Code of Practice

for the Flood Protection of Buildings

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1 Introduction

This Code of Practice is issued by the Property Care Association.

The aim of this Code of Practice is to provide guidelines that set the principles and standards to which PCA members work.

This Code is based on current "best practice" and aims to provide a concise and thorough guide to Flood Protection. Information is given on associated matters and, where appropriate, reference is made to other documents and legislation.

Background information that may be useful when dealing with clients is also provided. All information conforms to or improves upon recommendations provided by: DCLG/ Defra/Environment Agency, Natural Resources Wales/ Scottish Environment Protection Agency (SEPA).

Improvements on recommendations are based on data from PCA members with long-standing proven records in Flood Protection.

The Code of Practice is intended for use in England, Wales, Scotland and Ireland. It is the responsibility of individual members to ensure that they are aware of, and follow, all legislation relevant to work carried out and any changes to it.

Red exclamation marks are found next to sections of particular importance.

1.1 Flooding

Flooding often represents a personal disaster for the people who are directly affected. The consequences of any flood can have a significant impact on those affected, not just physically and financially but also emotionally. It is important that any professional involved in the protection of buildings at flood risk understands this, to ensure the needs of the individual can be accommodated as part of the overall package.

Flooding can be caused by water from a variety of sources, some of which may not be close to the affected property or immediately apparent. Identifying the probable source(s) of the potential floodwater is important, as this will affect critical factors such as the depth, rate of flow and speed of onset, all of which need to be taken into consideration when recommending and/or designing appropriate flood protection methods and equipment.

Floodwater not only enters buildings through obvious openings in the wall, but can also rise up through flooring, or seep through the brickwork itself, particularly during prolonged flood incidents. Another entry point, which may sometimes be overlooked, is through the party walls of semi-detached or terraced properties (unless these too have flood protection, or have higher floor levels than the property being modified).

Undertaking flood protection work to buildings is, therefore, more complex than simply fitting protective products in accordance with the manufacturer's guidance.

2 Definitions

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

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

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

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

DAMP-PROOFING
This is defined as protection against the incursion of damp, by adding a damp course or by coating with a moisture-resistant preparation.

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

FLOOD AVOIDANCE
Aims at avoiding the floodwater entirely, by locating buildings above the flood level, elevating or raising buildings above the flood level, or to allow buildings to rise with the floodwater. *(This approach is beyond the scope of this document).*

FLOOD RESILIENCE
Adapting a property to minimise the effect of floodwater, so that no permanent damage is caused and the structural integrity is maintained. (May also be termed the 'flood repairable' approach, or 'Water entry strategy').

FLOOD RESISTANCE
Protecting a property, using flood protection products and/or building materials, with the aim of preventing floodwater from entering and damaging the building's fabric and contents. (Applicable to the maximum flood depth for which the equipment is designed).

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

HYDROSTATIC PRESSURE
Pressure created by a static head of water.

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

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

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

SACRIFICIAL MATERIALS
Materials used in house fittings that are likely to be damaged in case of flooding but can be easily replaced.

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

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

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

WET PROOFING
A retrofitting strategy where floodwater is not prevented from entering the building, but the building is adapted to flooding in a way that potential damage is reduced.

3 Training and accreditation requirements

Any person involved in the installation of Flood Protection must have training commensurate with their duties. Training in Flood Protection should be given in accordance with generic PCA training and manufacturer product-specific requirements.

Prior to work on any site, a surveyor should ensure that all necessary health and safety accreditation is possessed and all necessary training has been carried out.

General advice on training and training courses is available from the PCA.

4 Flood Protection

4.1 Introduction

It is not practical to provide a guidance document that covers all the possible aspects of flood protection, not least because new products are still being developed. This section of the Code considers some basic principles that should be borne in mind by those contracted to survey, supply and/or fit flood protection measures to homes or businesses.

Technique-specific issues for consideration are shown in italics.

4.1.1 Customer expectations

Clients should be made aware that it is not only difficult to make existing buildings totally flood resistant, but that in some cases it may not be advisable to do so (*see section 7.5 on structural damage in floods of extreme depth or duration*). High levels of flood resistance (keeping water out, or 'water exclusion strategy') can be achieved, however, where the type of flooding, cost and design constraints permit.

An alternative approach exists which is particularly suited to locations subject to frequent flooding and/or flood depths regularly exceeding typical resistance method design heights. Water is allowed to enter, but the building is equipped to endure the effects of flooding with minimal repair. This is known as flood resilience, wet proofing, 'water entry strategy', or a 'flood repairable' solution.

In most projects where flood protection is being considered, a combination of the techniques outlined later in this guidance may be recommended.

4.1.2 What is the difference between Damp-proofing and Flood-proofing?

Damp-proofing is defined as 'protection against the incursion of damp, by adding a dampcourse or by coating with a moisture-resistant preparation'.

'Water repellent coatings' or 'damp-proofing masonry creams' conforming to ISO 15148:2002 are not designed for underwater use and are many formulations are unsuitable for flood protection purposes.

Products compatible with the requirements of BS8102: 2009 – "Code of Practice for the protection of Structures from Water from the Ground" - may be suitable in some cases (see section 4.2.3.1).

4.2 Flood Resistance (water exclusion strategy)

Before any flood resistance measures are implemented, it is important that the property is stable and is able to resist the additional loads that may be placed on it, be it any head of water. If there is any doubt, it is important

to consult a structural engineer who can provide advice and guidance.

4.2.1 Keeping water away

To prevent water reaching a protected structure, temporary or permanent barriers can be installed around the building/grounds.

Although owners are entitled to safeguard their own property from flooding, they may not cause harm to the land or properties of others as a consequence (for example - due to deflection of water). The design must ensure such damage will not result from the construction of flood protection works, or the owner could be liable to a civil claim, seeking compensation and/or an injunction.

The advice of the Environment Agency (England), Natural Resources Wales, or SEPA (Scotland) must be sought before such work commences, as it this will affect existing flood flow patterns. Permanent barriers, in particular, can reduce the capacity of an existing floodplain, such that equivalent *compensatory flood storage* will be required as detailed in PPPS25 (this is also termed a 'compensation slice'). The advice of the Environment Agency will be required in these circumstances. A 'Flood Defence Consent' must also be obtained before any work commences if such structures are to be located in, on or near watercourses of any kind (and such permission may not be granted).

4.2.1.1 Permanent solutions

Typical solutions include: boundary walls/fences incorporating sealed gates; earth 'bunds' (also known as flood banks, or levees); automatic barriers; 'demountable' systems with permanent groundworks.
Expert geological survey and engineering design is needed where extensive groundworks are required.
Property protected only to design height of product. There can be problems with seepage under/through walls and via garden wells. Auxiliary pumps usually required. Structure of buildings not a limiting factor.

4.2.1.2 Temporary solutions

These include barriers placed around boundaries, or across flow routes such as driveways. A variety of barrier methods are available, including mobile dams (water-filled or air filled); modular barriers and 'pallet-barrier' variants.
Property protected only to design height of product. Structure of buildings is not a limiting factor. Can be installed in water. May need significant manpower to deploy. May need measures to deal with seepage.

4.2.2 Keeping water out

To prevent water entering a protected structure the basic principle is to close all openings and create one of the following two solutions:

- A waterproof outer shell (sometimes termed 'water proofing' or 'dry-proofing').
- Apply waterproofing treatments to the inner faces of walls and the floors (sometimes termed 'tanking').

Structure of buildings may be a limiting factor. The advice of a structural engineer should be sought to establish whether the building has the structural integrity to withstand the expected hydrostatic pressure.
Unless the building is specifically designed to resist these pressures, once the depth of flooding exceeds around 600 mm, it may be safer to allow water to enter the building. In general terms, the fabric of modern buildings can be less substantial than older properties. Older properties may be able to withstand depths up to 900mm, but for most modern buildings 600mm is the advised maximum.

4.2.2.1 Waterproofing the outer shell

This can be achieved either by applying a suite of permanent measures (sometimes termed 'passive or, rather misleadingly 'fit-and-forget'), or by using a combination of permanent techniques with temporary aperture closures, such as door guards and airbrick covers (deployed only when flooding is imminent). For ducts/service entry or exit points, specially designed plugs and sealed systems are available; other water entry points, such as the joints around door and window frames can be sealed to brickwork with mastic/silicone sealants.

Typical techniques include:
Cementitious renders, impervious slurries, resins, bonded sheet membranes, brush or spray applied silicones, liquid applied bituminous coatings and other proprietary products.

All of these coatings will retard drying to some degree if the walls and floors that they cover become wet, though this should not be problematic or increase the period needed to recover the building after a flood in a well-designed system. For these to be totally effective they must form a continuous barrier, with no gaps or breaks whatsoever in order to protect the whole of the occupied space from free water ingress.
There still may be groundwater problems; brickwork needs to be in good condition to be effective; below-ground work also involved; may just reduce penetration rate; may need facing bricks as well; may need planning approval if treatment visually alters building. If existing 'weep holes' are permanently sealed then damp problems can result.
A further option may be to face walls with low adsorption bricks e.g., engineering bricks conforming to BS 3921: Class A (blue) - water absorption <4.5%; Class B (red) - water absorption <7%.
Below ground work involved; may just reduce penetration rate; visually alters building hence may need planning approval.

'Perforated engineering bricks' are not suitable for this application, as they conform to a lower standard.

4.2.2.2 Other structural changes

In some situations a solution may be to raise building thresholds (if existing lintel heights permit this) or to construct a 'storm porch' to external doors.
These options are <u>not</u> appropriate for floods over 300mm in depth, or of lengthy duration. Both options may also compromise disabled access, which would render them inappropriate for most commercial premises or for buildings likely to be occupied by anyone with mobility issues.
Additional water ingress can occur via sewer manholes, which can lift up due to backflow during flooding. In this case, 'bolt-down' covers can be installed.
May require bespoke manufacture; liaison with local authority/ sewerage agency also needed.

4.2.2.3 Waterproofing inner faces of walls and floors (sometimes termed 'tanking')

These techniques are particularly vulnerable to damage if alterations are made at a later date.

4.2.2.4 Drained Cavity Systems

Cavity drainage membranes constitute a water management system, they have no resistance to hydrostatic pressure. The structural elements of the building form the primary water resisting layers and the internal water management system controls and removes any water before it enters the protected space. This technique was developed to protect occupied spaces (such as basements and cellars) from normal groundwater ingress, rather than flooding situations.

It is essential that such systems are free draining at all times as the build up of hydrostatic pressure will result in failure. Cavity drainage membranes for flood protection must be used in conjunction with pumping systems.

4.2.2.5 Sumps and pump systems

When used as part of flood protection measures, this should usually be provided as a packaged unit, comprising a purpose-designed preformed sump liner or chamber (with an integrated access cover) housing, as a minimum, dual (duty standby) automatic float-switch operated pumps. The pumps activate when the water level reaches a set height within the liner. Pumps are always sited at the lowest point within a structure, allowing collection of penetrating water by gravity, and then lifting this up to a suitable external discharge point which must be identified and appraised.

Battery back-up protection

Battery back-up pump systems are typically included to protect in the event of a power cut, with additional mechanical pumps being added to provide further redundancy or additional capacity as necessary. Such systems should include high level alarms to forewarn in the event of a problem, alerting either via local audible alarm or, where required, telephone/text message via remote telemetry. Backup pumps and alarms should always be included where there are consequences of failure, and in MOST other situations. It should also be noted that 'Type C' systems require a maintenance schedule, as failure of mechanical pumps could result in flooding. Where back up pumps are omitted the consequence and risk of a pump / power supply failure should be fully understood and formally agreed by all parties.

Maintenance of Sumps and Pumps

Maintenance of the pump unit will vary according to the type of pump configuration installed. Information relating to the servicing of individual pumps and configurations should be provided by the manufacturer.
Consideration should be given to the operation of the main and back up pumps and the condition of any batteries and switchgear should be established. Seals, washers and valves may require inspection and replacement.
The inspection and alteration of electrical circuits must be undertaken by a registered electrician.

4.2.2.6 Multi-Coat Renders

These are multi-coat cementitious renders and screeds, modified with chemical additives. The modified mortar is applied by conventional rendering or screeding techniques. The number and make up of these layers will be dependent on the materials used and the substrates they are applied to. *Guidance for the use and application of products should be sought from the material manufacture.* These products have been used in a range of applications including waterproofing basements or water retaining structures and tunnels.

Cementitious Coatings

These are pre-mixed cementitious compounds comprising cement, graded aggregates and chemical additives. They are supplied in powder form to be mixed with water and/or polymers on site and applied as a slurry by brush, trowel or spray, to form a coating that is usually between 2mm to 6mm thick. With the correct preparation, they can be applied directly to sound, level substrates or they can be applied to a proprietary render coat previously applied to the substrate. They can be further modified to improve adhesion elasticity and flexibility. Guidance for the use and application of such products should be sought from the material manufacturer. These products have been used in a range of applications including waterproofing

basements or water retaining structures and tunnels.
In almost all situations these products will need to be protected and covered by additional layers of plaster or render. This will not only protect the waterproofing system from impact damage, but will also reduce the likelihood of atmospheric moisture condensing on these un-insulated surfaces.
Multi-coat renders, cementitious coatings, bonded membranes and similar waterproofing products rely on the product being applied in a continuous fashion over the surfaces they protect, with no gaps or breaks whatsoever. It is essential, therefore, to ensure that where such products are being used to prevent flood water ingress, they are designed and applied with skill and care. This will ensure the systems are continuous and unbroken throughout the whole of the structure that is being protected, as missed sections, damage or a lack of continuity will result in failure.
Clients should be always made aware of the effects these treatments may have on the appearance of the property.

4.2.3 Aperture closures

Rooms with gas appliances often have vents through the external wall to prevent the build up of carbon monoxide. Any barriers to these vents MUST be removed before the gas appliances are switched back on. You should keep a list of all vents that have been blocked off and make sure they are opened again after the floodwater has gone. An alternative approach is to build bund walls around such vents, to the expected flood height, plus an additional 20%.

There are many products currently available for closing off doors, windows, airbricks and other apertures such as vents and pet-flaps.
If temporary (manually deployed) barriers are to be recommended, the client will need easily accessible storage space, and both the physical ability and sufficient warning time to deploy the equipment correctly.
May need measures to deal with seepage; this includes products carrying a Kitemark, where a permitted leakage rate is specified. Measures may also need to include a property specific flood alarm system, if public warnings are not available in the area (for example, where prone to flooding from un-gauged streams or surface water).

4.2.3.1 Airbricks

Typical solutions include airbricks that automatically close as water rises, then open as levels drop, thereby avoiding damp problems (Kitemarked versions are available). Another option is the 'periscope' type which fits over an existing airbrick to raise the vent height (300-900mm high versions available).
Needs careful installation and regular maintenance to ensure optimal performance.

4.2.3.2 External doors (including French windows/patio doors)

Typical solutions include modifying existing external door openings and installing fixings for attaching temporary barriers; automatic door guards (pop-up, drop-down, and flip-up types are all available, though some of these are more appropriate for commercial properties). These solutions must be combined with water resistant brickwork or masonry to external walls, unless the expected flooding is of a very short-lived nature.

May be difficult to evacuate building if people are trapped inside with rising water.

Some types of aperture protection may need measures to deal with seepage, hence combining aperture closing techniques, water proofing and drained cavity protection backed by sumps and pumps will inevitable reduce water affecting the occupied space.

Alternatively, permanently fitted flood resistant doors and frames are available, some of which include an 'escape hatch', or 'stable door' design, to aid rescue/delivery of emergency supplies whilst keeping water out of the property.

Care should be taken that none of the above options are used in situations where water may be kept out at depths that are dangerous to the structural integrity of the building. A structural engineer's advice should be sought here.

4.2.3.3 Windows

Typical solutions include modifying existing window openings by installing fixings for attaching temporary barriers.
Some types of window protection may need measures to deal with seepage (including Kitemarked products, where a permitted leakage rate is specified) hence combining window protecting techniques, water proofing and drained cavity protection backed by sumps and pumps will inevitably reduce water affecting the occupied space.
Flood resistant windows and frames are available. Some products allow windows to open when required; the glass used must be capable of withstanding collision from floating debris however it must be understood that even toughened glass will be vulnerable if subject to heavy impacts.

May be difficult to evacuate building if people are trapped inside with rising water.

Other water ingress points include appliance vents and pet flaps, for which proprietary covers are available.

4.2.4 Other measure types

Additional solutions, not covered in the above sections include:

4.2.4.1 Anti-backflow measures

For downstairs toilets, 100mm or 150/160mm non-return valves (NRVs) can be fitted to sewer pipes; these must conform to BS EN 13564. An inspection chamber is required to accommodate these. For shower room outlets, kitchen/utility sinks, showers and domestic appliances dishwashers and washing machines, 32/40mm valves are normally required.
Regular maintenance required to prevent blockages occurring that will compromise performance. May need to assess the impact on neighbours. The client must be advised against attempting to use upstairs lavatories/sinks etc when valve is in closed position (unless pumped NRVs have been installed).
Alternatively, specially designed toilet seals/bungs are available; also shower seals and/or bungs for other drainage points.

4.2.4.2 Modern 'sandbag' equivalents

For example, absorbent bags capable of holding tens of litres of water which are both lightweight and quick to deploy. These may be a useful option to recommend for very low depth flooding (e.g. surface water issues), diverting water 'run off', or as an adjunct to the above measures.
Another use, as they can absorb up to 20 litres of water, is to soak up the (permitted) seepage from Kitemarked flood protection products.
Sufficient bags must be stored ready for use. Some bags are re-usable after cleaning, others need to be disposed of appropriately after single use.

NOTE. This standard does not recognise traditional sand filled bags as an affective form of flood protection.

4.2.4.3 Flood alarms

Commercial mains units operated by floodwater, or water rising in a foul sewer, are available, which trigger an alarm inside the property. Individual property units triggered by

rising floodwater at a distance from the property (for example, at the lowest point in a garden) can also be found, but owing to battery operation they may be less reliable. Community alarms are also available, which can text or telephone several numbers when activated, which may suit isolated groups of properties.

4.3 Flood Resilience (water entry strategy)

A permanent approach, sometimes known as 'flood repairable solutions', 'water entry strategy' or 'wet-proofing', in which building materials and techniques are employed that will be minimally affected by water. This can dramatically shorten the cleaning, drying and recovery period required. They can enable rapid repair and re-occupation of the premises (although cleaning/drying costs will still be incurred).
The building structure could still be at risk if high velocity flows are experienced, or substantial debris impacts occur, even though the water levels are equivalent inside and outside the property.

Unless the building is specifically designed to resist these pressures, once the depth of flooding exceeds around 600 mm, it may be safer to allow water to enter the building. In general terms, the fabric of modern buildings can be less substantial than older properties. Older properties may be able to withstand depths up to 900mm, but for most modern buildings 600mm is the advised maximum.

A 'sacrificial' approach may be adopted whereby fittings are designed to be replaced after a flood. Alternatively, durable fittings that are not appreciably affected by water and can be easily cleaned should be specified (e.g. use of plastic materials or stainless steel for kitchen units). The cost of these units may need to be balanced against the predicted frequency of flooding.

Although it offers the most 'future proof' option, this approach can be highly disruptive to install so may only be appropriate for a minority of clients. In some situations this approach may be cost effective only when undertaken as part of flood damage recovery work. Clients should be made aware that the financial benefits may not be felt for a number of years.

4.3.1 Water compatible internal walls

Closed cell cavity insulation offers additional advantages. It may be possible to retain the materials following a flood and they will provide improved thermal insulation even in wet conditions. Horizontally fixed plasterboard panels may be used, which can be removed and replaced following a flood, as a 'sacrificial' solution.
An alternative, particularly suitable for use in older, historic buildings, is the use of lime-based plaster. This is capable of withstanding repeated immersion and, though a more expensive solution initially, this could be more cost-effective in the longer term for some properties and clients. The Society for the Protection of Ancient Buildings (SPAB) produces technical briefings on this, and other specialist solutions for use in historic properties.
There may be problems with 'salt efflorescence' in plaster coatings either from soluble salts existing within the underlying masonry, or those transported via moisture rising through capillary action from the ground. These issues should be discussed fully with the client at an early stage.

4.3.2 Water compatible flooring

Replacing timber floors and fitted carpets/ laminates with concrete floors and tiled

surfaces. Some robust wooden flooring types may be capable of cleaning and re-sanding following inundation. Another option may be to use removable carpets fixed with Velcro, or hooks and eyes set into the floors. Manganese Oxide board (trade name 'Dragonboard') does not absorb water and can be disinfected and dried, hence also an option for replacement flooring.

4.3.3 Water compatible kitchen and bathroom fittings

Products originally developed for hospital or industrial uses, in stainless steel or plastic, are available.

4.3.4 Raised electrics/meters; mounting kitchen white goods on plinths; mounting boilers on walls

There are practical limits as to how high electrics/kitchen appliances can be raised. Meters and sockets can be raised above the 600mm level, but client-specific needs must be taken into consideration (for example, wheelchair users, or those with mobility/reach issues). Another possibility, for buildings of more than one storey, is to change the wiring so that the ground floor ring main can be switched off, leaving the supply to the upper floors still available.

4.3.5 Water compatible steps/ stairs

Specialist manufacturers can supply bespoke hardwood and/or steel staircases. The lowest treads of wooden stairs can be replaced by concrete.

4.3.6 Removable internal doors

By using quick-release hinges, and avoid painting over door hinges, occupants with adequate physical capabilities can remove doors, which may then be placed on top of tables or other robust furniture to create storage above water level (appropriate for low level flooding of less than 600mm only).

5 Standards

The following codes/specifications are directly relevant to flood protection equipment.

5.1 Kitemark certification

Publicly Available Specification (PAS) 1188 provides a benchmark for flood resilience technologies. The testing procedures involve static water, waves and currents. It was first developed by the British Standards Institution in association with the Environment Agency in 2003, then updated in 2009 and again in 2014.

The 2014 version of PAS-1188 has a substantial reduction in the allowable seepage/ leakage for building aperture products compared to the preceding versions (2009 and earlier) but some leakage is still permitted. (The 2009 limit is specified as '*one litre per hour per metre of seal under the designated maximum water depth',* the equivalent 2014 limit is half a litre).

Four different types of product are covered, as follows:

- PAS 1188-1 Flood Protection products. Building aperture products
- PAS 1188-2 Flood Protection products. Temporary and demountable flood protection products
- PAS 1188-3 Flood protection products. Buildings and building skirt systems (Note – none in production at the time of writing)
- PAS 1188-4 Flood protection products. Demountable products.

5.2 Other standards

The following standards are of relevance to associated products which may be used when carrying out flood resistance work to buildings.

European standards (beginning 'BS EN') have the same status as British Standards.

BS EN 13969 Flexible sheets for waterproofing. Covers bitumen damp proof sheets, including bitumen basement tanking sheets.

BS EN 13564 - 2002 Anti-flooding devices for buildings (covers Non Return Valves for Sewers).
This specifies types and requirements for materials, performance, design, construction and marking for factory made anti-flooding devices for faecal and/or non-faecal wastewater for use in drainage systems of buildings operating under gravity in accordance with BS EN 12056-1.

BS EN 12087:1997 Thermal insulating products for building applications.
This determines how much water is absorbed when an insulation material is totally immersed in water. The long term water absorption by total immersion is not directly related to the conditions on site, but has been recognised as a relevant condition of test for some products in some applications.

The flood risk assessment should be carried out in accordance with BS 8533 'Assessing and managing flood risk in development. Code of Practice'. This gives recommendations and guidance on the appropriate assessment and management of flood risk where development is proposed in the UK. It is intended to provide developers, and decision makers (local authorities and regulators), with practical assistance for dealing with flood risk in and around their development. It has been created to help the user to analyse flood risk and to guide the selection of appropriate risk management solutions.

A US-based organisation, FM Approvals, have produced a detailed standard for 'flood abatement products' (FM2510) (for details see reference section).
Additional regulations which may impact upon the design and construction of flood protection works include:

- The Equality Act 2010
- The Fire Precautions Act 1971
- The Gas Safety (Installation and Use) Regulations 1998
- The Building Regulations (England and Wales) 1991
- The Building Regulations (England and Wales) 2006
- The Building Standards (Scotland) Regulations 1990
- Statutory Rules of Northern Ireland 1991
- Statutory Rules of Northern Ireland 1994
- Statutory Rules of Northern Ireland 2000

Any property that is **Listed**, or sited in a **Conservation Area**, is likely to have considerable additional restrictions on the type of alterations that can be undertaken. For example, the design is typically required to be compatible with the building's age, style and materials. Specialist advice must be sought in advance of any work commencing, and Listed Building Consent(s) obtained where necessary.

6 Inspection, risk assessments and health and safety

6.1 General risk assessment

A suitable and sufficient risk assessment should be made by a suitably trained and competent person before inspection works are commenced. The risks that installation and use of Flood Protection poses to a client/site should be determined on a site by site basis. The information contained in this Code of Practice may assist in the formulation of such a risk assessment.

6.2 Site assessment

When a site assessment takes place it should be carried out by a PCA approved specialist who is expert in Flood Protection and with appropriate knowledge of building design.
Site assessment should include:

- An inspection of the immediate site surroundings
- Site history (including any previous flooding events, and any Flood Protection measures already adopted/installed)
- Any proposals for development, including the timing and the location of proposed structures.

Initial inspections should aim to establish the condition of the building, the construction methods, and the materials that will be encountered.

6.3 Risk assessment (health and safety)

The Health and Safety Act 1974 specifies the legal requirements applying to working practices, including the following duties of the employer:

- safety procedures must be displayed for all to see
- workers must be trained to use machines and equipment
- appropriate protective clothing must be worn
- all risks must be controlled and monitored

In addition, the legislation requires every employee to be responsible, so far as reasonably practicable, for the provision of a safe working environment, the provision of appropriate safety equipment and instruction, training and information on the safe use of plant, equipment and materials necessary for the job.
Employees in turn, have an obligation to make proper use of the safety equipment provided and to act upon the information and training given to ensure their own safety and that of others who may be affected by their acts or omissions.
Product/equipment manufacturers are also required to undertake a risk assessment of all the stages of product manufacture, to ensure the safety of workers and prevent industrial accidents.

6.4 Construction (Design and Management) Regulations 2015 (CDM2015)

All construction projects, whether commercial or domestic, are covered by these regulations, which set out what people involved in construction work need to do to protect (i) themselves and (ii) anyone the work affects, from harm. Full details are available from: http://www.hse.gov.uk/Construction/cdm/2015/index.htm

The above is a brief summary of the legislation and should not be taken as a complete statement of the law.

7 Understanding the flood risk

7.1 Caution

To achieve the best outcomes it is strongly recommended that an adequately trained and competent specialist surveyor forms part of the team from the outset. The individual should be fully conversant with the process of protecting buildings from flooding detailed in this Code of Practice.
The design strategy chosen should be informed by a site-specific flood risk assessment for the building (or development site). Such a flood risk assessment should be carried out in accordance with **BS 8533**.
Key parameters of this assessment are the expected flood depth, duration and frequency,

since they determine the likelihood of being able to keep water out of the building (resistance) and whether it is more cost-effective to plan for water ingress (resilience). The existence of any flood warning schemes, and the expected lead times for issue of warnings, should also be taken into consideration.

In general terms, flooding associated with greater depths and longer durations would favour the adoption of the water entry strategy, while shallow and short-duration flood water would favour the water exclusion strategy.

7.2 Flood history

Knowing that the building has a history of flooding can be very useful. Buildings that flood periodically will probably have been repaired several times, and this can result in the use of a great many construction materials and repair techniques, all of which may have an effect on the design and methods that should now be employed.
When assessing the risk to the property of structural defects associated with the pressures exerted onto the building during past floods, the following information should be established:

- How high has floodwater reached in the past?
- What was the flow rate of the water?
- Source(s) of the flood water

The latter is important as, for example, flooding from seawater could expose building materials to saltwater damage, particularly over prolonged periods.

7.3 Source(s) of flooding

Flooding can be caused by water from a variety of sources, some of which may not be close to the affected property or immediately apparent. These include:

- Rivers
- The sea
- Heavy rainfall
- Heavy rainfall running off impermeable surfaces, or saturated ground (overland runoff)
- Backup/overload of drainage systems
- Blocked ditches/drainage channels
- Water rising out of the ground
- Combinations of two or more of the above

If surface water flooding is the issue, note that flood warnings are not currently available (at the time of writing). A flood alarm system should be recommended to such clients, so that occupiers can be alerted before water enters the property. This may also be appropriate where municipal defences exist that rely on mechanical devices such as pumps (which could be subject to failure).

Community based alarm systems may be appropriate for groups of buildings, but this is beyond the scope of this document.

7.4 Risk level (probability/depth)

The maps referred to in this section give a general guide only, and are <u>not</u> accurate down to individual property level. They do not take into account local variations in physical features, or property-specific information such as the height of the lowest floor above the surrounding ground.
The maps do not include information about the flood risk from groundwater in England and Wales, although information can be obtained from some specialist providers (chargeable service).

Maps are available from the sources listed below.

7.4.1 England

Flooding from rivers/the sea:
http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=floodmap#x=357683&y=355134&scale=2
Surface water flooding:
http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?lang=_e&topic=ufmfsw&layer=default&scale=2&x=357683&y=355134#x=357683&y=355134&scale=2

7.4.2 Wales, Northern Ireland and Scotland

Combined river/coastal/surface water maps are available as follows:
http://naturalresources.wales/about-us/news-and-events/blog/flood-risk-maps-live-on-our-website/?lang=en
http://mapping.dardni.gov.uk/FloodMapsNI/index.aspx
http://www.sepa.org.uk/flooding/flood_maps.aspx
For Scotland only, a separate map showing areas at risk of groundwater flooding is also available from the same website.

An easily searchable source of information for England and Wales, including real-time river gauge data and maximum levels, is available here:
http://www.gaugemap.co.uk/

7.5 Detailed Flood Risk Assessment

This should include the following features:

- A list of all vulnerable apertures (doors, windows, air bricks)
- A list of all other possible water entry points (including service ducts, pipe and cable entry points, boiler vents)
- An inspection of the wall to see if it will withstand standing water for a period in excess of 24 hours, including checking of brickwork and mortar, or equivalents.
- A check on utility meters below a 900mm threshold.
- A check on the internal floor of the property. (Properties with raised floors, cellars and basements are obviously more prone to flooding than others.)
- A check on the sewerage system, particularly if property has downstairs toilets/showers.

The client should be made aware that most properties in the UK can only be protected from flooding lasting hours rather than days. Extended periods of flooding can allow water to penetrate the building fabric, and unilateral water pressure can also cause structural damage in deeper floods. (Refer also to section 4.2.3 for more details regarding structural integrity issues).

8 Understanding the building

8.1 Construction methods

In order to devise the appropriate method(s) of protecting any building, it is necessary to fully understand the construction of the property concerned. For example, because water affects different materials in a variety of ways, the existing building fabric may mean it is unsuitable for flood resilience measures.

It is also essential to ascertain whether any flood mitigation measures have been applied in the past, and whether these have ever been exposed to any flood events. If present, and if they are known to have performed as intended, then it may be appropriate to retain them. For example, lime-based plasters can be capable of drying out without damage (unlike gypsum or plasterboard) and cement- rich waterproof renders can also be highly resistant to exposure to free water. These materials may have been incorporated during previous flood repairs or as an element of free water resisting measures.

For semi-detached, terraced properties or blocks of houses, attempting to protect one unit could be pointless, as water can move through porous or honeycombed party walls, particularly where suspended timber or block and beam floors exist. Unless the solid floor levels of any attached units are substantially higher than the client property, then these too are likely to need careful consideration and flood protection.

Any cracks, interfaces between construction types, damage, or sections of porous material that form part of building fabric at low level that would permit ingress of water, must be identified. These elements can considerably affect the risk of water ingress during flood exposure.
Any defect, porous construction product or forms of building construction that could allow water to enter through the fabric of walls and floors must be considered carefully. Any schedule of flood protection works must make allowance for waterproofing these elements, in order to avoid compromising the performance of other flood protection work.

8.2 Routes for ingress of water – above ground

If flood resistance measures are to be successful, then the building must be thoroughly examined and a comprehensive list of apertures, and other ingress points that will require sealing prepared. This should include (but is not limited to) the following:

- Doors (and seals around these)
- Patio doors/French windows (and seals around these)
- Windows (and seals around these)
- Air bricks/vents/weep holes/pet flaps
- Service ducts (including telephone/satellite cables)
- Pipework for both sewers and domestic appliance pipes require appropriately sized non-return valves (NRVs) to prevent water entering via ground-floor sinks/toilets/shower outlets)
- Via permeable bricks/blocks (unless already sealed)
- Damaged/weathered mortar
- Interfaces between incompatible construction types
- Unsealed cavities in walls and floors
- Porous and fibrous construction products
- Timber framed and other conventional and non-traditional construction types
- The presence of retrofit insulation fitted to or positioned within the building fabric

Some highly porous solid construction products (such as aerated lightweight blocks; cob; cinder block; 'bungeroosh' or some rubble filled stone walls) must be considered to have almost no resistance to water movement when under pressure. It is important that the underlying construction materials are fully understood together with their water resisting and water tolerance characteristics, such that these are taken into account in any schedule of flood protection. It is also essential to understand that many of these delicate or friable products cannot be waterproofed by applying strong impervious layers directly to them, as this may accelerate deterioration and or cause further problems.

8.3 Routes for ingress of water – below ground

Depending upon the local soil type and underlying geology, water may move through the ground itself before it flows across the surface, and this may affect basements, cellars and the foundations of a building.
Floodwater is more likely to seep through floors in permeable ground than in impermeable ground. Permeable ground allows floodwater to pass through it and includes chalk, gravel or sand. Impermeable

ground will prevent water passing through it and includes clay. However a number of factors, such as permeable soil in drainage trenches, may increase the permeability of clay soils

Flood protection products (such as flood boards) are not designed to protect against floodwater entering in this way, and specialist techniques are required. *(See section 4.1.2 regarding the difference between 'damp-proofing' and flood protection).*

Determining soil type:

The local authority may be able to provide details of ground conditions in the area: www.lga.gov.uk

The British Geological Survey and National Soil Resources Institute may also be able to help with determining the soil type: www.bgs.ac.uk or www.silsoe.cranfield.ac.uk/nsri.

Specialist surveyors may also be able to advise on local soil types. The Royal Institution of Chartered Surveyors can advise on professionals to undertake these surveys: www.rics.org.uk/index.html

8.4 Historic buildings

If a building has listed status, or is situated in a conservation area, or is historically important then advice must be sought from the appropriate body or bodies. There are both technical and legal implications of working on protected structures, which must be understood. Any guidance issued must be carefully and fully adhered to (for example, 'Listed Building Consent' may be required in advance of work commencing).

The client is responsible for ensuring that any works are compliant with current building regulations and that it will be fit for purpose.

8.5 Other issues

The owner of the property is responsible for ensuring any local restriction, covenants, constraints applied by conservation authorities or local government are communicated to the contractor and are adhered to. In turn, the surveyor or specialist contractor should do all that is reasonable to ensure that the building's owner has sought the necessary consents and approvals before work begins.

9 Understanding the client

9.1 Before work begins

Prior to commencing work, members should try to ensure sure that the client(s) have all the professional advice needed on the project, if it is a large or complex flood protection project. This may involve getting the support of engineers, surveyors or other specialist professionals.

The contractor should ensure sufficient insurance cover commensurate with the scale and risks associated with the services that are being provided.

Clients must be provided with a written quotation and specification for the project including, though not restricted to, the following:

- The expected cost of works
- What is included in the price
- What form of agreement will be used between the contractor and the client
- How long the job is expected to take
- When the work can start
- Any work to be undertaken by the client or other contractors.
- Key delivery dates
- Whether the work is covered by any warranty, together with details of any such cover
- Payment terms.

Where appropriate, clients should be supplied with samples of all materials and fittings for prior approval.

9.2 During work

When work is in progress, clients should be briefed regularly on progress. If there are unavoidable problems or delays, clients should be informed of these issues as early as possible.

If there are any changes to the work specified or extra costs, these should be confirmed in writing and agreed with the client before such additional work begins.

At all times the client, and the client's property, must be treated with respect.

9.3 After completion

When the work is complete, the site should be left clean and tidy and ready for use.

Any relevant operating instructions, warranties and guarantees should be handed over to the client.

Where applicable, the client must also be properly briefed about any relevant maintenance or operating issues and given training if necessary.

A date should be arranged for the contractor to return and deal with any defects which may have arisen during the first few months.

9.4 Customer Care Issues

Some types of temporary flood protection equipment require physical strength and/or manual dexterity to deploy correctly. A client's abilities in these respects must, therefore, be taken into consideration when recommending equipment and fittings.

Similarly, if any members of the client's household, or employees/customers of a client's business have, or are likely to have, mobility issues, then appropriate measures should be included. For example, if wheelchair ramps are already fitted at the property, then appropriate wheelchair access arrangements must be incorporated into the flood protection design.

The client's requirements as regards the physical appearance of the completed work should also be explored and incorporated into the design and selection of fittings and equipment. For example, the visibility of stanchions for flood gates/boards may be an issue for some clients.

10 Reports

The surveyor and his employer have a duty of care to the client and the report that is submitted detailing the site conditions, limitations and recommendations must demonstrate that this duty of care has been discharged.

10.1 Site assessment

A site assessment must be comprehensively detailed and must be undertaken by persons who have the appropriate levels of knowledge, skill and experience.

Reports that are submitted to homeowners may form the basis of the contract and must therefore be accurate, comprehensive and understandable.

The person responsible for formulating the report and specification must be aware that the report is a permanent record of the site investigation and the recommendations that flow from the observations.

The report should accurately reflect the individual characteristics of the building, it should be individual to the property and highlight any limitations and restrictions that were imposed by the client, by site conditions or any lack of access.

The report should explain and justify all the protection measures that are recommended

and highlight any concerns or limitations that may limit the effectiveness of the flood protection measures that are recommended. Where it is reasonable to anticipate that the flood protection systems that are recommended in the report will allow some leakage, this must be clearly stated.
It is important that the client's expectations are clearly set out in the report. The flood protection measures that are then recommended must meet or exceed these expectations. In the event that these expectations cannot be met for practical, technical or financial reasons, this must be clearly indicated in the written report.
Where leakage is expected or anticipated then this must be set out in the report with further guidance as appropriate.

The report should always include:

- The site location
- Full details of the contracting organisation/client
- A description of the site and the area immediately surrounding the site
- An accurate record of the flood history of the site (if applicable)
- A scaled map with dimensions
- An outline of development plans for the site (if applicable)

When, as a result of site investigations or following the commencement of work, it is found that additional work is needed, the client should be made aware of the full implications of these extras before additional work is undertaken or additional costs are incurred.

10.2 Storage and maintenance

During the initial site investigations it is important to consider that many flood protection systems require regular inspection and maintenance. Surveyors should also understand that outcomes can be improved if residents understand how and when to deploy flood protection measures, and are both trained and practiced in their installation.

10.3 Maintenance

Where it can be anticipated that products or flood protection measures will require regular inspection, repair or maintenance to maximise their efficiency, or ensure that products can be deployed quickly and effectively and that they will work as intended, the supplier must make this clear when the specification for work is provided. It follows that this must be set out clearly in the report.

For example, the 'Neoprene' material used for seals on some aperture barriers is designed to be oil, chemical and weather-resistant (compared to natural rubber). The seals may, however, become degraded over time, particularly if subjected to physical abrasion, and so must be regularly checked and replaced when necessary.

The client must be informed of the likely cost and frequency of any planned inspection, repair or maintenance. Where the efficacy of flood protection measures could be affected by neglect, the homeowner should be offered the means to meet any maintenance obligations imposed by the supplier. Contractors may provide maintenance contracts, cleaning and scheduled inspection facilities if this is felt appropriate.

Where flood protection measures are installed that require fitting or activating in the event of a flood warning, then the appropriate training and instructing must be provided to the residents or owners of the building.

As buildings can change hands, it is imperative that new occupants are made aware of any

fitting instructions, repair maintenance and cleaning requirements that are recommended.

11 Warranty

Contractors should be able to provide clients with assurances that the work specified and subsequently undertaken will be effective in providing Flood Protection to the design standard.
The concept of the 'design standard' should also be explained to the client. For example: if a property is designed to be protected to a flood depth of 600mm and a flood event of 615mm arises, then the property will flood. This is known as 'residual risk', which is always present in any flood solution, because it will be built to a) a budget, b) a design standard or c) a structural limit. (This issue is best addressed at the design stage, by offering flood resilience if such a flood event is anticipated).

Any limitations should be clearly stated. For example, Neoprene seals must be inspected annually, even if no flood has occurred in the interim.

Where appropriate and at the discretion of the contractor, guarantees and insurance may be available. These provide additional levels of protection to the client in respect to any failure of the specified controls.

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