 Health and safety issues during the drying process

Health and safety issues in drying out of buildings can be grouped into main concerns: Concerns for the safety of those carrying out the drying and decontamination process during the course of their duties; and concern for the present and future health of the buildings occupants.

For those carrying out the drying a complete health and safety assessment should be carried out before drying commences. These processes are detailed in (Garvin *et al.* 2005) and (Building Research Establishment 1997) as well as in Flood Repair Forum (2006) where the relevant health and safety at work legislation is signposted.

The health of occupants may also be affected, particularly if they are resident during the drying process, but also in the long term if drying is inadequate. There is recognition that health problems associated with damp conditions or with the presence of contaminants may arise (Building Research Establishment 1974, National centre for healthy housing and enterprise community partners 2006, Ashley *et al.* 2009, Klintberg *et al.* 2008, Akpinar-Elci *et al.* 2008). A concern about long term toxic mould growth is prevalent in research material from the US but practitioners in the UK regard this as a low risk in properly controlled drying procedures. If it is possible to vacate the premises this will significantly reduce any health risks and simultaneously allow a greater range of drying options to be considered, possibly speeding up the drying process. Practitioners also seemed to be confident that, if sensible precautions are taken, health, safety and security impacts within the building may be reduced to a minimum (Tagg *et al.* 2009, Farrington *et al.* 2009). Proper and prompt removal of disposed contents, silt and debris is also necessary to prevent a public health nuisance and this may be expedited by efficient waste removal practices. Clear guidance for property owners and occupiers would be appropriate to allay the concerns of residents regarding health and safety; current leaflets are contradictory and confusing. In addition, the use of a sanitation certificate with appropriate standards would reassure occupants that their home was safe to return to (Farrington *et al.* 2009).

Key publications:
Garvin *et al.* (2005)
Flood Repair Forum (2006)

Areas for further study:
Prevalence of increased illness during the drying process linked to occupancy, drying method, speed of drying
Clear guidance for operatives and occupants on the appropriate health and safety measures to be implemented

8 Keeping the customer informed

Throughout all the stages of the flood damage repair process the importance of good communication cannot be overstated. In an independent analysis of the work of building contractors involved in the recovery from recent UK floods, Paul Hendy (2009) highlights the fact that flood victims have a reduced ability to give and receive information which necessarily impacts on relationships with contractors, and for that matter, any other professionals involved. Communication was found to be at the root of all complaints, with unrealistically short times for restoration given by the insurance industry leading to false expectations.

It is suggested in the above report that it is the responsibility of all professionals/organisations/companies involved in flood damage restoration to ascertain the most suitable way of communicating with the client as early as possible, to ensure that the project manager updates the client weekly and that a backup team manager is appointed to cover when the project manager is absent. In the specific case of building contractors (but easily extended to other professionals) this can be aided by: creating and updating a Work Flow Chart every two weeks to keep client informed on progress; setting up a local telephone number to reduce telephone bills; and prioritising properties, (i.e. vulnerable people and the elderly) while explaining to others why there is a delay,

Key publications:

Flood Repair Forum (2006) *Repairing flooded buildings; an insurance industry guide to investigation and repair*. BRE Press

Paul Hendy (2009). An independent analysis of the Flood Repair Programme – Jan 2005 to May 2009

Areas for further study:

Development of protocols for dealing with access to properties when home owners/occupiers are not contactable

More detailed advice to homeowners regarding the whole flood damage restoration process – this is envisaged to be part of the management hierarchy and process flow chart, and could be posted on a national website

Greater clarity on the roles and responsibilities involved in the drying and restoration process, particularly the role of project manager who would manage the whole process

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Appendix 1
Guidance and Standards for drying flood damaged buildings. Deliverable 1 - Review of existing guidance

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Appendices

1 Introduction

Over the past decade there have been several major flooding events that have affected widespread areas of the UK. This includes the Easter 1998 flood which particularly affected the Midlands, the widespread winter 2000 floods, the January 2005 Carlisle flood, and the summer 2007 floods that resulted from intense rainfall which caused major disruption in Yorkshire, Humberside and large areas of the Midlands and Southwest. These events were accompanied by increased media and public interest, partly driven by the emerging acceptance of climate change. As a result, there is improved knowledge of what causes floods, what it is like to be affected, and how the response and recovery processes work.

Against this backdrop of increased interest in flooding and its management, many reports, guidance and advice have been produced over the last 10 years, specifically on repair and restoration of buildings damaged by flood water. In spite of this, there continues to be dissatisfaction over the recovery process, with many families unable to return to their homes for several months, or some cases for more than a year. Whether this is related to problems with the drying or repair phases is not clear, and certainly for major flooding events there may be a shortage of competent organisations who can undertake such work. Many of these issues have been highlighted by the extensive Pitt Review into the 2007 floods (Pitt, 2008), which found there was *“significant dissatisfaction with the time it took to dry out and stabilise properties”*, and that *“cases of undue delay may be due to the absence of definitive guidance about drying methods.”* Pitt also noted the conflicting and limited advice on when it was suitable to return to a damp property and other health aspects. In recognition of the impact that the drying phase could have on communities and long-term health problems for families, together with the costs of insurance and temporary accommodation, Pitt produced **Recommendation 73**:

> *“The Government, the Association of British Insurers and other relevant organisations should work together to explore any technological or process improvements that can be made to speed up the drying out and stabilising process of building recovery after a flood.”*

Of course there are likely to be several suitable drying scenarios for any property and the choice of method must be considered in the context of managing the whole repair process, repair of neighbouring property and the availability of suitable equipment and power sources. Currently there is little evidence to demonstrate the rationale behind different drying strategies.

Given this experience from recent flooding, there is clearly a need to revisit the existing guidance on drying and repairing flooded properties, and to see to what extent the industry is using it and whether there are new approaches that need to be considered in light of recent events. New drying technologies have also been trialled in recent years, and again there is a need to determine how widely these are now being used. Finally, the industry and other stakeholders need to be consulted as to the desirability for new guidance to improve the drying out and restoration of flooded buildings, and the form and content of such guidance.

In response to the comments from Pitt, DCLG has commissioned this study to assess the current situation regarding the drying of flood-damaged properties, and to propose improved guidance that addresses the shortfalls in the use of the existing advice. These overall aims will be delivered by specific project objectives, as follows:

- Identify and examine existing guidance, information and practices on the drying of flooded properties, and the current use of such guidance.
- Produce generic guidance for the drying of flooded properties based on existing knowledge.
- Establish how this guidance could be made more widely available and taken up by the industry.
- Identify areas where knowledge gaps exist and to recommend subjects for further research.

This initial project deliverable deals with the first two of these objectives.

2 History of available guidance

Advice and guidance for the drying of flood damaged buildings has become increasingly available over the past decades and takes many forms. Early publications include the 1973 Building Research Establishment (BRE, 1973) *Repair and renovation of flood-damaged buildings* and the 1974 *Drying out buildings* (BRE, 1974). Much of the guidance is embedded in publications aimed at the wider field of repair and restoration of flooded buildings and some is specific to the drying process. Advice of different kinds is available: "how to" guides and manuals aimed at flood repair professionals, such as the British Damage Management Association (BDMA) and National Flood School (NFS) training manuals; standards and specifications such as PAS64 and British Standards relating to workmanship on building sites which may be adhered to with regard to specified moisture contents; and advice of a more general nature aimed at homeowners such as the English Heritage technical advice note.

The following table (Table 1) lists some of the guidance available, the authors and the year of publication. It is not exhaustive, but rather indicative of typology. In addition to the leaflets and books listed there are: professional training courses (such as offered by the NFS, the BDMA and the Property Care Association (PCA); online resources (e.g. the National Flood Forum (NFF) and Association of British Insurers (ABI) websites); which are too numerous to mention and phone advice helplines.

Some of this guidance (marked in bold in Table 1) has formed the basis of the literature review under existing guidance (Section 4) and some has been discussed with consultees (Section 5).

Much of the advice given by all these sources and guides is similar as they may be recycling information from the same source. However, there are conflicts in some cases, particularly in advice given to homeowners; this may be due to attempts to summarise complex information. Often it is unclear whether the advice is backed up by scientific or professional sources. Advice and guidance from overseas sources contains much relevant material but specific building element, humidity and temperature advice may have to be tempered by knowledge of differing construction techniques and prevailing ambient conditions.

Table 1 Summary of relevant publications

Title	Author	Date of Publication	Type of Publication	Just Drying	UK
Repair and renovation of flood damaged buildings	BRE	1973	Digest 152	N	Y
Drying out buildings	BRE	1974	Digest 163	Y	Y
Restoring a house after flood damage	Building Research Association of New Zealand	1984	Advice booklet	N	N
Repair and renovation of flood-damaged buildings	BRE	1984	Digest	N	N
BS 8000-2.2 Workmanship on building sites. Code of practice for concrete work. Site work with in situ and precast concrete	BSI	1990	Standard	N	N
Dealing with flood damage	BRE	1991	Advice leaflet	N	Y
Repairing your flooded home	FEMA/ Red cross	1992	Advice Booklet	N	N
Standards and reference guide for professional water damage restoration (1st ed)	IICRC	1995	Standards	N	N
Repairing flood damage: immediate action	BRE	1997	Guide 11 Part 1	N	Y
Repairing flood damage: ground floors and basements	BRE	1997	Guide 11 part 2	N	Y
Repairing flood damage foundations and walls	BRE	1997	Guide 11 part 3	N	Y
Repairing flood damage: services, secondary elements, finishes, fittings	BRE	1997	Guide 11 part 4	N	Y
A review of testing for moisture in building elements	M. Dill	2000	Book (CIRIA c538)	Y	Y
Assessing moisture in building materials, parts 1 – 3, good repair guide	BRE	2002	Book	Y	Y
Preparing for floods. Interim guidance for improving the flood resistance of domestic and small business properties (2003 reprint)	Office of the Deputy Prime Minister (ODPM)	2003	Advice Booklet	N	Y
Flood damaged property: a guide to repair	D.G. Proverbs and R Soetanto	2004	Book	N	Y

Title	Author	Date of Publication	Type of Publication	Just Drying	UK
Flooding and historic buildings	English Heritage J. Fidler, C. Wood and B. Ridout	2004	Technical advice note	N	Y
Moisture measurement guide for building envelope applications	Institute for research in construction (Canada)	2004	Technical guidance	Y	N
Standards for the repair of buildings following flooding	S. Garvin, J Reid & M Scott	2005	Book (CIRIA c673)	N	Y
Repairing flooded buildings: an industry guide to investigation and repair	Flood repairs forum / BRE	2006	Book	N	Y
PAS64	BSI/Chris Netherton	2006	Standard	Y	N
Creating a healthy home, a field guide for clean-up of flooded homes	National centre for Healthy housing and Enterprise community partners (US)	2006	Advice Booklet	N	N
Standards and reference guide for professional water damage restoration (3rd ed)	IICRC	2006	Standards	N	N
New guide to restorative drying	Dri –eaz (US)	2006	Technical manual	Y	N
Flood damage restoration Part 2: technical procedures	IICRC	(revised) 2006	Technical guidance	N	N
Flood clean up advice	Newark and Sherwood District Council	2006	Advice leaflet	N	Y
Repairing flood damaged buildings	Australian Red Cross	2007	Information leaflet	N	N
Condensation and dampness pack	BRE	2007	Collection of Good repair guides, digests and information papers. (contains some of above)	N	Y
Understanding basic flood recovery procedures	BDMA	2007	Advice leaflet	N	Y
Self help for victims of flooding, what you can do	BDMA	2007	Advice leaflet	N	Y
After a flood	Environment Agency	2007	Advice leaflet	N	Y
Damage management, Official training and reference manual	BDMA	unknown	Training manual	N	Y

3 Overview of drying equipment and moisture measurement

In this section a brief overview of drying and measuring methods and equipment is presented.

3.1 Drying

Once standing water, mud, silt and wet contents are removed there are basically three ways of removing retained moisture from buildings:

- Naturally with ventilation possibly fan assisted.
- Convection drying using heat and ventilation.
- Using dehumidifiers.

These methods are not mutually exclusive: accepted wisdom is that there is not one right way for all situations. In many cases a combination of methods may be appropriate as building conditions change and drying passes through phases.

Within each category there are many variations in application of the basic principles and many proprietary products with differing specifications available to assist the drying process.

3.1.1 PUMPS

To extract standing water pumps are used. Vacuum pumps can be fitted to a variety of delivery mechanism including mats and wheeled devices which will extract moisture from floor coverings. Absorbent material can also be used to remove surface water.

3.1.2 DEHUMIDIFIERS

There are two types of dehumidifier: refrigerant and desiccant. Refrigerant dehumidifiers cool down the air and extract water through condensation. This type of equipment operates best between 15-28^{o}C and at 60-98% relative humidity. Desiccant dehumidifiers use chemicals which can attract water (desiccants) to draw water from the air. They operate best between 0-25^{o}C and 40-90% relative humidity. Thus desiccant dehumidifiers have a greater range of operation.

3.1.3 HEATERS

When using heat to dry flooded buildings it is essential to also ensure adequate ventilation and air movement. Heat allows greater moisture absorption by the air and so increases evaporation from wet building elements. This warm saturated air needs to be evacuated, usually to the outside of the building. Drier air replaces it allowing more moisture to be absorbed. Fan heaters are often used or heaters accompanied by separate fans. Heat exchangers may also be used. The available heaters vary by their power output and therefore by the temperature of air they supply and the speed in which moisture can be evaporated from building elements. They may vary from domestic sized fan heaters sited in each room to superheating trailers designed to heat multiple rooms over 60^{o}C. Alternatively it is possible to use the in situ heating, such as the central heating system.

3.1.4 AIR MOVERS

Moving air with or without heat, air movers can be generalised fans which create wide circulation or can be directed to cover particular areas. Pipes can be attached which can be directed through drill holes or vents to access voids, for example cavity walls. This is sometimes called injection drying.

3.1.5 COMBINED MODELS

Some products are now available which combine methods, for example the use of dehumidifiers with heating and dehumidifiers which blow or suck dry air through voids.

3.1.6 SOFTWARE AND DIGITAL CALCULATORS

In order to decide on the level of drying equipment appropriate to install in flooded properties, a series of calculations involving moisture load and room dimensions are necessary. Skilled operatives can carry out these calculations using tables and drying equipment specifications but there are more automatic procedures available. Some tools/software are available, for example the National Flood School Moisture Wizard; hand held digital calculator type devices are also available.

3.2 Overview of moisture measurement

Monitoring the drying process is necessary for two main reasons: during the drying process, measurement enables better control of the environment and allows the perfect drying chamber to be maintained more easily. Moisture measurement is also used to signal the end of the drying process. It is important not to over-dry - this wastes energy and time and increases the risk of damage to building components. Equally important is to restore the moisture level to the appropriate level for reinstatement and to be sure that restored components are not damaged by trapped moisture or high humidity levels. Whatever the drying goal, moisture measurement tests whether it has been achieved.

As with the drying process it may be that more than one moisture measurement technique will be used to test moisture in different materials and at different drying stages. There are standards available for some building elements for certificating final levels of dryness but these methods may not be the best for monitoring and controlling the process of reaching drying goals.

All moisture measurement techniques have advantages and disadvantages and require some level of skill in the operator. Not least because measures of moisture are expressed in different ways depending on the method used and to some extent the equipment chosen. Most moisture measurement methods do not directly measure water content - they use material properties, such as electrical conductivity, which vary with moisture level. In order to directly measure moisture content it is necessary to remove samples of the material from the building element and use oven drying or chemical reaction to remove the water. Taking samples in itself requires care in the method and siting of samples and is destructive of the material tested. Whatever method is used the operator will need to be aware of the possibility of trapped moisture and be cognisant that some areas are likely to be wetter than others, ensuring that all necessary readings are taken. This may be particularly important if heat is used in drying as the elements may take some time to reach equilibrium once heat is removed.

Guidance on moisture measurement is available from a CIRIA publication C538 (Dill, 2000), *A review of testing for moisture in building elements*. A useful set of selection tables gives some indication of which test method may be appropriate for a given situation and building material.

Moisture detecting equipment is available at a vast range of sophistication and cost. Monitoring equipment which can download stored results to laptops or transmit wirelessly via weblinks can help to control the drying process. Many probes feature combinations of test methods, for example temperature with humidity or resistance with capacitance. Kits with a suite of methods are also available. In theory it is possible to monitor all facets of the drying process and take remedial action when conditions change. However, most of these techniques require expertise, training and investment in equipment.

3.3 Common methods of testing

Within this section are methods of testing used by practitioners to a greater or lesser extent as evidenced by literature review and consultations.

3.3.1 CALCIUM CARBIDE TESTING (SPEEDY MOISTURE METER, CM TESTER, CARBIDE BOMB)

A sample is extracted and the water content established via converting it to acetylene gas in reaction with calcium carbide. The pressure exerted by the gas in a closed flask gives the quantity of water extracted. This is then compared to the wet weight of the original sample.

3.3.2 GRAVIMETRIC (OVEN DRYING)

A sample is taken and then weighed and dried in laboratory conditions. Widely regarded as the most accurate method but can be subject to poor sampling technique and sampling site selection.

3.3.3 CAPACITANCE METER (RADIO FREQUENCY, IMPEDANCE, DIELECTRIC, ELECTROMAGNETIC WAVE, PERMITTIVITY)

Capacitance meters are usually hand held devices without pins: when held against a material they create an electric field within the material. Wetter materials give greater response. Meters may be calibrated for WME or give arbitrary readings which can be compared to give relative moisture contents. They are non destructive, but it can be problematic to ensure good contact between the device and test area. Surface coverings and material properties such as metal, knots, etc, can cause false readings.

3.3.4 RESISTANCE METER (CONDUCTANCE MOISTURE METERS, PIN METERS, PROBE METERS)

The principle behind the test is the application of a voltage across two points, giving a current and therefore resistance measurement. Moisture content can be determined from knowledge of the resistance properties of the material at different wetness. Commercial meters are usually calibrated for wood. Some include probes that need to be inserted into the material and these can be of different lengths allowing for testing at different depths, however it is somewhat destructive. It is important to calibrate or adjust readings for the relevant material and note that salts, metals and temperature can affect readings.

3.3.5 HUMIDITY SENSORS (HYGROMETER, HYGROSTICKS)

Humidity sensors rely on measuring the relative humidity of air next to or within air pockets in materials. Relative humidity is affected by air temperature and so associated temperature readings should be taken. There are different forms of sensor; some for surface application and others which probe materials. At its most basic it can involve wooden dowels which are weighed to determine water content. Sophisticated electronic relative humidity probes and mechanical hygrometers are also available. In general this is a slower method since it requires time for the inserted material to come into equilibrium with the test material.

3.3.6 MICROWAVE (HIGHER FREQUENCY POWER ABSORPTION METHOD)

Microwave measurement works on a similar principle to the capacitance meter but at a higher frequency, in theory making it less susceptible to impurities. It is generally felt to be superior to capacitance but until recently was impractical in situ. There are still not many models available, and little evidence of them being used in practice by the consultees. In theory meters give absolute measurement of water content instantly but in practice some calibration may be required.

3.3.7 RADAR (IMPULSE RADAR, GROUND PENETRATING RADAR, SUB-SURFACE RADAR)

Useful for scanning large areas quickly and can detect changes in moisture content. It can also be useful in identifying other structural components which may be relevant in choice of drying method. However, it is ineffective where structures contain metal and reinforced concrete. The cost and expertise factors make it impractical for most situations, data requires post processing of results for interpretation.

3.3.8 THERMOGRAPHIC (THERMAL IMAGING, INFRARED THERMOGRAPHY)

Moisture content is inferred from variations in temperature - this method does not measure moisture content. It is completely non invasive and can scan a large area quickly. Needs care in interpretation and is affected by surface coverings; measurements must be undertaken in equilibrium. May be useful to detect wet spots for further detailed examination; also very useful for bad access areas such as roofs.

3.4 Emerging methods

The following methods have been identified as possible alternatives to the more established procedures described above. As far as the literature search and consultations have revealed they are not currently used in practice.

3.4.1 THERMAL HEAT PROBE

Based on soil testing devices, the thermal heat probe is currently under development in an ESRC funded project. This method uses the changing thermal conductance of materials with the introduction of moisture. Insensitive to salts and relatively cheap to produce a device.

3.4.2 TIME DOMAIN REFLECTOMETRY (TDR)

An application derived from soil measurement; this method measures permittivity in a fluctuating electric field. A further development of microwave and radar type measurement, that uses a probe. Portable devices are available for soil measurement and larger probes for buildings are being developed but the data requires interpretation and conversion data for moisture content of most building materials is not yet available.

3.4.3 NUCLEAR MAGNETIC RESONANCE (NMR)

A mainly laboratory based technique giving precise data about moisture content and distribution. The principle is based on the magnetic properties of hydrogen nuclei within water molecules. They are detected using a spectrometer. The method requires calibration for each material. Generic portable NMR systems are becoming more common but are limited by the size of the powerful magnets. Specific probes are being developed but there is a high cost, making this a developing field.

3.4.4 SOPHISTICATED ELECTRICAL TECHNIQUES

Four point electrical probes have the potential to overcome some of the disadvantages of the resistivity meters available; alternative probe configurations and distances are also being tested.

4 Review of existing guidance

The review of existing guidance on drying of flood buildings is split into four main categories: guidance documents available in the UK, technical publications, international sources and a specific category related to historic buildings given their particular characteristics and requirements. Tables summarising the advice on the major issues related to property drying that were identified in this review were also produced and are presented in Section 6.

4.1 Guidance documents

4.1.1 DRYING OUT BUILDINGS

Building Research Establishment Digest 163, 1974, BRE Press

This document describes drying methods for buildings and methods for testing the condition of walls, floors and joinery including dampness levels at the end of drying. The drying process is often governed by a need for early completion of construction and economic considerations but this must be weighed against problems with excessively fast drying which can cause cracking of screeds/plaster finishes and distortion of wood.

Drying will occur in three phases covering free evaporation from the surface, evaporation from pores and water lost from fine pores and cells. The drying process described in this report is concerned with phase two. A number of different drying methods are discussed along with advice regarding appropriate ventilation. It is recommended to keep the windows open during natural drying and also if heaters are used for speeding up the drying process. Mould growth may otherwise develop and will incur extra costs. Dehumidifiers should be used keeping windows closed and are most efficient used in conjunction with heaters. Dehumidifiers remove moisture from structures very quickly which can cause distortion of lighter timber units.

Advice on determining when a building is dry is also provided. It is stressed that it is not possible to tell whether a material is sufficiently dry and ready for decoration based on touch, visual inspection or time since construction, although the longer the better. A number of methods for measuring moisture contents in timber, floor screeds, and walls are discussed. Timber can be tested using an electrical moisture meter and should be as close to its natural soil moisture content (10-12%) when painted. Floor screeds can be tested with a hygrometer and readings within the range 75-80% indicate that flooring can be laid. Electrical moisture readings can also be taken but readings may be misleading due to contaminating screeds and if used directly on the surface. Electrical moisture meters, coloured indicator papers and hygrometers are used for measurements on walls. Similar problems to floor measurements may arise and overnight covering is recommended for the first two methods.

Aside from recommendations regarding methods, some notes on adequate use of different equipment are also provided, including different types of dehumidifier, moisture meters for wood and hygrometers.

(Note: Reference is made to Digest 55 painting walls and Digest 106 painting woodwork)

4.1.2 REPAIRING FLOOD DAMAGE: IMMEDIATE ACTION

BRE Good Repair Guide 11, Part 1, 1997, BRE Press

This guide provides advice on cleaning buildings during the first few days after a flood has receded and provides a list of immediate actions for homeowners. Much of the advice also applies to other water damage caused by burst pipes, leaks and storm damage. The guide was designed primarily for homeowners and occupiers but can also assist surveyors, contractors and insurers.

Advice for immediate actions by homeowners after a flood includes check for external structural damage, switch off electricity supplies and gas appliances, check drainage system, contact insurers, remove wet carpets and furniture, clean walls and floors, drain floors and cavities and start drying the building.

With respect to drying it is recommended to keep internal doors open and to open external windows and doors whenever possible. Further ventilation of under floors and walls can be achieved by opening floor hatches, lifting timber boards and by removing damaged plaster board. To increase ventilation further it is recommended to heat the building using an industrial heater; if the heating system is working thermostats should be kept at around 22^{o}C. Chimneys must be dried out over several weeks by slowly increasing the size of solid fuel fires or length of use of gas heaters.

4.1.1 REPAIRING FLOOD DAMAGE: GROUND FLOORS AND BASEMENTS

BRE Good Repair Guide 11, Part 2, 1997, BRE Press

This guide provides advice on the treatment and repair of floors and basements which have been affected by flooding. Advice covers older and newer types of floors: suspended timber, concrete on the ground and suspended concrete (incl. insulation). The guide was designed for surveyors, contractors and insurers to advise homeowners and occupiers on repair works and drying methods.

The document outlines a number of priorities for repair and drying work immediately after a flood. These include: inform the insurer as quickly as possible, start drying the building with ventilation and heating, expose and determine type of floor, investigate floor condition, decide on repairs, get estimates of cost and drain under suspended floors and basements. The guide provides detailed information on the most suitable methods for drying, ventilation and measurement of soil moisture content in floors.

The building needs to be dried using the central heating system (22^{o}C) or portable heaters and dehumidifiers as set out in Part 1. For drying floors it is important to expose the floor surface and increase ventilation by opening plinth, panels as well as lifting debonded areas of wood flooring, tiles and adhesives. Drying of different types of flooring is described in more detail in the guide.

Drying of suspended floors needs to be undertaken quickly as mould growth can start within days. Dehumidifiers can be used but with caution as warping may result. Insulation materials below suspended floors may not recover and will have to be replaced. Rigid insulation boards do not deteriorate but take a long time to dry. Timber should be checked after a year for outbreaks of fungal attacks and adequate ventilation must be ensured, conforming to British Standards. Hatches in the flooring must be constructed so the moisture content of the joists and other timber in the ventilated underfloor area can be measured (target is 24%). As a rule of thumb the soil moisture content should be checked about two months after enclosing the underfloor and should be less than 24% from October-May and less than 22% between June-September.

Concrete floor construction will have an influence on drying times. Damage will be limited if the dpm is between the slab and the screed. In general concrete and screeds do not absorb a lot of water but once wetted take a long time to dry. If covered by timber based flooring the void or insulation will not dry easily. Drilling through the floor is recommended to establish location of the dpm and wetness. It is also recommended to lift the floor and remove wet insulation. A hygrometer can be used to test dryness. Similar methods are recommended for suspended concrete floors. In addition concrete beams may be subject to corrosion if there is a high chloride content in the flood water. Water can also be retained below the floor which will require draining and ventilation to speed up drying. Optical probes via holes can be used for examining the space. Basements need to be drained and dried by heating, ventilating and dehumidifying. Ventilation can be increased by venting vertically through the upper storeys. Underfloor ventilations may need to be cleared or increased.

4.1.2 REPAIRING FLOOD DAMAGE: FOUNDATIONS AND WALLS

BRE Good Repair Guide 11, Part 3, 1997, BRE Press

This guide provides advice on the treatment and repair of foundations and walls which have been affected by flooding. Advice for different types of walls is included: solid walls, cavity walls, timber-frame walls and non-traditional walls. The guide was designed for surveyors, contractors and insurers to advise homeowners and occupiers on repair works and drying methods.

The document outlines a number of priorities for repair and drying work immediately after a flood. These include: inform the insurer as quickly as possible, stabilise foundations, start drying the building, investigate the condition of walls, decide on repairs, get estimates of cost and remove wet materials that may delay drying. The guide provides detailed information on the most suitable methods for drying of different types of walls and general advice on speeding up drying.

Masonry walls are best dried by evaporation from the outer surface and weather conditions are therefore of importance. Thickness of walls is critical with double thickness increasing drying time four times. Walls with ventilated cavities will dry quicker than those with sealed or filled cavities. Drying through the inner surface is best undertaken by ventilation and using heaters/central heating system (22 ^{o}C). It is recommended to remove low-permeability internal finishes to speed up drying. Solid walls generally take a long time, often more than a year and rising damp may be a problem if there is no effective damp course proofing (dcp). Linings of plaster in good condition can however dry out within a few weeks and redecoration can start once the surface is dry.

For cavity walls different problems are encountered for the outer leaf, cavity and inner leaf. Bricks, stone and concrete walls may deteriorate if they remain wet for several months. Brick and concrete walls may also shrink/crack during drying. In the cavity, mud and other debris may lead to permanent rising damp. Furthermore, wet and damaged insulation can increase drying times. Inner leaf masonry can take up to a year to dry but the surface layers can dry sufficiently to be suitable for decoration within a few weeks with aid of heating or in spring/summer.

Timber frame walls exposed in well-ventilated air can dry to an acceptable moisture content of 20% in about three weeks, although bottom members may take longer. Plasterboard may need to be removed below the tide mark but this will usually not be necessary if the flood lasted hours or the depth was less than 15 cm. It is recommended to measure the soil moisture content of timber and sheathing taking account of adhesives and additives using deep probes and only enclose the frame when the soil moisture content is below 20%.

For other types of wall, similar drying methods are used as these often have timber-frame panels as an infill between masonry walls.

4.1.3 PREPARING FOR FLOODS - INTERIM GUIDANCE FOR IMPROVING THE FLOOD RESISTANCE OF DOMESTIC AND SMALL BUSINESS PROPERTIES 2003 Reprint, ODPM (2003)

This interim guidance was prepared in response to the 1998 and 2000 floods. It emphasises the importance of carrying out a flood risk assessment to determine the depth, duration, frequency and consequences of flooding affecting any property, as this will determine the best response in terms of mitigation to protect the property and reduce the risk. A property audit should be undertaken, to identify the potential entry routes for floodwater and the materials used to construct the house.

The document provides guidance on flood protection measure to be used on the outside of the property, such as door-guards and air-brick covers. It also notes special requirements for historical buildings. Advice is provided on permanent measures to help reduce the extent of flood damage, and deals with external and internal walls, floors and services and fittings.

For internal finishes, it notes that gypsum plaster is often removed to enable the underlying masonry to dry out after a flood. Several recommendations are given, such as lime-based plaster which provides better resistance to floodwater and quicker drying times. It also notes the Environment Agency advice on how to prepare a flood plan and details the various checklists that homeowners can use to identify the key issues to be considered. However, overall there is no advice given on the drying of flood-damaged properties.

4.1.4 PAS 64 PROFESSIONAL WATER DAMAGE MITIGATION AND INITIAL RESTORATION OF DOMESTIC BUILDINGS CODE OF PRACTICE

BSI 23 (2005)

This code of practice (Publicly Available Specification) provides guidance and recommendations for the restoration of water-damaged buildings and contents but does not have the status of a specification or confer legal immunity when complied with.

The role of an initial survey is stressed, to assess the type of property (age, materials), the type of flooding (depth, duration) and the setting of a method statement and drying goals based on the degree of damage.

The code establishes Categories of Water Damage, from Category One (water from a clean source) to Category Four (water from a source that carries significant quantities of pathogenic agents and/or toxic elements). Categories of Risk are also established ranging from Minor (up to 3 rooms) to Major (if 4 or more rooms are affected); subdivisions within the Minor risk category are based on the presence of structural damage or health risk.

Several sample forms are included in the Annex of this code to help the management of the recovery from flood damage; they are listed below with comments on the ones most relevant to the present study:

- **Risk assessment**

- **Loss assessment**
  In this form the characteristics of the room being assessed are summarised, including dimensions, temperature and relative humidity, construction materials and coverings. Moisture readings and drying goals are also recorded, as well as the cause of the claim and actions taken by both the home occupier and the loss assessor. Although the PAS 64 recommends that moisture readings are taken on unaffected components to obtain base readings as well as on affected components, the exact nature/location of the moisture readings in the form is not given, apart from whether it is on the floor, ceiling, wall, etc. It is therefore not clear what they mean. It is also interesting to note that the estimated drying time is printed in the form, which is given as three weeks – presumably this is a general goal.

- **Cleaning report**

- **Drying report**

  The example drying report includes actual values and goals in terms of temperature, relative humidity and specific humidity. There are various parameters relating to moisture content in the form as well as the projected drying date and space for description of the equipment installed. It is not clear however, how many of these reports should be issued during the drying process.

4.1.5 STANDARDS FOR THE REPAIR OF BUILDINGS FOLLOWING FLOODING

CIRIA (2005)
Garvin, S., Reid, J. and Scott, M. C623, Construction Industry Research and Information Association (CIRIA), London

This CIRIA guide covers all aspects of the requirements for repair of flooded buildings including making safe, drying, decontaminating, health and safety, surveys and repair. It is aimed primarily at building professionals but also contains advice to homeowners and can be used by those commissioning repair work. A reader guide is provided at the start so that information can be located quickly.
Most relevant to this research are: Section 1.1 "Flooding sources and implications"; Chapter 2 "Making safe, contamination and drying"; and Appendix 4 "Guidance on dehumidification".

The publication also covers repair including the assessment of flood risk and the appropriate level of resilience to install.

A flowchart of steps for safe and effective decontamination and drying of flooded buildings contains the following steps:

1. Conduct a full health and safety risk assessment.
2. Be aware of the direct and indirect health effects of flooding.
3. Decide method for disposal of remaining standing water and extract the bulk of the water.
4. Assess flood damage to the building contents and manage as appropriate.
5. Decontaminate the building in accordance with the guidance.
6. Dry the building until the moisture content of materials reaches an appropriate level.
7. Fully document the making safe, decontamination and drying activities.

The document contains fairly detailed guidance on the steps to be taken including tables of building elements and the way to decontaminate and dry them. It also refers the professional to further reading and applicable standards and pays particular attention to health and safety issues.

Advice on drying procedure states that it will often be necessary to change the drying equipment during the drying process to maintain optimum drying chamber. Natural drying takes months, assisted drying reduces to weeks.

Types of dehumidifier are described and the way to determine appropriate equipment outlined: First identify the moisture load and select dehumidifiers which will remove the correct amount based on their designed moisture removal rate. The number of air movers can be calculated from the air volume and required number of changes per hour. A severely damaged building may need 10 changes per hour.
Drying efficiency depends on material properties, relative humidity, temperature, ventilation, dehumidification. Materials should be dried to levels at which dry rot (below 20% by volume) or other deterioration can occur. Secondary damage caused by the drying process should be avoided. It may be possible to reoccupy the building while still partly wet, installing temporary permeable decoration, if this will reduce stress to owners.

4.1.6 REPAIRING FLOODED BUILDINGS; AN INSURANCE INDUSTRY GUIDE TO INVESTIGATION AND REPAIR

Flood Repair Forum (2006), BRE Press

This recent publication was produced by the Flood Repairs Forum, a group representing organisations in insurance, investigation, loss adjusting, and construction and repair. It is a manual of best practice for the sequence of events that occurs in a flood claim, from inspection, through the drying process to the recommendation of flood resistant repairs.

The guide highlights the need for the appointment of a technically competent person to deal with “complex” building types or situations; these include historic buildings, timber framed buildings or buildings where unusual methods of construction have been used, as well as buildings that have been repeatedly flooded. Equally important, and applicable to all cases, is ensuring that effective communication exists with the policy holder (usually the home owner/occupier) and a staged approach is suggested in the guide. The information sought and given at the various stages of the claim process is identified in detail together with the various relevant parties that are likely to be involved (e.g. insurer, loss adjuster, assistance company, claims handler, damage management organisation, contractor).

In the guide four chapters are dedicated to the drying of buildings, a crucial stage in the flood repair process which, if not conducted properly can lead to an unsatisfactory conclusion of the whole process and need for remedial works. The first of these chapters gives a qualitative overview of the types of damage to expect; Chapters 7 and 8 describe the main categories of equipment and methods used in the UK for drying buildings, whereas Chapter 9 deals with the monitoring of the drying process, listing the main instruments used for humidity measurement and culminating in the certificate of drying and in the issue of a report on the flooding event for current and future owners.

Several forms are included in the guide, which are relevant to the present study. They are listed below with suggested enhancements:

- **Building condition report in respect of flood damage**

This form collates important information on the building and building services including general descriptions of the walls and floors and existing condition and defects. The form also requests other information which is considered to be very relevant to the definition of the drying measures required; this is the height of flood level and the date of the event.

- **Report of flooding event**

This form is used to identify the issues involved, to summarise the work carried out and to highlight any problems likely to arise. Once the repairs are completed, this report should be presented to the owner and for inclusion in the building user's manual (if available).

- **Report of repairs and treatment of a flooded building**

This form gives details of the work carried out and, similar to the previous report, should be presented to the owner and for inclusion in the building user's manual (if available).

4.1.7 UNDERSTANDING BASIC FLOOD RECOVERY PROCEDURES AND SELF HELP FOR VICTIMS OF FLOODING, WHAT YOU CAN DO, BDMA, 2007

British Damage Management Association

A series of leaflets provided by the BDMA for property owners and managers giving advice about steps to take in the immediate aftermath of a flood. They also contain further guidance and information to aid understanding throughout the restoration process. They are free to download from the BDMA website and can be bulk ordered in hard copy for issue to flooded areas or customers. Concise advice which naturally cannot provide much technical information.

4.1.8 AFTER A FLOOD: PRACTICAL ADVICE ON RECOVERING FROM A FLOOD

Environment Agency (2007)

An advice leaflet for property owners and managers of flooded property covering many areas including drying. It complements the EA website advice pages and floodline. Very concise advice and contains advice line phone number.

Homeowners are advised to ring their insurer or landlord as soon as possible and to call floodline. Not to enter the building if it is unsafe, to keep records and photograph damage. Be aware of contaminants, wear protective clothing, check electrics. If pumping out check water levels and place any generator outside the building. Shovel mud away and clean but not with a high pressure hose. If drying naturally, advice is to keep doors open. If using dehumidifiers close external doors and windows, turn central heating on to 20-22^{o}C.

4.2 Technical publications

4.2.1 METHODS OF DRYING FLOODED DOMESTIC PROPERTIES: THE PERCEPTIONS OF UK BUILDING SURVEYORS

Soetanto and Proverbs (2003)
Cobra 2003, Proceedings of the RICS Foundation Construction and Building Research Conference, Royal Institution of Chartered Surveyors, University of Wolverhampton, 1-2 September 2003

Background information on research into the mechanisms of drying of buildings is briefly presented in this paper. A literature review indicated little consensus of opinion and ignorance of damage assessment procedures or ‘optimal’ repair methods. It is a complex problem that is assumed to be simple. There are various phases that can be identified in the drying of brick and block materials, some dependent on the material properties, others on the evaporation characteristics of the surface. One of the relevant outcomes of research is that the prediction of drying times should take into account the duration of floodwater in contact with the building and the sorptivity characteristics of the materials. In composite materials, such as brick walls with render, if the first layer is not saturated, water absorption by the second layer is unlikely. Research has also indicated that assessment of the material’s level of dryness prior to reinstatement work is crucial to ensure a good standard of repairability.

This paper also presents the results of a UK-wide questionnaire survey of 289 building surveyors and loss adjusters regarding methods and equipment used for drying flooded domestic properties. This considered ‘current’ and ‘ideal’ drying methods and any constraints to the method actually used.

A combination of methods was found to be typically used in the drying process:

- use building’s heating system
- install desiccant dehumidifier
- increase ventilation with fans
- install refrigerant dehumidifier
- use natural ventilation
- install temporary heating

The large majority of respondents used the existing heating system to assist drying (which was considered to be practical and timely) and approximately half resorted solely to natural ventilation. The most effective method was considered to be the use of desiccant dehumidifiers. However, decisions regarding the number of dehumidifiers needed were still based on rules of thumb and trial and error (e.g. one per room, two per semi-detached house), rather than on a scientific basis.

Sealing off sections of the building to assist drying was found to be adopted by two thirds of respondents. This appears to be in contradiction with recommendations in the BRE Good Repair Guide 11 (1997) to leave internal doors open to promote ventilation. However, sealing off sections may aid the drying process when using dehumidifiers or be helpful in preventing secondary damage in other areas.

Determining whether the building is sufficiently dry to commence repair work revealed some interesting responses, with the great majority of respondents (79%) using visual observation, a method considered to be the least effective. The second most popular method was the use of electrical resistance meters; these are known to give inaccurately high results in the presence of salts and therefore may be a contributing factor to the delays observed in flood damage repairs.

More than half the respondents, given the choice, would not adopt different methods from those used currently. This reveals a level of contentment that may hinder innovation and improvement of the drying process.

4.2.2 FLOOD DAMAGED PROPERTY. A GUIDE TO REPAIR

Proverbs & Soetanto (2004), Blackwell Publishing Ltd, ISBN 1-4051-1616-1

This guide is particularly aimed at the insurance and building repair industries and provides definitive guidance for property professionals, insurers and homeowners on the appropriate repair of flood damaged domestic property. The work was inspired by a lack of guidance available to professionals on re-instating flood damaged property to pre-incident conditions, which has resulted in considerable variation in scope and quality of repair services offered by the insurance industry. The book aims to help provide consistent repair recommendations, provide best practice standards for the industry, ensure optimum solutions to homeowners' particular flood damage and help reduce the cost and time involved in undertaking repair works. The research was undertaken by the Universities of Wolverhampton and Loughborough and part funded by Lloyds TSB Insurance.

In the guide, chapters 2-4 are of relevance to this study covering flood risk assessment, flood characteristics and a review of methods used for drying buildings. The remaining chapters (5-8) represent the main contribution of the book which includes benchmarks for the reinstatement of a wide range of different flood damage conditions including those for floors, walls, doors, windows and utilities found in domestic properties. The book presents results from surveys amongst experts with regard to current practice in drying and repair of flood damaged buildings. The following findings are of particular relevance:

Flood characteristics such as contaminant content, velocity, duration, sewage and faeces content, source of floodwater and flood water depth are all considered important or very important by the experts, apart from velocity of flow when it comes to determining the level of damage, drying requirements and costs involved in repair works. Sources of information and methods used for determining flood characteristics are however often based on visual inspection (flood depth) and local information/witnesses (regarding contaminant content, sewage content, duration and source of flood water) and therefore subjective and prone to variation. This is thought to be due to the costs and time involved in information gathering. It was also found that more experienced experts placed more importance on flood characteristics than less experienced surveyors which indicate a need for training of surveyors and other practitioners.

Aspects and measures for drying of flooded buildings are discussed including methods and/or equipment employed for drying building, sealing off sections of the building to assist drying and methods and/or equipment used to determine whether a building is sufficiently dry for repair works to commence. The findings in the book are in line with those presented in a previous paper by the authors (see summary in section 4.2.1). A survey amongst experts indicates a preference for using various methods to assist drying rather than just focusing on one method and two thirds of experts seal off sections of the building to assist drying. Dampness levels at the end of drying are mostly determined based on visual inspection or sometimes not at all with drying carried out for a fixed number of days after flooding. These methods were however assessed to be the least effective by the experts and the method perceived as the most effective was the use of humidity sensors, thermographic inspection and calcium carbide moisture meters to measure moisture content. Humidity sensors and calcium carbide meters are currently used by around a third of experts whereas thermographic inspection is used very little. It is however not clear from the book whether this is due to cost.

Overall findings from existing guidance, literature and consulting experts indicate that much flood damage assessment including choice of drying methods relies heavily on surveyors' individual perception and attitudes towards the repair work required which can lead to conflict between interested parties. A lack of definitive guidance on various aspects of drying out flooded buildings was identified and further research is recommended. This could include large scale physical modelling of drying of a property subjected to artificial floods.

4.2.3 IMPROVING THE FLOOD RESILIENCE OF BUILDINGS THROUGH IMPROVED MATERIALS, METHODS AND DETAILS REPORT NO. WP2C REVIEW OF EXISTING INFORMATION AND EXPERIENCE

CIRIA (2005a)
Wingfield, J., Bell, M. and Bowker, P. *Improving the flood resilience of buildings through improved materials, methods and details*. Report WP2c – Review of existing information and experience (Final Report), June 2005. Construction Industry Research and Information Association (CIRIA)

This project was carried out to examine the resilience of materials to flooding and was a review of existing experience and information about flood resilience in the UK and internationally. Particularly relevant sections for this research are Section 9, scientific based research on resilience, Section 10 water and flood resistance properties of construction materials and Section 11, water and flood resistance properties of construction elements. A highlight of the scientific research evidence is the Oak Ridge National Laboratories and Tuskegee University flooding of prototype building structures.

The report concludes that much of the available information is expert opinion and best guess information. However, within the report there are examples of material properties data and drying time curves provided by manufacturers. Detailed guidance on building elements is given which cannot be captured in this summary.

Consultees believed that the clean up response time can affect drying and restoration time by limiting further damage. Remove as much water and wet material as possible to speed drying. They also believed that stripping gave faster drying times, the decision to retain or strip out materials will depend on their durability and their effect on drying times. Different materials have different resilience and drying times, factors that affect drying times with some evidence are presented here.

Fibreglass insulation slows drying where it is applied, e.g. in walls, under floors, should be stripped out as it may contribute to rot in timber but it can be recovered and replaced. Closed cell insulation repelled water. Carpets, vinyl and wood flood coverings slow drying. Ceramic and quarry tiles do not slow drying. Water repellent coatings on bricks slow drying. Concrete floors with insulation can cause trapped moisture. Masonry takes a long time to dry. Cavity walls dry faster than solid ones except if insulated. Lime plaster aids drying by allowing vapour transmission. Lime plaster can be applied during drying to draw salts from masonry. Drying times of bricks vary from 21 to 84 days. Too much heat can crack timber. Modular buildings can be replaced quickly and refurbishment of flooded modules carried on offsite allowing early reoccupation. Companies may need quick reoccupation
Promote air circulation.

In the conclusion the report proposes that a flood defence manual which describes the actions necessary to take in a flood situation should be available for every building in the flood zone.

4.2.4 IMPROVING THE FLOOD RESILIENCE OF BUILDINGS THROUGH IMPROVED MATERIALS, METHODS AND DETAILS. REPORT NO. WP5C FINAL REPORT – LABORATORY TESTS

CIRIA (2006)
Escarameia, M. Karanxha, A. and Tagg, A. *Improving the flood resilience of buildings through improved materials, methods and details*. Report no. WP5C Final Report – Laboratory tests (Final Report), July 2006, Construction Industry Research and Information Association (CIRIA)

Quantifying the flood resilience properties of walls in typical UK dwellings
Escarameia, Karanxha & Tagg (2007)
Building Services Engineering Research & Technology (BSERT), Vol.28, Number 3, 2007

This report and later paper describe work undertaken as part of a project commissioned by the Department for Communities and Local Government (DCLG) and EA/Defra aimed at obtaining a better understanding of how buildings behave when subjected to floodwater, leading to the improvement of the building resilience characteristics. Laboratory tests were carried out to provide baseline experimental information on seepage and drying rates and their evolution with time. A selection of typical building materials, wall types and floor arrangements, as well as wall/floor junctions was tested simulating external and internal wetting (three and one day respectively) and the drying phase (minimum of six days, natural drying) - see Appendix 1 - Table 1 for a summary of characteristics of the wall panels tested.

During the drying phase, measurements were taken regularly of the surface moisture of the various wall components at ground level, at 0.5m and 1m above the floor. Following a pragmatic approach, a general-purpose moisture meter was selected as it could be easily used to measure surface moisture in a “before-and-after” type comparison study. Values would be recorded at the start of the test prior to the beginning of the wet phase to give the baseline conditions, then at the end of the wet phase and during the drying phase. A surface resistance moisture meter and calibration plate (Pinless Electrophysics CT100) was used, giving readings in terms of % Wood Moisture Equivalent (WME).

With regard to surface drying, the results were based on comparisons of pre-flood and post-flood conditions. Although the data collected during the test programme (surface moisture levels) only provided an indication of the moisture status of the wall surfaces and its evolution with time, it was useful, in particular, for indicating whether the surface of a composite was able to return to the original moisture levels, measured at the start of the wetting phase.

The increase in moisture levels following flooding was generally found to be only within 5% (even at ground level) for masonry walls but generally higher for timber framed construction.

Most of the walls tested did not manage to go back to their original moisture levels within the time allocated for the drying phase of the tests. .Possible reasons for this are associated with the presence of certain insulation materials in the wall cavity and the amount of water ingress that the walls allowed in the first place.

In spite of their higher porosity, external wall faces constructed with pressed facing bricks did not show better drying characteristics than walls constructed with engineering bricks Class A. However, empty cavity walls with internal face constructed of concrete blocks 3.5N returned to their original moisture levels at the end of the drying phase whereas those constructed with Aircrete still retained some moisture.

An analysis involving extrapolation was carried out of the drying data to estimate the time required for the wall to achieve its pre-flood moisture levels – see Appendix 1 - Table 2. Only the internal faces were analysed as these are typically used for assessments of moisture levels by surveyors undertaking flood damage repair in properties. The data collected during the tests included moisture values at three different levels but it was decided to use the ground level data for the analysis as this would provide the most conservative conclusions. In all cases the data was collected on the internal face after the plaster board was removed.

4.2.5 IMPROVING THE FLOOD RESILIENCE OF BUILDINGS THROUGH IMPROVED MATERIALS, METHODS AND DETAILS, REPORT WP6 - COLLATION AND ANALYSIS OF POST-FLOOD OBSERVATIONAL DATA

CIRIA (2007)
Tagg, A., Escarameia, M. & Ortiz, J. M. *Improving the flood resilience of buildings through improved materials, methods and details.* Report no. WP6 – Collation and analysis of post-flood observational data, Construction Industry Research and Information Association (CIRIA)

The report describes work done to improve the flood resilience of buildings through improved materials including a literature review, consultations and collection of drying data for comparison with earlier laboratory testing. Parts relevant to this investigation (and not covered directly elsewhere) include information from consultations in Section 3.2 and Appendix 1, and Section 7 "Analysis of drying data". The report covers general moisture measurement guidance similar to that summarised above.

The investigation identified that there was no set protocol for collecting drying data, making evidence-based comparison of drying methods problematic. Very little drying data was available to the team for analysis despite a request through the BDMA. Two of the interviewees, Munters and Rameses provided some example data to the project.

These two data samples produced limited results as the level of detail regarding drying actions, monitor positions and ambient conditions was somewhat lacking. Drying times were similar at about 10-12 weeks for Munters and Rameses data. This extended dying time may be related to the fact that it was a winter flood and ambient conditions were not conducive to fast natural drying. The rates of reduction of %WME averaged about 1% per day which is comparable with the natural drying rates achieved in Wallingford's tests. An interesting difference occurs between internal and external walls in the Rameses data with internal walls initially getting wetter before drying. This may be due to gaining equilibrium and their initial dry conditions may be due to the removal of wet plaster revealing levels of the combined wall structure into which water had not yet penetrated.

Comments on different drying properties of materials from consultees suggested that insulation can make a big difference: solid polystyrene maintains shape but takes a long time to dry, so taking it out if possible will speed drying. In general, more solid materials absorb water more slowly but in lengthy floods (and possibly in property left before drying) they can take longer to dry out. Moisture behind plaster is difficult to dry out. In Boscastle most properties were force dried in two months and it was observed that clay mortar slowed drying in some cases. There was a view that rendering could cause breathing problems if water gets around it, and that lime mortar breathes well if it is not over decorated.

Other views were that tanking inside can be a measure to enable reoccupation more quickly and dry from outside. Restorers advice about what should be retained is often ignored, with too much stripping out being done. It normally takes 6-8 weeks to dry properties and can use injection drying, blowing or extracting air to dry cavities and voids.

Advice on monitoring the drying process from consultees included: turn off driers for 24 hours before measuring moisture; remote monitoring is not foolproof (and not at equilibrium) and cannot move equipment so would not necessarily reduce number of visits; take measurements above tide line for setting drying goals.

4.2.6 MOISTURE MEASUREMENT IN BUILDING MATERIALS: AN OVERVIEW OF CURRENT METHODS AND NEW APPROACHES

Phillipson, M. C., Baker, P. H., Davies, M., Ye, Z., McNaughtan, A., Galbraith, G. H. and Mclean, R. C. (2007)
Building Services Engineering Research Technology, 28(4), pp.303-316

This paper contains a review of the advantages and disadvantages of commonly used moisture measurement techniques and discusses emerging technologies both those suitable for site application and those not. It then considers three new methods which are being developed for site use.

The paper concludes that many on site methods lack accuracy and may be unduly influenced by unidentified material inclusions such as metals and salts. The reviewed laboratory techniques, while accurate are determined to be unsuitable for in situ investigations.

Moisture measurement techniques for site use must be consistent and quick and easy to use.

Main techniques are:

- drilling and carbide meters (Destructive but accurate)
- electrical property meters (less destructive, can monitor continuously, accuracy problems and only surface measurement)
- proxy material (can be destructive, slow, requires more expertise),
- microwave humidity at surface (non destructive but difficult to interpret and only surface)

Other techniques:

- thermographic imagery (non destructive but skill needed in interpretation
- ground penetrating radar (for basements, skill needed)
- microwave absorption (need probes on both sides of material, not always practical)
- nuclear magnetic resonance (very costly),

Three methods which are more promising are being developed partly as a result of transfer of ideas from work in soil moisture measurement. These methods are: dual thermal heat probe, time domain reflectometry and more sophisticated electrical techniques.

4.2.7 AN INVESTIGATION OF THE CURRENT STATE OF PREPAREDNESS OF THE FLOOD DAMAGE MANAGEMENT SECTOR IN THE UK: WHAT LESSONS HAVE BEEN LEARNT?

Rhodes & Proverbs (2008)
COBRA 2008, The construction and building research conference of the Royal Institution of Chartered Surveyors (RICS), Dublin Institute of Technology, 4-5 September 2008

This paper covers research undertaken to collect views from UK flood damage management professionals through a mix of questionnaires and interviews. It reviews existing literature on the impacts of flooding on UK properties, listing the various parties that are typically involved in a flood claim process: the insured home occupier/owner, the insurer, a contractor/repairer, a drying/cleaning specialist, the loss adjuster and sometimes an independent surveyor. Existing guidance documents for the repair of buildings are also summarised in this paper.

The areas covered in the survey of flood damage professionals were:

- factors that were considered important in the repair of flood damaged properties
- self-assessment of performance during last major flood event
- guidance documents used
- factors that were considered important for preparedness of professionals
- perceived levels of preparedness
- differentiators of the various flood damage management companies

Interestingly, it was found that damage management companies perceived themselves as being fully prepared in every aspect to cope with past and future flood events. This appears to be in contradiction with customer reports, where, after a prompt response, shortcomings were reported particularly as the process of restoration developed. In the case of the Carlisle flood of 2005, the general perception was that damage companies were ill-prepared and many were speculative repair contractors with no real experience. The paper noted that the flood damage industry is one in which it is difficult to monitor standards. A key issue was the use of the available guidance and the general lack of knowledge for specific flood damage repair.

It was also interesting to note that of all the factors that were considered as important in the effective repair of damaged properties, the return to habitable condition was at the bottom of the list (although still having a high score). From the public perspective this has to be one of the top priorities but flood damage companies do not appear to place the same importance, possibly for commercial reasons. Overall there was a need to improve control and the project management of the process.

4.3 International sources

4.3.1 REPAIRING YOUR FLOODED HOME

FEMA/American Red Cross (1992)

A booklet prepared jointly by the American Federal Emergency Agency (FEMA) and the Red Cross giving advice for homeowners on repairing homes after flooding. It covers most aspects including health, stress, financial and practical:

> Homeowners are advised to open up the house, to open cupboards and use fans to move air. If appropriate they should run dehumidifiers and use desiccants such as cat litter in cupboards or alternatively call in professionals. The importance of record keeping is stressed including photographs and samples of discarded items. During the cleaning process, undamaged items should be moved for storage and damaged items which can be retained should be removed for cleaning and storage. Most wall and floor coverings and many contents including upholstery, food, medical supplies and baby items should be discarded.
>
> Drying options will depend on construction materials used. It is usual to replace wallboard, plaster can stay but will take a long time to dry. Fibreglass and cellulose insulation will need to be removed to speed drying and may be possible to reinstate when dry. Styrofoam may need hosing. Above all, residents should look after themselves and ensure that vulnerable people stay away from any contaminated areas.

4.3.2 MOISTURE MEASUREMENT GUIDE FOR BUILDING ENVELOPE APPLICATIONS

Said, M. N. (2004)
Institute for research in construction, National Research Council, Canada.

This document prepared for a Canadian market and focussed on continuous moisture measurement, nevertheless covers the main moisture measurement techniques in detail. In particular, if more regular measurements of moisture levels are required during the drying process, the continuous methods may be highly germane. In addition, these sorts of moisture measurement may be appropriate for frequently flooded property as warning systems or for historic properties as long term quality assurance.

The methods are grouped into five categories based on measurement principle, namely:

- resistance
- voltage
- capacitance
- microwave
- thermal

A comprehensive literature review is presented including studies which compare and contrast different methods on the same application.

The main conclusions relevant to this investigation are:

- different moisture measurement techniques are appropriate in different situations and for different materials
- calibration is needed to convert meters designed for measuring wood content for other building materials
- calibration is needed to convert meter readings in different temperature ranges, which may be relevant in high temperature applications
- thermal and microwave methods are non invasive and can be used to identify moisture anomalies. This analysis can be followed up by more invasive techniques in problem areas
- resistance and voltage based systems are most appropriate for continuous monitoring because they can be connected to a data logging system

4.3.3 CREATING A HEALTHY HOME, A FIELD GUIDE FOR CLEAN-UP OF FLOODED HOMES

National Centre for Healthy Housing and Enterprise Community Partners (2006**)**

An American publication concentrating on the clean up and drying of homes which have flooded. It is aimed at either “do it yourself” or contractors and gives advice on when it is imperative to call a professional. It concentrates on mould remediation but deals with many building elements.

Homeowners are advised to get written estimates and check contractors’ liability insurance. Asbestos must be removed by professionals. Insurers should be contacted immediately but owners should not wait until a loss adjuster comes before removing wet and mouldy materials. A highly qualified person should perform the final inspection and testing.

The guide recognises that, during emergencies, residents and volunteers may do clean up work normally reserved for professionals. In this case they should wear personal protective equipment, beware of lead dust, carbon monoxide, electric shocks, cuts and punctures. They should not bring contaminated protective clothing and equipment into clean living accommodation.

In managing the site it is important not to enter buildings which are structurally unsound and to open doors and windows for 30 minutes before working inside. Fans can be used to blow air from clean through dirty areas unless sewage is present. Cleaning and toileting facilities should be available. Undamaged areas should be sectioned off for storage of undamaged or cleaned items. It may be possible to save china, glass, jewellery, metal, all wood furniture, some small electrical items, important documents, photographs. Carpets, upholstery, electricals with fans, paper and food will probably need to be discarded; this should be removed in accordance with regulation.

There is a recognition that property owners may have to choose between “gutting” or “selective” tear out. Judgment may be based on the inherent value of historic materials but the advice suggests that gut tear out may be the cheaper option.
If gutted, natural drying can vary from two weeks to several months; if electricity is available, use fans and dehumidifiers. If selective tear out is chosen, then all spaces should be opened and insulation disposed of. It is important to employ a professional to determine whether the building is dry.

4.3.4 RESEARCH ON THE IMPACTS OF SPEED DRYING

Presentation by Lambert, P. (2006)
EPSRC flood repair network workshop on Identification and facilitation of flood damage research. Sheffield.

Lambert carried out wetting and drying tests on a variety of building elements using the DRYAIR moisture flush process. This is a proprietary high temperature drying technique but results are likely to be somewhat transferable to similar high temperature systems. Materials tested were:

- Brick
  - Reclaimed Brick Solid Wall
  - Second Grade Brick/Concrete Block Cavity Wall
  - London Brick/Breeze Block Cavity Wall
- Timber
  - Floorboard
  - Skirting/Architrave

- Timber – fabricated
  - Softwood Door
  - Hardwood Door
  - Chair
- Miscellaneous
  - Plasterboard
  - Sandstone.

It was concluded that the system was very effective in removing moisture from the elements within 42 hours. The conditions of temperature and humidity achieved in the test centre were constant and this ensured rapid drying and minimum distortion. Relative humidity was brought below 20 per cent within four hours. Ambient temperature climbed to 55^{o}C with the panel maximum temperatures ranging from 56-66^{o}C

No distortion was observed in masonry wall panel or sandstone. Marginal and acceptable distortion was observed in more absorbent materials. The plasterboard and internal door were damaged during the wetting stage. Monitoring temperature and relative humidity seems to be an effective monitoring method during structural drying.

4.3.5 A PORTABLE NMR DEVICE FOR THE EVALUATION OF WATER PRESENCE IN BUILDING MATERIALS

Poli, T., Toniolo, L., Valentini, M., Bizzaro, G., Melzi, R., Tedoldo, F. & Cannazza, G. (2007)
Journal of Cultural Heritage, 8, 134-140.

Experimentation towards a portable Nuclear Magnetic Resonance (NMR) device is reported in this paper. NMR is primarily a laboratory based technique which measures the absolute water content of a material by quantifying hydrogen nuclei. A powerful magnetic field is necessary and the size of the magnet limits the portability of the method. Problems may occur in the presence of organics or polymers in the building material.

The new device is based on a commercially available portable NMR system with suitably adapted probing devices. Early results are promising but many more calibration tests are needed to build up a database for different materials. The test is non invasive and so is suitable for use in historic building situations.

4.3.6 THE OPTIMISATION OF A THERMAL DUAL PROBE INSTRUMENT FOR THE MEASUREMENT OF THE MOISTURE CONTENT OF BUILDING ENVELOPES

Ye, Z., Tirovic, M., Davies, M., Baker, P. H., Phillipson, M. C., Galbraith, G. H. and Mclean, R. C. (2007)
Building Services Engineering Research Technology, 28(4), pp.317-327.

This paper follows from Phillipson et al (2007) which identified three potential moisture measurement methods for future development. This paper explores the practical application of a dual thermal heat probe design. Thermal heat probes rely on the fact that heat is absorbed differently by different materials and wet material has different thermal properties than dry material.

The research suggests that the tested probe may be an improvement on existing techniques. The main advantages are that it:

- can detect relative changes in wetness even if material properties are unknown
- is designed to be used in very wet conditions such as post flood
- is unaffected by the presence of salts

The design settled on for aerated concrete was between 45-60mm long with a spacing of 12-16 mm. The testing was done on small blocks of concrete and achieved an accuracy +/-2% (kg/kg). As far as we know this method is not yet commercially available and further research is needed on materials other than aerated concrete and in situ walls.

4.3.7 TIME-DOMAIN REFLECTOMETRY METHOD AND ITS APPLICATION FOR MEASURING MOISTURE CONTENT IN POROUS MATERIALS: A REVIEW

Cerny, R. (2008) Measurement*,* 08.

Time-domain reflectometry (TDR) is based on the electrical capacitance behaviour in a time varying electric field. This paper describes the theory and a selection of applications of the technique. TDR has many applications, but moisture measurement is one of the most frequent. The method is seen to be ideal for long term monitoring as it has the advantage of being less sensitive to salts than capacitance and resistance meters and is less destructive than gravimetric methods. The review recommends further developments in TDR measurement, in particular the formula for generating moisture content for a wide range of materials from meter readings. Soil formulae are not readily transferable because of the hygroscopic water content of porous building materials.

4.3.8 SUITABILITY OF TIME DOMAIN REFLECTOMETRY FOR MONITORING MOISTURE IN BUILDING MATERIALS

Phillipson, M. C., Baker, P. H., Davies, M., Ye, Z., Galbraith, G. H. & Mclean, R. C., 2008
Building Services Engineering Research Technology, 29, 261-272.

Follows from Phillipson et al (2007) and similar to Cerny (2008) above. Time Domain reflectometry has been used to measure soil moisture since 1980s. In application to buildings it can rapidly detect changes in moisture but absolute moisture content requires more calibration work.

4.3.9 AIR GAPS IN BUILDING CONSTRUCTION AVOIDING DAMPNESS AND MOULD

Klintberg, T. A., Johannesson, G. and Bjork, F. (2008)
Structural Survey, 26(3).

This paper covers a new patented construction technique designed to deal with water damage, the Air Gap Method. Walls and floors are designed with air gaps, inlets and outlets equipped with heating elements. The paper concludes that property with this modification would dry out more quickly and with less mould than standard construction and might therefore be a useful adaptation in floodprone areas.

The paper also describes the use of air gap technology in pre-fabricated bathrooms installed within an old bathroom with water damage as marketed by www.inwall.nu. This allows re-occupation of wet buildings more quickly, because the building can continue to dry without harming the occupants. The technology might be justified in commercial premises where business interruption is key and possibly in other situations such as historic buildings.

As part of the experimentation, the authors also compared moisture meter readings from a protimeter "Surveymaster SM" with the results of weighing the samples for actual water content. It showed that while evaporation occurred throughout the experiment, the moisture meters appeared to be over estimating the moisture content of the timber. In particular, the moisture meter failed to recognise changes in wetness during the most saturated phases. The trend of measurements was generally correct but there was a great deal of variation between meter measurements. This comparison raises the issue of meter accuracy in the initial stages of drying.

4.4 Historic buildings

Most of the guidance covered in the foregoing review sections recognises that historic and older buildings may need specialist advice. Much of the guidance summarised below stresses the damage that moisture can do to historic structures but also reassures that older structures are often more resilient being constructed of more porous substances. A factor that cannot be ignored in the restoration of older buildings is that permissions may be required to carry out work in listed buildings and conservation areas. But this review has identified several specific concerns expressed regarding older and historic buildings which makes them different in terms of drying goals and options. These include the following:

- the desire to retain original materials is much higher in historic structures
- different construction techniques are often used which may be outside the experience of many contractors leading to water paths unfamiliar to practitioners
- different materials are used which may result in unusual responses to drying techniques
- extra health and safety concerns due to structural problems and the presence of possible toxins not allowed in modern buildings, e.g. lead paint
- the desire for non-invasive moisture measurement techniques
- reoccupation in the short term may be more important due to the commercial pressures on many ancient buildings

Documents summarised here include some giving general advice to owners and managers of historic buildings and papers covering drying of historic structures, non invasive measuring techniques and water transport within ancient structures.

4.4.1 TREATMENT OF FLOOD-DAMAGED OLDER AND HISTORIC BUILDINGS

National Trust for Historic Preservation (1993)
Information booklet. National Trust for Historic Preservation.

The booklet was prepared to advise flooded home owners and those responsible for flood damaged older buildings in Louisiana but is based on an earlier advice booklet for Northern states within the US. It contains some sensible general advice on health and safety and advocates natural drying except in areas with high humidity.

The advice to homeowners includes contacting historic preservation experts and being aware that there may be financial assistance available. Homeowners should wait until the water recedes, make sure it is safe to approach and enter building, including staying away from electrics or turning off electricity. Be aware of risks such as mud making surfaces slippery, gas leaks and carbon monoxide.

Take photos and record damage, making an inventory of found and lost items; architectural elements can be carried by floodwater, do not throw away something which may be valuable to someone else. Remove mud while still wet, open all cavities, clean and disinfect. Only pump out water from basements once groundwater has receded.

Ideally, don't use heat to start with, use natural ventilation. Heat can be introduced later in the process particularly in humid areas. Use of industrial equipment to remove moisture too quickly will cause permanent damage. Lift historic tiled floors if laid over wood.

4.4.2 FLOOD DAMAGE IN HISTORIC BUILDINGS

Hutton, T. & Marsh, C. (2002)
The Building Conservation Directory

An article which covers risk, resilience and advice about management of historic buildings. It emphasises the fact that many older buildings were quite resilient to flooding until modern fixtures and fittings were added. In refurbishing flooded buildings it is important to identify and drain moisture traps, remove any non historic material to aid drying. It is good practice to replace these modern finishes with more original ones although modern through ventilated dry linings can also be useful. Water trapped behind panelling should be drained, if saturated the panelling should be dismantled and dried in a controlled manner to avoid distortion. Timber floorboards should be treated carefully depending on condition. It may be sufficient to remove the occasional board if not buckled. If buckled, remove and dry under controlled conditions. Accelerate drying by ensuring maximum through ventilation and opening all moisture traps. Strip plaster (unless it is historically valuable) to expose underlying structures. Consider the installation of accelerated drying machinery but be aware that this requires much management time. If the building is listed then consent may be needed and advice of specialists should be sought.

4.4.3 NATURAL DISASTERS AND URBAN CULTURAL HERITAGE

Toboroff, J. (2003) in Kreimer, A., Arnold, M. & Carlin, A. (Eds.)
Building Safer Cities. World Bank.

A book chapter regarding wider aspects of the issues surrounding natural disasters; however, in respect of drying it recommends that remedial work can be more damaging than the disaster itself. Recommendations include to record damage, not to dry out too quickly, ventilate and then dehumidify. Also recommends freeze drying of very important timber building elements which is a technique recommended elsewhere for conserving flooded paper, photographs and books.

4.4.4 FLOODING AND HISTORIC BUILDINGS, TECHNICAL ADVICE NOTE

Fidler, J., Wood, C. and Ridout, B. (2004)
English Heritage.

A technical advice note aimed at homeowners and small business owners of historic buildings. Specifically buildings which are listed, or in conservation areas, areas of outstanding natural beauty (AONB), national parks or are locally important. Much of the advice is applicable to building stock dated pre 1914. Museum owners are advised to call in specialists.

Some of the advice is useful to any homeowner, particularly about disinfecting and health and safety. However the main focus consists of ways to retain historic fabric and the warning that standard damage management practices can be detrimental to historic fabric and may contravene listed building consent legislation. Most of the advice is based around natural drying and the need for patience and care is stressed throughout. There is quite a lot of detailed instruction on building elements which cannot be captured in this summary.

4.4.5 HOW WET ARE THESE WALLS? TESTING A NOVEL TECHNIQUE FOR MEASURING MOISTURE IN RUINED WALLS

Sass, O. and Viles, H. A. (2006)
Journal of Cultural Heritage, 7(4), pp.257-263.

A research paper comparing two moisture measurement methods. Wooden dowels and electrical resistivity using adhesive ECG electrodes. Both methods were designed to detect moisture to a depth of 40cm. Two methods were trialled: 40cm wooden dowels and electrical resistivity to a depth of 40cm. A network of dowels or electrodes was used to produce moisture maps depicting wet patches. Results of the new electrical resistivity were promising. Electronic resistivity as used here is a totally non invasive technique, suitable for sensitive historic buildings.

4.4.6 AN OPERATIVE PROTOCOL FOR RELIABLE MEASUREMENT OF MOISTURE IN POROUS MATERIALS OF ANCIENT BUILDINGS

Sandrolini, F. & Franzoni, E. (2006)
Building and Environment, 41, 1372-1380.

Moisture measurement is important to prevent decay of historic buildings and to allow contract specifications of moisture reduction. This paper considers the advantages and disadvantages of various methods and recommends the gravimetric method as the most reliable and accurate. Further it suggests that a strict protocol of sampling and laboratory analysis is necessary to obtain a true representation of moisture content. In this protocol repeated measurements are carried out by drilling material and repeatedly measuring and replacing the same material, in a cavity protected by plasticine and a rubber stopper. The method is in use in several historic buildings, both Italian (St. Marco Basilica in Venice, Palazzo Pio at Carpi, St. Francesco church at Correggio, St. Luca and Alemanni porticoes in Bologna) and Maltese (St. Caterina d'Italia church in La Valletta).

Shortcomings of the alternative systems are described in similar way to Phillipson et al (2007). And damage is minimised by repeatedly using the same drilled material; in other papers operatives are advised to discard oven dried samples once weighing has occurred.

4.4.7 ENGINEERING HISTORIC FUTURES: STAKEHOLDERS DISSEMINATION AND SCIENTIFIC RESEARCH REPORT

Cassar, M. and Hawkings, C. (2007)
UCL centre for sustainable heritage

A multi-faceted study into moisture management in historic buildings, not entirely limited to flooding. The contents include: two case studies examining drying options within damp historic buildings of different construction types; a report into two wetting and drying experiments based on the historic building case studies; evaluation of wooden dowels as a moisture measurement technique; stakeholder statements and feedback from dissemination workshops which may also add information to the general debate.

Within the lab, test walls were constructed which reflected the construction in the two case study buildings. One was of clay brick with lime mortar and was 650mm thick consisting of two skins solid filled with half bricks and mortar. The other was of Locharbriggs, lime mortar and a lime putty Ashar finish on the exterior surface; it was approximately 550mm thick with a rubble infill core. The brick wall was flooded from the cold (external) side for three days and the sandstone wall sprayed on the cold (external) side to simulate heavy rainfall.

The water penetrated through to the warm side of the brick wall though it was higher on the cold side. Natural and forced drying using a desiccant dehumidifier with some heat were compared: natural drying was slower and did not occur within the 50 day experiment. With forced drying the cold external surface dried within a month; within the core it took two months and the warm side of wall took over four months.

Forced drying dried out the surface quickly but left the core wet for much longer. This finding is in line with theory: evaporation at surface depending on ambient conditions but transfer within materials depending on material properties.

In the spray tests of the sandstone wall, damp failed to penetrate into the core.

In the in situ tests of damp walls within the two historic sites, air circulation, partitioning and dehumidification were tested. In a damp basement of brick construction the wall was saturated despite tanking. Removal of tanking and lime plaster did not make a significant difference to drying of wall under dehumidification. Dehumidifier was provided by Munters (type not identified, presumably desiccant) and air was heated.

In the case studies wooden dowels were used. These were seen to be inadequate to measure dynamic moisture changes, lagging behind the wall moisture content by up to three weeks. Other core materials were suggested as preferable for example clay and alternative methods were discussed at the workshops. In the lab XRays were used.

From the dissemination workshops, rapid drying is seen as detrimental, a case of damage to wood panelling in Poland was cited.

The report recommended further research into: moisture measurement in situ; What is the equilibrium state for typical historic materials?; the rate of deterioration in historic materials due to moisture i.e. How important is it to dry quickly?; controlled drying of different wall types to the clay brick and stone considered here.

4.4.8 SUMMARY OF ADVICE FOR HISTORIC BUILDINGS

Document	**Advice given**
National Trust for Historic Preservation (1993)	Contact historic preservation experts There may be financial assistance available Take photos and record damage Inventory found and lost items, architectural elements can be carried by floodwater, do not throw away something which may be valuable to someone Do not use heat to start with, use natural ventilation. Heat can be introduced later in the process. Use of industrial equipment to remove moisture too quickly will cause permanent damage. Lift historic tiled floors if laid over wood.
Hutton &Marsh (2002)	If listed, seek permissions and specialist advice Old buildings are more resilient New fixtures are the problem Remove modern finishes to aid drying and replace with ventilated dry lining if required Drain voids, open up moisture traps. Dry timber in controlled manner removing if necessary and replacing Strip plaster unless historic Consider drying equipment but manage the environment closely
Toboroff et al (2003)	Freeze drying timber elements
EH – TAN (2004)	Standard emergency procedures may breach listed building consent legislation Particularly vulnerable historic building materials are: stone; bricks and mortar; timber frames; wattle and daub; timber boards and panelling; earth walls and floors; Lime plaster; decorative finishes Do not strip out architectural features. Any stripping out may need planning permission. Much of the historic fabric of buildings can be retained even if it looks sodden. Do not clean with high pressure water Lift 1 in 6 floorboards Open voids such as box shutters, cupboards and electrical

Document	Advice given
	outlets if it is safe Remove carpets, MDF, impermeable covering Remove non historic wall coverings Remove insulation Retain detached items and search wide area and downstream for items which are missing Consider injection drying for voids Over fast drying can warp timber, cause salt migration, peel paint and other delicates. Use natural ventilation as much as possible, employ fans to increase circulation. If necessary use low background heat but install humidistats not thermostats Or use dehumidifiers but not if wall paintings or other decorative wall coverings present Dry removed items in controlled conditions, turn timber frequently and apply gentle pressure to large flat items. Protect soft bricks from frost damage during cold weather with insulation and screening There may be grants available for emergency work Consult the conservation officer of your local planning authority Before flooding can lay in a store of absorbent material to mop up puddles and damp spots. Keep photographic records of architectural features, before flood and during flood and continue to photograph damage and during restoration. If historic elements are removed to aid inspection, photograph, record position and number each element Consider using keyhole techniques for inspection such as endoscopes Hollow sounding plaster does not imply unsound Consider replacing cement mortar in walls and historic floors during drying process with sacrificial lime to aid drying and draw salts. Inspect 6 months after for mould growth and then annually
CIRIA (2005)	Particular care should be taken to obtain necessary permissions when dealing with listed or historic buildings.
RFB (2006)	Historic buildings are complex and require a technically competent person
Sass & Viles (2006)	ECG electrodes are a non invasive resistivity method for moisture detection
Cassar & Hawkings (2007)	Do not panic, historic structures are naturally wet and breathable Do not force dry Important to have a business continuity plan in place. Need to establish normal conditions of wetness Establish construction if possible including internal wall structure Need to use existing records and historic monitoring if any is available and owners of historic property should aim to make these records easily available Adequate ventilation prevents algae growth All historic buildings are different so generic models and guidance will not work, Need specialists to restoring particular elements e.g. wall paintings

5 Outcome of consultations

The literature review was complemented by some targeted direct consultation of individuals/organisations with potential to provide information that would not be able to be captured through the formal meetings and workshop. Detailed notes of these consultations are presented in Appendix 2:

Notes of telecom with SH of PCA
Notes of meeting with Roger Woodhead of Rameses Associates Ltd
Notes of telecom with Mike Waterfield of Munters
Notes of meeting with Chris Netherton of the National Flood School

The findings from these consultations will be analysed alongside the outcomes of the 1st Steering Group and the Stakeholder Workshop.

6 Findings

A number of general issues were identified as being the most critical to any guidance on drying of flooded buildings and, although these issues will be further discussed and developed as the study progresses, they provided the basis for structuring the findings of the review. Tables 6.1 and 6.2 indicate which of the documents reviewed provide advice on the various issues identified; it uses a system whereby firm advice is denoted by a black tick and limited/insufficient advice is denoted by a grey tick. In the tables in Section 6.2 the firm advice given by the various publications is summarised according to each issue.

6.1 How documents address major issues

Table 6.1 Summary of how documents address major issues – Guidance Documents

Issue	BRE (1974)	BRE GRG 11 – 1 (1997)	BRE GRG 11-2 (1997)	BRE GRG 11 – 3 (1997)	ODPM (2003)	PAS 64 (2005)	CIRIA (2005)	RFB (2006)	BDMA (2007)	EA leaflet (2007)
Advice to homeowners	✗	**✓**	✓	✓	✗	✗	**✓**	**✓**	**✓**	✓
Advice on emergency organisation immediately after flood	✗	✗	✗	✗	✗	✓	**✓**	✓	**✓**	✓
Survey of property after flood (including flood characteristics)	✗	**✓**	**✓**	✓	✓	✓	**✓**	**✓**	✓	✓
Assessment of stakeholder needs and drying goals	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗
Options for drying	**✓**	**✓**	✓	✓	✗	✗	✓	**✓**	✗	✓
Equipment / process to use based on flooding / property type	✗	✗	✓	✓	✗	✓	✓	✓	✗	✗
How to measure and record moisture (when is it 'dry')	**✓**	✗	✓	✓	✗	**✓**	**✓**	✓	✓	✗
Health and safety aspects (including vermin)	✓	✓	✗	✗	✗	✓	**✓**	✓	✓	✓
Links between drying & repair contractors (& homeowner and insurers)	✗	✓	✗	✗	✗	✓	**✓**	**✓**	✗	✗

Notes:
Symbol in bold black denotes guidance is given that fully addresses the issues
Symbol in grey denotes some but insufficient guidance

Legend:
BRE (1974) -
BRE GRG 11 – 1 (1997) – BRE Good Repair Guide 11 Part 1
BRE GRG 11 – 1 (1997) – BRE Good Repair Guide 11 Part 2
BRE GRG 11 – 3 (1997) - BRE Good Repair Guide 11 Part 3
ODPM (2003) - Preparing for floods. Interim guidance for improving the flood resistance of domestic and small business properties
PAS 64 (2005) – Professional Water damage mitigation and initial restoration of domestic buildings
CIRIA (2005) – Standards for the repair of buildings following flooding
RFB (2006) – Repairing flooded buildings
BDMA (2007) – "Self help for victims of flooding, what you can do" and "Understanding basic flood recovery procedures"
EA leaflet (2007) - After a flood: practical advice on recovering from a flood

Table 6.2 Summary of how documents address major issues – Technical Publications

Issue	Soetanto & Proverbs (2003)	Proverbs & Soetanto (2004)	CIRIA (2005a)	CIRIA (2006)	CIRIA (2007)	Phillipson et al (2007)	Rhodes & Proverbs (2008)
Advice to homeowners	**✗**	**✓**	✓	✓	✓	**✗**	**✗**
Advice on emergency organisation immediately after flood	**✗**	**✓**	✓	✓	✓	**✗**	**✗**
Survey of property after flood (including flood characteristics)	✓	✓	✓	✓	✓	✓	**✗**
Assessment of stakeholder needs and drying goals	✓	✓	✓	✓	✓	**✗**	**✗**
Options for drying	**✓**	**✓**	✓	✓	✓	✓	**✗**
Equipment / process to use based on flooding / property type	✓	**✗**	**✗**	**✗**	✓	**✗**	**✗**
How to measure and record moisture (when is it 'dry')	**✓**	✓	**✗**	**✗**	✓	✓	**✗**
Health and safety aspects (including vermin)	**✗**	**✗**	✓	✓	✓	**✗**	**✗**
Links between drying & repair contractors (& homeowner and insurers)	**✗**	✓	**✗**	**✗**	✓	**✗**	**✓**

<u>Notes:</u>
Symbol in bold black denotes guidance is given that fully addresses the issues
Symbol in grey denotes some but insufficient guidance

<u>Legend:</u>
Soetanto & Proverbs (2003) - Methods of drying flooded domestic properties: the perceptions of UK building surveyors
Proverbs & Soetanto (2004) – Flood Damaged Property. A Guide to Repair
CIRIA (2005a) – Improving the flood resilience of buildings through improved materials, methods and details Report no. WP2C Review of existing information and experience
CIRIA (2006) – Improving the flood resilience of buildings through improved materials, methods and details. Report no. WP5C Final Report – Laboratory tests
CIRIA (2007) – Improving the flood resilience of buildings through improved materials, methods and details, Report WP6 - Collation and analysis of post-flood observational data
Phillipson et al (2007) – Moisture measurement in building materials: an overview of current methods and new approaches
Rhodes & Proverbs (2008) - An investigation of the current state of preparedness of the flood damage management sector in the UK: what lessons have been learnt?

6.2 Summary of findings by issue

6.2.1 ADVICE TO HOMEOWNERS ON DRYING

Document	Advice given
BRE (1974)	-
BRE GRG 11 – 1 (1997)	Immediate actions after flood event for homeowners include: - check external structural damage (seek expert advice/local authority for advice) - Switch off electricity supplies and gas appliances - Check drainage system - Contact insurers - Remove wet carpets and furniture - Clean walls and floors - Start drying building
BRE GRG 11-2 (1997)	-
BRE GRG 11-3 (1997)	-
ODPM (2003)	-
PAS 64 (2005)	-
CIRIA (2005)	Contact insurers quickly Pump out even without insurance approval to prevent further damage Record and document as much as possible If appointing a surveyor should be RICS If appointing contractor get several quotes Contractors should be members of a recognised trade association
RFB (2006)	Windows to be open if the weather is fine Electric sockets and fittings not to be used if affected by water; electrical appliances to be disconnected; if in doubt about safety, call an electrician Move as many objects to higher levels as possible, away from floodwater Also, general advice on the claims chain
BDMA (2007)	Keeping busy may help you cope but don't take on too much Much of the work will need specialists Controlled measurement and records of drying process are essential. Use competent organisations
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	Flood protection measures including flood warning services and flood protection products which can reduce drying time
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.2 ADVICE ON EMERGENCY ORGANISATION IMMEDIATELY AFTER FLOOD

Document	Advice given
BRE (1974)	-
BRE GRG 11 – 1 (1997)	-
BRE GRG 11-2 (1997)	-
BRE GRG 11-3 (1997)	-
ODPM (2003)	-
PAS 64 (2005)	-
CIRIA (2005)	Competent person should make a full health and safety risk assessment Pump out standing water but never more than 1m in any one day Remove building contents, remove fixtures and fittings as appropriate to aid cleaning. Remove mud and silt but disposal must be in accordance with controlled waste regulations Wash down and clean, use power washing and scrubbing if possible Assess contamination and continue if necessary Document activities Most dirt and contaminants will sink to lowest level and may be concentrated in basements
RFB (2006)	-
BDMA (2007)	Remove standing water mud and debris if safe to do so Protect furniture and possessions from further damage by for example placing furniture on plastic bags. Move undamaged items Remove saturated items Record damage Record flood characteristics Open windows and doors
EA leaflet (2007)	
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	Homeowners at risk are recommended to develop a flood risk plan covering communication links, evacuation, emergency contact details and ways to turn off power supplies
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.3 SURVEY OF PROPERTY AFTER FLOOD (INCLUDING FLOOD CHARACTERISTICS)

Document	**Advice given**
BRE (1974)	-
BRE GRG 11 – 1 (1997)	Damage to look for and if possible clean up: - Structural damage - Mud and silt build up in drainage system - Check for mud and silt on external surfaces - Mud and water under floors, in cavities, in plasterboards walls - Mark the water level on the walls
BRE GRG 11 – 2 (1997)	Investigate construction and condition of floors, underfloor spaces and basement
BRE GRG 11 – 3 (1997)	-
ODPM (2003)	-
PAS 64 (2005)	-
CIRIA (2005)	Depth and duration of flood will affect the level of damage, these should be recorded. Nature of the floodwater can also have implications and should be recorded, chemical analysis of floodwater should be carried out if necessary. Document damage.
RFB (2006)	Building Condition Report in respect of flood damage This form collates important information on the building and building services including general descriptions of the walls and floors and existing condition and defects. The form also requests the height of flood level and the date of the event.
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	-
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.4 ASSESSMENT OF STAKEHOLDER NEEDS AND DRYING GOALS

Document	**Advice given**
BRE (1974)	Mentions different goals by construction industry and homeowners. The drying process is governed by early completion/economic considerations but can cause problems with cracking/shrinkage
BRE GRG 11 – 1 (1997)	-
BRE GRG 11 – 2 (1997)	-
BRE GRG 11 – 3 (1997)	-
ODPM (2003)	-
PAS 64	
CIRIA (2005)	-
RFB (2006)	-
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	-
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.5 OPTIONS FOR DRYING

Document	**Advice given**
BRE (1974)	Different methods of drying mentioned including ventilation: - Windows should be kept open during drying with or without heaters - Windows must be closed if dehumidifiers are used. It is recommended to use dehumidifiers in combination with heaters
BRE GRG 11 – 1 (1997)	Recommendations for drying include: - Keep internal doors open and to open external windows and doors whenever possible. - Further ventilation of under floors and walls can be achieved by opening floor hatches, lifting timber boards and by removing damaged plaster board. - Heat the building using an industrial heater; if the heating system is working thermostats should be kept at around 22^{o}C. - Chimneys must be dried out over several weeks by slowly increasing the size of solid fuel fires or length of use of gas heaters.
BRE GRG 11 – 2 (1997)	
BRE GRG 11 – 3 (1997)	
ODPM (2003)	-
PAS 64	
CIRIA (2005)	-
RFB (2006)	Optimum operating ranges - refrigerant dehumidifiers: 15-28C and 60-98% RH - desiccant dehumidifiers: 0-25C and 40-90% RH
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	Based on survey of professionals Most popular methods: - various methods combined with existing heating to assist drying and natural ventilation; also sealing off sections - use of dehumidifiers Ideal method: - install temporary heating
Proverbs & Soetanto (2004)	As in Soetanto & Proverbs (2003)
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs 2008	-

6.2.6 EQUIPMENT / PROCESS TO USE BASED ON FLOODING/PROPERTY TYPE

Document	**Advice given**
BRE (1974)	-
BRE GRG 11 – 1 (1997)	-
BRE GRG 11 – 2 (1997)	-
BRE GRG 11 – 3 (1997)	-
ODPM (2003)	-
PAS 64	
CIRIA (2005)	-
RFB (2006)	-
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	-
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.7 HOW TO MEASURE AND RECORD MOISTURE (WHEN IS IT 'DRY')

Document	**Advice given**
BRE (1974)	Moisture in timber, floor screeds and walls is measured using different methods. Visual inspection or touch are not acceptable methods for determining acceptable dryness: - Timber can be tested using en electrical moisture meter. Target of 10-12% (natural condition) considered ready for decoration - Floor screeds moisture is measured using a hygrometer (different types are available) with a target range of 75-80% for flooring to be laid. - Electrical moisture meters, coloured indicator paper and hygrometers are used on walls. No target provided. Appropriate use of equipment is discussed including need for overnight coverings for electrical moisture meters and coloured indicator paper. The presence of salts may produce misleading results with electrical meters.
BRE GRG 11 – 1 (1997)	-
BRE GRG 11 – 2 (1997)	-
BRE GRG 11 – 3 (1997)	-
ODPM (2003)	-
PAS 64 (2005)	Measurements of moisture to be taken within any unaffected, structurally similar, material; Produce drying goal based on this measurement; if not present use an accepted relative scale to identify the drying goal Use specific or absolute humidity (in kg per kg) when calculating and recording the amount of moisture in the air Use equilibrium relative humidity when describing amount of moisture in a solid material (e.g. concrete, screed, plaster, brick) Use percentage moisture content when describing amount of moisture in soft or hard wood Relative moisture content should be used when invasive techniques will result in further loss or is impractical Consult specialists when anomalies in readings occur
CIRIA (2005)	Important to measure moisture during drying to ensure that drying does not occur too slowly or too quickly. Monitoring should encompass: Air movement Air temperature Air moisture content Drying is achieved when: Internal conditions normal Remaining moisture will not support mould growth Building materials will return to equilibrium without damage. Monitoring equipment includes Digital hygrometers, Resistance or conductance meters, capacitance meters, drilling techniques, karsten tubes, borescope

Document	Advice given
	Materials can appear dry visually while still saturated because of surface evaporation.
RFB (2006)	-
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	Based on survey of professionals Most popular methods: - visual observation, electrical resistance metres Ideal method(s): - humidity sensors, thermographic inspection (rarely used at present)
Proverbs & Soetanto (2004)	-
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.8 HEALTH AND SAFETY ASPECTS (INCLUDING VERMIN)

Document	Advice given
BRE (1974)	Document notes that a damp building may be a health hazard and can lead to unsightly mould growths
BRE GRG 11 – 1 (1997)	Contact local authority (Building Control Department) for advice on structural damage. Advised not to enter building until inspected by structural engineer/surveyor
BRE GRG 11 – 2 (1997)	-
BRE GRG 11 – 3 (1997)	-
ODPM (2003)	-
PAS 64	
CIRIA (2005)	Make safe before entering building. Important to complete decontamination before drying process begins. BDMA risk based approach (a three page matrix of hazard severity, likelihood and actions) should be a minimum. Look out for indirect effects such as stress. Moulds can appear within 48 hours. Ensure adequate ventilation while using pumps in confined spaces.
RFB (2006)	-
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	-
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	-

6.2.9 LINKS BETWEEN DRYING & REPAIR CONTRACTORS (& HOMEOWNER AND INSURERS)

Document	**Advice given**
BRE (1974)	-
BRE GRG 11 – 1 (1997)	-
BRE GRG 11 – 2 (1997)	-
BRE GRG 11 – 3 (1997)	-
ODPM (2003)	-
PAS 64	-
CIRIA (2005)	See "Advice for homeowners"
RFB (2006)	Stresses importance of effective communication with the policy holder (usually the home owner/occupier) Suggests staged approach The information sought and given at the various stages of the claim process is identified in detail together with the various relevant parties that are likely to be involved (e.g. insurer, loss adjuster, assistance company, claims handler, damage management organisation, contractor)
BDMA (2007)	-
EA leaflet (2007)	-
Soetanto and Proverbs (2003)	-
Proverbs & Soetanto (2004)	-
CIRIA (2005a)	-
CIRIA (2006)	-
CIRIA (2007)	-
Phillipson et al (2007)	-
Rhodes & Proverbs (2008)	The chain typically involves: - insured homeowners - insurer - contractor/repairer - drying/cleaning specialist - loss adjuster Occasionally also an independent surveyor acting on behalf of the insured but paid by the insurer.

7 Outline of proposed guidance on drying

An outline of the proposed guidance document on drying is given next. It will be further developed and enhanced following the future consultations at steering group meetings and study workshop:

- Introduction (target audience, scope).
- Definition of type and duration of flood event.
- Definition of target drying levels for different materials/types of construction.
- Determination of target drying times.
- Forms (likely to be based on amendments/improvements from Flood Repairs Forum book and PAS 64).
- Advice to homeowners on immediate action following floods.
- Advice to non-expert professionals (for large scale flood events where expert resources may be insufficient).

8 Conclusions and recommendations

8.1 Conclusions

This section presents some initial views and conclusions from a review of literature related to drying flooded homes. At this stage, we do not think it appropriate to produce definitive and 'final' conclusions, as the 1st Steering Group (SG) and Stakeholder Workshop have yet to take place, and we do not want to restrict debate by appearing to have reached a firm conclusion on what needs to be done. This section will therefore try to present what are hopefully unequivocal findings, plus pose some wider questions that the SG and workshop need to consider.

A significant body of literature has been reviewed for this report, covering all aspects of drying and repair of flood-damaged homes, plus methods for drying and measuring moisture. Whilst there is clearly additional material that could be reviewed, there seems little point in so doing as all of the key issues have been covered, at least in part, by the referenced documents. HR Wallingford and Wolverhampton University produced a list of what appeared to be the key issues that needed considering in this project, to address the overall objectives, and each document has been cross-referenced to these key aspects.

The review has considered documents that go back more than 30 years, and it is interesting that some of the earlier documents, mainly from BRE, do appear to provide good guidance on how to respond after a flood and how to go about drying a house. However, the media and public interest in floods and their effects really does appear to start with the 1998 Easter floods, and most of the guidance that are currently in use and known about have been produced in the past 10 years.

Overall, the two documents that cover the majority of the issues considered to be important are PAS 64 and the CIRIA 'Standard'. In addition, the book from the Flood Repair Forum (FRF) also scores well. PAS 64 is very thorough and provides comprehensive and clear guidance on how to go about drying a standard property, apart from specific advice to homeowners and the options for drying. However, it does provide the clearest advice on how to go about measuring and recording moisture levels, linked to the initial survey and drying goals. It contains recording forms that can only aid understanding of the drying process, which the project team consider to be very useful. The CIRIA guide is very comprehensive, but does not provide such clear information on the measurement of moisture, and is geared to repair professionals, whereas PAS 64 (although not addressed to the homeowner) is appropriate for a non-technical audience. The FRF guide is more of an institutional document, dealing well with the organisations involved in the whole process of restoring a flooded home. This is not surprising given that it was created with the insurance industry in mid. It does also include recording forms although these are not as detailed as those in PAS 64.

There exists a lot of literature and research on how to measure moisture, and this seems to be a developing field. It is clear that determining the impact of a flood is not a trivial task, given the different materials that make up a house, but there is no reason why definite guidance could not be produced that sets out which monitoring equipment to use on different materials and how to interpret the results. Providing definite guidance however requires considerable thought, given the abundance of methods and their limitations. With appropriate training of competent operators, there should be no problem in undertaking a comprehensive survey of the property immediately after a flood, deriving suitable drying goals and monitoring this during the drying process, amending this as things develop and doing final testing.

The drying equipment available is also well-established, and will be subject to improvement over time. Improved drying methods have been developed over the past decade and these are being taken up by the industry. Clearly, enhanced drying may come at a financial cost, and could damage contents and the building fabric if used incorrectly. Again, it should be possible to have clear guidance on alternative drying methods and to match the different equipment to the flood damage. Similarly, the needs of homeowners or occupiers should be considered during the various drying phases.

In considering the comments from the Pitt Review on concerns over the time taken to dry a house after the 2007 floods, one can quickly 'brainstorm' some possible reasons for the difficulties:

- It is not possible to dry a house as quickly as expected.
- It is difficult to measure moisture levels and to monitor the drying process.
- There is often an expectation to achieve moisture levels that were never present prior to the flood or cannot be achieved in current ambient conditions.
- Many buildings were of non-standard construction or were older buildings not covered by existing guidance.
- There are insufficient competent professionals available during a major flooding incident to cover all of the affected properties.
- There is insufficient equipment available to be mobilised during a major flood.
- Cost considerations are lengthening the drying process.
- The standard recovery timetables used by insurers, loss adjustors and the drying industry do not facilitate a prompt return by the owner.
- The timescales of the drying and restoration process were not communicated effectively to the homeowner.

The first two points are not supported by this review since it is clear that a standard construction home could be dried in three weeks or less if enhanced drying was used. As noted above, there are very sophisticated methods for measuring and monitoring moisture levels. Most of the other issues are not well covered in the majority of the documents reviewed here. Only the two publications from Wolverhampton University (Rhodes & Proverbs and Soetanto & Proverbs) have considered some of the institutional issues. For example, the industry considers that it is well-prepared in the event of a major flooding incident, but this appears not to be the case from the feedback from the Carlisle flood. Similarly, much of the drying process seems to be based on experience and judgement, rather than hard technical evidence. Therefore it is difficult for a homeowner to question how the drying process is going, due to lack of availability of recorded data. The issue of homeowners wanting to return as quickly as possible to their properties is not considered to be a major factor by the industry, contrary to the findings of the Pitt Review.

Some of the above social and institutional issues are not well covered in the documents reviewed here. Therefore these should be key questions for the SG and stakeholder workshop. There is also the question whether the guidance should separate internal flooding from that caused by major flood events, so that the additional social and economic issues caused by the latter are dealt with by dedicated technicians who are fully aware of the issues.

8.2 Recommendations

Both the PAS64 and the RFB include a number of forms that are relevant for the drying process and are considered to very helpful if they were in common use. These forms have been identified in Section 4.1 and some enhancements are proposed here ensure that all the information on the flood event is captured and monitoring of the drying process is fully recorded.

Forms in PAS64

Loss assessment - suggested enhancements:

- include the date of the event, the level of the flood water and to specifically include moisture readings on unaffected components as well as on affected ones for comparison purposes and to help set drying goals
- include the category of water damage and categories of risk, as per Annex E

Drying report - suggested enhancements:

- to indicate the frequency of these reports (possibly weekly)
- to explain on footnote the various drying parameters

Forms in RFB

Building condition report in respect of flood damage - suggested enhancement:

- explicitly request information on the building materials used for the walls and ground floor (rather than a general description). This would aid the estimation of likely drying times based on findings from recent laboratory work (CIRIA, 2006)

Report of flooding event – suggested enhancement:

- indicate the duration of the flood event in the section “Details of the flooding event”

Report of repairs and treatment of a flooded building

This form gives details of the work carried out and, similar to the previous report, should be presented to the owner and for inclusion in the building user’s manual (if available) for the benefit of future owners.

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Appendix I Tables from CIRIA (2006) and Escarameia et al (2007)

Table 1 General characteristics of walls tested (CIRIA, 2006)

Wall Type	Cavity	Insulation	External face	Internal face	External facing material	Internal facing material	Test Wall no.
Masonry	Empty	None	Engineering brick Class A	Concrete block 3.5N	None	Plaster board (removed during drying phase)	Wall ME1
				Aircrete	None	Plaster board (removed during drying phase)	Wall ME2
			Pressed facing brick (spike-textured)	Concrete block 3.5N	None	Plaster board (removed during drying phase)	Wall ME3
				Aircrete	None	Plaster board (removed during drying phase)	Wall ME4
				Concrete block 3.5N	Cement render	Plaster board (removed during drying phase)	Wall ME5
	Part-fill	Rigid PU foam	Pressed facing brick (spike-textured)	Aircrete	None	Plaster board (removed during drying phase)	Wall MPF1
		Rigid PU foam	Concrete block 3.5N	Concrete block 3.5N	Cement render	Cement render	Wall MPF2
	Full-fill	Mineral fibre (batts)	Pressed facing brick (spike-textured)	Aircrete	None	Plaster board (removed during drying phase)	Wall MFF1

		Blown-in insulation		Concrete block 3.5N	None	Plaster board (removed during drying phase)	Wall MFF2
		Mineral fibre (batts)		Concrete block 3.5N	None	Internal lime plaster	Wall MFF3
	Solid Wall	None	Aircrete		Lime–cement render	Lime-cement render Thin gypsum plaster layer	Wall M1
Timber frame	Empty	Mineral fibre insulation on the internal face	Pressed facing brick (spike-textured)	1 course of Concrete 3.5N blocks, vapour control membrane, OSB3 18mm, polyethylene membrane	None	Plaster board (removed during drying phase)	Wall TF1
			Pressed facing brick (spike-textured)	As above	Cement render	Plaster board (removed during drying phase)	Wall TF2
			Pressed facing brick (spike-textured)	As above	Cement/lime render	Plaster board (removed during drying phase)	Wall TF3

Table 2 Drying times of walls tested (Escarameia, Karanxha & Tagg, 2007)

Wall type	Test Wall No.	Time to recover original moisture levels*	Observations
Masonry, empty cavity External face: Engineering bricks Internal face: Concrete blocks	ME1	160 hrs (approx. 7 days)	Measured
Masonry, empty cavity External face: Engineering bricks Internal face: Aircrete	ME2	300 hrs (approx. 12.5 days)	Extrapolated
Masonry, empty cavity External face: Pressed facing bricks Internal face: Concrete blocks	ME3	160 hrs (approx. 7 days)	Measured
Masonry, empty cavity External face: Pressed facing bricks Internal face: Aircrete	ME4	851 hrs (approx. 35.5 days)	Extrapolated
Masonry, empty cavity External face: Pressed facing bricks Internal face: Concrete blocks External cement render	ME5	160 hrs (approx. 7 days)	Measured
Masonry, part-fill rigid insulation External face: Pressed facing bricks Internal face: Aircrete	MPF1	628 hrs (approx. 26 days)	Extrapolated
Masonry, part-fill rigid insulation External face: Concrete blocks Internal face: Concrete blocks External cement render Internal cement render	MPF2	140 hrs (approx. 6 days)	Measured
Masonry, mineral fibre full-fill insulation External face: Pressed facing bricks Internal face: Aircrete	MFF1	3764 hrs (over 5 months)	Extrapolated
Masonry, blown-in full-fill insulation External face: Pressed facing bricks Internal face: Concrete blocks	MFF2	240 hrs (10 days)	Extrapolated
Masonry, solid Thin joint system External lime–cement render Internal lime-cement render with gypsum skim	M1	90 hours (approx. 4 days)	Measured
Timber frame External face: Pressed facing bricks Internal face: Concrete blocks	TF1	331 hrs (approx. 14 days)	Extrapolated

Timber frame External face: Pressed facing bricks Internal face: Concrete blocks (at ground level) External cement render	TF2	225 hrs (approx. 9.5 days)	Extrapolated
Timber frame External face: Pressed facing bricks Internal face: Concrete blocks (at ground level) External cement/lime render	TF3	386 hrs (approx. 16 days)	Extrapolated

* Based on data collected at ground level on the internal face of the walls

Appendix II Notes of consultations

Notes of telecom with Steve Hodgson, PCA (Property Care Association)

14 January 2009

Interviewee: Steve Hodgson (SH)
Interviewer: Manuela Escarameia (ME)

Steve Hodgson (SH) was invited to participate in the Steering Group (SG) set up for this project and has accepted. SH was therefore generally aware of the aims of the study but ME gave a brief introduction and explained the decision to consult directly with key members of the SG before the meetings or workshop took place.

Which guidance documents on drying is SH /PCA aware of and which are used by PCA?
SH: Members of the Flood Remediation Group (within the PCA) were mainly concerned with repairs rather than the drying process but they have experience of coming in to carry out repairs after drying is supposedly completed only to encounter that the drying was not adequately done. There are many pitfalls associated with property drying and this requires specialist knowledge and high level of skill. It is important to carry out tests for indication whether there are underlying causes that prevent drying. In some cases, properties appear never to dry and many "drying specialists" do not have the required skills to determine when the properties are in a good condition for repairs to be carried out.
SH was aware of the BRE guides, BDMA documents, PAS 64, i.e. all major relevant publications.

Which drying certificate does SH/PCA use, if any?
SH: Standard forms and certificates are not used by PCA members. SH added that the issue of a drying certificate can be meaningless since levels of moisture mean different things in different types of material and this is not really understood by many drying contractors. The drying certificate can be a mere signing off stage. If the drying certificate is seen as a document that carries a duty of care it is ok, but at present if a defect comes to light subsequently, the drying company appears to have little or no liability or responsibility to go back and re-dry or fund any of the necessary remedial repairs.

What is missing from the guidance?
SH: Drying requires proper diagnosis and monitoring of moisture, which requires high level of skill. As experts may be few, it is important to coordinate efforts so that experts can guide those with less expertise. It is peculiar that a company with a drying machine can declare a building dry without adequate

checks. Currently the guidance is not explicit enough and does not provide the required level of technical advice.

Any changes to be made in the light of new experience?
The current guidance lacks information on how to deal with calamities, i.e. large flood events, where resources are going to be stretched.

How to deal with Health & Safety, security, vermin and power issues?
SH: The PCA/SH is not directly involved in these issues. However, SH has a background in pest control. In flood damaged properties fungal growth can be a problem which then leads to pest species such as sewage and house flies. The use of heat and dehumidifiers will normally eliminate the risk. Rats are not a major problem if normal pest control measures are taken, such as removal of food from the premises.
With regard to H&S, important issues to consider are: whether or not the property is occupied by people during the drying process, events that predate the flood and may affect the condition of the property and relationship with occupants.
With regard to security, it will mainly depend on local conditions.

What are typical drying times, is three weeks realistic?
In view of previous answers this question was not asked. Diagnostic and monitoring is required to assess the drying status and therefore will largely depend on individual cases.

What are the staff training requirements?
SH: The PCA represents contractors, only a couple of which are involved in drying but the bulk is involved in repairs. The PCA is a hub of information and provides courses on the investigation and repair of damaged properties but does not provide a specific industry qualification relating to flood recovery (as the National Floods School does).

Interview with Roger Woodhead of Rameses Associates Ltd, Rameses head office, Margaret Street, Stone

15 January 2009

Interviewee: Roger Woodhead
Interviewer: Jessica Lamond

Which guidance are you aware of and which do you use?
Aware of the training manual of the National Flood School (not available for purchase) which is based on the IICRC manual, PAS64, Flood Forum book. Rameses works to the same standards as PAS64 but don't work to it rigidly. See below re drying reports. They use the NFS manual but also in house expertise and experience. Not members of the BDMA so not aware of their material.

Which drying forms and certificates are used if any?
Rameses carry out total reinstatement and guarantee the entire works. Drying reports are only issued on rare occasions where Rameses do not proceed with reinstatement. Structural drying information is stored internally. More recently, Rameses' main client has been utilising the services of one of the UK's larger R&R providers on Rameses cases. The quality of drying certificates from suppliers working alongside Rameses and their willingness to cooperate in the process is a constant disappointment. The quality of the information is generally poor, even when provided.

What is missing from the guidance?
The current technical guidance contains the information needed to do a professional drying job. Problems occur when guidance is not followed. PAS64 is a standard, not a manual. There is too much reluctance on the part of policyholders to take emergency matters into their own hands. Whether this be the cause of a "nanny state" mentality or misinformation from notification of loss teams at insurance companies is uncertain, but policyholders should feel empowered to take mitigation measures. This is a contractual duty under a policy of insurance. Immediate action to lift floor coverings and remove water from buildings can substantially reduce the extent of damage, accelerate drying times and ease the entire claim process. Stronger guidance on self help would shorten drying because less water would be absorbed into buildings.

What changes would you make in the light of new experience?
A better understanding of WME (wood moisture equivalence) of materials by some technicians might be helpful to users of moisture meters. Insurers have specified Key Performance Indicators based on the guidance which do not always help drying to proceed. For example installing a single air mover within 24 hours ticks the box for "installation of drying equipment", but is

meaningless. Meaningful performance indicators such as target drying times might be better, but would involve delegation of authority to Damage Management Companies to take best action without reference to insurer.

Training and regulation issues
Training is often in house and Rameses observes industry recognised standards in this training. Sometimes staff are sent out on NFS courses. Rameses is not a member of BDMA so does not use BDMA accreditation courses. Very important to have properly trained personnel as a little knowledge can be a dangerous thing. Operatives need to know what they don't know and when to call on expert advice. Sub-conscious incompetence is too common.

How do you deal with health and safety, security, vermin and power supply issues
Health and safety procedures are followed. Keeping good drying conditions inhibits mould and use of hydronic heating can kill germs, mould and most pests. In general, contamination issues are overstated. Vermin are not usually a problem. Power supplies are usually restored fairly quickly and a temporary board put in. Using generators overnight is a security risk. Rameses remove all customers contents if possible, removing the security problems. If clients wish contents to remain then keep building locked at all times. Rameses operate with key safes to allow safe multiple trade access via key codes.

What are typical drying times? Is three weeks realistic?
If best practice guidance is followed to the letter, no interruptions of supply and standard construction, then 3 weeks is possible. In reality, 6-8 weeks is more typical for most franchise operators. Desiccant dehumidifiers are typically more effective than refrigerant; they can be used to push dry air into confined space and in cold conditions. However, they are far more expensive and there are security risks in connection with the wet air outlet. Speed drying can shorten drying to a matter of days but can cause damage to vulnerable building elements. Need to carefully monitor all elements and remove contents and vulnerable elements. Usually used where business interruption justifies extra cost and possibility of damage. Also cost effective where several properties are to be dried at once by one contractor e.g. local authority. Smaller speed dryers might be more cost effective for more cases.

How dry is dry and how to decide
Important to set a drying goal, measure humidity in a non flooded part of the structure this will avoid over drying and unrealistic goals. Rameses use a variety of monitors: Protimeters are the most common; they are the industry standard, they give a variety of readings to enable control of humidity, temperature, relative and actual moisture content (wood). They can give false readings if there are salts and metals but importantly they will give false negatives not false positives. Read to a depth of 10-15mm There are also long probe attachments to allow for deeper readings. For walls and floors the

British Standard is to use hygrosticks and the equilibrium relative humidity technique. Hygrosticks give air temperature and humidity.
A calcium carbide meter is the most accurate. This involves taking samples. Rameses also use USB data loggers which can store data continuously and download to a laptop. In the past used PTC remote monitoring – now discontinued due to inadequate justification of cost, as Rameses do not earn any income from structural drying. Also use thermal imaging as a supplementary tool and salt analysis, as required.

Telecom with Mike Waterfield of Munters

14 January 2009

Interviewee: Mike Waterfield
Interviewer: Jessica Lamond

Which guidance are you aware of and which do you use?
With regard to the use of guidance Munters have their own in house methods, guidance and training developed over 50 years, so the use of other guidance is not so relevant to them. Munters have been involved in the preparation of past guidance and it reflects, in broad terms, their approach.

Main publications which are useful as far as guidance are the CIRIA standards, BDMA training manual and PAS64. They are the best with CIRIA standards being technically the best of those three. The English Heritage Technical advice note also has some helpful information but it would be useful for this to include more about where modern drying methods might be helpful.

Which drying forms and certificates are used if any?
Munters have a totally paperless system with laptops on site. They have their own versions of report forms and drying certificate on that system.
Reports include: Health and Safety audit; survey of property and ambient conditions; recommendations and actions taken.
Policyholders and insurers can access this information via a portal and can be given paper copies of key documents, for example the inventory of contents and drying certificate if required.

What is missing from the guidance?
Depends on the guidance, for example PAS64 has very little technical information and is more about soft skills. Guidance should strike a balance between too much technical detail and none at all. It should give insurers and policyholders the idea of what to expect from a professional rather than try to be a training manual.
Improvements might be in the areas of advice about when it is appropriate to strip out and when not. Guidance on specific building materials and how to measure their dryness. General guidance on average drying times.
Environmental information about the “greenest” drying and restoration option.

What changes would you make in the light of new experience?
Less emphasis on one size fits all and more on being guided by expert knowledge of individual situations. Emphasis on allowing trained technicians to use their knowledge based on the circumstances.

Training and regulation issues
Munters train in house, they also make use of BDMA technician qualification. Would like to see more qualified personnel. Possibly raising the BDMA or

some other qualification to a CORGI status or similar. This would mean a lot of work for BDMA in terms of ensuring quality and monitoring standards.

How do you deal with health and safety, security, vermin and power supply issues?
A health and safety audit is standard procedure. Always decontaminate before drying and deal with any other issues.

As Munters generally dry within sealed buildings there is no need to leave premises vulnerable overnight but security is still an issue and a protocol needs to be followed as to: who is ultimately responsible, builder, DMC or policyholder; who has access to the building and holds keys; and whether the policyholder is resident and leaves premises open. In large events the opportunistic may target the area.

With good decontamination and quick drying vermin, flies, mould etc are not usually a problem inside the building. There is more likely to be a problem outside with dumped contents, mud etc. In a large scale event it can be difficult to dispose of waste, skips may not be available in the required numbers and the local authority can have a part to play in coordinating disposal. This has worked well in the past in some events.

Power supply is not usually a big problem, either the property supply is used or a temporary supply arrangement installed in most cases. Generators are rarely needed.

What are typical drying times? Is three weeks realistic?
Of course drying times vary by flood duration and property construction, even adjacent terraces can be different. If asked to put an average it would be 4-8 weeks rather than three weeks. Speed drying can be much shorter but it is less well known and understood. It is typically only used in time critical situations as it is very costly and insurers cannot justify expenditure on domestic basis. When speed drying need to be aware of potential damage to building elements.

How dry is dry and how to decide
Required dryness will depend on planned finishes, could dry to British Standard but that might be too wet for some finishes on floors. There may be room for more guidance on this issue. Munters always assume like with like and might change their drying based on future plans if they were aware of them. In other cases prior conditions mean that it is impossible to get to standards. Munters guarantee their work and in the case of future problems it can be difficult to attribute cause to the flood or to other dampness and wetness sources.

Other issues
There is a growing tendency to hand responsibility for leading restoration projects to the builder; damage management companies and policyholders are consulted less about the options than they used to be. This is cost effective for insurers in terms of admin but may not be as cost effective along

the whole restoration chain. Policyholders may not be aware of any other option than the standard strip out everything. The perception of dirtiness and health hazards from flood water needs to be subjected to scientific realism, maybe by some health professionals; cleaning and drying will destroy most germs. Good to have a record of flood repair treatment including drying methods to stay with the property.

Meeting with Chris R Netherton (National Flood School) – 19th January 2009

Following a brief tour of the test building used to train technicians in drying homes, Chris explained some of the options for drying, including those that used high temperatures. Using standard techniques the test home would take four days on average to dry following a soaking with 2000 gallons of water. A thermodryer device such as 'Water Out', which uses propane gas to achieve high temperatures, would only take 13 hours. There was concern in some quarters that use of high temperatures resulted in deformed materials but Chris thinks it is the actual wetting that causes the damage, rather than the drying. It is also important, when choosing drying equipment, to be aware that options that add moisture to a building as part of the process, such as a fuel heater, will result in longer drying times.

There was brief discussion of procedures in other countries, such as Sweden where the fire service take responsibility for drying homes, and whether the UK needed a national flood repair service.

The history of PAS 64 was discussed, which set out to be 'best practice' in terms of people conforming to the recommendations for drying a house. However, the original intention had been to include more 'how-to' information, which BSI did not think was appropriate for a publicly available specification. However, there remains a need for more information of a practical nature. Chris thought the drying advice in the CIRIA guide (Standard for the repair of buildings following flooding, 2005) was too loose. Chris indicated that there were on-going discussions with BSI regarding a new practical guide, which would include more 'how-to' information, although he did not know when this might be produced. Important aspects contained in PAS 64 include the moisture map, which sets out clearly the damage problems and where the drying has to start from. This should be accompanied by good record-keeping, so that everyone is aware of how well the drying process is going, or if there are problems that were not apparent at the start.

There was discussion of the links with the insurance industry, and issues such as the cost of drying versus the cost of temporary accommodation. There could be an issue of the cheapest option being selected by the insurance company or loss adjustor. This option may not be compatible with companies following the full detail of what is in the guidance. Chris also remarked that there is lack of communication between the various departments/groups within insurance companies and a dedicated arm to deal with flood situations would be advantageous.

A problem often encountered when drying/restoring properties is changes of specification in the fittings to accommodate homeowner preferences. Certain levels of moisture in the floor may be adequate for carpets (which have been present before the flood damage) but not for thin laminated flooring, which can buckle easily. Changing from suspended floors to mass concrete floors, which can appear to be a resilient measure, may be inadequate if the reason for the original suspended floor was the presence of a stream under the floor.

In many cases, damage repairers too readily strip out everything inside a flood damaged house including stud walls when there is no justification for this and which increases the costs.

The NFS provides auditors to check complaints that insurers receive about the drying of a flooded house. They undertake a survey and recommend the best course to take to rectify the problems.

Another key factor is that people who dry buildings need to have knowledge of construction types and materials. Chris had identified 23 different types of construction, which could affect the way these buildings should be dried. One possible project would be to undertake a demographic study for England & Wales to identify these different housing types. This could then be linked to flood hazard and social groupings to assess the likely outcome of a major flooding event, in terms of drying times, need for temporary accommodation etc. Another option could be to have a ‘logbook’ for a house, which would record any resilient or resistant repairs, plus details of flood events and subsequent drying and recovery. This could be a useful asset for the homeowner.

Finally, it is important to recognise the changing conditions that nature poses when trying to dry a flooded home. The flood house at NFS changes conditions four times a day as the environmental conditions change. Repetitive complaints in Hull over poor drying were not always founded as it was due to the proximity to local waterbodies. This produced conditions that were already damper than might be expected so there was never a chance of getting back to the anticipated ‘dry’ condition. There might be a need for new software to take the information from the original moisture map and building survey and to determine what drying equipment is required, in terms of type and number of units.

Appendix 2

Guidance and standards for drying flood damaged buildings – consultation workshop summary report

10th February 2009, Royal Statistical Society, London

1. Chairman's welcome and introduction

The chair, John Batty welcomed delegates to the workshop and invited delegates to introduce themselves to the remainder of the group.

2. Overview of project

Andy Tagg of HR Wallingford provided an overview of the project, including the objectives, composition of the research team, and the expected outline content of the ultimate project deliverable: a new guidance document to be published by the end of March 2009.

3. Workshop objectives

Robin Farrington of CIRIA introduced the plans for the workshop and explained what the research team was hoping to gain from the planned exercises.

The objectives of the workshop were described as:

- to understand the drying process from flooding to "ready for repair", including timings, obstacles and suggested solutions
- to identify gaps in existing guidance and requirements for new guidance
- to establish how any new guidance could be made more widely available and taken up by the industry
- to understand how public communications can be integrated into the drying process

4. Group break-out session 1

Part 1 – Mapping out the process and stakeholder responsibilities and timescales for taking a flooded house to reoccupation

Delegates were asked to work in groups to list the processes involved in repairing flood damaged buildings, from the flood event to the building being ready for occupation. A 1950s semi detached house with cavity walls was used as an example. These processes were mapped out on a timeline for a "best case scenario" in order to get an idea of what are appropriate timescales for completion of each task (in a best case scenario).

Part 2 – Identifying obstacles to the process

Delegates were then asked to identify obstacles to the process mapped out in the first session, together with potential timescales for impact on the programme. These are shown in Appendix I.

5. Feedback from session 1 and open discussion

The following key milestones were identified, with potential timescales shown in italics:

i. Flood occurs – ***day 0***
ii. Householder telephones insurance provider – ***day 1***
iii. Policy details obtained – ***day 1***
iv. Emergency advice provided by local authority/insurance provider – ***day 1***

v. Appointment of loss adjustor and damage management contractor by insurance provider – ***within 3 days***

vi. Householder contacted by loss adjustor and/or damage management contractor – ***within 3 days***

vii. Visit from loss adjustor/damage management contractor - ***within 3 days***

viii. Initial overview report including findings from initial survey assessment – ***report by end of week 1***

ix. Contents dealt with by householder – ***day 1***

x. Property is decontaminated and sanitation certificate issued allowing works to proceed - ***start of week 2***

xi. Arrangement for disposal/salvage of materials – consents required for skip and logistics of placement of skip finalised – ***within week 1***

xii. Agreement of scope of works and timeline by all parties (plus payment schedule) – ***week 2***

xiii. Drying commences – ***by end of week 2***

xiv. Drying completed – ***4 to 8 weeks after commencement***

xv. Drying certificate issued – ***as above***

xvi. Audit of drying by 3rd party – ***week 9***

xvii. Sanitation inspection certificate issued - ***week 9***

xviii. Decoration, repairs, re-fit (overseen by project manager appointed at start to ensure that drying works not compromised eg by taking out wooden flooring and replacing with wet concrete floor) – ***week 10***

xix. Householder moves back into house – ***10 to 24 weeks after flood event***

xx. Claim closure

Overall, there was general agreement that in a best case scenario the drying process should take in the region of between 4 to 8 weeks depending on the extent of the flood event and depth of water. There was general agreement that, in a best case scenario, the overall process from the point at which the flood occurs to the point whereby the property is ready for occupation again, should take in the region of between 10 to 24 weeks (although with speed drying this could be significantly reduced).

Andy Tagg provided a brief comparison of how the above timescales compare to the findings of the National Flood School's work in Hull after the summer 2007 floods (information had been provided by Chris Netherton). In general there was a 30 day average for completion of the drying process start to finish. The general consensus on the timescales given above were compared to the findings of the Pitt Review, which suggested much greater times for the drying process. This suggests that rather than the drying process itself being the "bottle neck" holding up reoccupation of houses, it are a number of hurdles related to the whole process from flooding to reoccupation, and that the drying process should be considered as just one element within the overall restoration process.

Obstacles to the restoration process mapped out in the first session were identified and assessed on their potential impact on the programme of works. These are listed in Appendix I.

The main obstacles to the restoration process were identified as

- a lack of communication and coordination between the different stakeholders
- a lack of understanding of the key stages in the restoration process and how they link together or can impact on one another, and
- a lack of understanding of respective roles and responsibilities
- competency of contractors as well as loss adjustors and insurance company representatives.
- a lack of resources particularly after floods affecting large numbers of properties.

There was broad agreement that in order to bring clarity to the overall restoration process, a single point of contact should be assigned at the beginning to oversee the entire process right to the point where the property is ready for occupation. This "project manager" could potentially be from any of the stakeholder groups (insurance company, loss adjustor, damage management contractor), provided they are appropriately qualified and *competent,* with a good understanding of buildings and how the initial survey should determine the correct drying procedure.

It was suggested that the first responders to queries from householders during an emergency (i.e. local authority representatives and insurance company call centre staff) should be provided with a checklist of key considerations and questions to ask the householder, as well as a list of the key contacts within each of the stakeholder organisations. This would ensure that the householder is provided with contact details of the individual who will be the dedicated project manager for the restoration of their property. This project manager should then be able to provide the householder/policy holder with information on the different stages in the restoration process, who will need to be contacted/appointed (i.e. "stripping out" contractor, damage management contractor, refitting contractor), likely timescales for each stage, as well as information on alternative accommodation arrangements.

It was generally agreed that an initial assessment of the property should be undertaken within the first week, and for an overview report to be completed by the end of this first week. It was suggested that this report cover the following:

- assessment of health and safety issues (asbestos present? Microbiological pathogens from floodwater - PPE required for works? Structural stability of property? Potential for mould/spore growth?)
- subsequent assessment of whether the householder needs to vacate the property, together with details of alternative accommodation arrangements if required
- assessment of pre-loss condition where possible (potentially using neighbouring un-flooded house as benchmark) as well as any latent defects (insurance company to investigate any prior claims)
- initial assessment of whether strip out required or whether further assessment required later

- record of construction materials present and other survey information, such as floor/wall construction and whether groundwater is an issue
- assessment of whether contents need to be removed or whether drying can be completed with contents left in-situ
- proposed method of drying and timescales for completion
- payment plan

It was suggested that many of the obstacles arising during the drying process could be overcome if regular contact is maintained with the householder, with recommended visits every 2 to 4 days, or at least every week.

6. Group break-out session 2

Delegates were asked to list solutions to the obstacles identified, sorted into what can be covered by new or existing guidance, or what would require more substantial change (e.g. new policy, legislation etc).

7. Feedback from session 2 and open discussion

Feedback from this session is given in Appendix I.

Obstacles that could be overcome by new guidance included:

i. risk sharing – it was agreed that a holistic view is required and the guidance could map out the stakeholders involved, the processes involved and roles and responsibilities.
ii. competency – a minimum level of competency or standard could be specified in the guidance.
iii. contractual arrangements – the guidance could clarify details of the management process
iv. latent and pre-existing defects – the guidance could highlight this issue and potentially recommend greater access to surveyors during the restoration process.
v. customer access to information – the guidance could specify sources of information for householders, as well as specify the stages within the restoration process where the householder should have communication from the appointed “project manager”. The guidance could also provide an understanding of how quickly the householder can expect each stage of the restoration process to be completed.
vi. guidance on when best to strip out – the guidance could cover cost effective solutions, and list the key considerations (a cost benefit curve could be produced)
vii. validating/auditing the works – the guidance could set out the requirements for monitoring and auditing including what information should be provided on a drying certificate. NHBC guarantee

Obstacles that are currently covered by guidance but need to be highlighted within this new guidance included:

i. health and safety, and public health issues
ii. poor monitoring techniques

Obstacles that fall outside of the scope of guidance included;

i. availability of alternative accommodation – it was generally agreed that overall resourcing issues experienced during flood events should be investigated at a national level with regards to emergency planning.
ii. by-laws – these may need to be reviewed regarding placement of skips and containers etc
iii. competency - accreditation to ensure competency could be implemented through a statutory instrument such as through Building Control.
iv. access to properties – this is a potentially problematic issue, particularly with regard to access to properties whose owners are away on holiday or the landlord is not contactable.
v. management hierarchy – this issue may need policy change to ensure consistency with flood management hierarchy where it is likely that the Floods and Water Bill will enable local authorities to be the lead organisations and the Environment Agency to provide an overview role. There is a need to ensure insurance companies and damage management consultants fit into this management hierarchy.

8. Group break-out session 3

Delegates were asked to work in their groups to answer the following questions:

1) Can communications with the householder be improved throughout the drying process? If so, what information do they want to receive and how regularly should they be updated? Who should be communicating this to the householder?

2) Should there be a task content, timescale and standard for each stage in the process? If so, who should set and monitor it?

3) At what point would you agree that the drying process is finished, and the building is ready for repair?

4) How can this guidance be disseminated to the industry to increase the likelihood of it being adopted?

5) How can it be determined where “stripping out” is more effective than drying?

6) Overall, how could the drying process be made more coordinated and effective overall, especially in large-scale events?

9. Feedback from session 3 and open discussion

Feedback from each group on the questions listed above is given in Appendix II. The key consensus points for each question were as follows:

1) It was agreed that the householder should be made aware of:
    a. all the different parties involved
    b. the main point of contact
    c. the different stages in the restoration process

d. likely timescales
e. potential noise and H&S issues if they are planning to remain in the house
f. who will pay for the electricity used during the works
g. the frequency of communication.

It was further agreed that the main point of contact (the “project manager”) should be a “competent” individual and would most likely be from either the insurance company, the damage management contractor, or the appointed loss adjustor. The householder should be kept up to date with the current situation as it develops and informed of any unforeseen issues.

2) It was agreed that the householder should be provided with a flowchart showing the different stages involved, the different roles and responsibilities, and the expected timescale for each stage. It was proposed that this information could be published on the internet and could potentially be linked to the EA flood warning web-pages and services. It was suggested that the provision of timescales for each stage in the restoration process should be assessed on a job by job basis rather than be specified within the new guidance, but generic timescales could be provided. It was agreed that drying targets need to be estimated and explained to both the householder and the insurance company, and a method statement be provided. This should all be overseen by a competent project manager.

3) It was agreed that any attempt to quantify “dryness” should be done on a “property by property” basis. It was suggested that the criteria for “dryness” should include
   a. when moisture readings reach the expected “dry” readings for the material being dried in the subject property (benchmark data from BRE references for particular materials).
   b. when the property is returned to its pre-incident condition or better (below 75% ERH + 5% - from BS 8203).
   c. comparison to datum readings in non-flooded buildings (potential to use neighbouring unflooded house as benchmark).
   d. when the property no longer supports mould growth
   e. when the property is dry enough for contact materials for repair.
   f. Structural Evaporation Standards Calculations (SECS) could be utilised.

   “Dryness” should be determined by analysis of collected data from a moisture survey and visible evidence. Monitoring is therefore important. The “signing off” of a property as being “dry”, should be at the point of handover after full restoration rather than at the point of issue of drying certificate. This would prevent issues arising such as moisture being introduced by fitting a new concrete floor after the old timber floor has been dried.

4) It was agreed that in order to obtain the greatest amount of impact and uptake of any new guidance, sufficient buy-in should be obtained from

the insurance industry. Suggestions for dissemination vehicles included:

   a. creation of a consultation paper for distribution to relevant professionals.
   b. inclusion or incorporation of the guidance into British Standards.
   c. creation of a guidance pamphlet for those advising the public.
   d. RICS and British Damage Management Association to disseminate.
   e. Government sponsored website to define the restoration processes, roles and responsibilities, with both public and professional areas.

5) It was suggested that a cost-benefit curve could potentially be produced in the new guidance. Key considerations for whether or not to “strip out” included:
   a. cost
   b. type of building, materials
   c. the drying process intended to be used
   d. the range of options available
   e. the resources available
   f. time available
   g. whether leaving materials in-situ would seriously slow down the drying process.
   h. determined by “loss of integrity” of the building materials (for example, plasterboard will always require replacement).
   i. Historical value of materials
   j. Property owners preference

6) It was generally agreed that the suggested approach of appointing a single point of contact (project manager) for the entire restoration process would greatly streamline the process. Other suggestions for ways in which the process could be improved included:
   a. co-ordination of restoration of a block of properties.
   b. local authorities to prioritise vulnerable groups with the cooperation of the insurers and facilitated by the ABI. This could be achieved by checking EA flood mapping and forecasting data for postcodes in vulnerable areas, against insurance company policy holders (central database?).
   c. agreed standards of basic restoration and repair between insurers. These, together with block management of properties, should reduce party wall issues.

Appendix I Log of feedback from sessions 1 & 2 – mapping out the restoration process with obstacles and potential solutions

Obstacles to the drying process	Potential impact on programme	Solutions covered by guidance	Solutions requiring more substantial changes (e.g. policy changes, new bodies being formed)
Resources			
Electrical supply	+ 1 to 3 weeks	No electricity and pre-paid meters – water damaged supply. Already stated in guidance that a temporary supply should be made available. Insurance company/LA should deal with this Recommended further reading for subsequent reinstatement process – DCLG guide on resilient construction – flood resilient electrical measures e.g. 2 systems, one for as-flooded, which can be isolated	Change in regulations that require supply boxes on 1st floor
Availability of Loss Adjustor	+ 7 days		
Availability of contractor			
Availability and designation of alternative accommodation	+ approx 1 month		
Shortage of supply of materials	+ up to months		
Building contractor not available			
Availability of equipment		Insurers having good contracts in place to ensure availability. All available equipment must be maintained and ready to go. – need to specify this in any new guidance	Government stock piles
Logistics – location of damage area compared to resource (competent contractor)		Damage management company policy should cover this	
Householder			

Incorrect householder expectation		Limited access to guidance notes Initial site inspection and quality of technician – BDMA examinations, PAS 64 – in order to avoid conflict over pre-loss condition Guidance should set expectations for all stakeholders – ownership by project manager (working for insurance company), early intervention required (commercial decision)	Damage mitigation advice prior to incident BDMA approved or similar
Delay in choices by the customer	+ 2 weeks		
Interference or lack of cooperation from homeowner, particularly if they are in occupation, victims/occupants turning equipment off, early reinstatement	+ 7 days for each incident	Detailed advice to property owner and managing expectations. Health and Safety at Work Act, risk assessment Issues need to be highlighted in guidance Guidance provided with insurance policy and implemented when a claim is made. This needs to be highlighted in any new guidance	
Multi-tenancy		First visit contact shall determine communication (landlords and tenancy issue)	
Jealousy/envy between neighbours comparing work being done		Communication	
Dealing with contents remaining in the property	+ approx 1 month	BDMA have guidance on this, needs to be highlighted	Guidance is required on how this could be dealt with so as not to hinder timescales
Security of property		Issue needs to be highlighted in guidance	Is information accessible by flood victims/contactors?
Contractor (stripping out, drying and reinstatement)			
Contractors lack of communication		Not covered by any other guidance	A paradigm shift is required in the industry to enable more openness

			and communication
Stripping out contractor differs from drying contractor, different objectives/motives		Needs to be covered under new guidance – consistency of application of CIRIA Standards of repair	
Delays in stripping out		A simple flow chart will clear communication	Government intervention in, for example, allocating responsibility to companies on, for example, a street basis.
Incorrect “strip out”	+ up to 3 months	Guidance should specify decision process and highlight requirement for good project management	Need for more consistent training (legal requirement) for insurance industry and contractor
Delayed payment to contractor	+ 12 months		Changes could be made to legal requirements for contracts
No air movement	+ 3 months		
Inappropriate drying measuring techniques		Needs to be covered in new guidance	
Failure to determine cost effective practices		Guidance required	
Ignorance on the benefits of the speed drying process		Needs highlighting in guidance	
Drying targets not correctly identified - Unrealistic drying times/goals		Dense materials – BRE 8203:2001, BRE guidance cover this, needs bringing together and highlighting in guidance	
Avoid piecemeal treatment of properties			Should be some way of ensuring that one insurer covers the whole street after a flood event
Equipment resource type used		BDMA guidance covers this (in training manual)	
Secondary damage from uncontrolled evaporation	+ 6 weeks	Needs to be covered in new guidance	
Theft of equipment	+ 5 to 7 days	No guidance current available	Possibly could have standards/guidance for tracking equipment
Site visits (finding that machines have been switched off) – servicing		Guidance should recommend that site visits should be every 48 hours	Efficiency certificate every 6 months for DH equipment

equipment		PAS64 covers this, but requires better understanding Every 3 to 7 days	Better training required
Resource for monitoring and techniques for monitoring		BDMA and BRE have guidance on this, needs bringing together	
Wrong method of drying/equipment used – equipment not working efficiently	+ 1 hour to 4 days	Guidance required	
Drying certificate (free of caveats)			
Sanitation certificate (3rd party)		Guidance to show testing	Standards required
Incorrect reinstatement		Must be guidance under Building Regulations	Could be covered if surveyors, only, create the specification
Training /competence	+ 12 months	Training required BDMA has guidance in-house damage management training	Training required What qualifications are required? Standard level of competence required
NHBC type guarantee on every drying job			Should be considered at Government level and implemented by NHBC Needs to be submitted as suggestion for amendment/addition to existing regs
Insurance company			
Incorrect telephone advice	+ up to 14 days	Part covered in various guidance notes, dependent on training Technical information available – to call centre staff and claims assessors	
Type and level of insurance cover – buildings, contents and accidental damage		N/A on buildings with mortgage Should be covered by new guidance FSA compliance to smooth out disputes	Should contents insurance be a legal requirement?
Professional procurement		Training and guidance required Insurance companies to have a better technical understanding when it comes to procurement	

Loss adjustors and claims management training		Training and guidance required	
Slow claims management		Contractual obligation requirements (timescales) – service level agreements (SLAs) Claims management process needs clarifying	
Insurer consistency in approach to claim		Guidance required	
Stakeholder interaction			
Lack of communication between insurer, policy holder, contractor – coverage of responsibilities		New guidance could give flow chart for clear communication	
Division of responsibilities between stakeholders		Could be covered by new guidance	
One contact to oversee the process start to finish - Decisions made by insurers or loss adjustors		Not currently covered by guidance. Vital to have one person to run each customer and coordinate the works involved for example independent project manager. Needs to be highlighted that decisions will be made by them, so guidance should be tailored to their needs	A “guidance chart” could be provided to homeowners
Authority to proceed with drying (delegated authority)		Guidance should state where and when authority lies with insurance company/damage management company – who leads? Early identification and pre-planning and process management	
Access to site	+ 2 to 4 weeks	Guidance on communication channels Property owner must supply key to main contractor	Clear plans and responsibilities for emergency preparedness required
Unable to agree specification with building contractor and surveyor	+ 1 week to 6 months	Refer to your insurance policy. Guidance notes do cover this	

Local and national press		Depending on who guidance is aimed at, guidance on dealing with press in positive manner may be useful	
Failure to audit process		Needs to be covered in new guidance	
Listed building consent, and other consents required (such as for skips)	+ 3 months	Issues need to be covered in guidance	Policy changes required - Byelaws could be amended/removed Bodies who give final approval need to be educated and given an understanding of the process so that better prioritization of people vs building can be done
Contractors communication		Surveying model. IT platforms that exchange information easily	
Communication / conflict of opinion (contractors)		Training availability required for LA/contractors	Flood project management teams (hierarchy of responsibility – LA, EA etc)
Lack of risk sharing (passing blame onto the contractors)			Change in industry psyche required
Other issues/considerations			
Historical and listed buildings		Specific guidance needed. English Heritage guidance on flooded buildings and SPAB guides	Scope for some research
Capillary action		Need for old buildings to ventilate	SPAB guide and control of damp in old buildings (SPAB TP 5)
Health and safety issues: ACM (asbestos containing material), mould issues, microbiological ("black water")	+ approx 1 month	Risk assessment and public awareness and communication. Safety for homeowners and workers COSHH and CDM HSE / Department of Health legislation/guidance covers this, but needs bringing together and signposting under this context Issue needs to be highlighted in new guidance to ensure that drying	Already exists, should come under legislation

		commences before this becomes a real problem	
Party wall / Adjacent property not being dealt with due to not insured/overseas		Examine provision of Party Wall Act. All surveyors best practice should consider effects from neighbouring property Notify neighbours/policy holder's insurance company	Statute / nuisance. Ensure guidance document covers issues relating to adjoining properties Little can be done unless through legal redress
Re-flooding	+2 to 4 weeks	Could be covered by new guidance	Better flood warning
Local groundwater conditions		Guidance should highlight requirement to know the hydrogeology of the area.	
Different constructions of buildings		BRE has guidance/information, but needs bringing together under this context	Update and expand BRE guidance/info
Building materials (evaporative/moisture retardant) not conducive to drying programme		BRE/CIRIA/BDMA guidance all cover this, needs bringing together Already covered in part in DCLG Flood resilient construction guidance, needs to be highlighted in the context of drying	
Cavity walls with insulation		Could be covered by new guidance Will it be any value after saturation – still meet Part L of Building Regulations Can it be dried out/accessed and removed? Will this process delay the drying process	Could be covered by "thermal elements in Part L – Building control (specifying flooring) Ask Building Control and product trade association. Infra-red survey?
Laminated plaster board partitions		Not aware of any guidance	Insurers strip out if damaged. Opportunity for more robust replacement
Wood paneling		Could be covered by new guidance	
Rubble fill construction		Could be covered by new guidance	
Built in fixtures and fittings		Mentioned in "Preparing for Floods" guide	Cheap materials can be used which can be thrown away, or recommend that robust materials used with a removable trim
Determining pre-loss conditions		Houses built post-1955 are volume built so simple except for occupier	Better access to archives

		improvements Better initial inspection and communication with all	
Latent damp problems		Covered under existing guidance, but needs to be highlighted	Competent surveyor should establish this
Solid masonry		There are some guides from RICS, BRE, SPAB	Import reference as appropriate
Failure of, or no, damp proof course (damp problems existed prior to flood)		Records from insurers and lenders. Damp treatment company knowledge	Mortgage companies should be more pro-active at purchase stage then keep records
Sub-surface insulation		Part L thermal changes	Information from material/product suppliers
Vapour barriers		Needs to be covered in new guidance	
Floating floor			
Green products			
Timber frame – shrinkage/expansion			
Basement and tanks			
Too much stripping out		Down to the initial site inspection and industry knowledge	
Structural defects exposure (e.g. pre-incident rotten joists from woodworm/natural rotting, subsidence)		CIRIA R111 "Structural renovation of traditional buildings" covers this, needs bringing together and updating The fact that structural problems can occur needs highlighting in guidance	
Seasonality (barometric pressure etc)	+ 2 weeks	Affect of seasonality should be highlighted in new guidance. Possibly already covered in PAS 64	

Appendix II Log of feedback from session 3

	Can communications with the householder be improved throughout the drying process? If so, what information do they want to receive and how regularly should they be updated? Who should be communicating this to the householder?	**Should there be a task content, timescale and standard for each stage in the process? If so, who should set and monitor it?**	**At what point would you agree that the drying process is finished, and the building is ready for repair?**	**How can this guidance be disseminated to the industry to increase the likelihood of it being adopted?**	**How can it be determined where "stripping out" is more effective than drying?**	**Overall, how could the drying process be made more coordinated and effective overall, especially in large-scale events?**
Group 1 **David Proverbs** **Bill Lakin** **Richard Bates** **Mike Waterfield**	The method of communication needs to be agreed in writing, face-to-face and/or remotely. The householder should be made aware of all the different parties involved, the main point of contact, and the frequency of communication needs also to be agreed – likely that regular contact with	Drying targets need to be estimated and explained. Same drying methods (e.g. BDMA), work to a standard – contractor must set drying standard and communicate this to householder and insurer	When moisture readings reach the expected readings for the material being dried in the subject property. Compare to datum reading in non-flooded building 20 hr.	Create a consultation paper for distribution to relevant professionals. Include guidance in British Standards. Get buy-in from insurance industry	Considerations: (i) Cost (ii) damaged materials (iii) where leaving materials in-situ seriously slows down the drying process	[No response]

	drying contractor (competent person) The householder should be kept up to date with the current situation as it develops and informed of any unforeseen issues (likewise for householder to contractor).					
Group 2 **John Goudie** **John Blanksby** **Ingrid Wellard** **Neil Courtney** **Tim Humphreys**	Yes, communications can be improved. At the start of the process the following information should be provided to the householder: (i) when will the work start (ii) how long the work is likely to take (iii) who pays for the electricity used during the works (iv) anticipated noise levels, safety issues, and whether equipment will run 24/7. An update should then be given to the	Yes there should be a task content. A specification for the job should be provided. Provision of timescales for each stage in the restoration process should be assessed depending on the job. As to whether a standard for each stage in the restoration process should be provided, the householder should be provided with a	When the standard (set in question 2) has been reached.	ABI to agree this approach, a pamphlet to be available to those advising the public.	Comparative estimates of cost by a competent estimator	Technical – coordinate drying of attached properties. Insurers to agree nature and timing of drying. Social – Local authority to prioritise vulnerable groups with cooperation of insurers, facilitated by ABI. Need some sort of mechanism to get cooperation if there is not an even spread of risk across the insurance companies. Build this into local emergency plan so that locally they expect the chosen approach to

	householder at 50% predicted timescale – via a report by the body with the contractual relationship with the householder, typically the insurer.	graph showing the different stages in the process and at what point they are likely to reach each particular stage. End point set to suit normal ambient conditions. Insurance company (or the specialist employed by the company) to set standard advice on using an unflooded neighbour as a benchmark				prioritization.
Group 3 **Andy Tagg** **Robert Fairall** **Simon Ford** **Ian Townend** **Bob Spencer**	Yes, project manager to liaise with homeowners and be the contact who will deal with all processes. Homeowner to be given checklist of the procedure and do's and don'ts, and drying information	Yes. Project manager as in question 1. Schedule set on day one to control each task and possible timeframes.	Table of dry readings for different materials to give a reference. Buildings dry according to reference. Monitoring regularly is important	Government regulation standard. Get buy-in from insurance companies.	Stripping out only necessary in special circumstances. Not needed in most cases as is standard practice at present.	Coordination of all involved. Post coded areas batched to each contractor.
Group 4 **Richard Ayton-Robinson**	Yes. Single point of contact (named	Yes (see answer to question 1) – this should be set	When the building is returned to its pre-incident	New guidelines through this new guidance.	Software / decision making tool.	Nominated project manager / coordinator and a

Ben Kidd **Andy Habbershaw** **Ralph Burkinshaw** **Aaron Garner**	project manager). Flowchart provided, project viewed as a whole (joined up). Responsibilities clear and communicated. Schedule required and action against it / revision. Weekly updates given to householder by drying/project manager.	and monitored by the drying/project manager.	condition. Below 75% ERH + 5% (BS 8203). When the building no longer supports mould growth.		Depends on specific material issues, properties, surface coatings, most cost effective solution, whether the building has a floating floor construction.	process flow chart provided to all stakeholders.
Group 5 **Jonathan Garlick** **Mike Johnson** **Jessica Lamond** **Alan Cripps** **Jeff Charlton**	Stage 1 = Chapter 3 of Repairing Flooded Buildings, plus contact details should be provided to householder. An outline timetable should be provided when a drying plan has been developed. Review at approx 2/3 way through process – any adjustment in time, notify householder immediately and provide an updated repair programme. Consider using IT for customer	Not one size fits all. Drive by stages rather than rigid time interval – give an indicative timescale for each stage – if delays in getting drying contractor, say so. Assessor or surveyor should monitor the process developments.	This is building specific. When the building is not damp enough to attract spores, and dry enough for contact materials for repair.	RICS, BDMA can disseminate.	"Horses for courses". May be very saturated. Cost is a determining factor e.g. stripping a stud partition to bore from may have long term benefit and allow air circulation plus unit dries whole storey. Need to understand the building, the drying process, the whole problem and the range of options and resources	Block management if groups of properties. Agreed standards of basic restoration and repair between insurers e.g. wall cupboards and doors – this together with block management reduces party wall problems. IT system to identify extent of problems to get insurance claims officers in the field with access to the householder's policy options e.g. post

	enquiry database.				available. Time is also a mitigating factor.	code search of policies vs flood areas. (Central database of postcodes from EA flood maps and forecasting vs insurance policies)
Group 6 **Birgitte von Christierson** **Derek Bell** **J. Thompson** **P. Misson** **Rupert Scott**	Yes, the following information should be given to the householder: (i) the state of "dryness" (ii) how long the process will take? (iii) who pays for the electricity (approx £15 per day for 4 weeks)? (iv) where does this money come from? (v) how dry is "dry" The property should be monitored weekly and the resident informed of this, and their expectations managed. The householder should be provided with a certificate at the end of the works	Yes. A method statement should be provided for: (i) how the drying process is to be done (ii) how long this should take (iii) the timescale for completion A competent project manager is to be employed to oversee and monitor the whole process. This could be the drying contractor in conjunction with the homeowner.	The drying process is finished when the building is at, or better than, the pre-incident condition. This is determined by collected data from a moisture survey and visible evidence. This is done by a competent drying contractor	Each damage management company has different data gathering systems. Need to develop consistent approaches to professional procedures and practices for the industry. Government sponsored website to define the processes with public and professional areas.	Cost implications involved with stripping out. Determined by "loss of integrity" of the building materials e.g. plasterboard which will always need replacing. Cost analysis on two identical properties needs to be done.	Start to define a nationally accepted strategy/protocol for addressing post flood situations. This might address issues like: (i) Preference for drying only vs when to use stripping out (ii) Requirement for training/qualifications for de-humidification companies (iii) use of British standard for process of drying This is necessary if we are to start to co-ordinate activities. Without some common understanding we cannot coordinate anything.

Appendix III Delegate list

NAME	ORGANISATION	NOTES
Richard Ayton-Robinson	Chartered Institute of Loss Adjusters	
Richard Bates	Newark and Sherwood District Council	
John Batty	Bluejohn Marketing and Business Development	CHAIR
Derek Bell	Barnsley Metropolitan Borough Council	
John Blanksby	Pennine Water Group	
Kevin Brown	Lloyds TSB insurance	
Ralph Burkinshaw	Damp Investigation Services	
Jeff Charlton	Independent consultant/contractor	
Neil Courtney	Belfor UK	
Alan Cripps	Royal Institution of Chartered Surveyors	
Robert Fairall	Direct Air Dryers Ltd.	
Robin Farrington	CIRIA	CIRIA Staff
Simon Ford	Rainbow International	
Jonathan Garlick	Society for the Protection of Ancient Buildings	
Aaron Garner	Munters Ltd	
John Goudie	Defra	
Andy Habbershaw	Action Dry Emergency Services Ltd	
Tim Humphreys	Association of British Insurers	
Mike Johnson	DCLG	
Ben Kidd	CIRIA	CIRIA Staff
Bill Lakin	Chemdry	
Jessica Lamond	University of Wolverhampton	Research team
Peter Misson	Royal & SunAlliance - Loss Adjusting Services	
David Proverbs	University of Wolverhampton	Research team
Paul Redington	Norwich Union	
Rupert Scott	Trada Technology	
Bob Spencer	Mavinwood plc c/o Ansa Utilities	
Andy Tagg	HR Wallingford Ltd	Research team
John Thompson	Belfor-Relectronic (UK) Ltd	
Ian Townend	DryAir UK	
Birgitte von Christierson	HR Wallingford Ltd	Research team
Mike Waterfield	British Damage Management Association	
Ingrid Wellard	National Trust	

Appendix 3

Guidance and standards for drying flood damaged buildings: Stage Report

Introduction

The first project steering group meeting and consultation workshop for the *Guidance and standards for drying flood damaged buildings* project both raised a broad range of issues that are perceived to cause delay to the recovery and restoration process for flood-damaged homes.

This progress report helps to clarify which of these issues can be addressed by the guidance by dividing them into one of three categories:

a. those related directly to the drying process and therefore fall within the scope ofthis project and will be addressed by the proposed guidance
b. those related to the wider management of the restoration process, which fall outside of this project's remit but could be considered if the scope of this project is extended
c. those which require more substantive research, development and change (e.g. policy and legislation) and therefore fall outside the remit of this project

The report goes on to set out a case for why the writing of new guidance should proceed, based on the views from stakeholders expressed at the PSG meeting and the workshop.

Issues (1) falling within the scope of this project

i. risk sharing – it was agreed that a holistic view is required and the guidance could map out the stakeholders involved, the processes involved and roles and responsibilities.
ii. guidance on drying times
iii. guidance on what to include in the initial assessment of the flooded property report
iv. latent and pre-existing defects – the guidance could highlight this issue and potentially recommend greater access to surveyors during the restoration process.
v. Validating / auditing the works – the guidance could set out the requirements for monitoring and auditing including what information should be provided on a drying certificate. NHBC guarantee
vi. customer access to information – the guidance could specify sources of information for householders, as well as specify the stages within the drying process where the householder should have communication from the appointed "project manager". The guidance could also provide an understanding of how quickly the householder can expect each stage of the drying process to be completed.
vii. health and safety, and public health issues
viii. monitoring techniques

Issues (2) falling beyond the scope of this project, with potential to include

i. contractual arrangements – the guidance could clarify details of the management process
ii. competency – a minimum level of technical competency or standard for professionals.
iii. Guidance on the repair and reinstatement of buildings including appropriate methods and techniques

Issues (3) outside the scope of this project

i. availability of alternative accommodation – it was generally agreed that overall resourcing issues experienced during flood events should be investigated at a national level with regards to emergency planning.
ii. by-laws – these may need to be reviewed regarding placement of skips and containers etc
iii. competency - accreditation to ensure competency could be implemented through a statutory instrument such as through Building Control and / or the development of appropriate training and /or educational qualifications.
iv. access to properties – this is a potentially problematic issue, particularly with regard to access to properties whose owners are away on holiday or the landlord is not contactable.
v. management hierarchy – this issue may need policy change to ensure consistency with flood management hierarchy where it is likely that the Floods and Water Bill will enable local authorities to be the lead organisations and the Environment Agency to provide an overview role. There is a need to ensure insurance companies and damage management consultants fit into this management hierarchy
vi. more detailed advice to homeowners – this is envisaged to be part of the management hierarchy and process flow chart, and could be posted on a national web site.

The case for guidance

Overall, the view from the PSG and the workshop is that new guidance would be welcomed, if it addressed some of the issues and omissions in the existing guidance, and brought together the best elements that these existing documents provide. The workshop considered that the management processes involved in surveying and drying a house should be given greater emphasis and consideration, although this could imply changes to existing procedures used by insurers, loss adjustors and contractors. The PSG view was for a technical document that provided explicit advice on drying techniques. Taking all this on board, the project team recommendation is that guidance is required, and that this should follow the proposed contents, combining both technical and process management issues associated with the drying process (but not other aspects of the repair and reinstatement process), but subject to the following comments:

- the guidance will address the gaps identified in existing documents by the project team
- it will address issues that can be overcome by this guidance (set 1)

- it will cover the whole recovery process, in terms of roles and responsibilities, but it will not propose the changes in management responsibilities, as this may require significant policy changes
- it will cover the role of the homeowner in the process, but will not be public guidance
- it will concentrate on the drying process, with recommendations for approaches, equipment, monitoring and recording
- it will provide better signposting for each key step, taking the best parts from existing guidance
- it will not try to recommend the most economic options, nor provide cost-benefit curves, as this requires the collection of substantive data, which is not covered by this project (this also gets into commercial areas, which are best left to the industry to debate)
- it will cover health and safety for the drying process, but not in detail for the other steps

Proposed guidance contents and PSG view

For the PSG, the project team provided suggested contents for the new guidance, and based on discussions at the workshop the new proposed contents are as follows:

- Introduction (target audience, scope)
- Surveying the property (to include definition of flood, flood damage and property characteristics including latent defects)
- Methods of drying buildings
- Equipment for drying
- Determination of target drying times
- Monitoring the drying process
- Health and safety issues during the drying process
- Keeping the customer informed and managing expectations
- Further recommended reading
- Appendix - Forms and templates for use in conjunction with the guidance (likely to be based on amendments/improvements from Flood Repairs Forum book and PAS 64)

Following a wide-ranging discussion at the PSG, the general view was that the suggested contents seemed appropriate, and that what was needed was technical guidance, for those involved in the drying and repair of buildings. Whilst it was accepted that there was a need for better guidance for the public, this required a different set of text, and should be considered as an extra item outside the current scope.

Conclusion

The outcome of the PSG and workshop clearly indicated that new guidance would be welcomed, and provided a set of issues that it should address. The project team considers that not all of these elements can be included under the current project, either because they require substantial work to investigate and research, or because they are not suitable for the technical guidance that has been proposed. A grouping of issues has been set out above, and we have summarised what we consider should be in the new guidance.

A key issue now is timing, since there is less than two weeks before we are due to deliver the draft guidance on the 6th March, prior to the PSG meeting on the 10th. Therefore a quick decision is required that we should proceed with preparation of the guidance, or a relaxation in the programme should be granted, to allow further debate over the contents and target audience.

Department for Communities and Local Government

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