

# Temporary local flood protection in the United Kingdom. - An independent assessment.

David Crichton<sup>1</sup>

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## Abstract

*Traditionally there have been two types of temporary flood protection, sandbags and flood boards. In recent years, numerous systems have been invented to improve on these methods, and there are currently some 150 temporary flood protection products on the market in the UK alone. Insurance in flood hazard areas is becoming more expensive and less available, following the cancellation of the insurance industry guarantee of universal cheap flood insurance at the end of 2002. As a result demand for temporary protection is growing rapidly. The systems are not cheap, however, and those who buy them are increasingly looking to the insurance industry to provide discounts from their flood premium if the devices are fitted. This paper is mainly intended to help insurers to decide whether the system being fitted is appropriate, but it may also be of benefit to local authorities and property owners who are considering purchasing such products.*

*It outlines and compares different types of systems according to various performance characteristics, such as ease of deployment and effectiveness. It also describes the British Standards Institute tests introduced in 2003.*

## Keywords

Flood, Temporary Protection, Insurance

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<sup>1</sup> Visiting Professor, Middlesex University Flood Hazard Research Centre.  
Visiting Professor, Benfield Hazard Research Centre, University College London.  
Hon. Research Fellow, University of Dundee.  
Chartered Insurance Practitioner

## Introduction

As our climate changes, it poses new challenges for society, especially insurance companies<sup>2</sup>. One of the biggest challenges is flooding, already a growing problem in England and Wales, although it seems to be more under control in Scotland, especially since Devolution<sup>3</sup>. As people seek to protect their own property from flooding, temporary mobile and demountable flood defences are becoming increasingly popular.

Alan Wilson, Minister for the Environment in Scotland, announced on 1<sup>st</sup> October 2003 that the Scottish Executive supported the use by local authorities of temporary barriers to protect local properties. Some councils in Scotland are already supplying systems to residents in the few remaining areas where a flood alleviation scheme has not been completed.

There are so many different systems on the market in the UK (approximately 150 at the last count) that it is difficult to choose which ones are the best for the particular circumstances. The Environment Agency in England and Wales no longer list systems other than those which have a BSI Kitemark, although the Scottish Environment Protection Agency web site still has a comprehensive list<sup>4</sup>. Many temporary flood defence systems are also listed in the English National Flood Forum web site<sup>5</sup> and in a research report produced for the Environment Agency and Defra<sup>6</sup>. However these publications do not seek to compare different types of systems or to identify their drawbacks in any detail. Also, some of the best systems are not even listed in those documents. The main purpose of this paper is therefore to critically examine and compare the different types of systems suitable for local protection of domestic property. Many of these systems are “demountable”, that is some preparatory work is needed before a flood event, such as bases for posts, or frames for barriers etc. Some, however, are “mobile” which means they can be used anywhere without site preparation. The paper does not attempt to give a comprehensive list of proprietary products, but examples of selected products are given where appropriate.

In the UK there is no government compensation or insurance scheme for flood victims, and 95% of homes are insured in the private insurance market. From an insurers' point of view it is unlikely that ownership of temporary or demountable defences will in themselves justify a premium discount, owing to the uncertainty about whether they will be deployed in time, and uncertainty about their effectiveness. However insurers in the UK are currently considering such systems carefully and exploring options to encourage their use, and the use of resilient reinstatement methods in general<sup>7</sup>.

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<sup>2</sup> Crichton, D. 2001 *“The Implications of Climate Change for the Insurance Industry.”* (ISBN 1-903852-00-5), Building Research Establishment, Watford, England. Available from <http://www.brebookshop.com/> stock reference 42524.

<sup>3</sup> Crichton, D., (2003) *“Flood risk and insurance in England and Wales: are there lessons to be learnt from Scotland?”* Technical Paper Number 1, Benfield Hazard Research Centre, University College London. Available for free downloading from [www.benfieldhrc.org](http://www.benfieldhrc.org)

<sup>4</sup> <http://www.sepa.org.uk/flooding/protection/index.htm>

<sup>5</sup> <http://www.floodforum.org.uk/>

<sup>6</sup> Ogunyoye, F., and van Heereveld, M., Posford Haskoning (2002). *“Temporary and Demountable Flood Protection. Interim Guidance on use.”* DEFRA and Environment Agency, R & D Publication 130, Project manager Stokes, R.

<sup>7</sup> Building Research Establishment, 2003 *“Assessment of the Cost and Effect on Future Claims of Installing Flood Damage Resistant Measures.”* Commissioned and published by the Association of British Insurers, London, May 2003. Available from [www.abi.org.uk](http://www.abi.org.uk)

### 1. Selecting a system: factors to consider

In considering temporary or demountable protection, a number of factors need to be taken into account, including:

1. Cost and manpower requirements for deployment, and time taken for deployment, taking into account that deployment is likely to be in adverse weather conditions, during winter months and possibly in the dark,
2. Effectiveness and suitability taking into account the type of property, the type of flood, the site conditions, and resistance to theft, vandalism, or damage.
3. Storage of systems when not in use.

For convenience the author has chosen to divide the various systems into just two categories, self supporting systems and systems which are attached to the building being protected, as these cover almost all systems. Some systems can be either self-supporting or attached for example, "*Floodskirt*" or "*Flood Guards*", and such cases have been allocated to the category that describes them best (in the author's view). The general features of systems of these types are compared in the following table.

### Comparison Table

	<b>Self supporting defences</b>	<b>Attached defences</b>
Description	<p>Various types have been designed to replace sandbags, for example:</p> <ul style="list-style-type: none"> <li>• Rigid panels (or pallets) lying on angled frames and covered in fabric or plastic sheeting with the "mouth" facing away from the flood so the supports are under compression. The system may be entirely free-standing, relying on gravity and friction to keep it in place (e.g. "<i>Pallet Barrier Flood Control System</i>").</li> <li>• Demountable aluminium panels attached to fixing systems in the ground with rubber seals between panel and ground and between each panel (e.g. "<i>Dutchdam</i>").</li> <li>• Temporary barrier of angled fabric with the "mouth" of the system facing the floodwater: the supports for the barrier being under tension rather than compression. The system may be entirely free-standing, relying on gravity and friction to keep it in place (e.g. "<i>Rapidam</i>").</li> <li>• Demountable vertical barrier skirt system made from heavy fabric, rubber, or plastic sheeting suspended from a rail supported</li> </ul>	<p>Traditional flood boards made of timber (perhaps coated in tar) and screwed to the wall.</p> <p>There are also many proprietary systems. Some can be permanently fitted, such as the air brick "snorkel", but most are demountable (apart from "<i>Floodgates</i>", see below). With demountable systems, pre installed frames are permanently fixed to the walls of the property (e.g. "<i>Flood Guards</i>"). Strong plastic or braced aluminium panels are clipped to the frames when a flood is imminent to cover doors, windows and airbricks. The use of pre installed frames ensures a watertight fit for the panels.</p> <p>"<i>Floodgates</i>" do not require frames to be fitted to the property as they expand to fit the doorway using an internal system of levers tightened by a spanner. Panels are just over 600mm high and come in three standard widths:</p>

	<p>by vertical posts in preinstalled sockets (e.g. <i>"Floodskirt"</i>). This system is usually also attached to the building if the wall is strong enough. With <i>"Floodskirt"</i>, aluminium posts and box sections are available to be used behind the skirt to support it where the walls are not strong enough, for example conservatories.</p> <ul style="list-style-type: none"> <li>• Rigid demountable or sliding panels attached to posts, or guide rails. (e.g. <i>"Ferndon Flood Gate"</i>) Some attached systems can be used in this way also.</li> <li>• Hollow panels stored in deep trenches, the panels float up automatically when the trenches fill with water (e.g. <i>"Self closing wall"</i>)</li> <li>• Flexible tubes filled with sand or water, which stay in place with gravity and friction. (e.g. <i>"Aquadam<sup>TM</sup>"</i>)</li> <li>• The <i>"Floodwater Bags"</i> system is widely used in the USA and has recently become available in the UK. It consists of plastic bags, slightly larger than sandbags, with corner eyelets so they can be tied together. The bags are filled with water and a biodegradable polyacrylate polymer gel, as used in babies' nappies/diapers, makes the bag "stiffer" and able to resist flooding better. After the flood, it is claimed that the gel can safely be disposed of onto farmland or watercourses. Unlike sandbags, <i>"Floodwater Bags"</i> are reusable.</li> </ul>	<ul style="list-style-type: none"> <li>• 735mm to 980mm</li> <li>• 955mm to 1185mm</li> <li>• 1175mm to 1405mm</li> </ul> <p>Made to measure sizes can be provided. The panels can be stacked vertically up to 1840mm but few walls would be able to take the pressures of such a deep flood depth differential. <i>"Floodgates"</i> are only designed for doors or windows that are set back from the outside wall and are not suitable for airbricks. Both types can also be joined together horizontally using stanchions attached to preinstalled fixtures in the ground to become a self-supporting defence. Another important attached demountable system is <i>"Floodskirt"</i>. (This can also be a self-supporting system and has been described under the self-supporting section.)</p>
Deployment	<p>Usually requires at least two fit people to deploy. Deployment can take up to four hours and can be difficult in dark, wet, or windy conditions. (Some systems float up automatically but require regular maintenance to prevent silt blocking water flow holes.)</p>	<p>Lightweight panels allow rapid deployment by a single person with little or no training. <i>"Floodgates"</i> may require special mastic for rough walls to reduce leakage. Quicker, cleaner, and more effective than placing sandbags,</p>

	<p>"Floodskirt" is lightweight and it is claimed that rapid deployment by one person is possible.</p>	and no disposal problems.
Suitability	<p>Not dependent on the strength of the walls of the property, so especially suitable for</p> <ul style="list-style-type: none"> <li>• deep or fast moving waters, for example riverbanks.</li> <li>• outbuildings, conservatories, temporary buildings, caravans, above ground oil tanks, electrical sub stations, etc.</li> </ul> <p>Can be used in parallel to create temporary river channels to divert water flows to a safer area. Some can also be used as coffer dams in river beds to allow watercourse maintenance work (e.g. <i>"Pallet Barrier Flood Control System"</i> or <i>"Rapidam"</i>).</p>	<p>Not usually suitable for floods deeper than 1m above floor level as the building structure may not take the differential water pressure.</p> <p>Not suitable for walls with vulnerable cladding or coatings. Risk of foundation damage in long duration or high velocity floods on sandy soil.</p> <p>Not usually suitable for outbuildings owing to lack of structural strength of outbuilding walls.</p> <p>Demountable products, which use permanently attached frames, may not be acceptable on listed buildings.</p>
Semi detached or terraced properties.	<p>Only effective if the entire building is protected, or if the system can be attached to a wall at each end (e.g. <i>"Pallet Barrier Flood Control System"</i>, or <i>"Floodskirt"</i>). On sloping ground, may only be needed for the lower part of the perimeter. Can be difficult to use across gardens that are separated by walls or fences, or on very uneven ground. (The makers of the <i>"Pallet Barrier Flood Control System"</i> claim their system can be used on uneven ground.)</p>	<p>Can be used for a single property for short duration floods. If adjoining properties are flooded, it will take half an hour or so for floodwater to come through a properly constructed party wall, but at least it will have been "filtered" to some extent by the wall and will be relatively clean. The <i>"Floodskirt"</i> suppliers say they can tank party walls internally.</p>
Durability	<p>Fabric/plastic sheet types are vulnerable to damage from floating debris, although the <i>"Pallet Barrier Flood Control System"</i> uses solid wood, aluminium or steel panels behind the waterproof fabric, so repairs during a flood should be easy.</p>	<p>Should withstand impacts from floating debris, subject to the strength of the walls of the property.</p>
Effectiveness	<p>Should be effective for long duration and deeper floods. It is claimed that <i>"Floodskirt"</i> protected a property in Yalding against a 1 metre deep flood for more than 30 hours. An independent report by HR Wallingford also shows it to be effective. Some leakage can be expected, but pumps should be able</p>	<p>Effective only for short duration shallow floods. On the BSI test rig at HR Wallingford, water penetrated through the surrounding brickwork within only 30 minutes. The brickwork had to be sealed with a fibreglass membrane so they could test leakage around the panels. (On</p>

	<p>to cope. (Pumps should be powered by a generator or high performance batteries in case of power cuts). Pumps can be located outside the property (but behind the barrier) to prevent water reaching the house. The most likely source of leakage will be through the floors or backup through the sewage system, and precautions should be taken to prevent this if long duration floods are expected.</p> <p>Overtopping or debris impact damage could lead to complete failure of some systems with disastrous consequences for the property. (The makers of the "<i>Pallet Barrier Flood Control System</i>" claim that their system does not become unstable if overtopped, and that because there is a rigid board behind the fabric cover, it is less likely to be breached by debris impact.)</p>	<p>the BSI tests, some leakage was considered acceptable.)</p> <p>It is not known how long it would take for the water to come up through the floor, as this has not been tested, but half an hour is probably likely unless the foundations are properly tanked, so a sump pump is likely to be necessary.</p> <p>A good quality chemical waterproofing solution or bitumen coating can slow the leakage through the brickwork, but may not be completely effective, and may slow down the drying out process.</p> <p>"<i>Floodgates</i>" systems may need some pre installation work where the wall surfaces are not smooth enough in order to reduce leaks.</p> <p>For long duration floods, internal sump pumps may be required and internal finishes, carpets, etc will be damaged. However water that does penetrate will have been filtered by the wall and therefore cleaner and easier to deal with.</p>
Security (e.g. if the property is evacuated.)	Vulnerable to malicious damage or theft of pumps if property is evacuated. " <i>Floodskirt</i> " claim their pumps are built in to the system and are not vulnerable to theft.	Door panels are usually secured from inside the property and cannot be removed if the door is locked. " <i>Flood Guards</i> " can do an external lock on the panel for the final exit door.
Appearance when not deployed.	Some systems involve the construction of a trench round the property to contain pre-installed components. " <i>Floodskirt</i> " has all its components in the trench, including the fabric. The trench is covered with lids when not in use, designed to match surrounding paving.	Frames are permanently attached round doors, windows, and airbricks. " <i>Flood Guards</i> " produce these frames in different colours to suit the property, but this may not satisfy conservation officials.
Clean up and removal	Careful cleaning and drying of some systems is needed before removal and storage to prevent deterioration.	Hosing down and removal is quick and easy. Can be stored while still wet.

	Removal can take some hours. “ <i>Floodskirt</i> ” does not need to be dried before storage. It should be noted that traditional sandbags pose a health hazard after a flood as they are likely to be contaminated, especially by sewage, and they should be collected and disposed of properly. (It is claimed that “ <i>Floodwater Bags</i> ” can be cleaned and reused)	
Storage when not in use.	Some systems can be partly stored in trenches in the garden ready for deployment (e.g. “ <i>Floodskirt</i> ”). Others are designed to be flat packed (e.g. the “ <i>Pallet Barrier Flood Control System</i> ”.) Most require a considerable storage area. Fabric/plastic systems should be stored in a dry place out of the sun.	Can be stored in a coal bunker sized structure or small shed. Can be stored outside under a tarpaulin to prevent panels from blowing away in a strong wind.
Typical Cost	£15,000 for a substantial detached house. “ <i>Floodskirt</i> ” costs around £650 per metre run, including all enabling works.	£300 per door up to £2,000 per house

## 2. Self standing systems

While expensive, these systems can be very effective for detached properties where deep, high velocity, or long duration flooding is expected. Combined with pumps and generators, the water can be kept well away from the property, so reducing the risk of foundation damage, water penetration, or structural failure of the walls.

The main problems with self-standing systems are:

1. Bulky and heavy, usually requiring at least two fit people and over an hour for deployment and longer for removal. Deployment can be difficult in the dark, or in adverse weather, especially windy conditions. This may inhibit people from deploying the system until it is too late.
2. Space required around the property, so the barrier can be located far enough away from the walls to allow pumps to be used. If the barrier is close to the property, preparatory work will be needed to protect the foundations, and prevent water coming up through the floor.
3. Not usually suitable for semi detached or terraced properties unless shared by all the residents.
4. Failure or overtopping could be disastrous, with a sudden rush of water hitting the property.
5. Large storage space needed for some systems while not in use.

6. It may be difficult to access the property while the system is deployed. A high stepladder may be needed. (With the “*Rapidam*” self-supporting system “*Flood Guards*” products can be linked to provide an easy entry/exit point.)

Even if a self standing solution is used, it makes sense to also fit an attached system not only as a backup, but to provide immediate protection while the self standing system is being deployed.

### 3. Attached systems

These are much cheaper systems, costing as little as £300 per door, which should be adequate for short duration, shallow floods. Attached systems are quick to deploy by a single person with little or no training. Panels are lightweight and may be able to be carried by a child depending on the size and type. “*Floodgates*” do not require any preparatory work, but others will require permanent frames to be fitted to the property. The use of well-sealed, permanent frames should reduce leakage around the panels.

“*Flood Guards*” and “*Floodskirt*” can provide an alarm, which can detect rising water in good time for deployment and automatically telephone up to four numbers until the call is answered to give a message that deployment is necessary. If the occupiers are on holiday, there is no reason why they cannot deploy the system before they go, as the door panels for “*Floodgates*” and “*Flood Guards*” cannot be removed without opening the door.

The systems are based on the traditional concept of flood boards, which are simple floorboards or planks fastened over door and wall openings before a flood, and covered with some waterproofing material. Indeed there is still much to be said for the traditional methods (they are certainly cheaper). The English Environment Agency in conjunction with CIRIA have published useful information on how to make flood boards, and also other DIY tips for limiting flood damage, such as “wrapping” a property in plastic sheeting or laying sandbags<sup>8</sup>.

The main problems with attached systems are:

1. Water seepage through floors if the property is built on porous soil and the water table is high. It should be noted that rising groundwater is excluded from insurance policies in the UK.
2. Water seepage through walls, especially on brick cavity walls. In some cases brickwork will need repointing and cracks repaired. A good quality chemical waterproofing solution or even a fibreglass coating may help to reduce water penetration if applied to the outside masonry or brickwork, but this may not be acceptable on listed buildings. (On the other hand, for many older houses in flood hazard areas it is traditional to have black bitumen applied to the lower walls.) Traditional solid stone walls with lime mortar are much more resistant to flood water penetration and are stronger. Foundations may be at risk of scour if the soil

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<sup>8</sup> EA/CIRIA. 2001 (December). “*Damage Limitation: How to Make Your Home Flood Resistant*”. EA (Environment Agency) and CIRIA (Construction Industry Research and Information Association). Booklet 1201/BGIU. Available from Floodline or from [http://www.environment-agency.gov.uk/commondata/105385/damage\\_limitation\\_final\\_artwork](http://www.environment-agency.gov.uk/commondata/105385/damage_limitation_final_artwork). (note the final full stop is needed to access the document.) For some reason, access to the official final version is password protected.

is porous and in some cases it may be necessary to excavate around the foundations to strengthen and waterproof them.

3. They are dependent on the structural strength of the walls. Cavity wall or timber framed construction does not have sufficient strength to withstand high velocity or deep water floods unless the water is allowed in to equalise the pressure. This means that the height of the panels should usually be limited to 1m above floor level for such walls so as to allow overtopping if the flood becomes deep in order to prevent structural damage from the flood depth differential.
4. Not suitable for all properties. With most systems the panels are attached to a frame, which is permanently fixed to the walls, to ensure a waterproof seal. For some types of property there may be problems to be overcome if the property is a listed heritage building or if there is not enough room for the frame. For example a doorway in an inside corner of the building, or an airbrick which is in an inaccessible place. The "*Floodgates*" product however, does not require a frame as it expands within the doorway. They claim it will fit doorways in 99% of properties, and that it is now used on 150 listed buildings in the UK.
5. There is no suitable product for protecting heating flue openings such as a balanced flue, and even if there were, such a product could make the heating system dangerous to use. Balanced flues and external meter cupboards etc should be relocated above the likely flood level.
6. For a wide floor to ceiling window, such as patio doors, or French windows, a stanchion may be required to support the panel midway. "*Floodgates*" and "*Flood Guards*" can provide stanchions to enable panels to be connected. "*Flood Guards*" claim that their products can protect openings up to 2745mm wide with no additional supporting structure.
7. Some residents may be reluctant to have frames permanently attached to their property as it may indicate to visitors or prospective purchasers that there is a flood problem. ("*Floodgates*" do not require permanent fittings to the property.)

It is sensible to have a specialist survey undertaken by the suppliers to ensure that the system will be effective and will not result in structural damage from the water pressure. It should, however, be remembered that even if the flood is deep and the panels overtop, this type of system would give protection for some time, and significantly reduce the amount of water entering the property.

#### **4. Sewage Backup**

Both types of systems are vulnerable to this. For properties with combined drainage and sewerage systems, water can enter surface water drainage systems and may result in backup through downstairs washing machines, toilets, showers, and baths. Non return valves can be supplied but fitting may be expensive. A cheap solution for toilets is to use an inflatable plug (e.g. a rubber football bladder) to temporarily block the toilet.

#### **5. British Standards Institute "Kitemark" Scheme**

This scheme was launched in March 2003, and includes testing in a water tank at HR Wallingford.

As at October 2003, six product tests have been carried out (including one retest), but only three have passed. Wallingford only test to a depth of 1 metre. The tests include a "wave bay" to simulate the wash from passing vehicles. They also simulate lateral currents across the front of the building.

For door panels, 1 litre of water per metre of panel per hour leakage is accepted.  
For self-supporting barriers, 30 litres of water per metre per hour is allowed.  
4 more products are due to be tested soon, all barrier products.

For an up to date list of products that have been awarded a BSI Kitemark, see <http://www.environment-agency.gov.uk/subjects/flood/351186/351222/483612/484707/?version=1&lang=e>

At the time of writing the only three companies that have been awarded the BSI Kitemark are shown below. However there are many other systems available that have not yet been tested, and there is no reason to suppose that they are any less effective.

#### Self supporting

##### **"Pallet Barrier Flood Control System"**

This is a self supporting metal frame on which you place standard Euro pallets (available from a haulage contractor), waterproof marine plywood boards, or aluminium panels, then cover them with plastic sheeting.

#### Attached systems

##### **"Floodgates"**

These are panels designed to fit inside a doorway. Once in position they can be expanded using a spanner to form a tight fit. Alternatively they can be joined together using stanchions to become a self-supporting wall. Because they do not use pre installed frames, some leakage can be expected, and mastic may be needed.

##### **"Flood Guards"**

These are custom-made heavy-duty plastic demountable panels, which clip into frames permanently attached to the building, in order to avoid leakage.

Note, according to the Environment Agency web site, "Floodgates" only has approval for door barriers, while "Flood Guards" has approval for doors, windows, patio doors, and airbricks.

"Flood Guards" do not normally supply door barriers higher than 900mm in order to avoid structural failure of walls due to flood depth differentials. They will only supply higher barriers if a structural survey shows the building is strong enough.

"Flood Guards" products can also be linked to the "Rapidam" self-supporting system to provide an easy entry/exit point where "Rapidam" is deployed.

Individual "Floodgates" are just over 600mm high and the makers claim they can be stacked to a total height of 1840mm.

#### Comments

The BSI is a minimum standard, and does allow for a certain amount of leakage, so there is no guarantee that kitemarked products will provide absolute protection. For example, carpets and floors could still be damaged. While the author has seen a convincing demonstration of the "Flood Guards" product, which did not allow any water to leak past it, there is still scope for damage from any attached product due to damage to foundations. Water can also come in through walls, floors, or drains.

The best protection can only come from a comprehensive self-supporting system that is backed up by pumps, plus pre installation tanking of foundations to prevent damage to foundations or floors from rising groundwater (e.g. "Floodskirt"). Such systems are relatively expensive and as yet there are no BSI tests for such a comprehensive level of protection. A new BSI (PAS 3) for flood skirts will be available in January 2004, but as with the other BSI tests, it will still not test for rising groundwater.

### Summary

A BSI Kitemark is no guarantee of the effectiveness of a system, as many cases of flooding are due to hydrostatic pressure below the foundations of the building, leading to flood water bursting through the floor.

## **6. Hydrostatic Pressure**

Where an effective temporary defence is used, it will create a flood depth differential, which will result in hydrostatic pressure from the external floodwater. For both attached and self supporting systems this can cause water to rise up through the ground under the floors – in extreme cases this can lift floorboards, or cause concrete floors to crack and drainage sumps to be lifted up. In Yalding in January 2003, a sump pump was "blasted" out of the floor by the water pressure.

The "Neptune" system, which includes "floodskirt", incorporates a pressure relief valve with the sump pump to prevent such damage. A field test of "floodskirt" under 600mm deep flood conditions for an actual house was conducted for HR Wallingford in October 2001. The experts from HR Wallingford subsequently produced a report, which found that "Flooding of the courtyard in front of the building was maintained over a period of several hours with no apparent effect within the property".

## **7. Structural failure of walls**

With attached systems, water pressure can be exerted directly against the walls of the building, and can cause them to fail.

Dr Ilan Kelman of the Cambridge University Centre for Risk in the Built Environment (CURBE) has carried out considerable research into this problem with funding from Halifax General Insurance Services Ltd. A summary of the research and the results is available on the internet<sup>9</sup>.

Kelman concludes from his calculations that while more research is needed, a typical cavity wall could suffer severe structural damage if there is a flood depth differential of more than between 1 metre and 1.5 metres depth of water on one side<sup>10</sup>. Kelman refers favourably to the Environment Agency's "Damage Limitation" guide<sup>11</sup>, which suggests not sealing a property for flood depths greater than 1 m. This allows a sensible safety margin.

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<sup>9</sup> Kelman, I (2002) "*Physical Flood Vulnerability of Residential Properties in Coastal, Eastern England.*" PhD dissertation for the University of Cambridge. An extended summary is available online at <http://www.arct.cam.ac.uk/curbe/ilanphd.html#ilanphddownload>

<sup>10</sup> Kelman, Ilan and Robin Spence. 2003. "*A Limit Analysis of Unreinforced Masonry Failing Under Flood Water Pressures*". Masonry International, vol.16, no. 2 (Summer/May), pp. 51-61.

<sup>11</sup> EA/CIRIA. 2001 (December). "*Damage Limitation: How to Make Your Home Flood Resistant*". EA (Environment Agency) and CIRIA (Construction Industry Research and Information Association). Booklet 1201/BGIU. Available from Floodline (0845 988 1188) or from [http://www.environment-agency.gov.uk/commondata/105385/damage\\_limitation\\_final\\_artwork](http://www.environment-agency.gov.uk/commondata/105385/damage_limitation_final_artwork). (note the final full stop is needed to access the document.)

It should be borne in mind, however, that for single leaf brick, cavity wall, or timber framed construction any flood depth differential could result in the possibility of structural damage. (There are now around 12m homes in the UK with cavity wall construction.) Older properties with solid wall construction should be much more resistant to failure, especially stone solid walls with lime mortar, which has more flexibility.

(At the time of writing, Ilan Kelman and Robin Spence are about to publish a new paper on the possible failure of various building components from flood depth differential.<sup>12</sup>)

This research should be borne in mind when considering attached systems higher than 1m above floor level unless the building is of solid stone wall construction. A brick cavity wall may survive a standing water flood depth differential of up to 1.5m, but there are other factors to take into account, such as additional pressure from the velocity of the water, wave action, the wash from heavy vehicles or boats, or impact from floating debris. A safety margin is therefore advisable. While a 600mm, or even a 900mm barrier may be overtopped, this is only likely to happen for a short time unless the flooding is exceptional.

#### **8. Conservatories, garden sheds, garages, oil tanks etc.**

Attached systems are not suitable for protecting structures built with single leaf brick, or timber that cannot support the water pressure from a flood depth differential. In any case the water would soak through the surrounding walls too quickly. Above ground oil or gas storage tanks are very vulnerable to flood, as they can float off their mountings, resulting in leakage which can be dangerous and polluting.

If there is a need to protect any such structures, self-supporting systems should be used.

#### **9. Supply and/or deployment by local council or Water Company**

Councils, water companies, and the Environment Agency have started to buy temporary defences to protect people at high risk of flooding. This to be commended, especially for those who are vulnerable, such as the elderly, the disabled, single parent families, people with serious medical conditions, etc.

In Scotland, on 1<sup>st</sup> October 2003, the Minister for the Environment announced that it was Scottish Executive policy to encourage local authorities to provide temporary protection products for residents and businesses in their areas. Already, Scottish Water and Severn Trent Water have major programmes for fitting temporary protection systems and one way drain valves to properties at risk from sewage flooding.

Insurers, local authorities, landlords, water companies etc could make temporary systems available in various ways, for example:

- (a) Provide and deploy them in the event of a severe flood warning, removing and storing the product for re-use thereafter. This would be ideal in an area where a permanent flood defence is to be constructed in the next year or two. After that, the systems could be used elsewhere or sold to recover some residual value. (Because some

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<sup>12</sup> Kelman, Ilan and Robin Spence. 2003. "A Flood Failure Flowchart for Buildings". Proceedings of the Institution of Civil Engineers-Municipal Engineer (in press).

- systems are tailored to the specific property this may cause problems with mass deployment and subsequent resale.)
- (b) Provide them in advance to property owners and allow the owner to fit the product, with assistance for those residents who require help, before and after the flood event;
  - (c) Purchase the product in bulk (for which a discount could be negotiated on the individual retail price) and sell or hire them either at cost or at a subsidised price. (The possibility of a local authority selling on flood prevention products to residents in the area may have legal problems, but some authorities already sell environmental products such as composters, energy saving light bulbs, etc.)

Whichever approach is used, the products could carry the relevant logo of the company or authority promoting the scheme, to give publicity value and generate goodwill.

Local authorities should give priority to residents who are vulnerable, and residents in the most hazardous areas. By setting up such a scheme, the authority would be:

- demonstrating a proactive approach to assisting potential flood victims in protecting their property,
- safeguarding the property of the more vulnerable residents in the area, thus reducing risk to life, and reducing subsequent social work and healthcare costs,
- helping to reduce the demand on the authority's resources during flooding events, particularly the supply and disposal of sandbags.

There will be additional costs for sealing other apertures that could allow water into properties and for repairs to the structural fabric of the building (e.g. open jointed brickwork, settlement cracks, etc). This would require individual property inspections and since any necessary works would be general property maintenance the owner should be asked to undertake or meet the costs of any works required.

The promoter of such schemes would be wise to enter into agreements with affected householders to ensure that, in the unlikely event of the protection system failing, or structural damage to the property due to flood depth differentials, they would not be held liable for damages claims.

## **10. Loans**

In general, building societies will look favourably on requests for loans to make their properties more resilient to flood damage, according to the Council of Mortgage Lenders.

A major building society plans to announce preferential loans for customers wishing to purchase a particular system.

## **11. Permanent Protection**

As an alternative to temporary protection, it may be cheaper to install a perimeter flood wall, with temporary barriers at gates and driveways. Such a wall will need deep foundations and will need to be strong to withstand the flood depth differential. If made of brick, engineering bricks should be used, and they should be laid three courses thick. Alternatively a double wall should be built with the gap filled with hardcore or cement. Specialist advice will be needed on the exact specification.

It should be noted that if the property is located in a floodplain in England or Wales, permission may be needed from the Environment Agency, as such perimeter protection reduces the size of the floodplain storage. In Scotland, permission may be needed from the relevant local authority. If a private flood defence is constructed, other property owners may come to rely on it and this could create liability issues if the defence fails. In Scotland, if a property owner decides to demolish such a private defence, the local authority may be legally obliged to reinstate it. Pumps will still be needed to cope with rising groundwater from hydrostatic pressure, as well as surface water drainage from the site itself. One way valves will also be needed on sewage and drainage systems.

Another alternative, which should certainly be considered during reinstatement after a flood, is to raise the level of the ground floor, if the ceiling height is adequate, or if possible, to rearrange the accommodation to move valuable or vulnerable contents and fittings to a higher floor. Humidity and capillary action even to property above the flood level can still cause damage, however.

## **12. Selecting a system**

The purchaser should be satisfied that the system is of good quality, and that the supplier will not try a “hard sell” in circumstances where the system is not suitable. The BSI Kitemark is a good indicator of quality, and ensures that any product literature for approved products does not make false or misleading claims. Temporary flood protection systems are starting to come onto the market for homeowners to fit themselves, but there are dangers if the systems are not fitted properly and property owners need to be aware of the risks of structural damage from any attached systems if the property is not suitable. Ideally, a survey should be undertaken by a specialist surveyor<sup>13</sup> who can advise on the best options available.

As with most things in life, the more one spends the better the protection. However according to the British National Flood Insurance Claims Database<sup>14</sup> the average insurance claim for flooded contents is now around £15,000, which makes these systems look relatively cheap. It should also be remembered that many insurers are now applying large flood excesses, often as much as £5,000 or even more in flood hazard areas. Insurers should at the very least consider whether they should waive the excess where the householder has deployed a temporary flood defence, as this demonstrates that the householder has taken reasonable precautions to reduce losses.

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<sup>13</sup> For example, Woodward Associates, Surrey, telephone 01883 714888. While this company has links with Floodskirt Ltd, they will advise on other systems. The RICS can also advise on qualified surveyors.

<sup>14</sup> Black, A and Evans, S (1999) *"Flood damage in the UK: New insights for the insurance industry."* University of Dundee. ISBN 0 903674 37 8. Dundee, Scotland.

## Appendix

### List of some of the products mentioned

The selection of products for this list does not imply endorsement from the author. The list does not claim to show all products, only examples of their type.

For a more extensive list of temporary protection products available in the UK, see <http://www.floodforum.org.uk/>

or

<http://www.sepa.org.uk/flooding/protection/index.htm>

(The Environment Agency web site now only lists products which have the BSI Kitemark)

System	Supplier	Description and benefits
Dutchdam	Dutchdam BV B. Hosangweg 84 NL 2481 LA Woubrugge The Netherlands Tel. 0031 172 51 8088 Fax 0031 172 51 8087 Website: <a href="http://www.dutchdam.nl">www.dutchdam.nl</a>	Aluminium panels attached to ground fixings. Rubber seals between each panel and between the panels and the ground mean that a plastic sheet is not required and the system is more resilient to impact damage or instability caused by high velocity flows of water. <i>Can be used for deep-water floods and because it is demountable, and does not need fabric sheeting, the suppliers claim that deployment is quicker than for other panel systems.</i>
Floodgate (Note: there are a number of products which use similar names.)	Floodgate Limited, 49/51 Lammas Street, Carmarthen, Wales. SA31 3AL. Tel. 01267 234205 Fax. 01267 232752 website: <a href="http://www.floodgate.ltd.uk/">http://www.floodgate.ltd.uk/</a>	These are panels designed to fit inside a doorway. Once in position they can be expanded using a spanner to form a tight fit. Alternatively they can be joined together using stanchions to become a self-supporting wall. Because they do not use pre installed frames, some leakage can be expected, and mastic may be needed. <i>Relatively cheap and can be adjusted to fit. Ideal for councils and utilities to defend properties at risk of short term flooding especially by contaminated water.</i>
Floodguards	Floodguards International Ltd., Brunningshams Farm, Heath Ride, Wokingham, RG40 3QJ Tel. 0800 085 0846 Fax: 0118 9733596 website: <a href="http://www.floodguards.com/">http://www.floodguards.com/</a>	These are custom-made rigid plastic demountable panels, for doors, windows and airbricks. They clip into frames permanently attached to the building, in order to avoid leakage. <i>Quick and easy to deploy, and even if water seeps through brickwork, they will keep out contaminants, so reducing damage. Good for wave action in seafront properties.</i>
Floodskirt (part of the Neptune flood defence system)	Floodskirt Ltd 67A Station Road East Oxted, Surrey RH8 0AX Tel. 01883 714888 Fax: 01883 715929 Website: <a href="http://www.floodskirt.com">http://www.floodskirt.com</a>	A comprehensive system involving a skirt barrier attached to the walls or self supporting, and also tanking of foundations and party walls, one way valves on drains, integral pumps, etc to provide effective protection for long duration floods. <i>The most comprehensive system available, but expensive. Ideal for long duration "ponding" type floods up to 1 metre depth.</i>
Floodwater Bags	UK Distributor: Facilitas Environmental Limited Tel. 0207 404 3447 Email: <a href="mailto:peter.lunning@facilitas-enviro.co.uk">peter.lunning@facilitas-enviro.co.uk</a> <a href="mailto:dan.brennan@facilitas-enviro.co.uk">dan.brennan@facilitas-enviro.co.uk</a>	Floodwater Bags are a third larger than sandbags, and made of strong, non-porous plastic material with grommet holes in each corner to give the bags additional dike strength when cable tied together They have a removable filling nozzle with a screw cap, into which a pouch of super absorbent polymer is poured. (This is the same polymer that is used in disposable nappies, it is non-toxic and biodegradable.) The polymer swells 300 fold into a heavy gel by adding water to give

	<p>Manufacturer Floodwater Bags 13795 Seven Hills Road Traverse City, MI 49686 USA Phone: 00231.223.8730 Fax: 00231.223.8732 Website: <a href="http://watersorb.com/floodwater_bags/indexold.htm">http://watersorb.com/floodwater_bags/indexold.htm</a></p>	<p>the Floodwater Bag stability. The polymer gel replaces the use of sand in the traditional sandbag. After the flood recedes, the nozzle is re-opened and the gel is poured, or squeezed like toothpaste from a tube, from the Floodwater Bag. If left on the ground it will dissipate in a matter of days or as an additional benefit the polymer gel can be ploughed into the ground where it will retain moisture for plant growth. A special chemical compound has been developed to break the backbone of the polymer, so that it can be poured into sanitary sewers for disposal at sewerage treatment plants. <i>Good replacement for sandbags.</i></p>
Neptune	See "Floodskirt"	
Pallet Barrier Flood Control System	<p>Geodesign Barriers Ltd, 3 Fore Street, Topsham, Exeter, Devon. EX3 0HF Tel. 01392 876100 Fax 01392 874407 website <a href="http://www.palletbarrier.com/">http://www.palletbarrier.com/</a></p>	<p>This is a self supporting metal frame on which you place standard Euro pallets (available from a haulage contractor), waterproof marine plywood boards, or aluminium panels, then cover them with plastic sheeting. <i>Ideal for riverside properties or other areas where high velocity could be a problem. Can also be used as coffer dams during riverbank maintenance, or for creating a temporary river diversion away from properties.</i></p>
Rapidam	<p>Hydroscience Ltd c/o 66 Paxton Road Fareham Hants PO14 1AD Tel. 01329 832687 website: <a href="http://www.hydroscience.co.uk">http://www.hydroscience.co.uk</a></p>	<p>A self supported freestanding or demountable defence designed for rapid deployment in emergency situations. Winner of two prizes from the BBC television series "Tomorrow's World". Can be used in conjunction with Floodguards. <i>Good for emergency protection.</i></p>

### Further reading:

#### Environment Agency and CIRIA Booklets

The following are all available free of charge by calling Floodline (0845 988 1188)

- Caravans and Flood Risk; Advice for caravan and camping park owners.
- Damage Limitation; How to make your home flood resistant.
- After a Flood; How to restore your home.
- Living on the Edge; An updated guide to the rights and responsibilities of a riverside owner. (NB English law only)
- Flood Products: Using Flood Protection Products – A guide for homeowners.

#### CIRIA Advice Sheets

For builders and DIY – available from CIRIA see [www.ciria.org/flooding](http://www.ciria.org/flooding)

1. Identifying flood risk
2. How does floodwater enter a house – above ground?
3. How does floodwater enter a house – below ground?
4. Flood resilient walls
5. Flood resilient windows and doors
6. Flood resilient floors
7. Flood resilient services
8. Flood resilient sewers and drains